Program at a Glance

T ..... Tutorial S ..... Symposium W ..... Workshop CLEO-PR Joint OECC / PS

Sun 30 Jun

Time \ Room	Room C-1	Room B-2	Room F	Room G	Room H	Room I	Room J	Room K	Room 101	Room 103	Room 104A	Room 104B	Annex
12:30-15:00		W SWA1 Photon Frontier Network	S SA1 Laser Display I - Laser Technology	W SWB1 Optical Interconnects I: State-of-the-art Optical Interconnects: Moving from the Rack to The Chip		W SWC1 Future Perspective of Photonic Transport Network I Beyond 100G Technologies and Standardization	W SWD1 Software Defined + Elastic Optical Networks =?						Exhibition (set-up)
15:00-15:30		Coffee Break						Coffee Break					
15:30-18:00		W SWA1 Photon Frontier Network	S SA2 Laser Display II - Display Optics and Speckle	W SWB2 Optical Interconnects II: Challenges and Opportunities for Ultra-dense Inter-chip and On-chip Interconnects		W SWC2 Future Perspective of Photonic Transport Network II Space Division Multiplexing for Petabit / Fiber Transmission	W SWD1 Software Defined + Elastic Optical Networks =?	W SWE2 What will be Killer Devices and Components for the Next-Generation Optical Access Networks?					
18:00	Get Together Party						Get Together Party						

Mon 1 Jul

Time \ Room	Room C-1	Room C-2	Room F	Room G	Room H	Room I	Room J	Room K	Room 101	Room 103	Room 104A	Room 104B	Annex
Main Hall 8:30-12:30	8:30-8:50 Opening Remarks 8:50-9:30 Plenary Higgs boson : dawn of physics to explore the vacuum" Shoji Asai (The Univ. of Tokyo, Japan) 9:30-10:10 Plenary Space-division multiplexing – do we have a choice?" Mark D. Feuer (AT&T Labs - Research, USA) 10:30-11:10 Plenary Toward the smallest possible laser & resonator" Yong-Hee Lee(KAIST, Korea) 11:10-11:50 Plenary Coherent optical communications: past, present and future" Kazuro Kikuchi (The Univ. of Tokyo, Japan) 11:50-12:30 Plenary Photonics beyond diffraction limit:Plasmon waveguide, cavities and integrated laser circuits" Xiang Zhang (Univ. of California, USA)												
12:30-14:00	Lunch						Lunch						
14:00-16:00	MR1 Modulation Format	S MH1 New Frequency, Novel LDs and LEDs -Innovative Works on Widegap Semiconductors- I	MA1 Single-Frequency and Stabilized Lasers	MG1 Light-Matter Interaction	MI1 Photonic Crystal Devices	MP1 Cost-effective Devices for Access Networks	MS1 Multi Core Fiber Technology	MO1 Optical Signal Processing I	MD1 High Power Lasers and Applications I	MK1 High Speed Transmitter	MC1 Terahertz Hight Power Sources	MM1 Si Photonics: Photonic Integration and Coupling Structures	Exhibition (set-up)
16:00-16:30	Coffee Break						Coffee Break						
16:30-18:30	MR2 Space Division Multiplexing	S MH2 New Frequency, Novel LDs and LEDs -Innovative Works on Widegap Semiconductors- II	MA2 Structured Light Sources	MG2 Quantum Memory	MI2 Nanocavity QED	MQ2 Highly Efficient Optical Networks	MS2 Brillouin Measurement and Sensors	T MB2 Attosecond Physics I	MT2 Optical and Optoelectronic Signal Processing	MK2 Tunable Device	MC2 Terahertz Science I	MM2 Si Photonics: Novel Materials	

Tue 2 Jul

Time \ Room	Room C-1	Room C-2	Room F	Room G	Room H	Room I	Room J	Room K	Room 101	Room 103	Room 104A	Room 104B	Annex
8:30-10:00	TuR1 Long Haul Transmission	S TuN1 High-density Photonic Integration Platforms and Their Applications (III-V)	TuA1 High Power Fiber Lasers	TuE1 Femtosecond Laser Processing I	TuF1 Ultrafast Metrology	TuP1 New Applications of Optical Access Technologies	TuS1 Multi Core Fiber Amplifiers	TuO1 Optical Signal Processing II	S TuD1 High Power Lasers and Applications II	TuG1 Atom Optics	TuC1 NIR and MIR Techniques	TuJ1 Biophotonic Devices	
10:00-10:30	Coffee Break						Coffee Break						
10:30-12:00	TuR2 Optical Monitoring	S TuN2 High-density Photonic Integration Platforms and Their Applications (Silicon)	T TuA2 Frontier of Fiber Lasers	T TuE2 Femtosecond Laser Processing II	TuF2 Novel Comb Application	T TuP2 New Paradigm for Optical Access	TuS2 Parametric Processes	TuT2 Elastic and Software Defined Network	S TuD2 High Power Lasers and Applications III	TuG2 Quantum Optics	TuC2 Terahertz Imaging and Sensing	TuJ2 Bionanophotonics	
12:00-13:00	Lunch						Lunch						
13:00-14:30	Poster						Poster						
14:30-16:00	T TuR3 Digital Signal Processing	S TuN3 High-density Photonic Integration Platforms and Their Applications (Silica and Hybrid integration)	S TuA3 Novel Fiber Designs for Lasers I	TuB3 Strong Field Physics	TuF3 Precision Spectroscopy	TuQ3 Control Plane and Related Technologies	TuO3 Optical Storage	TuT3 Optical Packet Switching	S TuD3 High Power Lasers and Applications IV	TuI3 Solar Cells by Nanophotonics	TuE3 Nanoparticles and Nanostrucures	TuJ3 Bioimaging I	Exhibition
16:00-16:30	Coffee Break						Coffee Break						
16:30-18:30	TuR4 OFDM	S TuN4 High-density Photonic Integration Platforms and Their Applications (Application)	S TuA4 Novel Fiber Designs for Lasers II	TuB4 Attosecond Physics II	TuF4 Imaging and Metrology	TuQ4 Next Generation Optical Networks	TuS4 Few Mode Fiber Technology	TuT4 Integrated Devices for Optical Switching	S TuD4 High Power Lasers and Applications V	TuI4 Novel Phenomena in Nanphotonics			

Wed 3 Jul

Time \ Room	Room C-1	Room C-2	Room F	Room G	Room H	Room I	Room J	Room K	Room 101	Room 103	Room 104A	Room 104B	Annex
8:30-10:00	T WQ1 Photonic Networking Technologies	WI1 Diamond Nano-photonics and Novel Resonators	WA1 Femtosecond Fiber Lasers and Broadband Sources	S WE1 Biochip Fabrication by Femtosecond Laser I	T WF1 New Trends in Frequency Comb: Application of Light with Ultraprecision I	WP1 Novel WDM-PON	S WS1 Fiberoptic Technologies for the Next Era I (New Fiber Amplifiers)	WO1 Display		WG1 Quantum Computation	WK1 Quantum Dot Device	WM1 Si Photonics: Modulators and Active Devices	
10:00-10:30	Coffee Break						Coffee Break						
10:30-12:00	WR2 Large Capacity Transmission	WI2 Photonic Crystals	WA2 Ultraviolet and Visible Lasers	S WE2 Biochip Fabrication by Femtosecond Laser II	S WF2 New Trends in Frequency Comb: Application of Light with Ultraprecision II	WP2 Advanced Technologies for Access	S WS2 Fiberoptic Technologies for the Next Era II (Mode control technology)	WT2 OXC and Related Technologies	WH2 DUV-LEDs and Efficiency Improvements	WG2 Quantum Communication	WK2 Modulator	WM2 Si Photonics: Passive Devices	
12:00-13:00	Lunch						Lunch						
13:00-14:30	Poster						Poster						
14:30-16:00	WR3 Subsystems for Optical Transmission Systems	WI3 Plasmonics I	WA3 Advanced Technologies for Nonlinear Optics	WB3 Ultrafast I	S WF3 New Trends in Frequency Comb: Application of Light with Ultraprecision III	WQ3 Virtual and Autonomic Networks	WS3 Doped Fibers and Devices	T WT3 Photonics in Future Computing Systems	WH3 Blue-Green LDs, New Frequency Device	WL3 Inter Connection & Related Devices	WC3 Terahertz QCLs & Frequency-Comb based Techniques	WJ3 Molecular Imaging and Manipulation	Exhibition
16:00-16:30	Coffee Break						Coffee Break						
16:30-18:30	WR4 Nonlinear Compensation	WI4 Plasmonics II	WA4 Passively Mode-Locked and Q-switched Lasers	WB4 Ultrafast II	WF4 Holographic Metrology	S WP4 Recent R&D Activities of Telecommunication Technologies for Resilient and Sustainable Society	WS4 Fiber Nonlinearity	WQ4 Optical Signal Processing III	WH4 Novel Emitting Devices	WL4 Passive Waveguide Devices	WC4 Terahertz Science II	WJ4 Bioimaging II	
18:30-19:00													
19:00	Banquet						Banquet						

Thu 4 Jul

Time \ Room	Room C-1	Room C-2	Room F	Room G	Room H	Room I	Room J	Room K	Room 101	Room 103	Room 104A	Room 104B	Annex
8:30-10:00		ThI1 Photonic Crystal Lasers	ThA1 Mid-Infrared Lasers	ThB1 Nonlinear Phenomena I	ThF1 Novel Fiber Sensor Network	ThP1 Operational Issues for Access Networks		ThT1 Free Space Optical Devices and Interconnects			ThL1 Optical Sensors and Fiber Devices	ThM1 Si Photonics: Novel Functions and Applications	
10:00-10:30	Coffee Break							Coffee Break					
10:30-12:00	ThR2 FEC	ThI2 Nanocarbon & Metamaterials	ThA2 Advanced Near-Infrared Lasers	ThB2 Nonlinear Phenomena II	ThF2 Fiber Sensing Devices	ThP2 TDM-PON	T ThS2 Optical Fiber Cable Technology	ThO2 Optical Signal Processing IV	ThG2 Entangled Photons	ThK2 Photonic Active Device I	ThL2 Optical Modulators and Polymer Devices		Exhibition
12:00-13:00	Lunch							Lunch					
13:00-15:30	ThR3 Advanced Signal Processing for Coherent Receiver	ThI3 Nanowires & Nanoparticle	ThA3 Novel Solid State Laser Technologies	ThE3 Nanostructures and Micro/ Nano Processing	ThF3 Bio and Chemical Sensing	ThP3 Radio Over Fiber	ThS3 Novel Fibers	ThO3 Optical Signal Processing V	ThG3 Single Photons	ThK3 Photonic Active Device II	ThL3 Optical Switches		
15:30-16:00	Coffee Break							Coffee Break					
16:00-17:00			PD1 CLEO-PR	PD2 Joint	PD3 OECC/PS								

Oral, Sunday, June 30

Room B-2 2F

[SWA1] 13:00 - 17:10 Workshop
Photon Frontier Network

Organizer: Susumu Noda (Kyoto Univ., Japan)
Session Chair:

Opening Remarks
TBD
MEXT

SWA1-1 Invited
Overview of Photon Frontier Network
Yoshiaki Kato
Graduate School for the Creation of New Photonics Industries, Japan

SWA1-2 Invited
Exploring of Photon Science with High Power Laser
Ryosuke Kodama
Osaka Univ. & JAEA, Japan

SWA1-3 Invited
Ultrahigh-precision Coherent Control at the Quantum-classical Boundary
Kenji Ohmori
Inst. for Molecular Science, Japan

SWA1-4 Invited
Photonic Crystal Lasers
Susumu Noda
Kyoto Univ., Japan

SWA1-5 Invited
Recent Advances in Laser Based Coherent Photon Technology and Science
Makoto Gonokami
Univ. of Tokyo, Japan

Room F 1F

[SA1] 12:45 - 15:00 Symposium
Laser Display I - Laser Technology

Session Chair: Yushi Kaneda (The Univ. of Arizona, USA)

SA1-1 12:45 - 13:30 Tutorial
Laser Display Technologies: Light Sources and Systems
Kazuo Kuroda
Center for Optics Research and Education Utsunomiya Univ., Tochigi, Japan
This presentation reviews the important issues on laser display including the requirement for lasers (lasing wavelength, power), some examples of laser display systems, and the issues on image quality especially speckle noise reduction technique.

SA1-2 13:30 - 14:00 Invited
Blue and Green Nitride Based Laser Diodes for Projection
Georg Brueder, Thomas Hager, Clemens Vierheilig, Christoph Eichler, Soenke Tautz, Bernhard Stojetz, Teresa Lermer, Adrian Avramescu, Uwe Strauß
OSRAM Opto Semiconductors GmbH, Regensburg, Germany
We report on the development of single mode green laser and high power blue laser which are the basis for different laser projection applications.

SA1-3 14:00 - 14:30 Invited
Blue and Green Laser Diodes for Large Laser Display
Shingo Masui, Takashi Miyoshi, Tomoya Yanamoto and Shin-ichi Nagahama
Nichia Corporation, Tokushima, Japan
Watt-class AlInGaN blue and green laser diodes on c face GaN substrate are fabricated. The optical output powers were 3.75 W and 1.01 W, the wall plug efficiencies were 38.5% and 14.1%, respectively.

SA1-4 14:30 - 15:00 Invited
Compact Yellow-Orange Raman Lasers
T. Omatsu [1], A. Lee [2], H. Pask [2]
[1] Graduate School of Advanced Integration Science, Chiba Univ., Chiba, Japan, [2] Dept. of Physics and Astronomy, Macquarie Univ., NSW, Australia
We review continuous-wave (CW) and pulsed yelloworange lasers formed of a self-Raman crystal and an intracavity frequency-doubling crystal. Maximum CW and pulsed yellow-orange outputs of 140 mW and 264mW were observed, respectively. We also address thermal management to overcome the severe thermal loading in the self-Raman laser crystals.

Room G 1F

[SWB1] 12:30 - 15:00 Workshop
Optical Interconnects I: State-of-the-art Optical Interconnects: Moving from the Rack to the Chip

Organizers: Takaaki Ishigure (Keio Univ., Japan)
Tsuyoshi Konishi (Osaka Univ., Japan)

SWB1-1 Invited
Optical Interconnect for Current and Future Computers
Shigeru Nakagawa
IBM Research - Tokyo, Japan

SWB1-2 Invited
Migration of Embedded Electro-optical Interconnect Technologies into Data Centre Systems
R. Pitwon
Xyratex Technology Ltd.

SWB1-3 Invited
Compact and Power-efficient CMOS Optical Interconnect Technologies for ICT System
T. Takemoto
Hitachi, Japan

SWB1-4 Invited
High-density Polymer Waveguides for Chip-to-chip Optical Interconnection
Akio Sugama [1], Yasuhiko Arakawa [1,2]
[1] Inst. for Nano Quantum Information Electronics, the Univ. of Tokyo, [2] Inst. of Industrial Science, the Univ. of Tokyo, Japan

Oral, Sunday, June 30

Room I 2F

[SWC1] 12:30 - 15:00 Workshop

Future Perspective of Photonic Transport Network I: Beyond 100G Technologies and Standardization

Organizers:Toshiya Matsuda (NTT Corporation, Japan)
Toshihiko Hirooka (Tohoku Univ., Japan)
Hidehiko Takara (NTT Corporation, Japan)

SWC1-1 Invited

Standardization Activities on Next Generation 100GbE and beyond for Future Small Form Factor Optical Transceiver for High-density and High-bandwidth Client Side Optical Interfaces Enabling Multi-Tbps Front Panel Bandwidth

Kiyohisa Hiramoto
Oclaro, Japan

SWC1-2 Invited

Next Generation DSP for beyond 100G

Etsushi Yamazaki
NTT, Japan

SWC1-3 Invited

Next Generation Transponder and System Design

Maxim Kuschnerov
NSN Optical GmbH, Germany

SWC1-4 Invited

Flexible Modulation Formats in Next-generation Packet-optical Transport Systems

Dirk van den Borne
Juniper, Germany

SWC1-5 Invited

Elastic Optical Network Design: What Impacts are Brought by Flexible Grid

Motoyoshi Sekiya
Fujitsu Labs of America, USA

SWC1-6 Invited

MIMO and OFDM for 100Gb/s and Beyond Long-Haul Transmission

Neda Cvijetic
NEC Labs. America, USA

Room J 2F

[SWD1] 12:30 - 18:00 Workshop

Software Defined + Elastic Optical Networks =?

Organizers:Soichiro Araki (NEC, Japan)
Hiroaki Harai (NICT, Japan)

SWD1-1 Invited

Migration to Software-defined Transport Networks

Gordon Liu
Huawei Technologies, China

SWD1-2 Invited

Packet Optical Convergence

Samuel Liu
Juniper Networks, Germany

SWD1-3 Invited

Positioning An Optical Transport in Carrier's SDN

Ting Wang
NEC Laboratories America, USA

SWD1-4 Invited

Software Defined Elastic Optical Networks Using OpenFlow

Lei Liu[1], Takehiro Tsuritani[2], Itsuro Morita[2], Yawei Yin[1], Roberto Proietti[1], Ming Xia[3], Meral Shirazipour[4], Qing Xu[4], Stefan Dahlfort[3], and S. J. Ben Yoo[1]
[1] UC Davis, USA, [2] KDDI R&D Labs., Japan, [3] Ericsson Research Silicon Valley, USA, [4] Ericsson Research, USA

SWD1-5 Invited

Standardization Activities around Software Defined Networking and OpenFlow

Atsushi Iwata
NEC, Japan

Room K 2F

Oral, Sunday, June 30

Room B-2 2F

[SWA1] 13:00 - 17:10 Workshop
Photon Frontier Network

Organizer: Susumu Noda (Kyoto Univ., Japan)
Session Chair:

SWA1-6 Invited
Precise Comparisons of Optical Lattice Clocks
Hidetoshi Katori
Univ. of Tokyo, Japan

SWA1-7 Invited
Recent Progress on High Harmonic Generation and Application at RIKEN
Katsumi Midorikawa
RIKEN, Advanced Science Inst., Japan

SWA1-8 Invited
Nonlinear Optics in the Hard X-ray Region
Kenji Tamasaku
RIKEN, Harima Inst., Japan

SWA1-9 Invited
Terahertz Nonlinear Spectroscopy
Koichiro Tanaka
Kyoto Univ., Japan

Closing Address
Tsutomu Yabuzaki
Program Officer of Photon Frontier Network

Room F 1F

[SA2] 15:30 - 18:15 Symposium
Laser Display II - Display Optics and Speckle

Session Chair:Takashige Omatsu (Chiba Univ., Japan)

SA2-1 15:30 - 16:15 Tutorial
Advanced Speckle Contrast Reduction by Moving Diffuser
S. Kubota and Y. Tomita
Oxide Corp., Yokohama, JAPAN

Advance speckle contrast reduction by the oscillating diffusers with extremely high Q factor is described, which enables the substantially speckle-free laser theater design.

SA2-2 16:15 - 16:45 Invited
Speckle Contrast Reduction by Linear and Nonlinear Photonic Devices
E.-C. Liu[1], J.-H. Hong[1], S.-H. Fu[1], P.-C. Yeh[1], Y.-D Wang[1], C.-M. Lai[2], T.-L. Chiu[3], H. Yokoyama[4], A.-H. Kung[5], C.-C. Tu[6], C.-H. Lin[6], A. Boudrioua[7], N.-E. Yu[8], J.-H. Lee[1], H.-Y. Lin[1], L.-H. Peng[1]
[1] Dept. Elec. Eng. and Inst. Photonics and Optoelectronics, Nat'l Taiwan Univ., Taipei, Taiwan, R.O.C., [2] Dept. of Electric Engineering, Ming Chuan Univ., Taoyuan, Taiwan, R.O.C., [3] Dept. of Photonic Engineering, Yuan Ze Univ., Chungli, Taiwan, R.O.C, [4] New Industry Creation Hatchery Center (NICHe), Tohoku Univ., Sendai, Japan, [5] Inst. Photonics Technologies, National Tsing-Hua Univ., Hsinchu, Taiwan, R.O.C., [6] Touch Micro-System Tech., Taoyuan, Taiwan, R.O.C., [7] Universite Paris 13 - Institut Galilée, Villetaneuse - FRANCE, [8] Advanced Photonics Research Inst., Gwangju Institute of Science & Technology, Korea

Speckle contrast < 3.5% was achieved by means of (i) wavelength-diversity using spectrally-broad nonlinear photonic green lasers over the 520-545nm range and (ii) polarization- and phase-diversity using birefringent nano-photonic devices.

SA2-3 16:45 - 17:15 Invited
Speckle Dynamics in Laser Navigating Devices: Translation in Non-Paraxial Area
Victor Yurlov, Boris Kirillov, Taeyoung Kim
Samsung Electro-Mechanics Co., Ltd., Korea

Non-paraxial speckle dynamics interpretation in optical tracking devices (such as PC Mouse or Finger Navigator) is presented. Analytical expressions are derived for non-paraxial regime. The results of experimental checking are presented.

SA2-4 17:15 - 17:45 Invited
Laser Displays Using Scanning Optical Fiber
Brian Schowengerdt
Washington Univ., USA

SA2-5 17:45 - 18:15 Invited
Laser Backlighting LCD TV
Nami Nakano [1], Eiji Niikura [1], Rena Murase [1], Akihiro Nagase [1], Masaaki Hanai [2], Tomohiro Sasagawa [1], and Koji Minami [1]
[1] Advanced Technology R&D Center Mitsubishi Electric Corporation, Kyoto, Japan, [2] Kyoto Works, Mitsubishi Electric Corporation, Japan

We developed the laser backlight LCD TV. The backlight of this TV uses two kinds of light sources of red lasers and cyan LEDs. The developed LCD TV realizes a wide color gamut.

Room G 1F

[SWB2] 15:30 - 18:00 Workshop
Optical Interconnects II: Challenges and Opportunities for Ultra-dense Inter-chip and On-chip Interconnects

Session Chairs: Shinji Matsuo (NTT, Japan)
Takuo Tanemura (The Univ. of Tokyo, Japan)

SWB2-1 Invited
Optics in Servers and Computers: Challenges and Opportunities
H.J.S. Dorren
COBRA, Eindhoven Univ. of Technology, The Netherlands

SWB2-2 Invited
Scalability of VCSEL Arrays for Ultra-dense Chip-to-chip Optical Interconnects
Werner Hofmann
Technical Univ. of Berlin, Germany

SWB2-3 Invited
Monolithically Integrated CMOS Photonics for Optical Interconnects
Solomon Assefa
IBM Thomas J. Watson Research Center, USA

SWB2-4 Invited
III/V-on-Si Hybrid Lasers and Modulators for Optical Interconnects
J.E. Bowers
UCSB, USA

SWB2-5 Invited
Photonic Crystal Lasers for Optical Interconnects
Koji Takeda, Shinji Matsuo
NTT Photonics Labs, Nanophotonics Center, NTT Corporation, Japan

SWB2-6 Invited
Nanometallic Lasers for Optical Interconnects
V. Dolores-Calzadilla, D. Heiss, A. Fiore, M. K. Smit
COBRA Research Inst., Eindhoven Univ. of Technology, The Netherlands

Oral, Sunday, June 30

Room I 2F

[SWC2] 15:30 - 18:00 Workshop

Future Perspective of Photonic Transport Network II: Space Division Multiplexing for Petabit / Fiber Transmission

Organizers:Toshiya Matsuda (NTT Corporation, Japan)
Toshihiko Hirooka (Tohoku Univ., Japan)
Hidehiko Takara (NTT Corporation, Japan)

SWC2-1 Invited
Recent Progress in Multicore Fibers for Large Capacity SDM
Kunimasa Saitoh [1], Masanori Koshiba [1], Katsuhiro Takenaga [2] and Shoichiro Matsuo [2]
[1] Hokkaido Univ., Japan, [2] Fujikura, Japan

SWC2-2 Invited
Multicore EDFA for Space Division Multiplexing
Yukihiro Tsuchida, Koichi Maeda, Masateru Tadakuma, and Ryuichi Sugizaki
Furukawa Electric, Japan

SWC2-3 Invited
Few-mode Doped Fibers for SDM Amplifiers
Massimiliano Salsi
Alcatel Lucent, France

SWC2-4 Invited
Large Capacity Multicore Transmission Technologies
Akihide Sano
NTT, Japan

SWC2-5 Invited
Long Distance Multicore Fiber Transmission
Hidenori Takahashi
KDDI R&D Labs., Japan

SWC2-6 Invited
Recent Progress within the EU Project FP7 IST Modegap
H. de Waardt, H. Chen, V.J.A.M. Sleiffer, R.G.H. Uden, C.M. Okonkwo and A.J.M. Koonen
Eindhoven Univ., The Netherlands

SWC2-7 Invited
Heterogeneous Multicore Fiber for Record Petabit/s Transmission at over 100 b/s/Hz
Ezra Ip [1], Ming-Jun Li [2]
[1] NEC Lab. America, USA, [2] Corning, USA

Panel Discussion
Moderator: Toshio Morioka (Technical Univ. of Denmark, Denmark)

Room J 2F

[SWD1] 12:30 - 18:00 Workshop

Software Defined + Elastic Optical Networks =?

Organizers:Soichiro Araki (NEC, Japan)
Hiroaki Harai (NICT, Japan)

SWD1-6 Invited
Planning Tools for Off-line and On-line Flexgrid-based Core Networks
Luis Velasco
Universitat Politecnica de Catalunya, Spain

SWD1-7 Invited
Software Defined Network a Technology Enabler for Realisation of Converged Packet over Fixed-Flexi Grid Optical Network
Reza Nejabati, Dimitra Simeonidou
Univ. of Bristol, United Kingdom

SWD1-8 Invited
Flexible Transceivers
Kim Roberts
CIENA, Canada

SWD1-9 Invited
Flexible and Dynamic Node Architecture Using Universal Transceivers
Yasuhiko Aoki
Fujitsu, Japan

SWD1-10 Invited
Impact of Multi-flow Transponders on Elastic Optical Network
Takafumi Tanaka
NTT, Japan

Room K 2F

[SWE2] 15:30 - 18:00 Workshop

What will be Killer Devices and Components for the Next-Generation Optical Access Networks?

Organizers:Neda Cvijetic (NEC Laboratories of America, USA)
Naoto Yoshimoto (NTT Access Network Service Systems Laboratories, Japan)

SWE2-1 15:30 - 16:00 Invited
Cost Issues from an Operator's Viewpoint
Kota Asaka
NTT, Japan

SWE2-2 16:00 - 16:30 Invited
External Cavity Laser as a Candidate of the Cost-effective WDM Transmitter for Access Network
Jie Hyun Lee
ETRI, Korea

SWE2-3 16:30 - 17:00 Invited
Access Network Deployments of Tunable Devices: Enabling Technologies
Rob Murano
Aegis Lightwave, China

SWE2-4 17:00 - 17:30 Invited
10-Gbps WDM PONs Using Reflective Semiconductor Optical Amplifiers
Hoon Kim
National Univ. of Singapore, Singapore

SWE2-5 17:30 - 18:00 Invited
CDC Switch for the Next-generation Optical Access Networks
Yung Jui (Ray) Chen
National Sun Yat-sen Univ. Taiwan

SWE2-6 18:00 - 18:30 Invited
Integrated Optical Modulues for NG-PON Realization
Keita Mochizuki and Hiroshi Aruga
Mitsubishi Electric Co., Japan

Oral, Monday, July 1

Main Hall 1F

Opening Remarks 8:30 - 8:50

8:30 - 8:50 Opening Remarks

Plenary Session 8:50 - 12:30

8:50 - 9:30 Higgs Boson: Dawn of Physics to Explore the Vacuum Plenary

Shoji Asai Department of Physics, Graduate School of Science, The University of Tokyo, Japan

Session Chair: Yuichi Matsushima (Waseda University, Japan)

9:30 - 10:10 Space-division Multiplexing – Do We Have a Choice? Plenary

Mark D. Feuer AT&T Labs - Research, USA

Session Chair: Ken-ichi Kitayama (Osaka University, Japan)

10:30 - 11:10 Toward the Smallest Possible Laser & Resonator Plenary

Yong-Hee Lee Department of Physics, Korea Advanced Institute of Science and Technology (KAIST), Korea

Session Chair: Yoshiaki Nakano (University ot Tokyo, Japan)

11:10 - 11:50 Coherent Optical Communications: Past, present and Future Plenary

Kazuro Kikuchi Department of Electrical Engineering and Information Systems, The University of Tokyo, Japan

Session Chair: Masafumi Koga (Oita University, Japan)

11:50 - 12:30 Photonics Beyond Diffraction Limit: Plasmon Waveguide, Cavities and Integrated Laser Circuits Plenary

Xiang Zhang Department of Mechanical Engineering, University of California, Berkeley, USA

Session Chair: Susumu Noda (Kyoto University, Japan)

Oral, Monday, July 1

Room C-1 1F

[MR1] 14:00 - 16:00
Modulation Format
Session Chair: Akihide Sano (NTT Corporation, Japan)

MR1-1 14:00 - 14:30 Invited

High Capacity Multi-Mode Transmission Systems Using Higher-Order Modulation Formats

V.A.J.M. Sleiffer [1], Y. Jung [2], P. Leoni [3], M. Kuschnerov [4], R.G.H. van Uden [1], V. Veljanovski [4], L. Grüner-Nielsen [5], Y. Sun [5], D.J. Richardson [2], S. U. Alam [2], F. Poletti [2], B. Corbett [6], R. Winfield [6] and H. de Waardt [1]

[1] COBRA Inst., Eindhoven Univ. of Technology, Eindhoven, The Netherlands, [2] Optoelectronics Research Centre, Univ. of Southampton, Southampton, UK, [3] Universität der Bundeswehr München, Neubiberg, Germany, [4] Nokia Siemens Networks Optical GmbH, Munich, Germany, [5] OFS, Brøndby, Denmark, [6] Tyndall Nat'l Institute, Cork, Ireland

We look at multi-mode fiber as the potential means to upgrade capacity of optical transmission systems compared to current single-mode technology by employing multiple modes as transmission lanes as well as using higher-order modulation formats.

MR1-2 14:30 - 14:45

1 Tbit/s 256 QAM-OFDM transmission over 560 km with 14.3 bit/s/Hz spectral efficiency

Tatsunori Omiya, Masato Yoshida, and Masataka Nakazawa

Research Inst. of Electrical Communication, Tohoku Univ., Miyagi, Japan

We demonstrate a 1 Tbit/s 256QAM-OFDM transmission with a spectral efficiency of 14.3 bit/s/Hz. A record transmission distance of 560 km was achieved for terabit data with a spectral efficiency of more than 10 bit/s/Hz.

MR1-3 14:45 - 15:00

Compensation of Constellation Distortion due to Imbalance of Delay Detection in Incoherent Optical QAM Signaling

Kohei Mandai and Nobuhiko Kikuchi

Central Research Laboratory, Hitachi Ltd., Kanagawa, Japan

We experimentally confirm that distortion in constellation of received signals due to imbalance of delay detection causes BER degradation in incoherent optical QAM signaling and propose and demonstrate distortion compensation technique using digital signal processing.

MR1-4 15:00 - 15:15

Multi-channel generation and reception of Nyquist-WDM using digital DFTs

Liang B. Du and Arthur J. Lowery

Electrical and Computer Systems Engineering, Monash Univ., VIC, Australia

We experimentally demonstrate the generation and reception of multiple N-WDM channels with a single optical modulator and receiver. A 31 Gb/s system is demonstrated over 800 km with negligible implementation penalty.

MR1-5 15:15 - 15:30

Traceback Equalization against Modulation Non-Uniformity in QAM Transmitters

T. Sakamoto [1], G.-W. Lu [1] and T. Kawanishi [1]

[1] Nat'l Inst. of Information and Communications Technology, Tokyo, Japan

Investigated is a traceback equalization technique for non-uniformly synthesized optical QAM signals. Non-uniform impairments in a transmitter are individually estimated and signals are most likely decoded. Numerical proof is provided investigating 10-Gbaud, 16QAM signal reception.

MR1-6 15:30 - 15:45

Spectrally Efficient Modulation Based on SINC Waveform And Its Practical Implementation Using Wavefor m Truncation

Hidenori TAGA

Nat'l Sun Yat-Sen Univ., Kaohsiung, Taiwan

A nearly rectangular spectrum is realized by SINC waveform in the time domain. The causality issue of the SINC waveform is solved by a waveform truncation. Numerical simulations demonstrate the feasibility of this idea.

MR1-7 15:45 - 16:00

Optimization of Discrimination Filters for Orthogonal Time-Frequency Domain Demultiplexing

T. Sakamoto [1,2], R.P. Scott [1] and S.J.B. Yoo [1]

[1] Nat'l Inst. of Information and Communications Technology, Tokyo, Japan, [2] Electrical & Computer Engineering, Univ. of California Davis, One Shields Avenue Davis, USA

Orthogonal time-frequency domain multipled (OTFDM) signal is demultiplexed with a coherent matched detector. We optimize the discrimination LPFs in the detector to minimize inter-channel crosstalk, enabling ultrafast OTFDM transmission with spectral efficiency reaching Nyquist limit.

Room C-2 1F

[MH1] 14:00 - 16:00 Symposium
New Frequency, Novel LDs and LEDs -Innovative Works on Widegap Semiconductors- I
Session Chair: Hideki Hirayama (RIKEN, Japan)

MH1-1 14:00 - 14:30 Invited

GaN-based VCSEL fabricated on Nonpolar GaN Substrates

Shuji Nakamura

Solid State Lighting Energy Center, Materials and ECE Departments, Univ. of California, Santa Barbara, USA

The vertical cavity surface emitting laser diode (VCSEL) was fabricated using nonpolar GaN substrates. The direction of the polarization of the lasing was along a-axis.

MH1-2 14:30 - 15:00 Invited

AlGaN Deep Ultraviolet LEDs with External Quantum Efficiency Over 10%

Max Shatalov [1], Jinwei Yang [1], Yuri Bilenko [1], Michael Shur [2] and Remis Gaska [1]

[1] Sensor Electronic Technology Inc., SC, USA, [2] Rensselaer Polytechnic Inst., New York, USA

Deep UV LED structures with UV transparent design, reflective p-electrodes and die encapsulation exhibited external quantum efficiency above 10%. Progress in material growth and device fabrication will be discussed along with issues further limiting efficiency.

MH1-3 15:00 - 15:30 Invited

Development of AlGaN DUV-LED

Masamichi Ippommatsu [1], Akira Hirano [1], Isamu Akasaki [2], and Hiroshi Amano [3]

[1] UV Craftly Co., Ltd., Nagoya, Japan, [2] Meijo Univ., Nagoya, Japan, [3] Nagoya Univ. Nagoya, Japan

We report on development for commercial production of 50mW class AlGaN based deep ultraviolet light -emitting diodes (DUVLED) with wave length ranging 255 to 355 nm. DUVLED have about 10% EQE and over 10000 hours life time.

MH1-4 15:30 - 16:00 Invited

Recent Progress of Green Laser Diodes

Takao Nakamura

Semiconductor Technologies R&D Laboratories, Sumitomo Electric Industries, Ltd., Hyogo, Japan

Output powers of over 100mW and wall plug efficiencies as high as 8.9% in the wavelength range of 525-532 nm were demonstrated in InGaN based laser diodes on semipolar GaN substrates.

Room F 1F

[MA1] 14:00 - 16:00
Single-Frequency and Stabilized Lasers
Session Chair: Yuji Oki (Kyushu Univ., Japan)

MA1-1 14:00 - 14:30 Invited

Fiber Amplifiers for Gravitational Wave Detection

P. Weßels, M. Karow, V. Kuhn, M. Steinke, H. Tünnermann, D. Kracht, J. Neumann

Laser Zentrum Hannover e.V., Hannover, Germany Centre for Quantum Engineering and Space-Time Research - QUEST, Hannover, Germany

Interferometric gravitational wave detectors set very high requirements on their single-frequency laser source in terms of output power and stability. We discuss current approaches to fulfill these requirements using high-power single-frequency fiber amplifiers.

MA1-2 14:30 - 14:45

170 W single-frequency single-mode polarization maintaining fiber amplifier

L. Zhang, S. Cui, C. Liu, J. Zhou, and Y. Feng

Shanghai Key Laboratory of Solid State Laser and Application, and Shanghai Inst. of Optics and fine Mechanics, Chinese Academy of Sciences, Shanghai, China

A 170 W all-fiber linearly-polarized single-frequency sing-mode ytterbium amplifier at 1064 nm with an optical efficiency of 80 % was demonstrated with stimulated Brillouin scattering suppressed by applying longitudinally varying strain on the gain fiber.

MA1-3 14:45 - 15:00

High Power 1178 nm Single-Frequency MOPA Based on OP-SDL and PBGF

Mingchen Chen [1], Xinyan Fan [1], Akira Shirakawa [1], Tomi Leinonen [2], Emmi Kantola [2], Mircea Guina [2], Christina B. Olausson [3], and Jes Broeng [3]

[1] Inst. for Laser Science, Univ. of Electro-Communications, Tokyo, Japan, [2] Optoelectronics Research Centre, Tampere Univ. of Technology, Tampere, Finland, [3] NKT Photonics A/S, Birkerød, Denmark

We report a high power single-frequency 1178 nm laser combining an optically-pumped semiconductor disk laser and an Yb-doped photonic bandgap fiber amplifier. An power of 31 W with <200 kHz linewidth without SBS was demonstrated.

MA1-4 15:00 - 15:15

Single-frequency Nanosecond Fiber Laser Based on Self-Phase Modulation Pre-Compensation

Rongtao Su, Pu Zhou, Xiaolin Wang, Hanwei Zhang and Xiaojun Xu

College of Opto-electronic Science and Engineering, Nat'l Univ. of Defense Technology, Changsha, China

We demonstrate a scheme of high-peak-power, single-frequency nanosecond fiber laser based on self-phase modulation (SPM) pre-compensation and MOPA configuration. The linewidth was reduced from 1.4 GHz to 120 MHz because of SPM pre-compensated.

MA1-5 15:15 - 15:30

Wavelength-swept Single Longitudinal Mode Fiber Ring Laser Locked to 25 GHz ITU Grid

Chengliang Yang, Li Xia, Yuanwu Wang and Deming Liu

Wuhan Nat'l Laboratory for Optoelectronics National Engineering Laboratory for Next Generation Internet Access System College of Optoelectronic Science and Engineering, Huazhong Univ. of Science and Technology, Hubei, China

Wavelength-swept single longitudinal mode fiber laser incorporating Fabry-Perot filter and bandpass filter is demonstrated. The proposed laser has a tuning range over 30 nm with tuning step 0.2 nm.

MA1-6 15:30 - 15:45

All Polarization-Maintaining Fiber Erbium Frequency Combs for Stable Long-Term Operation

I. Coddington, L. C. Sinclair, W. S. Swann, and N. R. Newbury

Nat'l Inst. of Standards and Technology, Boulder, Colorado

We compare multiple polarization-maintaining fiber frequency combs operating at a range of repetition rates and show phase-locking of the carrier-envelope offset frequency. Designs are compatible with robust, fieldable frequency combs.

MA1-7 15:45 - 16:00

Temperature Stabilization of Yb-Doped Fiber Mode-Locked Oscillator for Long-Term Stable Passive Two-Color Synchronization

Dai Yoshitomi [1], and Kenji Torizuka [1]

[1] Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan

We report active temperature stabilization of Yb-doped fiber mode-locked oscillator to suppress the variation of repetition rate down to ~ 2.0 Hz in 4 hours for long-term stable passive two-color synchronization.

Room G 1F

[MG1] 14:15 - 16:00
Light-Matter Interaction
Session Chair: Kae Nemoto (National Inst. of Informatics, Japan)

MG1-1 14:15 - 14:45 Invited

Connecting Photons to Spins

Jörg Schmiedmayer
2 Vienna Center for Quantum Science and Technology, Atominstitut, Vienna, Austria

I will discuss three examples of connecting optical and micro wave photons to spins as quantum memory and compare their advantages and disadvantages for implementations in quantum information devices.

MG1-2 14:45 - 15:15 Invited

Technical Paper for CLEO-PR & OECC/PS 2013

Joerg Wrachtrup
3rd Inst. of Physics, Univ. of Stuttgart, Germany

High resolution imaging small magnetic fields is useful in a number of fields ranging from material to medical sciences. The talk will describe approaches measuring fields on the order of nT with few nm resolution.

MG1-3 15:15 - 15:30

Single Photon, Spin, and Charge in Diamond Semiconductor At Room Temperature

Yuki Doi [1], Toshiharu Makino [2], Hiromitsu Kato [2], Masahiko Ogura [2], Daisuke Takeuchi [2], Hideyo Okushi [2], Satoshi Yamasaki [2], Jörg Wrachtrup [3], Shinji Miwa [1], Yoshishige Suzuki [1] and Norikazu Mizuochi [1]
[1] Osaka Univ., Osaka, Japan, [2] Nat'l Inst. of Advanced Industrial Science and Technology, Ibaraki, Japan, [3] Universitat Stuttgart, Stuttgart, German

We succeeded to manipulate charge state of NV center between single NV- and NV0 by means of current injection. It might be used for decoupling of spin in NV center.

MG1-4 15:30 - 15:45

Coherent Control of an NV⁻ Center in Diamond with Adjacent Carbon ^{13}C

Burkhard Scharfenberger [1], William J. Munro [2], Kae Nemoto [1]
[1] Nat'l Inst. of Informatics, Tokyo, Japan [2] NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan

Using an effective spin model, we numerically investigate theoretically achievable driving fidelities of a three qubit system consisting of an NV center and a nearest neighbor Carbon 13C nuclear spin.

MG1-5 15:45 - 16:00

Ultrafast DC-Stark Shifting of a Single Quantum Dot

C. Wolpert[1,3], C. Dicken[1,3], K. Lindfors[1,3], H. Schweizer[3], M. Lippitz[1,3], L. Wang[4], P. Atkinson[4], A. Rastelli[4], O. Schmidt[4], R. Singh[2], and G. Bester[2]
[1] Max Planck Inst. for Solid State Research, Stuttgart, Germany, [2] Max Planck Institute for Solid State Research, Stuttgart, Germany, [3] 4th Physics Institute, Univ. of Stuttgart, Stuttgart, Germany, [4] Institute for Integrative Nanosciences, IFW Dresden, Dresden , Germany

We present ultrafast manipulation of the optical transition of a single GaAs/AlGaAs quantum dot (QD). We create DC electric fields on a picosecond timescale by exploiting the photo-Dember effect.

Room H 1F

[MI1] 14:00 - 16:00
Photonic Crystal Devices
Session Chair: Satoshi Iwamoto (The Univ. of Tokyo, Japan)

MI1-1 14:00 - 14:30 Invited

Hybrid III-V/SOI Nanophotonics: Lasers, Switches and Memories

F. Raineri [1,2], A. Bazin [1], P. Monnier [1] and R. Raj [1]
[1] Laboratoire de Photonique et de Nanostructures, CNRS, Marcoussis France [2] Universite Paris Diderot, Paris, France

Heterogeneous integration of III-V semiconductors on Silicon is one of the key technologies for next-generation on-chip optical interconnects. We extended this approach to nanophotonics by using photonic crystals to demonstrate highly efficient active devices.

MI1-2 14:30 - 14:45

InGaAs Nano-photodetectors based on Photonic Crystal Waveguide including Ultracompact Buried Heterostructure

Kengo Nozaki[1,2], Shinji Matsuo[1,3], Koji Takeda[1,3], Tomonari Sato[1,3], Eiichi Kuramochi[1,2], and Masaya Notomi[1,2]
[1] NTT Nanophotonics Center, [2] NTT Basic Research Laboratories, [3] NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

InGaAs nano-photodetectors using a photonic crystal waveguide were demonstrated for the first time to realize photoreceivers with small junction capacitance. 1-A/W responsivity and a 10-Gb/s eye pattern were confirmed for the 3-micron-long device.

MI1-3 14:45 - 15:00

On-chip Optical Correlator

Norihiro Ishikura, Ryo Hayakawa, Naoya Yazawa, and Toshihiko Baba
Dept. of Electrical and Computer Engineering, Yokohama Nat'l Univ., Yokohama, Japan

Using all technologies of photonic crystal, slow light and Si photonics, we first fabricated an on-chip optical correlator whose footprint is only 2.08 by 0.3 mm^2. Pico-second pulse waveform was successfully measured with this device.

MI1-4 15:00 - 15:15

Wavelength Conversion At 10 GHz Using A Two-Color Photonic Crystal Gate

S. Combrié[1],G. Lehoucq[1], L. Menager[2], S. Malaguti[3], G. Bellanca[3], S. Trillo[3], J. P. Reithmaier[4] and A. De Rossi[1]
[1] Thales Research and Technology France, Palaiseau, France [2] Thales Syst'emes Aeroport'es, Elancourt, France [3] Dept. of Engineering, Universit'a di Ferrara, Ferrara, Italy [4] Inst. of Nanostructure Techn. and Analytics, CINSaT, Univ. of Kassel, Kassel, Germany

An Indium Phosphide two-color optical gate based on a photonic crystal molecule was used to achieve wavelength conversion at a rate up to 10 GHz.

MI1-5 15:15 - 15:30

Ultra-Fast Low Energy Switching Using an InP Photonic Crystal H0 Nanocavity

Yi Yu, Evarist Palushani,Mikkel Heuck, Sara Ek, Nadezda Kuznetsova, Pierre Colman, Dragana Vukovic, Christophe Peucheret, Leif Katsuo Oxenløwe, Kresten Yvind, and Jesper Mørk
DTU Fotonik, Technical Univ. of Denmark, Kongens Lyngby, Denmark

Pump-probe measurements on InP photonic crystal H0 nanocavities show large-contrast ultrafast switching at low pulse energy. For large pulse energies, high-frequency carrier density oscillations are induced, leading to pulse-splitting.

MI1-6 15:30 - 15:45

High-Speed Slow-Light Tuning in pin-Diode-Incorporated Photonic Crystal Waveguide

R. Hayakawa, N. Ishikura, Hong C. Nguyen, and T. Baba
Yokohama Nat'l Univ., Yokohama, Japan

We fabricated Si photonic crystal waveguide with i-region-chirped pin diode structure using CMOS-compatible process. The delay of slow light pulse in this device was tuned by digital electrical signals up to 1 Gbps.

MI1-7 15:45 - 16:00

Improving Nanocavity Switching using Fano Resonances in Photonic Crystal Structures

Mikkel Heuck [1], Philip Trøst Kristensen [1], Yuriy Elesin [2], and Jesper Mørk [1]
[1] Dept. of Photonics Engineering, Technical Univ. of Denmark, Lyngby, Denmark, [2] Dept. of Mechanical Engineering, Technical Univ. of Denmark, Lyngby, Denmark

We present a simple design for achieving Fano resonances in photonic crystal coupled waveguide-cavity structures. A coupled mode theory analysis shows an order of magnitude reduction in switching energy compared to conventional Lorentz resonances.

Room I 2F

[MP1] 14:00 - 15:30
Cost-effective Devices for Access Networks
Session Chair: Elaine Wong (The Univ. of Melbourne, Australia)

MP1-1 14:00 - 14:15

Mutually Injected Fabry-Perot Laser Diodes for 10-Gb/s Broadcasting in WDM-PON

Sang-Hwa Yoo, Joon-Young Kim, Byung-I l Seo, Myeong-Gyun Kye, and Chang-Hee Lee
Dept. of Electrical Engineering, Korea Advanced Inst. of Science and Technology, Daejeon, Republic of Korea

We demonstrate cost-effective 10-Gb/s broadcast signal transmission for WDM-PON employing mutually injected F-P LDs. The interferometric noise suppression technique improves transmission performance by eliminating the fundamental periodic noise peak.

MP1-2 14:15 - 14:30

A 10-Gb/s Reconfigurable All-Optical VPN in WDM-PONs Based on Mutual Injection Locking in Fabry-Pérot Laser Diodes

Yazhi Luo, Jie Liu, Feng Li, Liqing Gan, Chao Lu and P. K. A. Wai
Photonics Research Center and Dept. of Electronic and Information Engineering, The Hong Kong Polytechnic Univ., Hung Hom, Hong Kong

A 10-Gb/s reconfigurable all-optical VPN scheme in WDM-PONs based on mutually injection-locked Fabry-Perot laser diodes is proposed and experimentally demonstrated. After 25-km fiber transmission, the power penalty at BER of 1E-9 is 1.4 dB.

MP1-3 14:30 - 14:45

Pre-compensation of Mach-Zehnder Modulator Nonlinearity for DD-OFDM System

Bangjiang Lin, Juhao Li, Yangsha Wan, Hui Yang, Yongqi He, Zhangyuan Chen
State Key Laboratory of Advanced Optical Communication Systems and Networks, School of Electronics Engineering and Computer Science, Peking Univ., Beijing, China

Using digital distortion, the Mach-Zehnder modulator nonlinearity is pre-compensated for direct detection OFDM system. The experiment and simulation results show that the method can extend the modulation index, improving the receiver sensitivity.

MP1-4 14:45 - 15:00

1.55μm, 10-Gb/s VCSEL Transmission for Optical Access Networks

Zaineb Al-Qazwini, Madhan Thollabandi, and Hoon Kim
Dept. of Electrical & Computer Engineering, Nat'l Univ. of Singapore, Singapore

We demonstrate the transmission of 10-Gb/s VCSEL signals over 20-km SSMF without any dispersion compensation. Thanks to the use of DC-balanced line coding and delay interferometer, receiver sensitivity <-15 dBm is achieved after transmission.

MP1-5 15:00 - 15:15

Bidirectional Stacked 40-Gb/s WDM-OFDMPON System Using the Electronic Controlled Liquid Crystal Tunable Filter

Meihua Bi, Hao He, Shilin Xiao, Jun Li and Weisheng Hu
The State Key Lab of Advanced Optical Communication Systems and Networks, Shanghai Jiao Tong Univ., Dept. of Electronic Engineering, Shanghai, China

A symmetric 40-Gb/s stacked WDM-OFDM-PON system by using our designed TBF for downstream wavelength selection and upstream chirp management is experimentally demonstrated. It can support 25-km fiber transmission with 1: 256 split ratios.

MP1-6 15:15 - 15:30

Apodized SSFBG Encoder/Decoder for 40G-OCDMA-PON system

Ryosuke Matsumoto [1], Takahiro Kodama [1], Satoshi Shimizu [2], Ryujiro Nomura [3], Koji Omichi [3], Naoya Wada [2], and Ken-ichi Kitayama [1]
[1] Dept. of Electrical, Electronics and Information Systems, Osaka Univ., Osaka, Japan, [2] Nat'l Inst. of Information and Communications Technology (NICT), Tokyo, Japan, [3] Optics and Electronics Laboratory, Fujikura Ltd., Chiba, Japan

We will present a special class of apodized SSFBG encoder/decoder which generates multi-level PSK code for 40G-OCDMA-PON. Our proposed apodization profile has improved the variability of BER performance that depends on each optical code patterns.

Oral, Monday, July 1

Room J 2F

[MS1] 14:00 - 15:30
Multi Core Fiber Technology
Session Chair: Katsunori Imamura (Furukawa Electric co., Ltd., Japan)

MS1-1 14:00 - 14:15

Power Coupling Distribution Characterization using Bi-Directional OTDR Waveform

Kazuhide NAKAJIMA [1], Yukihiro GOTO [1], Kotaro SAITO [1], Chisato FUKAI [1], Hiroki HAMAGUCHI [2], Itaru ISHIDA [2], and Shoichiro MATSUO [2]
[1] Access Network Service Systems Labs., NTT Corporation, Ibaraki, Japan, [2] Optics and Electronics Labs., Fujikura Ltd., Chiba, Japan

A technique is proposed for evaluating power coupling coefficient distribution in a multi-core fiber. The longitudinal crosstalk characteristic in a two-core fiber is successfully evaluated using a bi-directional OTDR waveform simply obtained with one core.

MS1-2 14:15 - 14:30

Influence of Multi-Core Crosstalk on Far-Field Pattern Measurement

Kazuhide NAKAJIMA, Chisato FUKAI, Yukihiro GOTO, and Kotaro SAITO
Access Network Service Systems Labs., NTT Corporation, Ibaraki, Japan

The impact of multi-core crosstalk on far-field pattern (FFP) measurement is clarified numerically and experimentally. We show that the neighboring core angle against the scanning plane greatly affects the FFP and mode-field diameter characteristics.

MS1-3 14:30 - 14:45

Cutoff Wavelength Measurement of Two Core Multi-core Fiber

R. Okuno, R. Fukami, M. Ohashi, and Y. Miyoshi
Osaka Prefecture Univ., Osaka, Japan

A multi-core fiber (MCF) cut-off wavelength by using multimode-reference technique is simulated. The cutoff wavelength of two core MCF is successfully estimated by our present technique.

MS1-4 14:45 - 15:00

High Density and Low Cross Talk Design of Heterogeneous Multi-core Fiber with Air Hole Assisted Double Cladding

Tatsuhiko Watanabe, Yasuo Kokubun
Graduate school of Eng., Yokohama Nat'l Univ., Yokohama, Japan

A novel high-density heterogeneous uncoupled multi-core fiber was designed using an air hole assisted double cladding structure. Low cross talk of -52.2dB at 100km transmission and identical dispersion characteristics for all cores can be obtained.

MS1-5 15:00 - 15:15

Optimized Design Method for Heterogeneous Trench-assisted Multi-core Fiber

Jiajing Tu [1], Kunimasa Saitoh [1], Masanori Koshiba [1], Katsuhiro Takenaga [2], and Shoichiro Matsuo [2]
[1] Division of Media and Network Technologies, Hokkaido Univ., Sapporo, Japan, [2] Optics and Electronics Laboratory, Fujikura Ltd., Sakura, Japan

By designing the cores, trench layers and core number, we propose a relative optimized design scheme for heterogeneous trench-assisted multi-core fiber (Hetero-TA-MCF), which is a bend-insensitive MCF with high density of cores and ultra-low crosstalk.

MS1-6 15:15 - 15:30

Closely Packed Multicore Fibers with Zero Differential Group Delay

Kin Seng Chiang [1], Min Liu [2], and Yan Qian [2]
[1] Dept. of Electronic Engineering, City Univ. of Hong Kong, Hong Kong SAR, China, [2] College of Communication Engineering, Chongqing Univ., Chongqing, China

There exists a simple approximate condition for general homogeneous multicore fibers to achieve zero differential group delay (DGD). The zero-DGD wavelength can be controlled effectively by introducing a refractive-index dip in the cores.

Room K 2F

[MO1] 14:00 - 16:00
Optical Signal Processing I
Session Chair: Hiroyuki Tsuda (Keio Univ., Japan)

MO1-1 14:00 - 14:15

Optical Grooming of 20Gbps OOK and 40Gbps DQPSK Signals in PPLN Waveguide

Sergio Pinna, Antonio Malacarne and Antonella Bogoni
Scuola Superiore Sant'Anna, Pisa, Italy, [2] CNIT, Pisa, Italy

A simple PPLN-based, integratable and wavelength preserving scheme, to all-optically groom a 20Gbps OOK and a 40Gbps DQPSK into a 20Gbaud 8-APSK signal, is presented and experimentally demonstrated. Performances are provided through BER measurements

MO1-2 14:15 - 14:30

Wavelength Conversion of 36QAM through Four-Wave Mixing in HNLF

Guo-Wei Lu, Takahide Sakamoto, and Tetsuya Kawanishi
Nat'l Inst. of Information and Communications Technology (NICT), Japan

We experimentally demonstrate wavelength conversion of a 50-Gbps 36QAM using four-wave mixing effect in highly-nonlinear fiber. Error free is experimentally achieved with a 0.3-dB power penalty at BER of 10-3 with respect to the input.

MO1-3 14:30 - 14:45

NRZ-DPSK to RZ-DPSK Format Conversion With Wavelength Shift Free and Pulsewidth Tunable Operations

Gazi Mohammad Sharif [1], Quang Nguyen-The [1], Motoharu Matsuura [2], and Naoto Kishi [1]
[1] Dept. of Communication Engineering and Informatics, [2] Center for Frontier Science and Engineering, The Univ. of Electro-Communications, Tokyo, Japan

We demonstrate NRZ-DPSK to RZ-DPSK format conversion. In this scheme, pulsewidth of the converted signal can be tuned in a wider operating range and wavelength of the converted signal remains same as of input signal.

MO1-4 14:45 - 15:15 Invited

Spontaneous Emission Faster Than Stimulated Emission

Eli Yablonovitch & Ming C. Wu
Univ. of California, Berkeley Electrical Engineering & Computer Sciences Dept., California, USA

With an optical antenna, spontaneous emission can be stronger and faster than stimulated emission, allowing direct modulation LED's for optical interconnects. We will present the evidence for 35X spontaneous emission enhancement by an optical antenna.

MO1-5 15:15 - 15:30

All-Optical WDM-to-OTDM Conversion Based on Supercontinuum Generation in a Highly Nonlinear Fiber

Quang Nguyen-The [1], Motoharu Matsuura [2], and Naoto Kishi [1]
[1] Dept. of Communication Engineering and Informatics, [2] Center for Frontier Science and Engineering, The Univ. of Electro-Communications, Tokyo, Japan

An all-optical format conversion from 4×10 Gb/s WDM to 40 Gb/s OTDM by using supercontinuum generation in a highly nonlinear fiber is demonstrated. Less than 2-dB power penalty is obtained after the OTDM demultiplexing.

MO1-6 15:30 - 15:45

Dispersion Tolerance of All-Optical Modulation Format Conversion from NRZ-OOK to RZQPSK Using XPM in Nonlinear Fiber

Weiming Yao, Hiroki Terauchi, Akihiro Tokunaga, and Akihiro Maruta
Graduate School of Engineering, Osaka Univ., Osaka, JAPAN

We experimentally investigate the dispersion tolerance of transmitted OOK signals for all-optical NRZ-OOK to RZ-QPSK modulation format conversion using XPM in nonlinear fiber at 10Gsymbol/s by evaluating BER performance of the converted signal.

MO1-7 15:45 - 16:00

Removal of Local Frequency Fluctuation in Distributed Coherent-Optical OFDM

Tomoyuki Kato [1], Ryo Okabe [1], Thomas Richter [2], Robert Elschner [2], Carsten Schmidt-Langhorst [2], Colja Schubert [2], and Shigeki Watanabe [1]
[1] Fujitsu Laboratories Ltd., Kawasaki, Japan, [2] Fraunhofer Inst. for Telecommunications, Heinrich Hertz Institute, Berlin, Germany

We demonstrate the removal of local frequency/phase fluctuations in a distributed coherent-optical orthogonal frequency-division multiplexing (CO-OFDM) scenario. Four 12.5 GBd QPSK subcarriers at symbol rate spacing were multiplexed to 100 Gb/s CO-OFDM without OSNR penalty.

Room 101 1F

[MD1] 14:00 - 16:00
High Power Lasers and Applications I
Session Chair: Ryosuke Kodama (Osaka Univ., Japan)

MD1-1 14:00 - 14:15

All Diode-Pumped 20-TW Laser System for DD Fusion Experiments

Takashi Sekine, Yuma Hatano, Yasuki Takeuchi, and Toshiyuki Kawashima
Hamamatsu Photonics K. K., Shizuoka, Japan

Diode-pumped solid-state laser pumped 20-TW Ti:sapphire laser system has been developed. Diode-pumped Nd:glass laser were used as a pump source. One of application of high-intensity laser, neutron generation by cluster fusion has been demonstrated.

MD1-2 14:15 - 14:30

Muti-joule Non-collinear OPCPA At 800nm in Yttrium Calcium Oxyborate

Xiaoyan Liang[1], Lianghong Yu[1], JinFeng Li[1], Yanqing Zheng[2], Yuxin Leng[1], Ruxin Li[1] and Zhizhan Xu[1]
[1] State Key Laboratory of High Field Laser Physics, Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, Shanghai, China, [2] Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China

The non-collinear optical parametric chirped pulse amplification in yttrium calcium oxyborate was experimentally demonstrated. The amplified energy of 3.36J centered at 800nm was generated with pump of 35J. After compression, the pulse duration was 44.3fs.

MD1-3 14:30 - 14:45

30-mJ, 1-kHz, Yb:YAG Thin Disk Regenerative Amplifier with Pulsed Pumping At 969-nm

Michal Chyla[1,2], Taisuke Miura[1], Martin Smrz[1], Patricie Severova[1,2], Ondrej Novak[1,2], Akira Endo[1], Tomas Mocek[1]
[1] HiLASE Project, Inst. of Physics AS CR, Prague, Czech Republic, [2] Czech Technical Univ. in Prague, Prague, Czech Republic

We have obtained 30-mJ output at 1-kHz from Yb:YAG thin disk regenerative amplifier. By applying pulsed pumping method, we have improved the efficiency from 12% to 19%, and obtained diffraction limited beam at 24-mJ output.

MD1-4 14:45 - 15:00

Present Status of Laser Development for the Intense laser-Compton Gamma-Ray Source At JAEA

Michiaki MORI, Atsushi KOSUGE, Hajime OKADA, Hiromitsu KIRIYAMA, Yoshihiro OCHI, Momoko TANAKA, and Keisuke NAGASHIMA
Advanced laser development group, Quantum Beam Science Directorate, Japan Atomic Energy Agency, Kyoto, JAPAN

We report on present status of high average power and high repetition rate short pulse laser development include laser storage cavity (i.e. Enhancement cavity) for nondestructive detection of isotopes using laser-Compton gamma-rays.

MD1-5 15:00 - 15:15

Nonlinear Optical Phenomena in Ultra-Intense X-ray Interaction with Matter

Hitoki Yoneda [1], Yuichi Inubushi [2], Makina Yabashi [2], Tetsuo Katayama [3], Tetsuya Ishikawa [2], Haruhiko Ohashi [3], Hirokatsu Yumoto [3], Kazuto Yamauchi [4], Hidekazu Mimura [5], and Hikaru Kitamura [6]
[1] Inst. for Laser Science, Univ. of Elecro-Communications, Tokyo, Japan, [2] RIKEN SPring-8 Center, Hyogo, Japan, [3] Japan Synchrotron Radiation Research Institute (JASRI), Hyogo, Japan, [4] Graduate School of Engineering, Osaka Univ., Osaka, Japan, [5] Dept. of Precision Eng., The Univ. of Tokyo, Tokyo, Japan, [6] Dept. of Physics, Kyoto Univ., Kyoto, Japan

New nonlinear optics in the X-ray region is expected at the ultra-intense field of a focused X-ray free electron laser. We report the first experimental evidence of nonlinear phenomena in the multi-keV region.

MD1-6 15:15 - 15:30

Relativistic Mirrors for Photon-Photon Scattering

J. K. Koga [1], S. V. Bulanov [1,2], T. Zh. Esirkepov [1], A. S. Pirozhkov [1], M. Kando [1] and N. N. Rosanov [3]
[1] Quantum Beam Science Directorate, JAEA, Kyoto, Japan, [2] Prokhorov Inst. of General Physics, Russian Academy of Sciences, Moscow, Russia, [3] Institute of Laser Physics, Vavilov State Optical Institute, Saint-Petersburg, Russia

Relativistic mirrors generated in laser-plasma interactions can enable the detection of photon-photon scattering. They can up-shift and tightly focus optical laser pulses to the x-ray regime. We find that photon-photon scattering events can be observed.

MD1-7 15:30 - 15:45

High-Order Harmonics from Gas-Target Irradiated by Relativistic-Intensity Laser

M. Kando[1], A. S. Pirozhkov[1], T. Zh. Esirkepov[1], T. A. Pikuz[1,2], A. Ya. Faenov[1,2], K. Ogura[1], Y. Hayashi[1], H. Kotaki[1], E. N. Ragozin[3,4], D. Neely[5,6], H. Kiriyama[1], J. K. Koga[1], Y. Fukuda[1], M. Nishikino[1], T. Imazono[1], N. Hasegawa[1], T. Kawachi[1], H. Daido[1], Y. Kato[1], S. V. Bulanov[1], K. Kondo[1]
[1] Japan Atomic Energy Agency, Kyoto, Japan, [2] Joint Inst. for High Temperatures, RAS, Moscow, Russia, [3] P. N. Lebedev Physical Inst., RAS, Moscow, Russia, [4] Moscow Inst. of Physics and Technology (State Univ.), Moscow, Russia, [5] Central Laser Facility, Rutherford Appleton Labo., STFC, Oxon, UK, [6] Univ. of Strathclyde, Dept. of Physics, SUPA, Glasgow, UK, [7] Applied Laser Technology Inst., Tsuruga Head Office, Japan Atomic Energy Agency, Fukui, Japan, [8] The Graduate School for the Creation of New Photonics Industries, Shizuoka, Japan

High-order harmonics of a Ti:sapphire drive laser were observed when the laser pulse was incident on a He gas-jet target at the relativistic intensity. Both the forward and off axis spectra shows the resolved harmonics.

MD1-8 15:45 - 16:00

The Effect of Photo-Neutrons on Diagnostics Using CR-39 for Laser-Accelerated Ion Beam

Masato Kanasaki [1,2], Yuji Fukuda [2], Hironao Sakaki [2], Akifumi Yogo [2], Satoshi Jinno [2], Mamiko Nishiuchi [2], Atsuto Hattori [2], Kenya Matsukawa [2], Kiminori Kondo [2], Keiji Oda [1], and Tomoya Yamauchi [1]
[1] Graduate School of Maritime Sciences, Kobe Univ., Kobe, Japan, [2] Kansai Photon Science Inst. (KPSI), Japan Atomic Energy Agency (JAEA), Kyoto, Japan

We have designed the suitable configuration for CR-39 to detect only laser-accelerated ions with less contaminant by photo-neutrons via bremsstrahlung processes of fast-electrons followed by photo-neutron reactions using Monte Carlo simulations.

Room 103 1F

[MK1] 14:00 - 16:00
High Speed Transmitter
Session Chair: Hajime Shoji (Sumitomo Electric Industries, Ltd., Japan)

MK1-1 14:00 - 14:15

Operating wavelength range of 25.8-Gb/s 1.3μm DML extended to 30 nm

W. Kobayashi, K. Tsuzuki, T. Fujisawa, Y. Ohiso, Y. Ogiso, T. Ito, S. Kanazawa, T. Yamanaka, M. Kohtoku, and H. Sanjoh
NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

A 30-nm operating wavelength range was realized for a 1.3μm InGaAlAs DML with a 25.8-Gb/s push-pull driving configuration. Clear eye openings, an 8.0-dBm output power, and a 4.0-dB dynamic extinction ratio were obtained.

MK1-2 14:15 - 14:30

Novel Hybrid-Waveguide EMLs for 100 Gb/s CFP2 Transceivers

T. Yamatoya [1], Y. Morita [1], Y. Hokama [1], K. Akiyama [2], R. Makita [2], N. Yasui [3], D. Morita [1], H. Kawahara [1], and E. Ishimura [1]
[1] High Frequency & Optical Device Works, Mitsubishi Electric Corporation, Hyogo, Japan, [2] Advanced Technology R&D Center, Mitsubishi Electric Corporation, Hyogo, Japan, [3] Information Technology R&D Center, Mitsubishi Electric Corporation, Kanagawa, Japan

Novel hybrid-waveguide EMLs for 100 Gb/s CFP2 transceivers have been demonstrated. They were operated with low modulation voltage below 1.5 Vpp and under high chip temperature of 55degC satisfying 100GbE and OTU4 specs.

MK1-3 14:30 - 14:45

4×25-Gbit/s EADFB Laser Array Monolithically Integrated with Cascaded Mach-Zhender Multiplexer

T.Fujisawa [1], S.Kanazawa, Y.Ueda, W.Kobayashi, K.Takahata, A.Ohki, T.Itoh, M.Kohtoku, and H.Ishii
[1] NTT Photonics Laboratories, Atsugi, Japan

A 4×25-Gbit/s EADFB laser array chip monolithically integrated with a cascaded Mach-Zhender multiplexer is developed for CFP4-class 100GbE transmitters for the first time. Our compact TOSA containing this chip satisfies system requirements with semi-cooled operation.

MK1-4 14:45 - 15:00

Compact 100GbE Transmitter Optical Sub-Assembly using Polarization Beam Combiner

Takaharu Ohyama, Akira Ohki, Kiyoto Takahata, Toshio Ito, Nobuhiro Nunoya, Takeshi Fujisawa, Ryuzo Iga, and Hiroaki Sanjoh
NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

We developed a 100GbE transmitter optical sub-assembly using electro-absorption modulator integrated distributed feedback laser diode arrays and a polarization beam combiner for wavelength multiplexing. It provides sufficient optical modulation amplitude for 100GbE of over 10km.

MK1-5 15:00 - 15:15

A Compact 44.6 Gbps 1.55-μm EML TOSA Employing Three-layer FPC Connection

M. Shirao [1], N. Ohata [1], K. Uto [1], T. Fukao [2] T. Hatta [2] and H. Aruga [2]
[1] Information Technology R&D Center, Mitsubishi Electric Corporation, Kamakura, Japan, [2] High Frequency & Optical Device Works, Mitsubishi Electric Corporation, Hyogo, Japan

We demonstrated a 44.6-Gbps EML-TOSA for CFP2 using a three-layer FPC with high tolerance against finite assembly accuracy. A mask margin of 12% and a path penalty of 0.5dB after 2.4km-SMF transmission were obtained.

MK1-6 15:15 - 15:30

24 Gbit/s Synthesis of BPSK signals via Direct Modulation of Fabry-Perot Lasers under Injection Locking

R. Slavik [1], J. Kakande [2], R. Phelan [3], J. O'Carroll [3], B. Kelly [3], and D.J. Richardson [1]
[1] ORC, Univ. of Southampton, Southampton, UK, [2] Bell Labs, Alcatel-Lucent, Holmdel, USA, [3] Eblana Photonics, Dublin, Ireland

BPSK modulation tunable over 30 nm is obtained, highlighting the practicality of a recently-demonstrated new scheme for direct synthesis of phase and amplitude modulated signals. Experiments are carried out at 12 and 24 Gbit/s.

MK1-7 15:30 - 15:45

High Efficiency Wavelength Conversion of 40 Gbit/s OOK and DPSK with Good Stability

Yousra Ben M'Sallem, Chul Soo Park, Sophie LaRochelle and Leslie Ann Rusch
Centre d'Optique, Photonique et Laser (COPL), ECE Dept., Universite Laval, Quebec, Canada

We investigate wavelength conversion using a quantum-dash mode-locked laser as pumps for FWM in a SOA. Error-free conversion is achieved over sixteen 100 GHz channels with high conversion efficiency at low pump and signal powers.

MK1-8 15:45 - 16:00

Compensation Technique for Distorted QAM Signal Constellations Generated by Semiconductor IQ Modulators

Y. Wakayama [1] and N. Kikuchi [2]
[1] Hitachi, Ltd., Central Research Laboratory, Tokyo, Japan, [2] Hitachi, Ltd., Central Research Laboratory, Kanagawa, Japan

We have proposed a novel digital signal processing based compensation technique for distorted QAM signal constellation and also experimentally confirmed the technique could improve its error vector magnitude.

Room 104A 1F

[MC1] 14:00 - 16:00
Terahertz Hight Power Sources
Session Chair: Masayoshi Tonouchi (Osaka Univ., Japan)

MC1-1 14:00 - 14:30 Invited

Intense Terahertz-wave Generation and Sensitive Detection Using Nonlinear Optical Effect

H. Minamide
RIKEN ASI, Sendai, Japan

Intense Terahertz-wave (THz-wave) generation and sensitive detection based on nonlinear optical effect have been developed. 1-kw peak-power, ultra-wide tunablity from 1 to 30 THz, and sensitive THz-wave detection comparable to cryogenic cooled bolometer are obtained.

MC1-2 14:30 - 14:45

Frequency and Bandwidth Tunable Terahertz Generation At a Fan-Shaped Quasi-Phase-Matching Device

Kyu-Sup Lee[1], Shunji Takekawa[2], Kenji Kitamura[2], Do-Kyeong Ko[1], and Nan Ei Yu[3]
[1] Dep. of Physics and Photon Science, Gwangju Inst. of Science and Technology (GIST), Gwangju, Korea, [2] Nat'l Institute for Materials Science, Ibaraki, Japan, [3] Advanced Photonics Research Institute, GIST, Gwangju, Korea

Simultaneous tunable terahertz wave generation with the frequency range (0.85 ~ 1.59 THz) and the bandwidth range (43 ~ 78 GHz) was demonstrated using a fan-shaped periodically poled stoichiometric lithium tantalate crystal.

MC1-3 14:45 - 15:00

Quasi-Phase Matching with Tapered Waveguides for Terahertz Generation

Banie Abeywickrama [1], Ampalavanapillai Nirmalathas [1], Christina Lim [1], Ka-Lun Lee [1] and Malin Premaratne [1,2]
[1] Dept. of Electrical and Electronic Engineering, Univ. of Melbourne, VIC, Australia, [2] Dept. of Electrical and Computer Systems Engineering, Monash Univ., VIC, Australia

Using numerical simulations we demonstrate that the Terahertz generation efficiency is increased by using tapered waveguides. We propose piece-wise taper which facilitates quasi-phase-matching and increases THz efficiency by 2 fold compared to conventional rod waveguides.

MC1-4 15:00 - 15:15

Tunable Narrowband Terahertz Generation by Optical Rectification in Lithium Niobate

Caihong Zhang [1], Yuri Avetisyan [1,2], Iwao Kawayama [1], Hironaro Murakami [1], and Masayoshi Tonouchi [1]
[1] Inst. of Laser Engineering, Osaka Univ., Osaka, Japan [2] Microwave Engineering Dept., Yerevan State Univ., Manoogian, Armenia

We propose and demonstrate a new simple approach to generate tunable narrowband terahertz radiation by optical rectification in lithium niobate covered by a binary mask, which allows to easily control the bandwidth and central frequency.

MC1-5 15:15 - 15:30

Intense THz Surface-Wave Generation From Intense-Laser Interactions with Metal Wires

S. Tokita [1], M. Hashida [1], T. Nagashima [2], and S. Sakabe [1]
[1] Inst. for Chemical Research, Kyoto Univ., Kyoto, Japan, [2] Institute of Laser Engineering, Osaka Univ., Osaka, Japan

Upon driving ultrafast electron current on a metal wire by irradiating a relativistic-intensity femtosecond laser pulse. we obtained an intense half-cycle THz surface wave with electric field strength exceeding 1 MV/cm.

MC1-6 15:30 - 15:45

Widely Tunable (1-15THz), Narrowband Picosecond Terahertz Light Source

K. Miyamoto [1], K. Suizu [2], T. Saito [1], T. Akiba [2], T. Omatsu [1,3]
[1] Graduate School of Advanced Integration Science, Chiba Univ., Chiba, Japan, [2] Dept. of Electrical, Electronics and Computer Engineering, Chiba Inst. of Technology, Chiba, Japan, [3] Japan Science and Technology Agency, CREST, Tokyo, Japan

We have developed a picosecond terahertz light source with a wide tunability (1-15THz) and a narrow linewidth (~120GHz) formed by a 1um picosecond laser, a fan-out PPSLT optical parametric amplifier and a DAST crystal.

MC1-7 15:45 - 16:00

Generation and Detection of Ultrabroadband Coherent Infrared Pulses with Frequencies up to 200 THz Using Air Plasma and 10 fs Pulses

Eiichi Matsubara, Masaya Nagai, Masaaki Ashida
Graduate School of Engineering Science, Osaka Univ., Osaka, Japan

We generated ultrabroadband infrared pulses through air plasma driven by hollow-fiber compressed intense 10-fs pulses and their second harmonics. Moreover, we coherently detected its electric-field profile in range up to 150 THz using air.

Room 104B 1F

[MM1] 14:00 - 15:45
Si Photonics: Photonic Integration and Coupling Structures
Session Chair: Pieter Dumon (Imec-Ghent Univ., Belgium)

MM1-1 14:00 - 14:15

Low-polarization-dependent silica waveguide monolithically integrated on SOI photonic platform

H. Nishi, T. Tsuchizawa, R. Kou, H. Fukuda, and K. Yamada
NTT Microsystem Integration Labs., Nanophotonics Center, NTT Corp., Kanagawa, Japan

We developed a low-polarization-dependent silica waveguide, which was based on multi-layer core and fabricated at low temperature. We experimentally confirmed its low polarization dependence, and monolithically integrated it with silicon photonic dynamic devices.

MM1-2 14:15 - 14:30

SOI-based Monolithic Integration of MOSFET with Thermo-optic Mach-Zehnder Switch towards Driver-on-chip Circuit Switches

G.W. Cong [1], T. Matsukawa [2], T. Chiba [2], H. Tadokoro [2], M. Yanagihara [2], M. Ohno [2], H. Kawashima [1], H. Kuwatsuka [1], Y. Igarashi [2], M. Masahara [2], and H. Ishikawa [1]
[1] Network Photonics Research Center, [2] Nanoelectronics Research Inst., Nat'l Institute of Advanced Industrial Science and Technology, Ibaraki, Japan

We demonstrate the monolithic integration of MOSFETs with thermo-optic (TO) Mach-Zehnder switches on SOI platforms. Successful driving operation was achieved for the TO switch via MOSFETs, which is promising for realizing driver-on-chip large-scale circuit switches.

MM1-3 14:30 - 14:45

Optimizing interdigital electrode spacing of CMOS APD for 10 Gb/s application

Toshiyuki Shimotori, Kazuaki Maekita, Ryoichi Gyobu, Takeo Maruyama, and Koichi Iiyama
Division of Electrical and Computer Engineering, Kanazawa Univ., Ishikawa, Japan

Silicon avalanche photodiodes fabricated by CMOS process with different interdigital electrode spacing were characterized. The largest bandwidth of 7GHz was achieved for the APD with 1um electrode spacing, and the gain-bandwidth product was 270GHz.

MM1-4 14:45 - 15:00

Monolithic photonic integrated circuit for optical performance monitoring of silicon Mach-Zehnder modulator in C and L bands

Hiroyuki Kusaka [1], Akira Oka [1], Kazuhiro Goi [1], Kensuke Ogawa [1], Tsung-Yang Liow [2], Xiaoguang Tu [2], Guo-Qiang Lo [2], Dim-Lee Kwong [2]
[1] Optics and Electronics Laboratory, Fujikura Ltd., Chiba, Japan, [2] Inst. of Microelectronics, Singapore Science Park II, Singapore

Monolithic photonic integrated circuit consisting of first-order mode splitter and Ge photodiode is designed, fabricated and characterized for optical performance monitoring of Si Mach-Zehnder modulator.

MM1-5 15:00 - 15:15

Inter-Layer Grating Coupler with Metal Mirrors for 3D Optical Interconnects

JoonHyun Kang[1], Yuki Atsumi[1], Takeshi Sifer[1], Yusuke Hayashi[1], Tomohiro Amemiya[2], Nobuhiko Nishiyama[1], and Shigehisa Arai[1,2]
[1] Dept. of Electrical and Electronic Engineering, Tokyo Inst. of Technology, Japan, [2] Quantum Nanoelectronics Research Center, Tokyo Institute of Technology, Japan

Inter-layer coupling between multilayer waveguides was demonstrated using a-Si:H grating coupler. The grating coupler consists of two vertically stacked waveguides sandwiched by metal mirrors. An enhancement of the coupling efficiency was observed by introducing mirrors.

MM1-6 15:15 - 15:30

Ultra-High-Efficiency Apodized Grating Coupler Using a Fully Etched Photonic Crystal

Yunhong Ding, Christophe Peucheret and Haiyan Ou
Dept. of Photonics Engineering, Technical Univ. of Denmark, Lyngby, Denmark

We demonstrate an apodized fiber-to-chip grating coupler using fully etched photonic crystal holes on the silicon-on-insulator platform. An ultra-high coupling efficiency of 1.65 dB (68%) with 3 dB bandwidth of 60 nm is experimentally demonstrated.

MM1-7 15:30 - 15:45

Amorphous Si waveguides with high-quality stacked gratings for multi-layer Si optical circuits

T. Endo [1], K. Saiki [1], K. Hiidome [1], H. Tokushige, T. Katsuyama [1], M. Tokuda [2], H. Takagi [2], M. Morita [2], Y. Ito [2], K. Tsutsui [2], Y. Wada [2], N. Ikeda [3] and Y. Sugimoto [3]
[1] Univ. of Fukui, Fukui, Japan, [2] Toyo Univ., Saitama, Japan, [3] NIMS, Ibaraki, Japan

Amorphous Si wire waveguides with stacked gratings are successfully fabricated by carefully controlling the SOG coating thickness. The peak energy of the light from the waveguide is controlled to be just 1.55 μm as designed.

Room C-1 1F

[MR2] 16:30 - 18:30
Space Division Multiplexing

Session Chair: Yoshinari Awaji (National Inst. of Information and Communications Technology (NICT), Japan)

MR2-1 16:30 - 17:00 Invited

The Future of Space-Division Multiplexing and Its Applications

Guifang Li

CREOL, The College of Optics & Photonics, Univ. of Central Florida, FL, USA and The College of Precision Instruments and Opto-electronic Engineering, Tianjin Univ., Tianjin, China

Space-division multiplexing (SDM) has attracted significant attention in recent years. The enabling technologies for SDM have been developed at a rapid pace and ushered in a new trajectory in single-fiber capacity growth for optical communication.

MR2-2 17:00 - 17:15

Characterization of Mode-Dependent Loss of Laser Inscribed Photonic Lanterns for Space Division Multiplexing Systems

Nicolas K. Fontaine, and Roland Ryf

Bell Laboratories/Alcatel-Lucent, NJ , USA

We characterize the 12×12 frequency-dependent trans- fer matrix, H(ω), of a 6-port photonic lantern spatial- multiplexer using a swept-wavelength interferometer. Eigen-value analysis of H(ω) provides of the mode-dependent loss and insertion loss.

MR2-3 17:15 - 17:30

Higher-Order Mode Conversion Using Cascaded Phase Plates

Koji Igarashi, Takehiro Tsuritani, and Itsuro Morita

KDDI R&D Laboratories Inc., Saitama, Japan

We propose a technique for higher-order mode conversion based on cascade multiple phase plates with simple phase patterns. Using our scheme, the mode conversion to LP11 and LP21 has been demonstrated.

MR2-4 17:30 - 17:45

Impacts of Increased Effective Area on the Capacity of Multi-Core Fiber System

J. H. Chang, H. G. Choi, and Y. C. Chung

KAIST, Dept. of Electrical Engineering, Daejeon, Korea

We evaluate the impacts of the increased effective area on the capacity of multi-core fiber (MCF). The results show that the use of large effective area is not effective for increasing the capacity of MCF.

MR2-5 17:45 - 18:00

Transmission Penalties in a 19-Core Fiber System with Self-Homodyne Detection

B.J.Puttnam [1], J-M. Delgado Mendinueta [1], J.Sakaguchi [1], R.S.Luis [1], W.Klaus [1], Y.Awaji [1], N.Wada [1], A.Kanno [2] and T.Kawanishi [2]

[1] Photonic Network System Laboratory, [2] Lightwave Devices Laboratory Nat'l Inst. of Information and Communications Technology (NICT), Tokyo, Japan

We investigate transmission penalties in a high capacity self-homodyne coherent detection system using a 19-core fiber. We show small implementation penalties of under 0.5dB and linewidth independence that may enable transmission of high-order modulation formats.

MR2-6 18:00 - 18:15

Conversion and Extraction of Spatial Modes from a Multimode Fiber by Reference-Free Holographic-Diversity Interferometry

Yuki Hirasaki, Atsushi Okamoto, Tomohiro Maeda, Akihisa Tomita, and Yuta Wakayama

Graduate School of Information Science and Technology, Hokkaido Univ., Sapporo, Japan

The wave fronts of speckle fields exiting a multimode fiber are controlled by using a spatial light modulator in cooperation with reference-free holographic diversity interferometry for the high performance adaptive compensation and multiplex transmission.

MR2-7 18:15 - 18:30

Comparison of DSP Equalizer Complexity between Strongly and Weakly Coupled Few Mode Fiber Transmission Systems

B. Inan[1,2], K. Igarashi[2], B. Spinnler[3], T. Tsuritani[2], and N. Hanik[1]

[1] Technical Univ. of Munich, Munich, Germany, [2] KDDI R&D Laboratories Inc., Saitama, Japan, [3] Nokia Siemens Networks, Munich, Germany

We analyze the complexity of MIMO-equalizers in both strongly and weakly-coupled FMF transmission systems. We found that the blind equalizer in the latter system has significantly smaller complexity than that in the former system.

Room C-2 1F

[MH2] 16:30 - 18:30 Symposium
New Frequency, Novel LDs and LEDs -Innovative Works on Widegap Semiconductors- II

Session Chair: Wataru Terashima (RIKEN, Japan)

MH2-1 16:30 - 17:00 Invited

GaN Nanocolumn Light-Emitters, Growth, and Optical Characterization

K. Kishino [1,2], A. Yanagihara [1], Y. Igawa [1], K. Ikeda [1], T. Ozaki [1], S. Ishizawa [1], K. Yamano [1], and R. Vadivelu [1]

[1] Sophia Univ., Tokyo, Japan, [2] Sophia Nanotechnology Research Center, Sophia Univ., Japan

Selective area growth of GaN nanocolumn arrays on Si substrates was developed. Orange-emitting nanocolumns on GaN/Al_2O_3 templates were optically characterized, fabricating red-color InGaN-based nanocolumn LEDs. Successful monolithic integration of four emission-colors nanocolumn LEDs was demonstrated.

MH2-2 17:00 - 17:30 Invited

Progress of Be-Based II-VI Green to Yellow Laser Diodes

S. Tanaka [1], J. Kasai [1], S. Fujisaki [1], S. Tsuji [1], R. Akimoto [2], T. Hasama [2], and H. Ishikawa [2]

[1] Central Research Laboratory, Hitachi, Ltd., Tokyo, Japan, [2] Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Ibaraki, Japan

Continuous-wave operation in green-to-yellow spectral region was demonstrated with BeZnCdSe quantum-well laser diodes with a low threshold current density.

MH2-3 17:30 - 18:00 Invited

Superluminescent Light Emitting Diodes of 100mW Output Power for Pico-Projection

U. T. Schwarz[1,2], F. Kopp[3], T. Weig[2], C. Eichler[3] and U. Strauss[3]

[1] Dept. of Microsystems Engineering, Univ. of Freiburg, Freiburg, Germany, [2] Fraunhofer IAF, Freiburg, Germany, [3] OSRAM Opto Semiconductors GmbH, Regensburg, Germany

A blue superluminescent LED (SLED) with power above 100mW was fabricated. These SLED shows promise for focus-free pico-projection due to reduced interference and improved image quality. We compared different straight and curved waveguide designs.

MH2-4 18:00 - 18:30 Invited

Optical Properties of Boron Nitride Single Crystals

Kenji Watanabe and Takashi Taniguchi

Nat'l Inst. for Materials Science, Ibaraki, JAPAN

In this paper, we review the recent growth technique for cubic and hexagonal BN and their optical properties.

Room F 1F

[MA2] 16:30 - 17:45
Structured Light Sources

Session Chair: Takunori Taira (Inst. of Molecular Science, Japan)

MA2-1 16:30 - 17:00 Invited

Lissajous and trochoidal beam generation from diode pumped solid state lasers

Y. F. Chen

Dept. of Electrophysics, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

We experimentally generate various Lissajous beams with an off-axis pumping scheme. With the transformational relationship, we experimentally generate various trochoidal beams by exploiting a cylindrical-lens mode converter.

MA2-2 17:00 - 17:15

Direct Generation of Ince-Gaussian Beam in Cr,Nd:YAG Self-Q-Switched Microchip Laser

Jun Dong[1,2], Xiao Zhou[1], and Guozhang Xu[1]

[1] Dept. of Electronic Engineering, School of Information Science and Technology, Xiamen Univ., Xiamen, P. R. China, [2] Key Laboratory of Underwater Acoustic Communications and Marine Information Technology, Ministry of Education, Xiamen Univ., Xiamen, P. R. China

Direct generation of higher-order Ince-Gaussian (IG) beams in laser-diode end-pumped Cr,Nd:YAG self-Q-switched microchip laser was achieved with high efficiency and high repetition rate.

MA2-3 17:15 - 17:30

Ultra-violet optical vortex generation

Yuta Sasaki [1], Yu Tokizane [1,2], Katsuhiko Miyamoto [1], and Takashige Omatsu [1,2]

[1] Graduate School of Advanced Integration Science, Chiba Univ., Chiba, Japan, [2] Japan Science and Technology Agency, CREST, Tokyo, Japan

We demonstrated for the first time an ultra-violet vortex output without a spatial separation of phase singularities by frequency-doubling a green vortex laser with a pair of β-BaB_2O_4 and reversed β-BaB_2O_4 crystals.

MA2-4 17:30 - 17:45

Helicity Control of a 2-μm Optical Vortex Output From a Vortex-Pumped Optical Parametric Oscillator

Taximaiti Yusufu [1], Yu Tokizane [1,2], Masaki Yamada [1], Katsuhiko Miyamoto [1] and Takashige Omatsu [1,2]

[1] Graduate School of Advanced Integration Science, Chiba Univ., Chiba, Japan, [2] Japan Science and Technology Agency, CREST, Tokyo, Japan

We have presented the first demonstration of the helicity control of the optical vortex output from a vortex-pumped optical parametric oscillator by inverting the wavefront helicity of the pump vortex beam.

Room G 1F

[MG2] 16:30 - 18:15
Quantum Memory
Session Chair: Kazuki Koshino (Tokyo Medical and Dental Univ., Japan)

MG2-1 16:30 - 17:00 Invited

Building A Quantum Repeater with Quantum Memories and Noiseless Amplifiers

P. K. Lam[1,2], M. Hosseini[1,2], G. Campbell[1,2], O. Pinel[1,2], B. Sparkes[1,2], J. Twamley[4], S. Rebic[1,2,4], H. M. Chrzanowski[1,2], S. Assad[1,2], J. Bernu[1,2], T. C. Ralph[1,3], N. Walk[1,3], T. Symul[1,2] and B. C. Buchler[1,2].

[1] Centre for Quantum Computation and Communication Technology, [2] Dept. of Quantum Science, The Australian Nat'l Univ., Canberra, Australia, [3] School of Mathematics and Physics, The Univ. of Queensland, Brisbane, Australia, [4] Centre for Engineered Quantum Systems, Dept. of Physics & Astronomy, Macquarie Univ., Sydney, Australia

We present a quantum repeater scheme that uses gradient echo memory and probabilistic noiseless amplification. We show that a quantum memory can process quantum information and a noiseless amplifier can distill entanglement.

MG2-2 17:00 - 17:30 Invited

Quantum memories with rare-earth-ion doped crystals

F. Bussières[1], C. Clausen[1], I. Usmani[1], A. Tiranov[1], N. Sangouard[1], H. de Riedmatten[1,2,3], M. Afzelius[1] and N. Gisin[1]

[1] Group of Applied Physics, Univ. of Geneva, Geneve, Switzerland, [2] ICFO-Institut de Ciencies Fotoniques, Mediterranean Technology Park, Barcelona, Spain ICREA-Institucio Catalana de Recerca i Estudis Avançats, Barcelona, Spain

Quantum networks consist in remote quantum memories capable of storing, processing and measuring quantum information distributed by photons. Here we describe how we used rare-earth-ion doped crystals to realize fundamental building blocks of quantum networks.

MG2-3 17:30 - 17:45

Frequency Multiplexed Quantum Memories with Read-Out on Demand for Quantum Repeaters

Neil Sinclair[1], Erhan Saglamyurek[1], Hassan Mallahzadeh[1], Joshua A Slater[1], Morgan Hedges[1], Mathew George[2], Raimund Ricken[2], Daniel Oblak[1], Wolfgang Sohler[2], and Wolfgang Tittel[1]

[1] Inst. for for Quantum Science and Technology, and Dept. of Physics & Astronomy, Univ. of Calgary, Alberta, Canada, [2] Dept. of Physics - Applied Physics, Univ. of Paderborn, Paderborn, Germany

We propose an approach to quantum repeaters based on frequency multiplexing and experimentally demonstrate the key component: a frequency multimode quantum memory featuring recall on demand in the frequency domain.

MG2-4 17:45 - 18:00

Investigations of Population Relaxation Properties of Hyperfine Sublevels in $^{167}Er^{3+}$ Ions Doped in a Y_2SiO_5 Crystal

Daisuke Hashimoto and Kaoru Shimizu

NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan

We have established the lifetime of the hyperfine sublevels of $^{167}Er^{3+}$ ions in Y_2SiO_5 using spectral hole burning, measuring it as 37.8 ms at 2.25 K. Its temperature dependence varies as $(1/T)^n$ ($n \sim 3$).

MG2-5 18:00 - 18:15

Process Tomography of Coherent State Transfer from Light Polarization to Electron Spin Polarization in a Semiconductor

H. Kosaka, T. Inagaki, Y. Mitsumori, and K. Edamatsu

Research Inst. of Electrical Communication, Tohoku Univ., Sendai, Japan

We demonstrate process tomography of coherent state transfer. We estimated process fidelity of the state transfer to be 81% and clarified that the phase-flip error is the major contribution to the fidelity degradation.

Room H 1F

[MI2] 16:30 - 18:30
Nanocavity QED
Session Chair: Fabrice Raineri (CNRS-LPN, France)

MI2-1 16:30 - 17:00 Invited

Nonlinear Photonics in Single Quantum Dot-Photonic Crystal Nanocavity Couples Systems

Satoshi Iwamoto, Yasutomo Ota, Hiroyuki Takagi, Naoto Kumagai and Yasuhiko Arakawa

Inst. of Industrial Science, the Univ. of Tokyo Institute for Nano Quantum Information Electronics, the Univ. of Tokyo, Tokyo, Japan

We will present our recent advances on single quantum dot-photonic crystal nanocavity coupled systems. Cavity enhanced two-photon emission and large optical Stark effect with extremely low control power in these systems will be mainly discussed.

MI2-2 17:00 - 17:15

Large Vacuum Rabi Splitting in an H0 Photonic Crystal Nanocavity-Quantum Dot System

Daisaku Takamiya [1], Yasutomo Ota [2], Ryuichi Ohta [1], Hiroyuki Takagi [1], Naoto Kumagai [2], Satomi Ishida [1], Satoshi Iwamoto [1,2], and Yasuhiko Arakawa [1,2]

[1] Inst. of Industrial Science, The Univ. of Tokyo, [2] The Institute for Nano Quantum Information Electronics, The Univ. of Tokyo, Tokyo, Japan

We demonstrate a large vacuum Rabi splitting in an H0 photonic crystal nanocavity-quantum dot system. The nanocavity with an ultra-small mode volume enabled us to observe the largest splitting ever reported using single InAs-quantum dots.

MI2-3 17:15 - 17:30

Enhanced and Suppressed Spontaneous Emission From a Buried Heterostructure Photonic Crystal Cavity

M. Takiguchi [1,2], H. Sumikura [1,2], M. D. Birowosuto [2], E. Kuramochi [1,2], T. Sato [1,3], K. Takeda [1,3], S. Matsuo [1,3], and M. Notomi [1,2]

[1] NTT Nanophotonics Center, NTT Corp., Kanagawa, Japan, [2] NTT Basic Research Laboratories, NTT Corp., Kanagawa, Japan, [3] NTT Photonics Laboratories, NTT Corp., Kanagawa, Japan

Buried-heterostructure photonic-crystal cavities strongly confine photons and carriers. Here, we demonstrate that we can greatly enhance and suppress the spontaneous emission rate in them by the cavity quantum-electrodynamics effect.

MI2-4 17:30 - 17:45

Photonic-Crystal-Based Platform to Control Spontaneous Emission From Single Molecules

T. Kaji [1], T. Yamada [1], S. Ito [2], H. Miyasaka [2], R. Ueda [1], S. Inoue [1], and A. Otomo [1]

[1] Advanced ICT Research Inst., Nat'l Institute of Information and Communications Technology (NICT), Kobe, Japan, [2] Division of Frontier Materials Science, Graduate School of Engineering Science, Osaka Univ., Osaka, Japan

We have developed a new photonic-crystal-based platform having a two-dimensional photonic band gap (PBG) for the control of spontaneous emission from single molecules and observed fluorescence-lifetime elongation of the single molecules by the PBG effect.

MI2-5 17:45 - 18:00

Controlling Inhibited Spontaneous Emission of InAs/InP Nanowires in Different Environment.

M.D. Birowosuto [1,2], G. Zhang [1], A. Yokoo [1,2], M. Takiguchi [1,2], and M. Notomi [1,2]

[1] NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan, [2] NTT Nanophotonics Center, NTT Corporation, Kanagawa, Japan

We experimentally investigate the inhibited spontaneous emission of telecom-band InAs quantum disks in InP nanowires near gold, SiO_2, and silicon interfaces. We have evaluated how the inhibition is affected by different interfaces and disk thickness.

MI2-6 18:00 - 18:15

Manipulation of Spontaneous Emission with Quasi-periodic Metamaterials

K. Nakayama [1,2], Y. Moritake [2], T. Suzuki [2], H. Kurosawa [2], T. Kodama [3], S. Tomita [3], H. Yanagi [3], and T. Ishihara [2]

[1] Center for the Advancement of Higher Education, Tohoku Univ., Sendai, Japan, [2] Dept. of Physics, Tohoku Univ., Sendai, Japan, [3] Graduate School of Materials Science, Nara Inst. of Science and Technology, Ikoma, Japan

Enhanced spontaneous emission of a quantum emitter by sub-wavelength quasi-periodic metamaterials is proposed and demonstrated. Strong enhancement of spontaneous emission of quantum dots was observed. This arises from the semi-localized mode inherent for quasi-periodic structures.

MI2-7 18:15 - 18:30

Self-frequency Summing in Photonic Crystal Nanocavity Quantum Dot Lasers

Yasutomo Ota [1], Katsuyuki Watanabe [1], Satoshi Iwamoto [1,2], and Yasuhiko Arakawa [1,2]

[1] Inst. for Nano Quantum Information Electronics, The Univ. of Tokyo, Tokyo, Japan, [2] Institute of Industrial Science, The Univ. of Tokyo, Tokyo, Japan

Self-frequency summing processes in photonic crystal nanocavity quantum dot lasers are observed. High quality factors and small mode volumes of the nanocavities facilitate efficient nonlinear frequency summing processes, generating a variety of visible emission lines.

Room I 2F

[MQ2] 16:30 - 18:30
Highly Efficient Optical Networks
Session Chair: Soichiro Araki (NEC Green Platform Research Laboratories, Japan)

MQ2-1 16:30 - 17:00 Invited

Recent Advances in Elastic Optical Networks

Masahiko Jinno

Kagawa Univ., Kagawa, Japan

This paper reviews the recent advances in elastic optical network from viewpoints of networking, hardware design, and standardization activities.

MQ2-2 17:00 - 17:30 Upgrade Invited

Performance Evaluation of Large-scale OXC Architectures that Utilize Intra-node Routing Restriction

Hai-Chau Le, Toshinori Ban, Hiroshi Hasegawa, and Ken-ichi Sato

Nagoya Univ., Nagoya, Japan

We evaluate the performances of scalable large-scale OXC architectures; all utilize a two-stage routing mechanism that dynamically groups wavelength paths and conditionally selects output fibers. The architectures are shown to reduce necessary hardware scale substantially.

MQ2-3 17:30 - 17:45

Fast Energy-efficient Point-to-MultiPoint Routing Algorithm for MiDORi

Akiko Hirao, Yuki Nomura, Hidetoshi Takeshita, Satoru Okamoto, and Naoaki Yamanaka

Graduate School of Science and Technology, Keio Univ., Yokohama, Japan

In this paper, we propose an algorithm which computes the energy-efficient P2MP-path for MiDORi network rapidly. By computer simulation, proposed algorithm can calculate within 3 seconds and reduce 30kW in large scale network.

MQ2-4 17:45 - 18:00

Cyclic Sleep Management Schemes of Backup Transponders for Power Saving and High-speed Failure Recovery

Tomoyuki Hino[1], Hitoshi Takeshita[1], Kiyo Ishii[2], Junya Kurumida[2], Shu Namiki[2], Kenji Mizutani[1], Shigeru Nakamura[1], and Akio Tajima[1]

[1] Green Platform Research Labs, NEC Corporation, Kawasaki, Japan [2] Network Photonics Research Center, AIST, Ibaraki, Japan

We propose cyclic sleep management schemes for backup transponders to achieve simultaneously low power consumption and high-speed failure recovery time. Recovery time shorter than 50ms was obtained with 38% power saving on backup transponders.

MQ2-5 18:00 - 18:15

Experimental Validation of Effect of the Power-Saving Standby Mode on the Backup Path

K. Mizutani [1], H. Takeshita [1], K. Ishii [2], J. Kurumida [2], S. Namiki [2], A. Tajima [1]

[1] Green Platform Research Laboratories, NEC Corporation, Japan, [2] Network Photonics Research Center, AIST, Japan

We propose new power saving optical network architecture. The power saving standby mode on the backup path using power-saving transponders / regenerators can save 50 % of power consumption.

MQ2-6 18:15 - 18:30

Enhanced Minimum Interference Routing Algorithms for Elastic Optical Networks

Fang Yi, Bingli Guo, Chen Xin , Yongqi He, Zhengbin Li

State Key Lab. of Advanced Optical Communication Systems and Networks Peking Univ., Beijing, China

This work introduces for the first time the notion of minimum interference to the RSA algorithm design and proposes two novel RSA algorithms in SLICE network. Our results show a noticeable spectrum efficiency improvement.

Room J 2F

[MS2] 16:30 - 18:30
Brillouin Measurement and Sensors

Session Chair: Yinchieh Lai (National Chiao Tung Univ., Taiwan)

MS2-1 16:30 - 17:00 Invited

End-reflection Assisted Brillouin Measurement for PON Monitoring

Fumihiko Ito, Hiroshi Takahashi, and Kunihiro Toge

NTT Access Network Service Systems Laboratories, NTT Corporation, Ibaraki, Japan

A novel technique to monitor branched optical fibers is presented, based on the Brillouin analysis with end-reflected probe beams. The principle of the method is described and accompanying applications are discussed.

MS2-2 17:00 - 17:15

Distributed strain measurement in GI fiber with sub-meter spatial resolution by DP-BOTDR

Satoshi MATSUURA, Masahiro KUMODA, Yusuke ANZAI, and Yahei KOYAMADA

Graduate School of Science and Engineering, Ibaraki Univ., Ibaraki, Japan

We report experimental results on distributed strain measurement in GI fibers with a sub-meter spatial resolution using a DP-BOTDR system. A 40-cm spatial resolution was achieved with a 7.1-micro strain error.

MS2-3 17:15 - 17:30

Bidirectional Brillouin Optical Correlation Domain Analysis Using Phase Modulation

Ji Ho Jeong [1], Kwanil Lee [1], Kwang Yong Song [1], Je-Ha Lee [1], Je-Myung Jeong [2], and Sang Bae Lee [1]

[1] Center for Opto-Electronic Convergence Systems, Korea Inst. of Science and Technology (KIST), Seoul, Republic of Korea, [2] Dept. of Electrical and Computer Engineering, Hanyang Univ., Seoul, Republic of Korea, [3] Dept. of Physics, Chung-Ang Univ., Seoul, Republic of Korea

Bidirectional Brillouin optical correlation domain analysis is proposed and experimentally implemented by using a phase modulator. Our proposed scheme leads to an enlarged measurement range with maintaining a spatial resolution.

MS2-4 17:30 - 17:45

Optimized Polarization State for Self-Heterodyne-Based Brillouin Measurement in Plastic Optical Fibers

Y. Mizuno, N. Hayashi, and K. Nakamura

Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Yokohama, Japan

We experimentally clarified that the role of the polarization state optimization in observing Brillouin scattering in plastic optical fibers lies, unlike silica fibers, in suppressing the tail of the Rayleigh-scattered light spectrum.

MS2-5 17:45 - 18:00

High-sensitivity optical fiber temperature sensor using multimode interference

Y. Kushida, H. Fukano, and S. Taue

Graduate School of Natural Science and Technology, Okayama Univ., Okayama, JAPAN

We have developed a simple high-sensitivity fiber temperature sensor using multimode interference. The structure comprises a large-core multimode fiber (MMF) sandwiched between single-mode-fibers. The MMF is coated with silicone-elastomer, whose refractive index varies with temperature.

MS2-6 18:00 - 18:15

Fabry-Perot Pressure Sensor Based on a Simplified Bandgap Fiber

Long Jin [1], Bai-Ou Guan [1], and Huifeng Wei [1]

[1] Inst. of Photonics Technology, Jinan Univ., Guangzhou, China, [2] State Key Laboratory of Optical Fiber and Cable Manufacture Technology, Yangtze Optical Fiber and Cable Company Ltd. R&D center, Wuhan, China

The response of a Fabry-Perot Pressure sensor based on a simplified bandgap fiber is experimentally and theoretically analyzed. The measured pressure sensitivity is -17.3 pm/MPa, which is mainly a result of the cavity-length change.

MS2-7 18:15 - 18:30

Simultaneous temperature and strain measurement by using a wide-band fiber Bragg grating

Lunlun Xian [1], Peng Wang [2] and Hongpu Li [2]

[1] Graduate School of Science and Technology Shizuoka Univ., [2] Faculty of Engineering, Shizuoka Univ., Hamamatsu, Japan

A novel power-interrogated sensor allowing for simultaneous measurements of the temperature and the strain is firstly proposed and experimentally demonstrated, which is based on the utilization of a linearly chirped fiber Bragg grating (FBG).

Room K 2F

[MB2] 16:30 - 18:30
Attosecond Physics I

Session Chair: Zhiyi Wei (Inst. of Physics, Chinese Academy of Sciences, China)

MB2-1 16:30 - 17:30 Tutorial

Attosecond Optics - from Genesis to Revelation

Zenghu Chang

CREOL and Dept. of Physics, Univ. of Central Florida, FL, USA

Attosecond optics emerged in 2001. It deals with the generation, characterization and application of extreme ultraviolet pulses shorter than one optical cycle of visible light. The duration of isolated attosecond pulses has recently reached 67-as.

MB2-2 17:30 - 18:00 Invited

Microjoule isolated attosecond pulses created by high-order harmonic generation

Eiji J. Takahashi and Katsumi Midorikawa

Extreme Photonics Research Group, RIKEN Advanced Science Inst., Saitama, JAPAN

We successfully generated a microjoule isolated attosecond pulse with 500 as duration in the XUV region. Our developed attosecond source has enough pulse energy making breakthrough for the attosecond nonlinear optics.

MB2-3 18:00 - 18:15

Generation and Measurement of Isolated 173-as XUV Laser Pulses At 82 eV

Hao Teng, Minjie Zhan, Peng Ye, Xinkui He, Wei Zhang, Lifeng Wang, Chenxia Yun, and Zhiyi Wei

Beijing Nat'l Laboratory for Condensed Matter Physics and Inst. of Physics, Chinese Academy of Sciences (CAS), Beijing, China

Isolated attosecond pulse is generated from neon gas driven by CEP stabilized sub-5fs Ti:Sapphire laser pulses at repetition rate of1kHz. The streaking retrieval shown the pulse duration is 173as with photon energy of 82eV.

MB2-4 18:15 - 18:30

Optimized attosecond XUV pulses with zeptosecond timing resolution

X. Han [1], A. Zahid [1], D.E. Laban [1], A.J. Palmer [1], W.C. Wallace [1], N.S. Gaffney [1], R.P.M.J.W. Notermans [1], M.G. Pullen [1], H.M. Quiney [2], I.V. Litvinyuk [1], R.T. Sang [1], and D. Kielpinski [1]

[1] ARC Centre of Excellence for Coherent X-Ray Science and Australian Attosecond Science Facility, Centre for Quantum Dynamics, Griffith Univ., QLD, Australia, [2] ARC Centre of Excellence for Coherent X-Ray Science, Univ. of Melbourne, VIC, Australia

We experimentally optimize the yield of attosecond XUV pulses, with pulse duration inferred from carrier-envelope-phase resolved spectral measurements. We also demonstrate generation of dual attosecond pulses with timing resolution of 90 zeptoseconds.

Room 101 1F

[MT2] 16:30 - 18:15
Optical and Optoelectronic Signal Processing

Session Chair: S. J. Ben Yoo (Univ. of California, USA)

MT2-1 16:30 - 17:00 Invited

Optical/Electrical Hybrid Switching for Datacenter Communications

Nathan Farrington [3], George Porter [1], Alex Forencich [1], Joseph Ford [1], Yeshaiahu Fainman [1], Amin Vahdat [2], and George Papen [1]

[1] Univ. of California at San Diego, CA, USA, [2] UCSD, on leave at Google, CA, USA, [3] Currently at Facebook, Menlo Park, USA

We discuss optical/electrical hybrid switching for datacenters. Our current prototype uses an optical circuit switched architecture based on a wavelength-selective switch (WSS) that has a measured mean host-to-host network reconfiguration time of 11.5 µs.

MT2-2 17:00 - 17:15

A Novel Optoelectronic 32-bit Serial-to-Parallel Converter for 25Gb/s Optical Label Processing

Salah Ibrahim, Hiroshi Ishikawa, Tatsushi Nakahara, Yasumasa Suzaki, and Ryo Takahashi

NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

An optoelectronic 32-bit serial-to-parallel converter with novel conversion scheme and shared-trigger configuration is developed for label processing of 100Gb/s (25Gb/s×4Lambda) optical packets. The converter exhibits high gain and tolerance to voltage swing of received bits

MT2-3 17:15 - 17:30

Optical Clock Pulse-Train Generator for Processing 25 Gbit/s x 4 λ Burst Optical Packets

Tatsushi Nakahara, Yasumasa Suzaki, and Ryo Takahashi

NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

Self-stabilizing optical clock generation for processing 100-Gbit/s (25 Gbit/s x 4 wavelengths) preamble-free, asynchronous optical packets is demonstrated by using a compact module consisting of an optical loop with a saturable absorber and SOA.

MT2-4 17:30 - 17:45

Massive Generation/Recognition of 2-D Label Using Optical Code and Wavelength

Koji Morita [1], Gihan Weerasekara [1], Takahiro Kodama [1], Satoshi Shimizu [2], Naoya Wada [2] and Ken-ichi Kitayama [1]

[1] Osaka Univ., Japan, [2] Nat'l Inst. of Information and Communications Technology (NICT), Japan

Massive number of generation and real-time recognition of 2-D label using optical codes and wavelengths are implemented for the first time.

MT2-5 17:45 - 18:00

40Gbps Operation of an Optical Serial-to-Parallel Converter for DPSK Signals with Phase Operation

Hiroyuki Uenohara, Yutaro Sano, and Hideyuki Kusano

Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Kanagawa, Japan

40Gbps operation of an optical serial-to-parallel converter with phase operation for DPSK signals was achieved due to suppression of chirp with a Mach-Zehnder-type phase modulator. Suppression ratio of above 10dB was obtained.

MT2-6 18:00 - 18:15

Improvement of Number of Processing Bit of a Si Photonic Optical Serial-to-Parallel Converter with Phase Operation

Hideyuki Kusano, and Hiroyuki Uenohara

Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Kanagawa, Japan

We investigate the novel design to compensate the power unbalance in the Mach-Zehnder delay interferometers of a Si photonic phase-operation-type optical serial-to-parallel converter. 5-bit improvement of the processed number of bits can be achieved.

Room 103 1F

[MK2] 16:30 - 18:30
Tunable Device
Session Chair: Milan Masanovic (Univ. of California, USA)

MK2-1 16:30 - 16:45

Wavelength Tuning of Hollow Waveguide DBR Lasers

Hideaki Yamakawa, Takahiro Sakaguchi and Fumio Koyama
Photonics Integration System Research Center, Precision & Intelligence Laboratory, Tokyo Inst. of Technology, Yokohama, Japan

We demonstrate the wavelength tuning of hollow-waveguide DBR laser with variable air core. Wavelength tuning of 8.2nm was obtained with a core-thickness change of 0.68μm. A novel design for wide continuous tuning is also presented.

MK2-2 16:45 - 17:00

Electro-thermally Tunable 850nm VCSELs with metal/semiconductor Thermally Actuated Mirror

M. Nakahama [1], H. Sano [1], S. Inoue [1], A. Matsutani [2], T. Sakaguchi [1], and F. Koyama [1]
[1] Photonics Integration System Research Center., Tokyo Inst. of Technology, Yokohama, Japan, [2] Semiconductor and MEMS Processing Center, Tokyo Institute of Technology, Yokohama, Japan

We report on an electro-thermally tunable 850nm VCSEL, exhibiting a large negative wavelength drift of 2.0nm/K. Continuous and linear wavelength tuning of 25 nm was obtained with heating power of 9.4 mW.

MK2-3 17:00 - 17:30 Invited

Super-high Resolution Optical Beam Steering Based on Bragg Reflector Waveguides

Fumio Koyama and Xiaodong Gu
Photonics Integration System Research Center, Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Yokohama, Japan

We proposed beam steering devices based on Bragg-reflector waveguides. We show a large steering angle and ultra-high steering resolution at the same time. We present our high-resolution beam steering concept based on VCSEL photonics.

MK2-4 17:30 - 17:45

High Power Operation at High Temperature of AlGaInAs/InP Widely Tunable BH Laser

M. Wakaba [1], N. Iwai [1], K. Kiyota [1], H. Hasegawa [1], T. Kurobe [2], G. Kobayashi [2], E. Kaji [1] M Kobayakawa [1], T. Kimoto [2], N. Yokouchi [1], and A. Kasukawa [1]
[1] Yokohama R&D Labs., Furukawa Electric Co., Ltd., Yokohama, Japan [2] FITEL Photonics Lab., Furukawa Electric Co., Ltd., Chiba, Japan

We fabricated high performance 1550 nm widely tunable lasers with buried-heterostructure configuration based on the AlGaInAs/InP system. The output power as high as 90 mW at a temperature of 70 °C was achieved.

MK2-5 17:45 - 18:00

Narrow-Linewidth Single-Mode and Tunable Two-Electrode Corrugated-Ridge Waveguide DFB Lasers

K. Dridi [1], A. Benhsaien [1], J. Zhang [2], and T.-J. Hall [1]
[1] Centre for Research in Photonics, Photonic Technology Laboratory, Univ. of Ottawa, Ottawa, Canada, [2] CMC Microsystems, Ottawa, Canada

A single-mode and narrow linewidth two-electrode corrugated-ridge waveguide DFB laser has been fabricated. The preliminary characterization shows side-mode suppression ratios over 50 dB, a tuning range over 3.2 nm, and a linewidth of 204 kHz.

MK2-6 18:00 - 18:15

Narrow Linewidth tunable DFB laser array for PDM-16QAM transmission

Tatsuya Kimoto [1], Go Kobayashi [1], Tatsuro Kurobe [1], Toshikazu Mukaihara [1], Stephen Ralph [2]
[1] Optical Devices Dept., FITEL Photonics Laboratory, Furukawa Electric Co., Ltd., Chiba, Japan, [2] Georgia Inst. of Technology, Georgia, USA

We report realization of narrow linewidth (<218 kHz) and high power characteristics (>15.5 dBm) in tunable light source integrated with DFB array and SOA. Results of PDM-16QAM transmission have been successfully demonstrated.

MK2-7 18:15 - 18:30

Linewidth Measurements of Frequency Tunable Laser in Optical Coherence Tomography

Y. Takasaki, K. kuroda, and Y. Yoshikuni
Kitasato Univ., Kanagawa, Japan

A new method for linewidth measurements in frequency tunable lasers is proposed. The coherent length obtained from the linewidth is equivalent to the coherent length estimated by using an optical coherence tomography interferometer.

Room 104A 1F

[MC2] 16:30 - 18:30
Terahertz Science I
Session Chair: Koichiro Tanaka (Kyoto Univ., Japan)

MC2-1 16:30 - 17:00 Invited

Interaction of Excitons with THz Pulses: "Atom Spectroscopy" on Quasi-Particles

Sangam Chatterjee
Faculty of Physics and Materials Science Center, Philipps-Universitat Marburg, Marburg, Germany

The interaction of excitons with strong THz pulses is investigated in semiconductor quantum wells. Phenomena like population transfer into dark states, inter-state coherences, and selection rules are discussed and compared to atomic systems.

MC2-2 17:00 - 17:15

Photoluminescence Flash Induced by Intense Single-Cycle Terahertz Pulses in Undoped GaAs Quantum Wells

K. Shinokita [1], H. Hirori [2], K. Tanaka [1,2], T. Mochizuki, C. Kim [3], H. Akiyama [3], L. N. Pfeiffer [4] K. W. West [4]
[1] Dept. of Physics, Graduate School of Science, Kyoto Univ., Kyoto, Japan, [2] Inst. for Integrated Cell-Material Sciences (WPI-iCeMS), Kyoto Univ., and JST-CREST, Kyoto, Japan, [3] Inst. for Solid State Physics, Univ. of Tokyo, and JST-CREST, Chiba, Japan, [4] Dept. of Electrical Engineering, Princeton Univ., New Jersey, USA

Intense terahetz pulses induce a photoluminescence flashes from undoped GaAs/AlGaAs quantum wells under continuous wave laser excitation. This result indicates that the number of excitons increases 10000-fold from that of the steady state.

MC2-3 17:15 - 17:30

Coherent Transitions in Doped-Germanium Using Intense Few-Cycle THz Pulses

Masaya Nagai, Yutaka Kamon, Yosuke Minowa, Eiichi Matsubara, and Masaaki Ashida
Graduate School of Engineering Science, Osaka Univ., Japan

We investigated nonlinear THz response of a doped semiconductor using intense THz pulses with different cycle-number. Coherent transitions between impurity levels were observed using few-cycle pulses, while ionization of impunities was driven by monocycle pulses.

MC2-4 17:30 - 17:45

Single-shot Terahertz Spectrometer Using an Echelon Mirror and Air Plasma

I. Katayama, Y. Hayashi, K. Masuda, Y. Minami, and J. Takeda
Graduate School of Engineering, Yokohama Nat'l Univ., Yokohama, Japan.

Single-shot detection of terahertz electric waveforms generated from laser-induced air plasma was demonstrated using an echelon mirror. The obtained waveforms have a good signal-to-noise ratio, which is feasible for single-shot terahertz spectroscopy of materials.

MC2-5 17:45 - 18:00

Intense Terahertz Supercontinuum Generated From Ultrashort Laser Induced Plasma of Metal Foil

Cunlin Zhang [1], Liangliang Zhang [1], Chao Deng [2], Kaijun Mu [1]
[1] Key Laboratory of Terahertz Optoelectronics, Ministry of Education of China, Beijing Key Laboratory for Terahertz Spectroscopy and Imaging, Dept. of Physics, Capital Normal Univ., Beijing, China, [2] School of Optoelectronics, Beijing Inst. of Technology, Beijing, China

The radiated THz supercontinuums were obtained by a Michelson interferometer in room temperature. We got more than 60μJ intense single THz pulse.The maximum spectrum was distributed from 0.3 - 149THz which get from Ru foil.

MC2-6 18:00 - 18:15

Terahertz Near-field Detection of Liquid by a Scanning Laser Terahertz Imaging System

K. Serita[1,2], H. Murakami[1], I. Kawayama[1], and M. Tonouchi[1]
[1] Inst. of Laser Engineering, Osaka Univ., Osaka, Japan, [2] Research Fellow of Japan Society for the Promotion of Science, Tokyo, Japan

Terahertz (THz) near-field detection of liquid was demonstrated by using a scanning laser THz imaging system. The obtained data indicate sample specific peaks and the technique has a potential for evaluating small amounts of liquid.

MC2-7 18:15 - 18:30

Terahertz Response of low-OH Synthetic Silica Glass Probed by a Broadband Plasma Source

C. Wolpert[2,3], S. Tani[1,2], Y. Kinoshita[4], T. Tanaka[2,3], and K. Tanaka[1,2,3]
[1] Dept. of Physics, Graduate School of Science, Kyoto Univ., Kyoto, Japan, [2] Inst. for Integrated Cell-Material Sciences (WPI-iCeMS), Kyoto Univ., Kyoto, Japan, [3] CREST, Japan Science and Technology Agency, Saitama, Japan, [4] Daico MFG Co. Ltd., Kyoto, Japan

We report on terahertz optical properties of highly pure synthetic silica glasses with an OH content below 1 ppm. Absorption coefficients as low as 4 cm-1 could be determined at 2 THz by time-domain spectroscopy.

Room 104B 1F

[MM2] 16:30 - 18:00
Si Photonics: Novel Materials
Session Chair: Yasuhiko Ishikawa (The Univ. of Tokyo, Japan)

MM2-1 16:30 - 17:00 Invited

Novel Dilute Nitride III/V-semiconductor Laser System for the Monolithic Integration to Si-microelectronics

W. Stolz
Material Sciences Center and Faculty of Physics, Philipps-Univ., Marburg, Germany

The novel dilute-nitride laser material system Ga(NAsP) can be grown lattice-matched to CMOS-compatible (001) Si-substrate, offering unique monolithic integration scenarios for future Si-optoelectronic and photonic integrated cicuits.

MM2-2 17:00 - 17:15

Optical absorption characteristics of single-layer graphene integrated on silicon waveguide

Kaori Warabi[1], Rai Kou[1,2,3], Shinichi Tanabe[4], Tai Tsuchizawa[2,3], Satoru Suzuki[4], Hiroki Hibino[4], Hirochika Nakajima[1] and Koji Yamada[2,3]
[1] Graduate school of Advanced Science and Engineering, Waseda Univ., Tokyo, Japan, [2] NTT Nanophotonics Center, NTT Corporation, Kanagawa, Japan, [3] NTT Microsystem Integration Laboratories, NTT Corporation, Kanagawa, Japan, [4] NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan

We characterized optical absorption of single-layer graphene, which was integrated on a sub-micron scale silicon waveguide. The result revealed that the absorption in TM mode is lower than that in TE mode by surface-plasmon polariton.

MM2-3 17:15 - 17:30

Thermal Nonlinearity and Optical Bistability in a Graphene-Silicon Waveguide Resonator

C. Horvath, D. Bachman, and V. Van
Dept. of Electrical and Computer Engineering, Univ. of Alberta, Alberta, Canada

We report observation of optical bistability due to enhanced thermal nonlinearity in a graphene-silicon waveguide resonator. Ohmic self-heating in the graphene layer results in a 2.7-fold increase in the nonlinear index over bare silicon waveguide.

MM2-4 17:30 - 18:00 Invited

Er Silicate Waveguides for On-Chip Optical Amplifiers

H. Isshiki
Dept. of Engineering Science, The Univ. of Electro-Communications (UEC), Tokyo, Japan

Er silicates waveguides for on-chip optical amplifiers are reviewed. The structure and the fabrication process are discussed.Preliminary results on the gain property of the waveguide using Si photonic crystal slot are shown.

Room C-1 1F

[TuR1] 8:30 - 10:00
Long Haul Transmission
Session Chair: Toshiharu Ito (NEC Corporation, Japan)

TuR1-1 8:30 - 8:45

Impact of the Interplay between Nonlinear and PDL Effects on Q-factor Distribution for Polarization Multiplexed Systems

Olga Vassilieva, Inwoong Kim and Motoyoshi Sekiya
Fujitsu Laboratories of America Inc., Richardson, USA

We show that Q-distribution due to combined NL/PDL effects is narrower compared to the case of the sum of each effect under any dispersion map. This enables Q-margin reduction in optical system design.

TuR1-2 8:45 - 9:00

Unrepeated Link Distance Increase for 448 Gb/s Channel Transmission by using Large Core Area Fiber

G. Meloni [1], L. Poti [1], E. Di Nezza [2], F. Cavaliere [3], A. D'Errico [3], R. Magri [3], and G. Ricci [3]
[1] CNIT, Pisa, Italy, [2] MPB Communications Inc., Quebec, Canada, [3] Ericsson Telecomunicazioni, Pisa, Italy.

Transmission of a 448 Gb/s DP-16QAM signal on a Raman amplified single hop S-SMF or LCAF link demonstrates that the use of LCAF leads to 20% of distance increase by only 8.8% of additional pump.

TuR1-3 9:00 - 9:15

Experimental Study of SPM and XPM using Real Time Coherent DSP for ROADM Systems

K. Ishida, H. Goto, K. Matsuda, M. Binkai, T. Yoshida, T. Tokura, and T. Mizuochi
Information Technology R&D Center, Mitsubishi Electric Corporation, Kanagawa, Japan

The distortion of coherent signals caused by nonlinear effects were studied experimentally using a real time DSP at 40 Gbps.

TuR1-4 9:15 - 9:30

Reach Extension of 43-Gb/s RZ-DPSK Signal by Optical Parametric Regenerator

Karen Solis-Trapala, Mingyi Gao, Junya Kurumida, Takashi Inoue and Shu Namiki
Network Photonics Research Center, Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Ibaraki, Japan

An optical parametric regenerator demonstrated experimentally is assessed numerically. The simulation results show a good agreement with the experimental findings and predict a 4-fold improvement in the transmission reach of a 43-Gb/s RZ-DPSK signal.

TuR1-5 9:30 - 10:00 Invited

Ultra-Long-Haul Transmission Using Multicore Fiber Repeatered by Multicore EDFA

Hidenori Takahashi, Koji Igarashi, Koki Takeshima, Takehiro Tsuritani, and Itsuro Morita
KDDI R&D Laboratories Inc., Japan

The multicore fiber transmission technologies is promising candidate to increase the capacity per fiber. In this paper, ultra-long-haul transmission using multicore fiber and multicore EDFA is explained.

Room C-2 1F

[TuN1] 8:30 - 10:00 Symposium
High-density Photonic Integration Platforms and Their Applications (III-V)
Session Chair: Tomoyuki Miyamoto (Tokyo Inst. of Technology, Japan)

TuN1-1 8:30 - 9:00 Invited

InP-based Photonic ICs

Meint K. Smit
COBRA Research Inst., TU Eindhoven, The Netherlands

Generic InP-based foundry processes lead to a large reduction in entry costs and bring photonic ICs within reach for many SMEs and larger companies.

TuN1-2 9:00 - 9:30 Invited

High-performance InP/GaAs Based Photonic Integrated Circuits

M. L. Mašanović [1,2], L.A.Johansson [1,2], J.S. Barton [2], W. Guo [1], M. Lu [1], and L. A. Coldren [1]
[1] ECE Dept., Univ. of California, CA, USA, [2] Freedom Photonics, CA, USA

InP photonic integrated circuits continue to play important roles in realization of modern optical communication systems, optical sensing and free-space communication systems. In this paper, we report on our recent work on InP advanced modulation format tunable transmitters and receivers, as well as 2D optical beam steering InP PICs.

TuN1-3 9:30 - 10:00 Invited

Multi-Guide Vertical Integration in InP: PIC Technology for Cost-Sensitive Applications

Valery Tolstikhin
OneChip Photonics Inc., ON, Canada

This paper describes the fundamentals and applications of the multi-guide vertical integration in InP, an authentic regrowth-free PIC technology for optical communications, and presents the exemplary transceiver and receiver PICs for optical access and interconnects.

Room F 1F

[TuA1] 8:30 - 10:00
High Power Fiber Lasers
Session Chair: Kensuke Shima (Fujikura Ltd., Japan)

TuA1-1 8:30 - 9:00 Invited

Coherent Beam Combining of Kilo-Watt High-Average-Power Narrow-Linewidth Nanosecond Fiber Amplifiers

Zejin Liu, Pu Zhou, Rongtao Su, Xiaolin Wang, and Yanxing Ma
College of Optoelectric Science and Engineering, Nat'l Univ. of Defense Technology, Changsha, China

We report coherent combining of seven nanosecond all-fiber amplifier array with an overall average power of 1.2 kW. The combined laser has a pulse width of ~3 ns and a peak power of 75.1 kW.

TuA1-2 9:00 - 9:15

98 W 1178 nm Yb-doped Solid-Core Photonic Bandgap Fiber Oscillator

Xinyan Fan [1], Mingchen Chen [1], Akira Shirakawa [1], Christina B. Olausson [2], and Jes Broeng [2]
[1] Inst. for Laser Science, Univ. of Electro-Communications, Tokyo, Japan, [2] NKT Photonics A/S, Birkerød, Denmark

A high power 1178nm Yb-doped photonic bandgap fiber laser is reported. A fiber Bragg grating and a Fresnel fiber end construct the resonator. 98W output power and 54% slope efficiency are achieved without parasitic lasing.

TuA1-3 9:15 - 9:30

Optimization of Multi-Watt Output Power in a Narrowband Fiber Optical Parametric Oscillator

Lei Jin, and Shinji Yamashita
The Dept. of Electrical Engineering and Information Systems, The Univ. of Tokyo, Tokyo, Japan

Optimization of output power in a fiber optical parametric oscillator at 1450nm is experimentally and theoretically studied. The optimum output coupling is above 0.8. A 2.4W peak-power was measured for a 70% internal cavity loss.

TuA1-4 9:30 - 9:45

Adjustable Broadband Raman Continuum Source at 1.3 mm by Means of a Dual-Wavelength Ytterbium-Doped Fiber Amplifier and Nonlinear Optical Fibers

L. A. Vazquez-Zuniga [1], Hong Sig Kim [2], Youngchul Kwon [1], and Yoonchan Jeong [1]
[1] Laser Engineering and Applications Laboratory, Dept. of Electrical and Computer Engineering, Seoul Nat'l Univ., Seoul, Korea, [2] Future IT Research Center, SAIT, Samsung Electronics, Gyeonggi-Do, Korea

We experimentally analyze the SRS polarization-dependence characteristics of a high-birefringent fiber. Exploiting such characteristic we generate a broadband source in the 1.3 um wavelength region with 240 nm bandwidth and good input-to-output conversion efficiency.

TuA1-5 9:45 - 10:00

Design of Resonantly Side-pumped 1645-nm Er:YAG Crystal Fiber Lasers with Grating Couplers

Shiuan-Li Lin [1], Yin-Wen Lee [2], Kuang-Yu Hsu [1], Chieh-Wei Huang [1], and Sheng-Lung Huang [1]
[1] Graduate Inst. of Photonics and Optoelectronics, Nat'l Taiwan Univ., Taipei, Taiwan, [2] Dept. of Electro-optical Engineering, National Taipei Univ. of Technology, Taipei, Taiwan

We investigate the resonantly side-pumped 1645-nm Er:YAG crystal fiber laser utilizing a gold-embedded grating coupler. The 91.5% pump coupling efficiency and 73% laser slope efficiency can be achieved in a 18-cm double-clad crystal fiber laser.

Room G 1F

[TuE1] 8:30 - 10:00
Femtosecond Laser Processing I
Session Chair: Ya Cheng (Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China)

TuE1-1 8:30 - 8:45
Imprinting of a Homogeneous Nanograting with Femtosecond Laser Ablation
Kenzo Miyazaki and Godai Miyaji
Inst. of Advanced Energfy, Kyoto Univ., Kyoto, Japan
We demonstrate that intense femtosecond laser pulses can directly imprint a homogeneous nanograting on gallium nitride surface in air through the surface plasmon polariton fields induced and controlled by a simple two-step ablation process.

TuE1-2 8:45 - 9:00
Periodic Grating Structures on Metal Surfaces Self-Formed by Femtosecond Laser Ablation
Masaki Hashida[1,2], Yasuhiro Miyasaka[1,2], Masahiro Shimizu[1,2], Tomoya Ogata[3], Hitoshi Sakagami[3,4], Shigeki Tokita[1,2], and Shuji Sakabe[1,2]
[1] Inst. for Chemical Research, Kyoto Univ., Uji, Japan, [2] Dept. of Physics, Kyoto Univ., Sakyo, Japan, [3] Dept. of Physics, Nagoya Univ., Aichi, Japan, [4] Nat'l Institute for Fusion Science, Gifu, Japan
Periodic grating structures are self-formed on Mo and Ti. The dependence of the grating structures interspaces on laser fluence can be explained by the parametric decay model in which ablation threshold is taken into account.

TuE1-3 9:00 - 9:15
New evolution in interfering femtosecond laser processing
Y. Nakata, Y. Matsuba, K. Murakawa, N. Miyanaga
Inst. of Laser Engineering, Osaka Univ., Osaka, Japan
Interference patterns are summarized in the case of four and six beam correlation, which can be transferred to metamaterial structure. In addition, the structural changes with different processing thresholds are investigated in detail.

TuE1-4 9:15 - 9:30
Three Dimensional Functional Microfluidic Chips Fabricated by Hybrid Femtosecond Laser Microfabrication
Dong Wu, Si Zhu, Jian Xu, Koji Sugioka, and Katsumi Midorikawa
Laser technology laboratory, RIKEN- Advanced Science Inst., Saitama, Japan
We propose a novel strategy which fuses femtosecond laser TPP and FLAE to integrate 3D complex polymer microdevices into glass-based microfluidic devices for highly functional applications. 3D microfilters were fabricated, showing excellent filtering functions.

TuE1-5 9:30 - 9:45
Monolithic Integration of Microelectric Components and Microfluidic Structures in Glass Using Femtosecond Laser
Jian Xu, Dong Wu, Sizhu Wu, Koji Sugioka, and Katsumi Midorikawa
Laser Technology Laboratory, RIKEN, Saitama, Japan
Microelectric components and microfluidic structures are monolithically integrated in a glass substrate by a femtosecond laser. The fabricated microchips are used as microheaters to control the temperature of in-channel fluids.

TuE1-6 9:45 - 10:00
Spatial and Temporal Control of Ice Formation Induced by Femtosecond Laser Impulse
Yoichiroh Hosokawa, Satoru Kumano, Kosuke Sawada, and Takanori Iino
Nara Inst. of Science and Technology, Nara, Japan
Femtosecond laser impulse which is generated under microscope was applied to a trigger to induce ice formation.

Room H 1F

[TuF1] 8:30 - 10:00
Ultrafast Metrology
Session Chair: Zhi Gang Zhang (Peking Univ., China)

TuF1-1 8:30 - 9:00 Invited
Progress in Large Scale, Longterm Stable Timing Distribution and Synchronization
Franz X. Kärtner[1,2,3]
[1] Center for Free-Electron Laser Science, Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany, [2] Physics Dept., Univ. of Hamburg and The Hamburg Center of Ultrafast Imaging, Hamburg, Germany, [3] Dept. of Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Inst. of Technology, Massachusetts, USA
We review a scalable, sub-10-fs precision timing distribution system for next generation accelerator and light source facilities and discuss its extension to sub-femtosecond performance using polarization maintaining dispersion compensated fiber links and integrated waveguide cross-correlators.

TuF1-2 9:00 - 9:15
Advances in Compact High Repetition Rate Yb:Fiber Laser Frequency Combs
Aimin Wang, Guizhong Wang, Chen Li, Tongxiao Jiang, Wei Zhang, and Zhigang Zhang
State Key Laboratory of Advanced Optical Communication System and Networks, School of Electronics Engineering, and Computer Science, Peking Univ., Beijing, P. R. China
We present the direct short pulse generation and spectrum broadening with ultra-high repetition rate fiber lasers that ensure the long-term stability of frequency combs.

TuF1-3 9:15 - 9:30
Optical Frequency Comb Using Dispersion Managed Er-doped Ultrashort Pulse Fiber Laser Using Carbon Nanotube Polyimide Film
Norihiko Nishizawa[1], Takeru Nagaike[1], Mitsutoshi Aramaki[1], Emiko Omoda[2], Hiromichi Katsura[2,3], and Youichi Sakakibara[2,3]
[1] Dept. of Electrical Engineering and Computer Science, Nagoya Univ., Nagoya, Japan, [2] Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, [3] Japan Science and Technology Agency (JST), CREST, Saitama, Japan
Optical frequency comb system based on Er-doped fiber laser with single wall carbon nanotube polyimide film was developed. Narrowing of fceo beat spectrum was achieved through dispersion management of fiber laser cavity.

TuF1-4 9:30 - 9:45
A New Method of Two-Photon Absorption Spectrum Measurement by Supercontinuum
B. Xue [1], T. Kobayashi [1,2,3,4], J. Du [1,2]
[1] Advanced Ultrafast Laser Research Center, Univ. of Electro-Communications, Tokyo, Japan, [2] Japan Science and Technology Agency, Core Research for Evolutional Science and Technology (CREST), Tokyo, Japan, [3] Dept. of Electrophysics, Nat'l Chiao Tung Univ., Hsinchu, Taiwan, [4] Inst. of Laser Engineering, Osaka Univ., Osaka, Japan
A new non-generated two photon absorption spectrum measurement was demonstrated. A white light supercontinuum beam with wide spectrum range was used for the measurement. A TPA spectrum of Rhodamine-6G was acquired in a single-step procedure.

TuF1-5 9:45 - 10:00
Intracavity High Harmonic Generation At 80 and 10 MHz Repetition Rates
A. Ozawa[1,2], M. Kuwata-Gonokami[3,4] and Y. Kobayashi[1,2]
[1] The Inst. for Solid State Physics, The Univ. of Tokyo, Chiba, Japan, [2] Core Research for Evolutional Science and Technology (CREST), JST, Japan, [3] Dept. of Physics, The Univ. of Tokyo, Tokyo, Japan, [4] Photon Science Center, The Univ. of Tokyo, Tokyo, Japan
Cavity-enhanced high harmonic generation is demonstrated at 80 and 10 MHz repetition rate with Yb-fiber laser. 80 MHz system offers larger comb-mode spacing appropriate for spectroscopy while 10 MHz system generates higher power vuv radiation.

Room I 2F

[TuP1] 8:30 - 10:00
New Applications of Optical Access Technologies
Session Chair: Naoki Suzuki (Mitsubishi Electric Corporation, Japan)

TuP1-1 8:30 - 8:45
WDM Transmission of Y-00 Cipher Signals for High Capacity Secure Optical Fiber Networks
Fumio Futami and Osamu Hirota
Quantum ICT Research Inst., Tamagawa Univ., Tokyo, Japan
Transmission capacity of Y-00 cipher increases by wavelength multiplexing (WDM) technique since Y-00 signals require no excess bandwidth. 10 channel WDM transmission each channel carrying 2.5-Gb/s Y-00 signals over 120 km was successfully demonstrated.

TuP1-2 8:45 - 9:00
Demonstration of OCDM-based 10G-PON with a multiple access noise suppression at RN
Takahiro Kodama [1], Ryosuke Matsumoto [1], Koji Morita [1], Naoya Wada [2], Gabriella Cincotti [3], and Ken-ichi Kitayama [1]
[1] Dept. of Electrical, Electronics and Information Engineering, Osaka Univ., Osaka, Japan, [2] Nat'l Inst. of Information and Communications Technology (NICT), Tokyo, Japan, [3] Dept. of Applied Electronics, Univ. Roma Tre, Rome, Italy
Cost-effective, asynchronous 4 ONUs OOK-OCDM-based 10G-PON system using a novel multiple access noise suppression at RN and its 50km-SMF transmission without dispersion compensation is experimentally demonstrated for the first time.

TuP1-3 9:00 - 9:15
Experimental Demonstration of a Centralized Optical Wireless Indoor Localization System for High-Speed Communications in Personal Areas
Ke Wang[1,2], Ampalavanapillai Nirmalathas[1,2], Christina Lim[2], and Efstratios Skafidas[1,2]
[1] Nat'l ICT Australia - Victoria Research Laboratory (NICTA-VRL), [2] Dept. of Electrical and Electronic Engineering, The Univ. of Melbourne, Australia
A centralized localization system based on the optical wireless technology for personal areas is proposed and experimentally demonstrated in this paper. A localization accuracy of ~5.26 cm is achieved.

TuP1-4 9:15 - 9:30
Software-defined Throughput Optimization for Next-Generation Optical Mobile Backhaul
Neda Cvijetic, Ting Wang
NEC Laboratories America, Princeton, USA
We propose a novel software-defined algorithm for dynamic, physical-layer-aware throughput maximization in next-generation mobile backhaul (MBH) networks. Results confirm >100Mb/s end-to-end per-cell throughputs with ≅2.5Gb/s optical backhaul links deployed at legacy cell sites.

TuP1-5 9:30 - 10:00 Invited
Datacenters: New Challenges and Opportunities for Optical Technologies
Milorad Cvijetic
Univ. of Arizona, AZ, USA
The main aspects of high-speed networking in data centers are discussed. The key challenges, as well as opportunities, for employment of optical network technologies to address current and future challenges are identified.

Room J 2F

[TuS1] 8:30 - 10:00
Multi Core Fiber Amplifiers

Session Chair: Kyozo Tsujikawa (NTT Access Network Service System Laboratories, Japan)

TuS1-1 8:30 - 9:00 Invited

Multicore EDFA for Space Division Multiplexing

Y. Tsuchida, K. Maeda, and R. Sugizaki

FITEL Photonics Laboratory, Furukawa Electric Co., Ltd., Chiba, Japan

Amplification characteristics of MC-EDFA are reviewed. Applicability to future network is evaluated by utilizing core-pumping configuration. In addition, cladding-pumping configuration, which has possibilities for reducing power consumption and downsizing, is demonstrated.

TuS1-2 9:00 - 9:15

Multicore EDF Optimized for Remotely Pumped Amplification System over Multicore Fiber

K. Takenaga [1], K. Ichii [1], S. Matsuo [1], Y. Abe [2], H. Ono [2], M. Yamada [3], and H. Masuda [4]

[1] Optics and Electronics Laboratory, Fujikura Ltd., Chiba, Japan, [2] NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan, [3] Graduate School of Engineering, Osaka Prefecture Univ., Osaka, Japan, [4] Interdisciplinary Faculty of Sci. and Eng., Shimane Univ., Shimane, Japan

Multicore EDF for a remotely pumped amplification system over an MCF have been designed and fabricated. The amplification characteristics of the fabricated MC-EDF were confirmed by assembling the MC-EDF as an EDFA.

TuS1-3 9:15 - 9:30

Cross-talk Characteristics of a Hybrid Multi-core Fiber Transmission System Using Distributed Raman Amplification

K. Kitamura, K. Tayama and H. Masuda

Interdisciplinary Faculty of Sci. and Eng., Shimane Univ., Shimane, Japan

We proposed a novel hybrid multi-core fiber transmission system using distributed Raman amplification. Cross-talk characteristics of the system were theoretically clarified. The cross-talk of a core increased with the Raman gain of the adjacent core.

TuS1-4 9:30 - 9:45

Fused Taper Type Fan-in/Fan-out Device for Multicore EDF

Hitoshi Uemura [1], Katsushiro Takenaga [1], Teijiro Ori [1], Shoichiro Matsuo [1], Kunimasa Saitoh [2], and Masanori Koshiba [2]

[1] Optics and Electronics Laboratory, Fujikura Ltd., Chiba, Japan, [2] Graduate School of Information Science and Technology, Hokkaido Univ., Hokkaido, Japan

Fused taper type fan-in/fan-out device with small MFD is developed for multicore EDF. Almost similar MFD and high accuracy core arrangement as multicore EDF are achieved by using high Δ single-core fiber in elongation process.

TuS1-5 9:45 - 10:00

Fiber Bundle Type Fan-out for Multicore Er Doped Fiber Amplifier

Kengo Watanabe, Tsunetoshi Saito, Yukihiro Tsuchida, Koichi Maeda, Masato Shiino

FITEL Photonics laboratory, Furukawa Electric Co., Ltd., Chiba, Japan

We achieved connection loss < 0.5dB between fiber bundle type fan-out (FBF) and MC-EDF by matching the mode field diameters of each fiber. This low connection loss realized NF improvement about 0.7dB.

Room K 2F

[TuO1] 8:30 - 10:00
Optical Signal Processing II

Session Chair: Hiroshi Murata (Osaka Univ., Japan)

TuO1-1 8:30 - 9:00 Invited

Nanophotonics Technology and Applications

Qing Gu and Yeshaiahu Fainman

Dept. of Electrical and Computer Engineering, Univ. of California at San Diego, La Jolla, CA, USA

This paper explores the role of nanotechnology with focus on nanophotonics in dielectric, metal, semiconductor inhomogeneous composition materials, as well as devices and subsystems for optical communications, information and signal processing, and sensing.

TuO1-2 9:00 - 9:15

Power-Saving Approach Toward 7-bit Optical Quantization for Photonic Analog-to-Digital Conversion

T. Satoh, T. Nagashima, K. Itoh and T. Konishi

Graduate School of Engineering, Osaka Univ., Osaka, Japan

We experimentally investigate the realization of low power consumption optical quantization with 7-bit resolution. We confirm the resolution improvement without increment of the signal power by incorporating the spectral compression technique using a phase modulator.

TuO1-3 9:15 - 9:30

High Precision Photonic ADC with Four Time-Domain-Demultiplexed Interleaved Channels

Filippo Scotti [1], Francesco Laghezza [1], Sergio Pinna [2], Paolo Ghelfi [1], and Antonella Bogoni [1]

[1] CNIT, Pisa, Italy, [2] Scuola Superiore Sant'Anna, Pisa, Italy

High-precision photonic-assisted ADC with very-low sampling jitter and 4-fold sample time-parallelization is presented. Performance evaluation is provided for sampled RF signals at different frequency, showing precision ≥7bit up to 40GHz.

TuO1-4 9:30 - 9:45

Connectivity Verification Between Optical Sampling and Quantization Techniques for All-Optical Analog-to-Digital Conversion

T. Satoh, M. Hasegawa, K. Itoh, and T. Konishi

Graduate School of Engineering, Osaka Univ., Osaka, Japan

We experimentally demonstrate the consecutive processing of optical sampling and quantization for all-optical analog-to-digital conversion. We generate 10 GS/s optical sampled signals using Four-Wave Mixing and connect these signals to optical quantization system.

TuO1-5 9:45 - 10:00

Parallel Use of Dispersion Devices for Resolution Improvement of Optical Quantization at High Sampling Rate

T. Nagashima, T. Satoh, P. Catalin, K. Itoh and T. Konishi

Graduate School of Engineering, Osaka Univ., Osaka, Japan

We investigated a resolution improvement approach for optical quantization in optical analog-to digital conversion with keeping high sampling rate over 100GS/s. The double resolved transfer function is realized at the same sampling rate in experiment.

Room 101 1F

[TuD1] 9:00 - 10:00 Symposium
High Power Lasers and Applications II

Session Chair: Shuji Sakabe (Kyoto Univ., Japan)

TuD1-1 9:00 - 9:30 Invited

New Laser Techniques for Repeatable Ultrahigh Peak Power Laser Beyond Petawatt

J. Kawanaka, T. Kurita, K. Fujioka, H. Furuse, K. Sueda, K. Tsubakimoto, Y. Fujimoto, H. Yoshida, and N. Miyanaga

Osaka Univ., Suita, Japan

Three key techniques for the next generation of repeatable ultrahigh peak power laser have been demonstrated in small scale, cryogenic Yb:YAG DPSSL, OPCPA in random-phased pump, and partially deuterated KDP crystal.

TuD1-2 9:30 - 10:00 Invited

The DiPOLE Project: Towards High Energy, High Repetition Rate Diode Pumped Lasers

K. Ertel, S. Banerjee, P.D. Mason, P.J. Phillips, C. Hernandez-Gomez, and J.L. Collier

Central Laser Facility, STFC Rutherford Appleton Laboratory, Didcot, United Kingdom

DiPOLE is a programme for the development of DPSSL systems producing ns-pulses up to the kJ-level at multi-Hz repetition rates. The chosen concept and results from a first prototype will be reviewed.

Room 103 1F

[TuG1] 8:30 - 10:00
Atom Optics
Session Chair: Yoshiro Takahashi (Kyoto Univ., Japan)

TuG1-1 8:30 - 9:00 Invited

Thermal Vortex Pairs in a 2D Bose Gas

Jae-yoon Choi, Woo Jin Kwon, Sang Won Seo, and Yong-il Shin
Dept. of Physics and Astronomy, Seoul Nat'l Univ., Seoul, Korea

We report the observation of thermally activated vortex pairs in a trapped quasi-2D Bose gas. This confirms the microscopic nature of the superfluid state in a 2D Bose gas trapped in a harmonic potential.

TuG1-2 9:00 - 9:15

Imaging a Single Atom's Absorption and Phase Shift

A. Jechow[1,2], E.W. Streed[1,3], B. G. Norton[1], S. Händel[4], V. Blums[1], and D. Kielpinski[1]
[1] Centre for Quantum Dynamics, Griffith Univ., Nathan Qld, Australia, [2] Photonics, Inst. of Physics and Astronomy, Univ. of Potsdam, Potsdam, Germany, [3] Institute for Glycomics, Griffith Univ., Qld, Australia, [4] Physics and Astronomy, Univ. of California Los Angeles, CA, USA

We have used a single trapped atomic ion to induce and measure a large optical phase shift of 1.3 radians in light scattered by the atom by utilizing spatial interferometry based on absorption imaging

TuG1-3 9:15 - 9:30

Coherent Storage of Ghost Images in Hot Atomic Vapor

Young-Wook Cho, Joo-Eon Oh, and Yoon-Ho Kim
Dept. of Physics, Pohang Univ. of Science and Technology (POSTECH), Pohang, Korea

We demonstrate the storage and retrieval of ghost images in hot atomic vapor. Our experiment shows that the spatially multimode correlation, a second-order property of light, can indeed be preserved during the storage-retrieval process.

TuG1-4 9:30 - 9:45

Photonic Polarization Qubit Quantum Memory Using Warm Atomic Vapor

Young-Wook Cho and Yoon-Ho Kim
Dept. of Physics, Pohang Univ. of Science and Technology (POSTECH) Pohang, Korea

We experimentally demonstrate the coherent storage for the photonic polarization qubit in two spatially separated ensembles of warm Rubidium atoms in a single vapor cell. We have fully characterized the memory with quantum process tomography.

TuG1-5 9:45 - 10:00

Splitting of Trapped Thermal Atoms for Atom-Chip Based Interferometry

Mahdi Ammar[1,2], Landry Huet[1], Jérôme Estève[2], Chris Westbrook[3], Isabelle Bouchoule[3], Jean-Paul Pocholle[1], Jakob Reichel[2], Peter Rosenbusch[4], Christine Guerlin[2], and Sylvain Schwartz[1]
[1] Thales Research and Technology, Palaiseau, France, [2] Laboratoire Kastler-Brossel, Ecole Normale Superieure, Paris, France, [3] Laboratoire Charles-Fabry Institut d'Optique, Palaiseau, France, [4] LNE-SYRTE, Observatoire de Paris, UPMC, CNRS, Paris, France

We present a design of an atom interferometer using thermal atoms trapped on a chip. We point-out that such an interferometer requires highly symmetrical potentials, and we propose a splitter based on microwave potentials.

Room 104A 1F

[TuC1] 8:30 - 10:00
NIR and MIR Techniques
Session Chair: Iwao Hosako (National Inst. of Information & Communications Technology, Japan)

TuC1-1 8:30 - 8:45

Semiconductor Optical Amplifier Integrated 1.3-μm Dual-mode Laser

Namje Kim [1], Kiwon Moon, Sang-Pil Han, Jung-Woo Park, Hyunsung Ko, Min Yong Jeon [2], and Kyung Hyun Park [1].
[1] THz Photonics Creative Research Center, Daejeon, Korea [2] Dept. of Physics, Chungnam Nat'l Univ., Daejeon, Korea

We have developed a semiconductor optical amplifier integrated λ/4 phase-shifted 1.3-μm dual-mode laser as an optical beat source for continuous-wave (CW) terahertz (THz) generation. The CW THz system is also demonstrated with low-temperature-grown InGaAs photomixers.

TuC1-2 8:45 - 9:00

Resonant Cavity-Enhanced Quantum-Dot Infrared Photodetectors with Guided-Mode Resonance Reflector

Chi-Cheng Wang and Sheng-Di Lin
Dept. of Electronics Engineering, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

We propose a resonant cavity-enhanced quantum-dot infrared photodetectors with a top mirror of Ge/SiO_2 sub-wavelength grating. The simulated maximum absorption is ~60-70% at 8 μm with an enhancement factor of ~6-20.

TuC1-3 9:00 - 9:15

Development of Type II Superlattice Detector for Future Space Applications in JAXA

Haruyoshi Katayama [1], Junpei Murooka [1], Ryota Sato [1], Masafumi Kimata [2], Takahiro Kitada [1], Toshiro Isu [3], Mikhail Patrashin [1], Iwao Hosako [4]
[1] Earth Observation Research Center (EORC), Space Applications Mission Directorate, Japan Aerospace Exploration Agency (JAXA), Ibaraki, JAPAN, [2] Graduate School of Science and Engineering, Ritsumeikan Univ., Shiga, JAPAN, [3] Inst. of Technology and Science, The Univ. of Tokushima, Tokushima, JAPAN, [4] Advanced ICT Research Institute, Nat'l Institute of Information and Communications Technology (NICT), Tokyo, JAPAN

We report the development of InAs/GaSb Type II superlattice (T2SL) detector in JAXA. We present the results of optical evaluation of the detector of which the cutoff wavelength is from 6um to 12um.

TuC1-4 9:15 - 9:30

Mid-IR Frequency Comb with Sub-Hertz Residual Linewidth From a Doubly-Resonant OPGaAs OPO

Kevin F. Lee [1], C. Mohr [1], Nick Leindecker [1,2], Konstantin L. Vodopyanov[3], Peter G. Schunemann[4], I. Hartl[5], and M. E. Fermann[1]
[1] IMRA America Inc., Michigan, USA, [2] E.L. Ginzton Laboratory, Stanford Univ., California, USA, [3] CREOL, College of Optics and Photonics, Univ. Cent. Florida, [4] BAE Systems, New Hampshire, USA, [5] Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

We show a mid-infrared source that is a low-threshold, doubly-resonant OPGaAs OPO pumped by a Tm fiber frequency comb laser, with a fully stabilized comb spectrum with sub-Hz relative linewidths.

TuC1-5 9:30 - 9:45

Chirped-pulse upconversion of mid-infrared pulses with four-wave difference frequency generation in gases

T. Fuji[1], Y. Nomura[1], Y.-T.Wang[2], A. Yabushita[2], C.-W. Luo[2], T. Kohzai[3], and S. Nakanishi[3]
[1] Inst. for Molecular Science, Okazaki, Japan, [2] Dept. of Electrophysics, Nat'l Chiao Tung Univ., Hsinchu, Taiwan, [3] Faculty of Engineering, Kagawa Univ., Takamatsu, Japan

Single-shot detection of mid-infrared spectra from 250 to 5500 cm-1 with 5 cm-1 resolution was demonstrated by using chirped-pulse upconversion with four-wave difference frequency generation in gases.

TuC1-6 9:45 - 10:00

Rapid, Wide Bandwidth Pulsed Cavity Ringdown Spectroscopy in the Mid Infrared

Toby K. Boyson [1], Dylan R. Rittman [2], Thomas G. Spence [3], Maria E. Calzada [3], Abhijit G. Kallapur [1], Ian R. Petersen [1], K. Paul Kirkbride [4], David S. Moore [2], Charles C. Harb [1]
[1] SEIT, The Univ. of New South Wales, ACT, Australia, [2] Shock and Detonation Physics Group, Los Alamos Nat'l Lab, NM, USA, [3] Dept. of Chemistry, Loyola Univ. New Orleans, LA, USA, [4] Forensic and Data Centres, Australian Federal Police, ACT, Australia

We present a new variant of the Cavity Ringdown Spectroscopy (CRDS) that is able to scan across more than 1400 nm of spectral bandwidth, analysing more than 150,000 datapoints in less than four seconds.

Room 104B 1F

[TuJ1] 8:30 - 10:00
Biophotonic Devices
Session Chair: Kazuaki Sawada (Toyohashi Univ. of Technology, Japan)

TuJ1-1 8:30 - 9:00 Invited

Optoelectronics Devices for Biomedical Applications

Takashi Tokuda, Toshihiko Noda, Kiyotaka Sasagawa, and Jun Ohta
Graduate School of Materials Science, Nara Inst. of Science and Technology, Nara, Japan

CMOS-based bio-implantable optoelectronic devices for biomedical applications are presented. Designs, functionalities of implantable on-chip brain imaging devices, optical stimulators for optogenetics and CMOS-based flexible neural stimulators for retinal prosthesis are described.

TuJ1-2 9:00 - 9:15

Multi-Channel Digital SiPMs for PET Application

Shingo Mandai and Edoardo Charbon
Delft Univ. of Technology, The Netherlands

We present a multi-channel digital Silicon photomultipliers capable of detecting and timestamping up to 48 photons and we show the advantage of generating multiple timestamps in the context of positron emission tomography.

TuJ1-3 9:15 - 9:30

Needle Type CMOS Imaging Device for Fluorescence Imaging of Deep Brain Activities with Low Invasiveness

Yoshinori Sunaga [1], Chikara Kitsumoto [1], Mayumi Motoyama [1,2], Yasumi Ohta [1,2], Toshihiko Noda [1,2], Kiyotaka Sasagawa [1,2], Yasuyuki Ishikawa [1,2], Takashi Tokuda [1,2], Sadao Shiosaka [1,2], and Jun Ohta [1,2]
[1] Nara Inst. of Science and Technology, Nara, Japan, [2] JST-CREST, Saitama, Japan

We propose a thin type CMOS image sensor for measuring neural activities. The sensor is designed very thin shape for low invasiveness to a mouse brain. We demonstrate fluorescence imaging with the sensor.

TuJ1-4 9:30 - 9:45

Surface Enhanced Raman Scattering (SERS) Imaging of Intracellular Transportation in 3D

Kazuki Bando [1], Jun Ando [1], Kai-Chih Huang [2], Nicholas Smith [3], Katsumasa Fujita [1] and Satoshi Kawata [1]
[1] Dept. of Applied Physics, Osaka Univ., Osaka, Japan, [2] Immunology Frontier Research Center, Osaka Univ., Osaka, Japan, [3] Dept. of Electrical Engineering Nat'l Taiwan Univ., Taipei, Taiwan ROC

We observed intracellular transportation by using surface-enhanced Raman scattering (SERS) from gold nanoparticles moving in cytosol. Simultaneous detection of the nanoparticle position and SERS spectra enables us to visualize micelles associated with the transportation process.

TuJ1-5 9:45 - 10:00

All-Fiber 1-D Optical Stretcher for Bio-Cells Implemented in a Lab-on-a-Chip

Sungrae Lee [1], Yoon-Sung Bae [2], Pyo Jin Jeon [3], Seongil Im [3], Dug Young Kim [2], Kyunghwan Oh [1]
[1] Photonic Device Physics Laboratory, Dept. of physics, Yonsei Univ., Seoul, Korea, [2] Center for 3D Nano Optical Imaging System, Dept. of physics, Yonsei Univ., Seoul, Korea, [3] Electron Device Laboratory, Dept. of physics, Yonsei Univ., Seoul, Korea

We suggest optical stretcher based on all-fiber technology combined with Lab-on-a-Chip system for diagnosing bio-samples. Optical momentum transfer between medium and cell surfaces induced stretching mechanical force along the beam direction.

Room C-1 1F

[TuR2] 10:30 - 12:00
Optical Monitoring
Session Chair: Hwan Seok Chung (ETRI, Korea)

TuR2-1 10:30 - 11:00 Upgrade Invited

Proposal of Optical-Sampling-Based Constellation Monitor for DP-QPSK Signals

Kazuro Kikuchi[1,2] and Sze Y. Set[2]
[1] Dept. of Electrical Engineering and Information Systems, The Univ. of Tokyo, Tokyo, Japan, [2] Alnair Labs Corporation, Tokyo, Japan

We propose a novel linear optical-sampling system for monitoring the constellation diagram of DP-QPSK signals. A polarization-constellation in the Stokes space is obtained with phase-noise-free optical-sampling measurements and converted to an IQ-constellation diagram.

TuR2-2 11:00 - 11:15

OSNR Monitoring Technique of m-ary QAM Formats Based on Analysis of Power Spectral Density in the Presence of Fiber Nonlinearities

Hyeon Yeong Choi, Takehiro Tsuritani, and Itsuro Morita
KDDI R&D Laboratories Inc., Saitama, Japan

We propose the OSNR monitoring technique for m-ary QAM formats in the presence of fiber nonlinearities, which is based on the analysis of the power spectral density of amplitude noises in a digital coherent receiver.

TuR2-3 11:15 - 11:30

Fast-Sweep, High-Resolution Optical Spectrum Analyzer

Hiroshi Furukawa [1], Takanori Saitoh [1], Kenichi Nakamura [1], Koji Kawakita [1] Masaru Koshihara [1] and Hiroshi Shimotahira [2]
[1] Anritsu Devices Co., Ltd., [2] Anritsu Corporation, Kanagawa, Japan

This paper describes a heterodyne optical spectrum analyzer with fast sweeping (160Hz) and high spectral resolution (2pm) using our unique wavelength sweep light source based on MEMS technology.

TuR2-4 11:30 - 11:45

Digital In-band OSNR Estimation for Polarization-Multiplexed Optical Transmission

Seiji Okamoto, Yoshiaki Kisaka, Koichi Ishihara, Etsushi Yamazaki, Masahito Tomizawa
NTT Network Innovation Laboratories, NTT Corporation, Kanagawa, Japan

We propose a fast digital optical signal-to-noise power ratio estimation technique that uses pilot sequence. Simulation shows that estimation accuracy of less than 0.2dB can be achieved. And, its basic operation is experimentally verified.

TuR2-5 11:45 - 12:00

OSNR Monitoring Technique Based on Software-Based Synchronous Amplitude Histogram Analysis

H. G. Choi, J. H. Chang, and Y. C. Chung
KAIST, Dept. of Electrical Engineering, Daejeon, Korea

We propose and demonstrate an OSNR monitoring technique based on the synchronous amplitude histogram implemented by using the software-based synchronization technique. This technique can accurately monitor the OSNRs of the QPSK and 16QAM signals.

Room C-2 1F

[TuN2] 10:30 - 12:00 Symposium
High-Density Photonic Integration Platforms and Their Applications (Silicon)
Session Chair: Yasuyuki Inoue (NTT, Japan)

TuN2-1 10:30 - 11:00 Invited

Dense CMOS-Photonics Integration in sub-100nm Technology Node

Solomon Assefa [1], Steven Shank [2], William M. J. Green [1], Alexander Rylyakov [1], Clint Schow [1], Marwan Khater [1], Swetha Kamlapurkar [1], Edward Kiewra [1], Carol Reinholm [1], and Yurii Vlasov [1]
[1] IBM T. J. Watson Research Center, New York, USA, [2] IBM Systems & Technology Group, Microelectronics Division, Vermont, USA

A sub-100nm technology that allows the monolithic integration of optical devices as features into a 90nm base high-performance logic technology node is demonstrated. The technology is promising for next generation optical communications for applications.

TuN2-2 11:00 - 11:30 Invited

High-performance Photonic Integrated Circuits Based on Si-Ge-silica Monolithic Photonic Platform

K. Yamada [1,2], T. Tsuchizawa [1,2], H. Nishi [1,2], R. Kou [1,2], T. Hiraki [1,2], K. Takeda [1,2], H. Fukuda [2], Y. Ishikawa [3], K. Wada [3] and T. Yamamoto [2]
[1] Nanophotonics Center, [2] Microsystem Integration Laboratories, NTT Corporation, [3] Dept. of Materials Engineering, The University of Tokyo, Japan

For telecommunications applications of highly-integrated silicon-based photonic devices, we have developed a silicon-germanium-silica monolithic photonic integration platform, on which high-performance silica-based passive devices and compact, high-speed silicon-based dynamic/active devices can be monolithically integrated.

TuN2-3 11:30 - 12:00 Invited

Foundry Technology and Services for Si Photonics

P. Dumon and A. Khanna
Imec - Ghent Univ., Dept. of Information Technology, Gent, Belgium

We discuss the progress in development and offering of silicon photonics integration platforms based on 200mm and 300mm wafer technologies. Devices have capability for developing high-speed datacommunication, but are also used for life-science applications.

Room F 1F

[TuA2] 10:30 - 12:00
Frontier of Fiber Lasers
Session Chair: Norihiko Nishizawa (Nagoya Univ., Japan)

TuA2-1 10:30 - 10:45

High-peak Power Pulse Amplification by SRS-suppressed Photonic Bandgap Fiber

Akira Shirakawa [1], Yuta Suzuki [1], Suguru Arisa [1], Mingchen Chen [1], C. B. Olausson [2], Jens K. Lyngsø [2], and Jes Broeng [2]
[1] Inst. for Laser Science, Univ. of Electro-Communications, Tokyo, Japan, [2] NKT Photonics A/S, Birkerød, Denmark

We report Yb-doped photonic bandgap fiber amplifier generating 19 kW nanosecond pulses without stimulated Raman scattering by long-wavelength cut distributed filtering. Modulation instability due to the huge anomalous waveguide dispersion around the cutoff was observed.

TuA2-2 10:45 - 11:00

Visible Emission Enhancement in Fiber Optic Atmospheric Pressure Helium Plasma Jet

Sahar Hosseinzadeh Kassani [1], Reza Khazaeinezhad [1], Chan Young Lee [1], Tavakol Nazari [1], Wonho Choe [2] and Kyunghwan Oh [1]
[1] Photonic Device Physics Laboratory, Inst. of Physics and Applied Physics, Yonsei Univ., Seoul, South Korea, [2] Dept. of Physics, Korea Advanced Institute of Science and Technology, Daejeon, South Korea

We generated atmospheric pressure helium plasma in a hollow optical fiber. We observed an optical gain at 615nm in the intersection of the generated plasma and an laser beam at 1552nm and the plasma plume.

TuA2-3 11:00 - 12:00 Tutorial

Hollow Core Photonic Crystal Fiber Optical Guidance and Applications

F. Benabid
GPPMM group, Xlim Research Inst., CNRS UMR 5272, Université de Limoges, Limoges, France

We give a historical perspective on the major results that led to the advent of the photonic bandgap guiding hollow core photonic crystal fiber (PBG HC-PCF) and to that of inhibited-coupling one (IC HC-PCF). We review the progress made on gas-filled HC-PCF and photonic microcells, along with their applications for coherent optics, Raman comb generation laser metrology, and discharge based lasers.

Room G 1F

[TuE2] 10:30 - 11:30
Femtosecond Laser Processing II
Session Chair: Tatsuo Okada (Kyushu Univ., Japan)

TuE2-1 10:30 - 11:30 **Tutorial**

Femtosecond Laser Processing for Biochip Applications

Koji Sugioka
RIKEN, Saitama, Japan

Recently, one of the most promising applications of femtosecond laser is fabrication of biochips. This tutorial gives a review of the state of the art and future prospects of femtosecond laser processing for biochip applications.

Room H 1F

[TuF2] 10:30 - 12:00
Novel Comb Application
Session Chair: Young-Jin Kim (Korea Advanced Inst. of Science and Technology, Korea)

TuF2-1 10:30 - 10:45

Self-Correction of Air-Refractive Index with Extreme Accuracy Using Frequency Combs

K. Minoshima [1], G. Wu [2], M. Takahashi [1,3], and H. Inaba [1]
[1] Nat'l Inst. of Advanced Industrial Science and Technology, Ibaraki, Japan, [2] Tsinghua Univ., Beijing, China, [3] Tokyo Univ. of Science, Chiba, Japan

Heterodyne interferometry of 61-m path-length based on two-color optical frequency combs is developed for air-refractive-index correction. Measured two-color optical-path-differences agreed with calculations with 10^{-11} for 10-hour. Corrected distance variation agreed with thermal expansion of base-plate.

TuF2-2 10:45 - 11:00

Fast, Asynchronous Sampling Distance Ranging Using an SOA Gate and a Dual-Wavelength Mode-Locked Fiber Laser

Lei Liu, Xin Zhao, Qi Wang, Zheng Gong, Jiansheng Liu and Zheng Zheng
School of Electronic and Information Engineering, Beihang Univ., Beijing, China

A fast ranging scheme based on the asynchronous sampling of ultrafast nonlinear saturation of an SOA is experimentally demonstrated using a dual-wavelength sub-picosecond fiber laser and a very simple setup.

TuF2-3 11:00 - 11:15

Precision Surface Profile Measurements by Comb-based Multi-wavelength Interferometry

Minah Choi, Sangwon Hyun, Byung Jae Chun, Seungman Kim, Seung-Woo Kim and Young-Jin Kim
Ultrafast Optics for Ultraprecision Group, Dept. of Mechanical Engineering Korea Advanced Inst. of Science and Technology (KAIST), Daejeon, South Korea

Precision measurement of large-stepped surface profiles is demonstrated using the frequency comb of a femtosecond pulse laser. Four optical wavelengths are selected out and a large step-height of ~70 μm is measured with nanometre precision.

TuF2-4 11:15 - 11:30

Interference imaging profilometry using optical frequency comb and compressive sensing

Quang Duc Pham and Yoshio Hayasaki
Center for Optical Research and Education (CORE), Utsunomiya Univ., Utsunomiya, Japan

We describe a new optical system using an ultra-stable mode-locked frequency comb femtosecond laser and the compressive sensing to measure an object surface profile.

TuF2-5 11:30 - 11:45

Application of Optical Frequency Comb Synthesizer/Analyzer to Tbit Multilevel Phase Modulation

Toshiaki Yamazaki and Tatsutoshi Shioda
Dept. of Electrical Engineering, Nagaoka Univ. of Technology, Niigata, Japan

Novel optical system for arbitrary waveform synthesizing and analyzing in terabit range has been proposed based on a 200 GHz optical frequency comb. As a demonstration 16-Tbit/s 80-bit PSK packet was experimentally synthesized and analyzed.

TuF2-6 11:45 - 12:00

Gapless THz Comb Spectroscopy

Takeshi Yasui [1], Yi-Da Hsieh [2], Yoshiyuki Sakaguchi [2], Francis Hindle [3], Shuko Yokoyama [2], Hajime Inaba [4], Kaoru Minoshima [4], and Tsutomu Araki [2]
[1] Univ. of Tokushima, Tokushima, Japan, [2] Osaka Univ., Toyonaka, Japan, [3] Université du Littoral Côte d'Opale, Dunkerque, France, [4] AIST, Tsukuba, Japan

We demonstrated gapless THz comb spectroscopy for high-resolution THz spectroscopy. Frequency sweeping of THz comb mode enables us to enhance the spectral resolution in THz spectroscopy down to the linewidth of THz comb mode.

Room I 2F

[TuP2] 10:30 - 11:30
New Paradigm for Optical Access
Session Chair: Naoto Yoshimoto (NTT Access Network Service Systems Laboratories, Japan)

TuP2-1 10:30 - 11:30 **Tutorial**

Software-defined Optical Access Networks for Multiple Broadband Access Solutions

Neda Cvijetic [1]
[1] NEC Laboratories America, NJ, USA

The principles of software-defined networking as applied to multi-service broadband optical access systems are discussed, with an emphasis on centralized software-reconfigurable resource management, digital signal processing (DSP)-enhanced transceivers and multi-service support via software-reconfigurable network "apps".

Room J 2F

[TuS2] 10:30 - 12:00
Parametric Processes
Session Chair: Mark Pelusi (Univ. of Sydney, Australia)

TuS2-1 10:30 - 11:00 Invited

Recent Advances in Wide-band Optical Parametric Mixer Synthesis

B. P.-P. Kuo

Photonic Systems Laboratory, Univ. of California, CA, USA

This paper reviews the recent advances in parametric mixers enabled by new highly-nonlinear fiber type. Precise phase-matching allowed by the new highly-nonlinear fiber enables synthesis of 750-nm tunable, Brillouin-managed parametric response.

TuS2-2 11:00 - 11:15

Guard-band-less Tunable Wavelength Conversion for Dual-Polarization Signal Based on Cascaded Single-Pump FWM Process

Takashi Inoue, Ken Tanizawa, and Shu Namiki

Nat'l Inst. of Advanced Industrial Science and Technology (AIST) , Ibaraki, Japan

We demonstrate stable operations of wavelength conversion for 86-Gbit/s DP-QPSK signal with arbitrary input/output wavelengths in 1535-1565 nm range, employing a dual-stage configuration of polarization-insensitive, single-pump FWM process in PM-HNLF with a loop structure.

TuS2-3 11:15 - 11:30

Fiber Optical Parametric Chirped Pulse Amplification of Sub-Picosecond Pulses

Valentina Cristofori, Zohreh Lali-Dastjerdi, Francesco Da Ros, Lars Søgaard Rishøj, Michael Galili, Christophe Peucheret and Karsten Rottwitt

Dept. of Photonics Engineering, Technical Univ. of Denmark, Lyngby, Denmark

We demonstrate experimentally, for the first time to our knowledge, fiber optical parametric chirped pulse amplification of 400-fs pulses. The 400 fs signal is stretched, amplified by 26 dB and compressed back to 500 fs.

TuS2-4 11:30 - 11:45

Phase Comparator using Phase Sensitive Amplifier for Phase Noise-Tolerant Carrier Phase Recovery of QPSK Signals

Mingyi Gao, Takayuki Kurosu, Takashi Inoue, Shu Namiki

Network Photonics Research Center (NPRC), Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan

We propose an all-optical phase comparator for phase noise-tolerant carrier phase recovery of QPSK signals. Our scheme, based on the 2nd-order phase sensitive amplifier, successfully doubled the input phase without doubling the phase noise.

TuS2-5 11:45 - 12:00

Phase Noise Tolerant QPSK Receiver Using Phase Sensitive Wavelength Conversion

Francesco Da Ros [1], Jing Xu [1], Lei Lei [1,2], and Christophe Peucheret [1]

[1] Dept. of Photonics Engineering, Technical Univ. of Denmark, Lyngby, Denmark, [2] Wuhan Nat'l Laboratory for Optoelectronics, School of Optoelectronics Science and Engineering, Huazhong Univ. of Science and Technology, Hubei, People's Republic of China

A novel QPSK receiver based on a phase noise reduction pre-stage exploiting PSA in a HNLF and balanced detection is presented. Receiver sensitivity improvement over a conventional balanced receiver is demonstrated.

Room K 2F

[TuT2] 10:30 - 11:45
Elastic and Software Defined Network
Session Chair: Reza Nejabati (Univ. of Bristol, United Kingdom)

TuT2-1 10:30 - 11:00 Invited

Optically Interconnected Data Center Using Software-Defined Networking Technology

Philip N. Ji

NEC Laboratories America, NJ, USA

An OFDM-based all-optical intra-data center network architecture without optical or electrical switches is described. It offers large capacity any-to-any switching with flexible fine granular bandwidth sharing, low power, low cost, and software-defined centralized control.

TuT2-2 11:00 - 11:15

OpenFlow-based Control Plane for the Application-Aware LOBS Network

Dongxu Zhang [1], Songtao Mai [1], Hongxiang Guo [1], TakehiroTsuritani [2], Jian Wu [1], Itsuro Morita [2]

[1] Beijing Univ. of Posts and Telecommunications, Beijing, China [2] KDDI R&D Laboratories Inc., Saitama, Japan

This paper presents an extended OpenFlow-based control plane for labeled optical burst switching networks to achieve application-aware burst assembly and scheduling, and experimental demonstration verifies its overall feasibility.

TuT2-3 11:15 - 11:30

On-demand Path Provisioning with Tentative Spectrum Reservation in Elastic Optical Networks

Naohiro Wakabayashi [1], Yusuke Hirota [1], Hideki Tode [2], and Koso Murakami [1]

[1] Dept. of Information Networking, Graduate School of Information Science and Technology, Osaka Univ., Osaka, Japan, [2] Dept. of Computer Science and Intelligent Systems, Graduate School of Engineering, Osaka Prefecture Univ., Osaka, Japan

We demonstrate the effectiveness of optical grooming in dynamic elastic optical networks. We propose and evaluate an on-demand path provisioning method with tentative spectrum resource reservation achieving significant improvement of transmitter saving and blocking probability.

TuT2-4 11:30 - 11:45

Demonstration of ROADM functionality on Optical Nyquist SCFDE Superchannel

Rui Ding, Zhennan Zheng, Rongshan Wang, Tingting Zhang and Fan Zhang

State Key Lab. of Advanced Optical Communication Systems & Networks, Peking Univ., Beijing, China

We experimentally demonstrate reconfigurable optical add-drop multiplexer functionality with less than 0.5-dB error vector magnitude penalty in a Nyquist superchannel system based on single carrier frequency domain equalization with polarization division multiplexing 16 QAM format.

Room 101 1F

[TuD2] 10:30 - 12:00 Symposium
High Power Lasers and Applications III
Session Chair: Hiromitsu Kiriyama (Japan Atomic Energy Agency, Japan)

TuD2-1 10:30 - 11:00 Invited

Generation of High-contrast, 30 fs, 1.5 PW Laser Pulses

T. M. Jeong [1,2], T. J. Yu [1,2], S. K. Lee [1,2], J. H. Sung [1,2], C. H. Nam [1,3] and J. Lee [2]

[1] Center for Relativistic Laser Science, Inst. for Basic Science, [2] Advanced Photonics Research Inst., Gwangju Inst. of Science and Technology, [3] Dept. of Physics and Photon Science, Gwangju Inst. of Science and Technology, Gwangju, Republic of Korea

A high-contrast, 30 fs, 1.5 PW Ti:sapphire laser has been developed for research on high field physics. The maximum output energy of 60.2 J was obtained from a booster amplifier pumped by four frenquency-doubled Nd:glass laser systems. Parasitic lasing was suppressed by index matching fluid with absorption dye and the careful manipulation of the time delay between the seed and pump pulses. After compression, the measured pulse duration was 30.2 ± 1.8 fs, and the output energy was 44.5 J, yielding a peak power of about 1.5 PW. A saturable absorber and two ultrafast Pockels cells were installed in the front-end system for the minimization of the amplified spontaneous emission (ASE) and pre-pulse intensity. An adaptive optics system was implemented for obtaining the near diffraction-limited focal spot.

TuD2-2 11:00 - 11:30 Invited

High-contrast Pw Ti:sapphire Laser System with A Combined Scheme of Doubled CPA and NOPA

Zhiyi Wei, Zhaoua Wang, Cheng Liu, Zhongwei Shen, Hao Teng and Haitao Fan

Beijing Nat'l Laboratory for Condensed Matter Physics and Inst. of Physics, Chinese Academy of Sciences, Beijing, China

We generated an ultrahigh laser power to 1.16PW by using a combined scheme of (DCPA) and (NOPA) based on Ti:sapphire laser facility, contrast ratio of around 109 was demonstrated within time scale of 400 ps.

TuD2-3 11:30 - 12:00 Invited

Generation and Applications of Sub-5-fs Multi-10-Tw Light Pulses

L. Veisz [1], D. Rivas [1], G. Marcus [1], X. Gu [1], D. Cardenas [1], J. Mikhailova [1], A. Buck [1,2], T. Wittmann [1], C. M. S. Sears [1], S.-W. Chou [1], J. Xu [1], G. Ma [1], D. Herrmann [3], O. Razskazovskaya [2], V. Pervak [2], F. Krausz [1,2]

[1] Max-Planck-Institut für Quantenoptik, Garching, Germany, [2] Ludwig-Maximilians-Universität München, Garching, Germany, [3] Lehrstuhl für BioMolekulare Optik, Dept. für Physik, Ludwig-Maximilians-Universität, München, Germany

We report on the development and relevant characteristics of an optical parametric synthesizer light source delivering sub-5-fs pulses with 80 mJ energy. The first applications of the system are attosecond and relativistic laser-plasma physics.

Room 103 1F

[TuG2] 10:30 - 12:00
Quantum Optics

Session Chair: Hajime Ishihara (Osaka Perfecture Univ., Japan)

TuG2-1 10:30 - 11:00 Invited

Ultrastrong coupling cavity and circuit QED

Cristiano Ciuti

Laboratoire MPQ, Université Paris Diderot-Paris 7 & CNRS, France

Recent advances in the field of ultrastrong coupling cavity and circuit QED will be reviewed.

TuG2-2 11:00 - 11:15

Microwave Response of an Impedance-Matched Δ-system in Circuit QED

K. Koshino [1], K. Inomata [2], T. Yamamoto [2,3], and Y. Nakamura [2,4]

[1] College of Liberal Arts and Sciences, Tokyo Medical and Dental Univ., Chiba, Japan, [2] RIKEN Advanced Science Inst., Saitama, Japan [3] NEC Smart Energy Research Laboratories, Ibaraki, Japan [4] Research Center for Advanced Science and Technology (RCAST), The Univ. of Tokyo, Tokyo, Japan

A driven qubit-resonator system functions as an impedance-matched Delta-system under some conditions. We analyze the microwave response of such a system and reveal the possibility of deterministic down-conversion of microwave photons upon a single reflection.

TuG2-3 11:15 - 11:30

Quantum Enhanced Microrheology of a Living Cell

Michael A. Taylor [1], Jiri Janousek [2], Vincent Daria [2], Joachim Knittel [1], Boris Hage [2], Hans-A. Bachor [2], and Warwick P. Bowen [1]

[1] Centre for Engineered Quantum Systems, Univ. of Queensland, Queensland, Australia, [2] Dept. of Quantum Science, Australian Nat'l Univ., Canberra, Australia

We demonstrate the first biological measurement with precision surpassing the quantum noise limit. Lipid particles within a living yeast cell are tracked with sub-shot noise sensitivity, thereby revealing the biological dynamics of the cellular cytoplasm.

TuG2-4 11:30 - 11:45

QED Cavity Arrays for Quantum Optical Switching

K. Kamide [1], M. Yamaguchi [1], T. Kimura [2], and T. Ogawa [1]

[1] Dept. of Physics, Osaka Univ., Osaka, Japan, [2] Dept. of Mathematics and Physics, Kanagawa Univ., Kanagawa, Japan

Coupled QED cavity arrays are shown to exhibit first-order phase transitions between superfluid and Mott-insulator or different superfluid states in presence of two photon modes. This indicates the system is applicable to quantum optical switching.

TuG2-5 11:45 - 12:00

New Lasing From Exciton-Polariton Condensates in High Excitation Regime

Tomoyuki Horikiri [1,2,3], Makoto Yamaguchi [4], Kenji Kamide [4], Yutaka Shikano [5], Yasuhiro Matsuo [1,3], Tim Byrnes [1], Natsuko Ishida [1,3], Andreas Löffler [6], Sven Höfling [1,6], Tetsuo Ogawa d, Alfred Forchel [6], Yoshihisa Yamamoto [1,2,3]

[1] Nat'l Inst. of Informatics, Japan, [2] Stanford Univ., USA, [3] The Univ. of Tokyo, Japan, [4] Osaka Univ., Japan, [5] Institute for Molecular Science, Japan, [6] Wurzburg Univ., Germany

A new lasing showing a unique spectrum based on a highly excited exciton-polariton condensate is implemented. Observed high energy peak matches a theory describing nonequilibrium system.

Room 104A 1F

[TuC2] 10:30 - 12:00
Terahertz Imaging and Sensing

Session Chair:Hitoshi Tabata (The Univ. of Tokyo, Japan)

TuC2-1 10:30 - 11:00 Invited

Terahertz Bio-imaging for Medical Applications

Joo-Hiuk Son

Dept. of Physics, Univ. of Seoul, Seoul, Republic of Korea

Various medical applications using terahertz technology are presented. Examples include the dynamic imaging of skin drug absorption, the diagnostic imaging of cancers such as brain tumors and oral melanoma, and the analysis of blood substances.

TuC2-2 11:00 - 11:15

Evaluation of Work Function of the Catalytic Electrode in the Fuel Cells

Toshihiko Kiwa, Takafumi Hagiwara, Tetsuya Kusaka, Kenji Sakai, and Keiji Tsukada

Graduate School of Natural Science and Technology, Okayama Univ., Okayama, Japan

The fuel cell was fabricated on the sensing plate and the catalytic reaction of the electrode was measured using terahertz chemical microscope. Change in THz at the catalytic cathode and anode could be observed.

TuC2-3 11:15 - 11:30

THz Measurement of Refractive Index and Thickness of Ceramic Coating on a Metal Substrate

T. Fukuchi [1], N. Fuse [1], M. Mizuno [2], and K. Fukunaga [2]

[1] Central Research Inst. of Electric Power Industry, Kanagawa, Japan, [2] Nat'l Institute of Information and Communications Technology, Tokyo, Japan

A method to obtain the refractive index and thickness of ceramic coating on a metal substrate by terahertz reflection measurement is presented. The measurement results are compared with the results of microscopic observation.

TuC2-4 11:30 - 11:45

THz Near-Field Distribution of Fractal Antenna

T.Tanaka [1,3], K.Ohno [2], and K.Tanaka [1,2,3]

[1] Inst. for Integrated Cell-Material Sciences (WPI-iCeMS), Kyoto Univ., Kyoto, Japan, [2] Dept. of Physics, Kyoto Univ., Kyoto, Japan, [3] Japan Science and Technology Agency ,CREST, Saitama, Japan

We obtained the field distribution on the fractal antenna by THz near-field microscope to evaluate the field enhancement by the antenna.

TuC2-5 11:45 - 12:00

THz 3D Imaging with Phase-shifting Interferometry

C. Otani [1], Y. Sasaki [1], T. Yuasa [2], M. Suga [2], H. Kasuga [3], H. Ohmori [3]

[1] Terahertz Sensing and Imaging Team, RIKEN, Sendai, Japan, [2] Graduate School of Science and Engineering, Yonezawa, Japan, [3] Material Fabrication Laboratory, RIKEN, Wako, Japan

Two kinds of terahertz (THz) 3D imaging with a continuous-wave (CW) source and phase-shifting interferometry were introduced.

Room 104B 1F

[TuJ2] 10:30 - 12:00
Bionanophotonics

Session Chair: Yusuke Ogura (Osaka Univ., Japan)

TuJ2-1 10:30 - 10:45

Lensless Imaging Device for Digital Counting of Fluorescent Micro-droplet Chambers

K. Sasagawa[1,3], H. Takehara[1,3], K. Miyazawa[1], D. Okabayashi[1], T. Noda[1,3], T. Tokuda[1,3], S.-H Kim[2,3], R. Iino[2,3], H. Noji[2,3] and J. Ohta[1,3]

[1] Graduate School of Materials Science, Nara Inst. of Science and Technology, Nara, Japan, [2] Dept. of Applied Chemistry, the Univ. of Tokyo, Tokyo, Japan, [3] JST-CREST, Saitama, Japan

We developed a miniaturized lensless fluorescence imaging device for digital counting of micro-droplet chamber array. Fluorescent beads in a droplet array were imaged with the device and its resolution was improved by using deconvolution method.

TuJ2-2 10:45 - 11:00

Photonic Crystal Nanolaser Sensors with ALD Coating

Keisuke Watanabe, Shoji Hachuda, Toshinari Isono and Toshihiko Baba

Dept. of Electrical and Computer Engineering, Yokohama Nat'l Univ., Yokohama, Japan

Nanolaser sensors achieve ultrahigh sensitivity for biomolecules while unexpected noise was an issue. In this study, it was suppressed by ALD coating. Higher permittivity coating improved the sensitivity, suggesting unknown principles of this sensor.

TuJ2-3 11:00 - 11:15

Proposal of a High Accuracy Filter-Less Fluorescence Detector for Bio-Applications

H. Nakazawa [1,2], K. Yamasaki [1], T. Toyofuku [1], I. Aikita [1], M. Ishida [1,3], and K. Sawada [1,3,4]

[1] Integrated Circuit and Sensor System Group, Toyohashi Univ. of Technology, Aichi, Japan, [2] JSPS Research Fellow, Tokyo, Japan, [3] Electronics-Inspired Interdisciplinary Research Inst., Aichi, Japan, [4] Core Research for Evolutional Science and Technology, JST, Tokyo, Japan

Filter-less fluorescence detectors (FFDs) do not require any optical filters for multicolor fluorescence detection. In this study, we experimentally demonstrate an FFD with improved detection accuracy for bio-applications, such as single nucleotide polymorphism (SNP) genotyping.

TuJ2-4 11:15 - 11:30

Photonic Crystal Nanolaser Array for the Observation of Time Evolution in Live Cells

H. Abe [1], T. Watanabe [1], Y. Nishijima [1], S. Ota [1], Y. Takemura [1] and T. Baba [1]

[1] Dept. of Electrical & Computer Engineering, Yokohama Nat'l Univ., Yokohama, JAPAN

We have fabricated a photonic crystal nanolaser array and applied it to observe live cells attached on it. In this study, we present the time evolution of HeLa cells acquired by automatic data processing.

TuJ2-5 11:30 - 12:00 Invited

Saturable scattering and its application to superresolution microscopy

Shi-Wei Chu [1,2], Tung-Yu Su [1], Yasuo Yonemaru [3], Masahito Yamanaka [3], Guan-Yu Zhuo [1], Ming-Ying Lee [1], Ryosuke Oketani [3], Satoshi Kawata [3], and Katsumasa Fujita [3]

[1] Dept. of Physics, Nat'l Taiwan Univ., Taipei, Taiwan R.O.C., [2] Molecular Imaging Center, National Taiwan Univ., Taipei, Taiwan R.O.C., [3] Dept. of Applied Physics, Osaka Univ., Osaka, Japan

We demonstrated saturable scattering from isolated plasmonic nanoparticles and achieved sub-80-nm far-field imaging without bleaching. This work expands the horizon of superresolution imaging from fluorescence to scattering.

Room C-1 1F

[TuR3] 14:30 - 15:30
Digital Signal Processing
Session Chair: Katsumi Takano (Yamagata Univ., Japan)

TuR3-1 14:30 - 15:30 Tutorial

Digital Signal Processing for Coherent Optical Communication Systems

Seb J. Savory
UCL Electronic & Electrical Engineering, Torrington Place, London, UK

Digital signal processing (DSP) is an enabling technology for future optical communication systems. This tutorial will discuss the emergence of DSP for optical communication systems before surveying the key algorithms required in digital coherent transceivers.

Room C-2 1F

[TuN3] 14:30 - 16:00 Symposium
High-density Photonic Integration Platforms and Their Applications (Silica and Hybrid Integration)
Session Chair: Koji Yamada (NTT, Japan)

TuN3-1 14:30 - 15:00 Invited

Heterogeneous Integration on Silicon Photonics

Alexander W. Fang, Brian R. Koch, Jae Shin, Erik J. Norberg, Eric Hall, and Gregory Fish
Aurrion, Goleta, CA, USA

Heterogeneous integration enables all the elements of photonic systems to be fabricated on a single chip allowing photonic integrated circuits to meet the complexity, volume and cost requirements of the next generation of communication systems.

TuN3-2 15:00 - 15:30 Invited

Active Device Integration on Silica Waveguide Platform

Hiroshi Takahashi
NTT Photonics Laboratories, Japan

Silica waveguide planar lightwave circuits have excellent optical characteristics, and integration with active devices can expand their application range. Compact receivers and highly functional modulators are demonstrated by integrating photodiodes and lithium niobate, respectively.

TuN3-3 15:30 - 16:00 Invited

Optical Nonreciprocal Devices on Silicon Waveguide Platforms

Y. Shoji, Y. Shirato, K. Mitsuya, and T. Mizumoto
Dept. of Electrical and Electronic Engineering, Tokyo Inst. of Technology, Tokyo, Japan

The magneto-optic effect is important to realize the optical nonreciprocal devices such as isolators and circulators. In this article, magneto-optical nonreciprocal devices are discussed that are based on silicon waveguide platforms.

Room F 1F

[TuA3] 14:30 - 16:00 Symposium
Novel Fiber Designs for Lasers I
Session Chair: Akira Shirakawa (The Univ. of Electro-Communications, Japan)

TuA3-1 14:30 - 15:00 Invited

Resonant Filtered Fiber Amplifiers

Thomas T. Alkeskjold [1], Marko Laurila [1], Christina B. Olausson [1], Johannes Weirich [1], Jens K. Lyngsø [1], Danny Noordegraaf [1], Sidsel Petersen [2], Mette Jørgensen [2], Kristian R. Hansen [2], Jesper Lægsgaard [2], and Martin D. Maack [1]
[1] NKT Photonics, Birkerød, Denmark, [2] DTU Fotonik, Dept. of photonics engineering, Technical Univ. of Denmark, Denmark

In this paper we present our recent result on utilizing resonant/bandgap fiber designs to achieve high performance ytterbium doped fiber amplifers for achieving diffraction limited beam quality in large mode area fibers.

TuA3-2 15:00 - 15:30 Invited

All-Solid Photonic Bandgap Fibers for Fiber Laser Applications

Kunimasa Saitoh [1], Shota Saitoh [1], Masahiro Kashiwagi [2], Shoichiro Matsuo [2], and Liang Dong [3]
[1] Graduate School of Information Science and Technology, Hokkaido Univ., Sapporo, Japan, [2] Optics and Electronics Laboratory, Fujikura Ltd., Sakura, Japan, [3] Clemson Univ., South Carolina, USA

Core size scaling in all-solid photonic bandgap fibers (AS-PBGFs) is discussed. It is shown that the effectively single-mode AS-PBGF with 100-micron core diameter can be achievable with 40-cm bending radius operating in the 3rd PBG.

TuA3-3 15:30 - 16:00 Invited

A New Route to High-Energy Nonlinear Fiber Optics

Siddharth Ramachandran, Paul Steinvurzel and Jeff Demas
Photonics Center and ECE Dept., Boston Univ., MA, USA

We present a new class of higher-order-mode fibers that decouple the dispersion-versus-mode-area trade-off in conventional fibers. This enables exploiting the multitude of nonlinear optical effects afforded by fibers, but at energy-levels potentially approaching bulk crystals.

Room G 1F

[TuB3] 14:30 - 16:00
Strong Field Physics
Session Chair: Kenichi Ishikawa (The Univ. of Tokyo, Japan)

TuB3-1 14:30 - 15:00 Invited

Attosecond Delays in Photoionization: A Theoretical Perspective

Alfred Maquet[1], Jérémie Caillat[1], Richard Taïeb[1], Marcus Dahlström[2], and Anne L'Huillier[3]
[1] Laboratoire de Chimie Physique-Matiére et Rayonnement (UMR 7614 du CNRS), Université Pierre et Marie Curie, Paris, France, [2] Atomic Physics, Fysikum, Stockholm Univ., AlbaNova Center, Stockholm, Sweden, [3] Dept. of Physics, Lund Univ., Lund, Sweden

A new generation of sources of XUV harmonic radiation, delivering "attosecond" pulses, makes feasible to investigate photoionization in the time domain, with unprecedented resolution. We discuss theoretical aspects related to this new class of experiments.

TuB3-2 15:00 - 15:15

Time-Dependent Complete Active-Space Self-Consistent Field Method for Multielectron Dynamics in Intense Laser Fields

Takeshi Sato and Kenichi L. Ishikawa
Photon Science Center, School of Engineering, Univ. of Tokyo, Tokyo, Japan

Time-dependent complete active-space self-consistent field (TD-CASSCF) method is developed. It introduces the concept of frozen-core, dynamical-core, and active orbital subspaces, allowing compact yet accurate representation of ionization dynamics in many-electron systems.

TuB3-3 15:15 - 15:30

Photoionization Yield of Atomic Hydrogen Using Intense Few-cycle Pulses

O. Ghafur[1,2], W. C. Wallace[1,2], J. Calvert[2], D. E. Laban[1,2], M. G. Pullen[1,2], A. N. Grum-Grzhimailo[3,4], K. Bartschat[3], I. V. Litvinyuk[1,2], R. T. Sang[1,2], and D. Kielpinski[1,2]
[1] ARC Centre of Excellence for Coherent X-Ray Science, Griffith Univ., QLD, Australia, [2] Australian Attosecond Science Facility and Centre for Quantum Dynamics, Griffith Univ., QLD, Australia, [3] Dept. of Physics and Astronomy, Drake Univ., Iowa, USA, [4] Inst. of Nuclear Physics, Moscow State Univ., Moscow, Russia

We present the measured photoionization yield of atomic hydrogen as a function of laser intensity for few-cycle pulses. Fits with exact ab-initio simulations produce better agreement than analytical theories and enable accurate intensity calibration.

TuB3-4 15:30 - 15:45

Analysis of Strong-Field Enhanced Ionization of Molecules Using Bohmian Trajectories

Ryohto Sawada [1,2], Takeshi Sato [2], and Kenichi L. Ishikawa [1,2]
[1] Dept. of Applied Physics, Graduate School of Engineering, the Univ. of Tokyo, Tokyo, Japan, [2] Photon Science Center, Graduate School of Engineering, the Univ. of Tokyo, Tokyo, Japan

We investigate enhanced ionization of 1D hydrogen molecular ions using Bohmian trajectories extracted from TDSE simulations. We identify trajectories characteristic of enhanced ionization. They contradict a common picture of "direct ejection from the up-field atom".

TuB3-5 15:45 - 16:00

Angular and spectral resolved quantum trajectories in high harmonic generation

Peng Ye, Xinkui He, Minjie Zhan, Hao Teng, Wei Zhang, and Zhiyi Wei
Beijing Nat'l Laboratory for Condensed Matter Physics and Inst. of Physics, Chinese Academy of Science (CAS), Beijing ,China

Arrow-like pattern is observed in high order harmonic spectrum driven by 4fs laser. Individual electron quantum trajectories from different half cycles, including long and short trajectories, can be clearly recognized spatially.

Room H 1F

[TuF3] 14:30 - 16:00
Precision Spectroscopy
Session Chair: Feng-Lei Hong (AIST, Japan)

TuF3-1 14:30 - 14:45

Ramsey-Comb Spectroscopy with Amplified Frequency Comb Pulse Pairs

Jonas Morgenweg, Itan Barmes, and Kjeld S. E. Eikema
LaserLaB Amsterdam, VU Univ., Amsterdam, The Netherlands

We demonstrate kHz-level "Ramsey-comb" spectroscopy using two amplified frequency comb pulses. This concept enables significantly improved accuracies on two-photon transitions as shown with rubidium and cesium, and is extendible to XUV wavelengths.

TuF3-2 14:45 - 15:00

Dual-Comb Coherent Raman Spectro-Imaging

Simon Holzner[1], Takuro Ideguchi[1], Birgitta Bernhardt[1,3], Guy Guelachvili[2],Nathalie Picqué[1,2,3] and Theodor W. Hänsch[1,3]
[1] Max Planck Institut für Quantenoptik, Garching, Germany, [2] Institut des Sciences Moléculaires d'Orsay, CNRS, Université Paris-Sud, Orsay, France, [3] Ludwig-Maximilians-Universität München, Fakultät fur Physik, München, Germany

Ultra-rapid coherent Stokes and anti-Stokes Raman spectroscopy with two laser frequency combs is demonstrated. Spectra and hyperspectral images are measured over a span of 1200 cm-1 at 4 cm-1 resolution within 15 microseconds.

TuF3-3 15:00 - 15:15

Adaptive Dual-Comb Spectroscopy with Free-Running Lasers

Takuro Ideguchi[1], Antonin Poisson[2], Guy Guelachvili[2], Nathalie Picqué[1,2,3] and Theodor W. Hänsch[1,3]
[1] Max Planck Institut für Quantenoptik, Garching, Germany, [2] Institut des Sciences Moléculaires d'Orsay, CNRS, Batiment 350, Université Paris-Sud, Orsay, France, [3] Ludwig-Maximilians-Universität München, Fakultät für Physik, München, Germany

A new concept of real-time dual-comb spectroscopy that only uses free-running femtosecond mode-locked lasers provides high quality Fourier spectra with resolved comb lines over 12 THz spectral span without a posteriori data processing.

TuF3-4 15:15 - 15:30

Accurate Frequency Measurement of the ν_3 Band of Methane from Sub-Doppler Resolution Comb-Referenced Spectroscopy

M. Abe [1], S. Okubo [2], K. Iwakuni [1], H. Nakayama [1], H. Inaba [2] and H. Sasada [1]
[1] Dept. of Physics, Faculty of Science and Technology, Keio Univ., Yokohama, Japan, [2] Nat'l Metrology Inst. of Japan (NMIJ), National Institute of Advanced Industrial Science and Technology (AIST), Ibaraki, Japan

We have determined 183 sub-Doppler resolution spectral frequencies of 12CH4 using a difference-frequency-generation source, an enhanced-cavity absorption cell, and an optical frequency comb from 86.7 to 93.1 THz with a typical uncertainty of 3 kHz.

TuF3-5 15:30 - 15:45

High Resolution Molecular Spectroscopy Assisted by an Optical Frequency Comb

A. Nishiyama, D. Ishikawa, and M. Misono
Dept. of Appl. Phys., Fukuoka Univ., Fukuoka, Japan.

We developed a high resolution spectroscopic system assisted by a frequency comb. Its features are high resolution, wide wavelength range, high power, and easy operation. As a demonstration, we measured hyperfine spectra of molecular iodine.

TuF3-6 15:45 - 16:00

A Lin ⊥ Lin Bichromatic Laser Beam Realized by Mutual Injection Frequency Locking

Bozhong Tan [1] and Sihong Gu [1,2]
[1] School of Physics, Huazhong Univ. of Science and Technology, Wuhan, People's Republic of China, [2] Key Laboratory of Atomic Frequency Standards, Wuhan Inst. of Physics and Mathematics, Chinese Academy of Sciences, Wuhan, People's Republic of China

Employing the mutual injection frequency locking configuration we have realized a lin⊥lin quasi-bichromatic laser beam. A package device can be realized with the scheme, which might be applied in the package CPT atomic clock.

Room I 2F

[TuQ3] 14:30 - 16:00
Control Plane and Related Technologies
Session Chair: Eiji Oki (The Univ. of Electro-Communications, Japan)

TuQ3-1 14:30 - 15:00 Invited

Optical Network Control and Management Technology Using OpenFlow

Lei Liu [1], Takehiro Tsuritani [2], Itsuro Morita [2], and S. J. B. Yoo [1]
[1] Dept. of Electrical and Computer Engineering, Univ. of California, CA, USA, [2] KDDI R&D Laboratories Inc., Saitama, Japan

In this paper, we review OpenFlow-based control and management technology for optical networks including multi-layer optical networks, multi-domain optical networks and elastic optical networks. We also present the interworking between OpenFlow and PCE/GMPLS control planes.

TuQ3-2 15:00 - 15:15

Iterative Bridge and Roll for Connection Rerouting

Qiong Zhang [1], Chengyi Gao [2], Xi Wang [1], Paparao Palacharla [1], Motoyoshi Sekiya [1]
[1] Fujitsu Laboratories of America, Inc., Richardson, USA, [2] The Univ. of Texas at Dallas, Richardson, USA

We propose a heuristic connection rerouting scheme that iteratively bridges and rolls a subset of connections for improving network utilization. The proposed scheme has no disrupted connection and has low computation and control complexity.

TuQ3-3 15:15 - 15:30

Investigation of Traffic Grooming Characteristics for OTN/WDM Networks

Yutaka Takita, Tomohiro Hashiguchi, Kazuyuki Tajima and Takao Naito
Fujitsu Laboratories Ltd., Kawasaki, Japan

We investigate traffic grooming characteristics by utilizing "Grooming Index". We mainly focus on the relationship between demand distribution in networks and traffic grooming. These are useful for judging the aptitude of networks to OTN grooming.

TuQ3-4 15:30 - 15:45

QoT Prediction for Core Networks with Uncompensated Coherent Transmission

Marianna Angelou [1,2], Philip N. Ji [1], Ioannis Tomkos [2] and Ting Wang [1]
[1] NEC Laboratories America, Princeton, NJ, [2] Athens Information Technology (AIT), Athens, Greece

We propose a comprehensive QoT prediction tool based on fast analytical modeling for on-the-fly signal assessments in networks with uncompensated coherent systems and confirm its superiority in reducing over-engineering compared to system-reach methods.

TuQ3-5 15:45 - 16:00

Resilient Photonic Network Architecture with Plug & play Optical Interconnection Technology

Toshikazu Sakano [1], Hirokazu Kubota [1], Tetsuro Komukai [1], Toshihiko Hirooka [2], and Masataka Nakazawa [2]
[1] NTT Network Innovation Laboratories, Kanagawa, Japan, [2] Research Inst. of Electrical Communication, Tohoku Univ., Sendai, Japan

This paper proposes a resilient photonic network based on digital coherent optical transceivers and movable ICT resource units. We develop a 100Gbit/s transceiver for the movable unit and experimentally confirm its plug & play capability.

Room J 2F

[TuO3] 14:30 - 16:00
Optical Storage
Session Chair: Tsutomu Shimura (The Univ. of Tokyo, Japan)

TuO3-1 14:30 - 15:00 Invited

Advanced Technologies of Current and Future ODD Technologies

No-Cheol Park, Kyoung-Su Park, Seokhwan Kim, Do-Hyung Kim, Wonseok Oh and Young-Pil Park

Dept. of Mechanical Engineering, Yonsei Univ., Seoul, Korea.

We introduce optical and mechanical issues in storage system. We discuss the mechanical issues in conventional ODD, image processing method in HDS, and TAMR technology as the applications of near field optics in storage system.

TuO3-2 15:00 - 15:15

Temporally Coded Collinear Holographic Memory

M. Kawasaki [1], R. Fujimura [2], T. Shimura [1], and K. Kuroda [3]

[1] Inst. of Industrial Science, the Univ. of Tokyo, Tokyo, Japan, [2] Tokyo Institute of Technology, Kanagawa, Japan, [3] Utsunomiya Univ., Tochigi, Japan

A collinear holographic memory system recording multi-channel time sequential signal is proposed and demonstrated. Higher recording density and data transfer rate comparing to the page-oriented system are expected because Run-Length Limited code can be used.

TuO3-3 15:15 - 15:30

Multilevel Logic Polarization Coded Holographic Memory

Y. Matsuhashi [1], R. Fujimura [2], T. Shimura [1], and K. Kuroda [3]

[1] Inst. of Industrial Science, the Univ. of Tokyo, Tokyo, Japan, [2] Tokyo Institute of Technology, Kanagawa, Japan, [3] Utsunomiya Univ., Tochigi, Japan

A polarization coded holographic memory is demonstrated. Writing and reading characteristics are examined through numerical calculations and experiments. The polarization state of the readout signal is influenced by the ratio of intensity and polarization gratings

TuO3-4 15:30 - 15:45

Super-resolved Complex Amplitude Reconstruction of Nanostructured Binary Data with Pattern Matching

Shinji Ishikawa and Yoshio Hayasaki

Center for Optical Research and Education (CORE) Utsunomiya Univ., Utsunomiya, Japan

We propose a new optical reconstruction of binary data formed by nanostructures using an interference microscope and a pattern matching method. We demonstrated the readable size under the presence of noises using a computer simulation.

TuO3-5 15:45 - 16:00

Configuration on an optically reconfigurable gate array under the maximum 120°C temperature condition

Retsu Moriwaki[1], Minoru Watanabe[1], and Akifumi Ogiwara[2]

[1] Electrical and Electronic Engineering, Shizuoka Univ., [2] Dept. of Electronic Engineering, Kobe City College of Technology, Japan

This paper presents a new wide-temperature condition acceptable optically reconfigurable gate array that can function well at 10-120°C temperature conditions. That and other features make this device very suitable for space applications.

Room K 2F

[TuT3] 14:30 - 16:00
Optical Packet Switching
Session Chair: Geert Morthier (Ghent Univ. - IMEC, Belgium)

TuT3-1 14:30 - 14:45

160 Gb/s Optical Packet Switch Module Employing SOI Integrated Label Extractor

S. Di Lucente [1], P. De Heyn [2], J. Luo [1], D. Van T hourhout [2], H.J.S. Dorren [1] and N. Calabretta [1]

[1] Eindhoven Univ. of Technology, Dept. of Electrical Engineering, Eindhoven, The Netherlands, [2] Ghent Univ. - IMEC, Dept. of Information Technology, Photonics Research Group, Ghent, Belgium

We demonstrate a full functional 1xN optical packet switch employing a Silicon-on-Insulator integrated label extractor combined with a FPGA-based controller. Experimental results show error-free on-the-fly parallel and asynchronous optical label detection, processing and packet switching.

TuT3-2 14:45 - 15:00

Self-Homodyne CO-OFDM Packet Transmitter with Polarization-Multiplexed Pilot Tone

Ruben S. Luis, Benjamin J. Puttnam, José-Manuel Delgado Mendinueta, Satoshi Shinada and Naoya Wada

Photonic Network System Laboratory Nat'l Inst. of Information and Communications Technology, Tokyo, Japan

Self-homodyne CO-OFDM packet transmission with polarization multiplexed pilot tone is demonstrated. Error-free operation is shown with laser linewidths of 500 kHz and data rates of 10.7 Gb/s and 19.6 Gb/s.

TuT3-3 15:00 - 15:15

Simulation and Demonstration of Largecapacity Fiber-delay-line Buffer for Optical Packet Switch

S. Shinada, H. Furukawa, and N. Wada

Nat'l Inst. of Information and Communications Technology, Tokyo, Japan

A required buffer size of fiber delay lines to resolve packet contentions was estimated from a simulation using pipelined algorism. Additionally, 31-fiber delay line buffer which consisted of tree-structured optical switches and fiber-sheets was demonstrated.

TuT3-4 15:15 - 15:30

Demonstration of Optical Packet Switching System based on 8 x 12.5 Gb/s All-Optical OFDM and SOA Switch

S. Shimizu[1], G . Cincotti[2], and N. Wada[1]

[1] Nat'l Inst. of Information and Communications Technology (NICT), Tokyo, Japan, [2] Engineering Dept., Univ. Roma Tre, Rome, Italy

We demonstrate an optical packet switching system based on 8 x 12.5 Gb/s all-optical orthogonal frequency division multiplexing and semiconductor optical amplifier-based switch. The bit-error-rate shows 0.5 dB power penalty due to the switching.

TuT3-5 15:30 - 16:00 Invited

Optical Transceiver ICs based on 3D Die-Stacking of Opto-electronic Devices

Pinxiang Duan [1], Oded Raz [1] and Harmen JS Dorren [1]

[1] Eindhoven Univ. of Technology, Eindhoven, the Netherlands

We review a wafer-scale process for making compact 3D-stacked transmitter and receivers ICs. Experimental results indicating error-free operation of the transmitter at 10 Gbps over 500m transmission through OM4-Plus fiber are given.

Room 101 1F

[TuD3] 14:30 - 16:00 Symposium
High Power Lasers and Applications IV
Session Chair: Eisuke Miura (National Inst. of Advanced Industrial Science and Technology (AIST), Japan)

TuD3-1 14:30 - 15:00 Invited

Laser-Plasma Acceleration and Radiation Sources for Applications

L. A. Gizzi [1,2], M. P. Anania [3], M. Ciofini [4], L. Esposito [5], P. Ferrara [1], G. Gatti [3], D. Giulietti [1,2,6], G. Grittani [1,2,6], J. Hostaša [5], M. Kando [7], M. Krus [8], L. Labate [1,2], A. Lapucci [4], T. Levatoa [8,9], Y. Oishi [10], A. Pirri [11], F. Rossi [12], G. Toci [11], M. Vannini [11]

[1] ILIL, INO-CNR, Pisa, Italy, [2] INFN, Pisa, Italy [3] LNF-INFN, Frascati, Italy [4] INO-CNR, Firenze, Italy, [5] ISTEC-CNR, Faenza, Italy, [6] Universitá di Pisa, Italy, [7] JAEA, Kyoto, Japan, [8] Fyzikálníústav AV ČR v.v.i., Praha, Czech Republic, [9] U. Tor Vergata, Roma, Italy, [10] CRIEPI, Kanagawa, Japan, [11] IFAC-CNR, Sesto Fiorentino (FI), Italy, [12] Universitá di Bologna and Sez. INFN, Bologna, Italy

Laser-plasma acceleration is now established while secondary sources are being developed. An overview of the field will be given with a discussion on perspectives for possible future development of high average power, all-optical radiation sources.

TuD3-2 15:00 - 15:30 Invited

Emission Characteristics of Electrons Accelerated in a Thin Foil and a Metal Wire by Intense Femtosecond Laser Pulses

Shuji Sakabe, Masaki Hashida, Shigeki Tokita, and Shunsuke Inoue

Inst. for Chemical Research, Kyoto Univ., Kyoto, Japan, Graduate School of Science, Kyoto Univ., Kyoto, Japan

The characteristics (angular distributions, spectra) of fast (>50 keV) electrons emitted from thin non-conductive and conductive foils and metal wires irradiated by intense femtosecond laser pulses with intensity of 3×10^{18} W/cm^2 are investigated in detail.

TuD3-3 15:30 - 16:00 Invited

Laser-Driven Ion Acceleration in the Radiation Pressure Dominated Regime

S. V. Bulanov[1], E. Echkina[2], T. Esirkepov[1], I. Inovenkov[2], M. Kando[1], J. K. Koga[1], F. Pegoraro[3], G. Korn[4], S. S. Bulanov[5], C. G. R. Geddes[6], C. Schroeder[6], E. Esarey[6], W. P. Leemans[6]

[1] Kansai Photon Science Inst., JAEA, Kyoto, Japan, [2] CMC, Moscow State Univ., Moscow, Russia, [3] Physical Dept., Univ. of Pisa, Pisa, Italy, [4] Institute of Physics, Czech Academy of Sciences, Prague, Czech Republic, [5] Univ. of California, California, USA, [6] Lawrence Berkeley Nat'l Laboratory, California, USA

Radiation pressure is an effective mechanism of momentum transfer to ions in laser plasmas. The energy of ions accelerated by the radiation pressure can be greatly enhanced due to a transverse expansion of a target.

Room 103 1F

[TuI3] 14:30 - 16:00
Solar Cells by Nanophotonics
Session Chair: Michal Lipson (Cornell Univ., USA)

TuI3-1 14:30 - 15:00 Invited

Manipulating Thermal Electromagnetic Fields by Engineering Nanophotonic Resonances

Shanhui Fan, Zongfu Yu, Eden Rephaeli, Aaswath Raman
Dept. of Electrical Engineering, Ginzton Laboratory, Stanford Univ., CA, USA

We present some of our latest works in manipulating thermal electromagnetic fields, examples including thermal extraction, and daytime radiative cooling.

TuI3-2 15:00 - 15:15

Super-high Density Si Quantum Dot Thin Film for Photovoltaic Properties Enhancement

K.Y. Kuo, P.R. Huang, Y.J. Chen, and P.T. Lee
Dept. of Photonics & Inst. of Electro-Optical Engineering, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

A gradient Si-rich oxide multilayer deposition structure is proposed to achieve super-high density Si quantum dot (QD) thin film while preserving QD size control ability for better photovoltaic properties.

TuI3-3 15:15 - 15:30

Enhancement of Optical Absorption in Solar Cells by Band-Edge Effect of Photonic Crystals. I -Formation of Multiple Bandedges-

Y. Tanaka [1], Y. Kawamoto [1], M. Fujita [1,2], and S. Noda [1]
[1] Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan, [2] Division of Advanced Electronics and Optical Science, Osaka Univ., Osaka, Japan

We numerically investigate broadband optical absorption enhancement in thin Si photovoltaic devices by multiple photonic band-edges that are produced by higher order modes for the vertical direction and photonic supercell structures.

TuI3-4 15:30 - 15:45

Enhancement of Optical Absorption in Solar Cells by Band-Edge Effect of Photonic Crystals. II -Topology Optimization for Further Absorption-

Yosuke Kawamoto, Yoshinori Tanaka, and Susumu Noda
Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

We investigate optical absorption enhancement in a solar cell structure using photonic crystals. We propose and investigate topology optimization for photonic crystal design and successfully find a structure with larger optical absorption.

TuI3-5 15:45 - 16:00

Tandem Photonic-Crystal Thin Films Surpassing Lambertian Light-Trapping Limit Over Broad Bandwidth and Angular Range

Ardavan Oskooi and Susumu Noda
Dept. of Electronic Science & Engineering, Kyoto Univ., Nishikyo-ku, Japan

We outline the design of a solar cell based on a tandem arrangement of two partially-disordered photonic-crystal slabs which have large absorption that surpasses the Lambertian light-trapping limit over a broad bandwidth and angular range.

Room 104A 1F

[TuE3] 14:30 - 16:00
Nanoparticles and Nanostrucures
Session Chair: Yoshiki Nakata (Osaka Univ., Japan)

TuE3-1 14:30 - 14:45

Fabrication of Ordered Hierarchical Structures Using Colloidal Monolayer Template and Pulsed Laser Deposition in Gas Phase

N. Koshizaki [1] and Y. Li [2]
[1] Nanosystem Research Inst., Nat'l Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, [2] Institute of Solid State Physics (ISSP), Chinese Academy of Sciences (CAS), P.R. China

We have developed a strategy for fabricating ordered hierarchical micro/nanostructures based on the combination of a colloidal monolayer substrate for microstructures and the pulsed laser deposition (PLD) process for nanostructures.

TuE3-2 14:45 - 15:00

Fabrication of Submicron-sized Spherical Particles Using Laser-induced Agglomeration and Fusion of Nanoparticles

Takeshi Tsuji [1], Tatsuya Yahata [1], Masato Yasutomo [1], Masaharu Tsuji [1], Kazunobu Igawa [1], Yoshie Ishikawa [2], Naoto Koshizaki [3]
[1] Inst. of Materials Chemistry and Engineering, Kyushu Univ., Fukuoka, Japan, [2] Dept. of Advanced Materials Science, Faculty of Engineering, Kagawa Univ., Kagawa, Japan, [3] Nanosystem Research Institute, Nat'l Institute of Advanced Industrial Science and Technology, Ibaraki, Japan

Submicron-sized gold particles were prepared using laser irradiation for gold nanoparticles stabilized by citrate. It was revealed that laser irradiation induces the agglomeration of the source nanoparticles prior to the fusion.

TuE3-3 15:00 - 15:15

Nanoparticle Synthesis by Femtosecond Laser Ablation in Liquid

Yasuhiko Shimotsuma [1], Yuya Yamada [1], Masaaki Sakakura [2], Kazuyuki Hirao [1], and Kiyotaka Miura [1]
[1] Dept. of Material Chemistry, Kyoto Univ., Kyoto, Japan, [2] Office of Society-Academia Collaboration for Innovation, Kyoto Univ., Kyoto, Japan

High efficient synthesis of nanoparticles with a diameter below the diffraction limit of laser light was demonstrated by femtosecond double-pulse ablation in liquid. Nano-diamond was also synthesized from carbonized bagasse using this technique.

TuE3-4 15:15 - 15:30

Hierarchical Pattern Structure in TiO_2 Nano-Aggregates Prepared by Pulsed Laser Ablation in Background Gas

Ikurou Umezu [1], Akira Sugimura [1] and Takehito Yoshida [2].
[1] Dept. of physics, Konan Univ., Kobe, Japan, [2] Dept. of Mechanical Engineering, Anan Nat'l College of Technology, Anan, Japan

Hierarchical micron- and submicron-sized repetitive pattern was found in TiO_2 nanocrystal aggregates prepared by pulsed laser ablation. The pattern structure can be varied by background gas pressure. The results show existence of stable aggregated structure.

TuE3-5 15:30 - 15:45

Laser Processing of Nano-porous Films Based on Plasmonic Excitation of Au Nanoparticles in the Films

Keita Muraoka[1], Tatsuya Shoji[1], Kazushi Yaamda[1], Noboru Kitamura[1], and Yasuyuki Tsuboi[1,3]
[1] Dept. of Chemistry, Graduate School of Science, Hokkaido Univ., Sapporo, Japan, [2] Future Applied Conventional Technology Center, Kyoto Inst. of Technology, Kyoto, Japan, [3] JST, PRESTO, Japan

We present a novel laser processing technique for nanoholes formation (d ~ 20–100 nm) on a polymer film based on resonant excitation of surface plasmon of Au nanoparticles.

TuE3-6 15:45 - 16:00

Architecting Functionally Graded Ti-Porous Structures Using Laser Rapid Manufacturing

C P Paul [1], Hareesh D. [2], S K Mishra [1], P Bhargava [1], C H Premsingh [1], D C Nagpure [1], KR Arunprasad [2] and L M Kukreja [1]
[1] Laser Material Processing Division, Raja Ramanna Centre for Advanced Technology, Indore (MP) INDIA, [2] Dept. of Mechanical Engineering, SRM Univ. Kattankulathur, Chennai (TN) INDIA

This paper reports the deployment of a 2 kW fibre laser based rapid manufacturing system for fabricating functionally graded Ti-porous structures using new Z-shape unit cell based architecture and evaluation of their mechanical properties.

Room 104B 1F

[TuJ3] 14:30 - 16:00
Bioimaging I
Session Chair: Jun Ohta (Nara Inst. of Science and Technology, Japan)

TuJ3-1 14:30 - 15:00 Invited

Surface-Enhanced Nanoplasmonics for Biomolecular Sensing and Imaging

Youngjin Oh, Jong-ryul Choi, Wonju Lee, and Donghyun Kim
School of Electrical and Electronic Engineering, Yonsei Univ., Seodaemun-gu, Korea

We investigate surface plasmon enhanced optical biosensing and imaging techniques. We describe nanostructure based co-localization to achieve high detection sensitivity and super-resolution imaging techniques by subwavelength fluorescence localization sampling combined with spatial modulation.

TuJ3-2 15:00 - 15:15

Photomechanical Targeted Drug and Gene Delivery to Central Nervous Systems

Shunichi Sato[1], Takahiro Ando[2], Yasushi Satoh[3], Hiroshi Nawashiro[4], and Minoru Obara[2]
[1] Division of Biomedical Information Sciences, Nat'l Defense Medical College Research Inst., Saitama, Japan, [2] Dept. of Electronics and Electrical Engineering, Keio Univ., Kanagawa, Japan, [3] Dept. of Anesthesiology, National Defense Medical College, Saitama, Japan, [4] Division of Neurosurgery, Tokorozawa Central Hospital, Saitama, Japan

We demonstrated efficient gene delivery to central nervous systems by photomechanical waves. The method was applied to recover motor function of rats with spinal cord injury. Photomechanical waves can also open the blood brain barrier.

TuJ3-3 15:15 - 15:30

Raman Imaging and Analysis: From Quantification of Cellular Dynamics to Molecular Structure

N. I. Smith [1], A. Hobro [1], N. Pavillon [1], K. Fujita [2], Y. Kumagai [3], and C. Coban [4]
[1] Biophotonics Lab, Immunology Frontier Research Center, Osaka Univ., Japan, [2] Dept. Applied Physics, Grad School of Engineering, Osaka Univ., Japan, [3] Host Defense Lab, Immunology Frontier Research Center, Osaka Univ., Japan, [4] Malaria Immunology Lab, Immunology Frontier Research Center, Osaka Univ., Japan

We develop protocols for Raman microscopy of living cellular changes in response to immunological stimulus and also attempt to quantify molecular structural information through analysis of obtained spectra from purified samples.

TuJ3-4 15:30 - 15:45

Fast Polarization-resolved SHG Microscopy for in Vivo Imaging of Collagen Orientation

Yuji Tanaka [1], Eiji Hase [2], Shuichiro Fukushima [1], Takeshi Yasui [1,3], and Tsutomu Araki [1]
[1] Graduate School of Engineering Science, Osaka Univ., Osaka, Japan, [2] Graduate School of Advanced Technology and Science, Univ. of Tokushima, Tokushima, Japan, [3] Inst. of Technology and Science, Univ. of Tokushima, Tokushima, Japan

Rapid, polarization-resolved second-harmonic-generation (SHG) microscopy was achieved based on an electro-optics-modulator-based polarization modulation. This system enables us to visualize orientation mapping of dermal collagen fiber in skin *in vivo* without influence of motion artifacts.

TuJ3-5 15:45 - 16:00

Multimodal Label-Free Microscopy

N. Pavillon [1], and N. I. Smith [1,2]
[1] Biophotonics Laboratory, Immunology Frontier Research Center (IFReC), Osaka Univ., Osaka, Japan, [2] PRESTO, Japan Science and Technology Agency (JST), Tokyo, Japan

We developed a multimodal microscope enabling simultaneous measurement of two label-free imaging methods, Raman microscopy and quantitative phase imaging. This approach provides real-time measurements through phase microscopy, along with the chemical specificity of Raman spectroscopy.

Room C-1 1F

[TuR4] 16:30 - 18:30
OFDM
Session Chair: Guifang Li (Univ. of Central Florida, USA)

TuR4-1 16:30 - 17:00 Invited

Block-wise Phase Switching for Double-sideband Direct Detected Optical OFDM Signals

Xi Chen, An Li, Di Che, Qian Hu, Yifei Wang, Jiayuan He, and William Shieh

Dept. of Electrical and Electronic Engineering, The Univ. of Melbourne, VIC, Australia

We propose phase switching for either main-carrier or subcarriers of two consecutive signal blocks to achieve fading-free double-sideband direct-detection (DD). In our demonstration, 40-Gb/s DD-OOFDM is successfully received over 80-km SSMF with single polarization and single detector.

TuR4-2 17:00 - 17:15

Estimation of Fast Fourier Transform Size of OFDM Signals for Elastic Optical Networks

K. Takeshima, H. Takahashi, and T. Tsuritani

KDDI R&D Laboratories Inc., Saitama, JAPAN

We proposed an FFT size estimation scheme for OFDM signals in elastic optical networks. We can maintain signal performance at the receiver without control channels, even when the FFT size is changed at the transmitter.

TuR4-3 17:15 - 17:30

Improving the Performance of Optical Phase Conjugator Using a Mid-way Filter

Md. Monir Morshed, Liang B. Du, and Arthur J. Lowery

Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), Dept. of Electrical & Computer Systems Engineering, Monash Univ., Clayton, Australia

We propose a novel optical phase conjugator with a mid-way filter preventing nonlinear products being shifted into the signal band. The simulated signal Qmax improved by 1.1 dB in an 800-km 557.5-Gbp/s 16-QAM CO-OFDM system.

TuR4-4 17:30 - 17:45

Efficiency Enhancement of CO-OFDM Systems Using Different Pulse Shapes

S. Hussin, K. Puntsri, D. Sandel, M.F. Panhwar and R. Noé

Optical Communication and High Frequency Engineering Dept., Univ. Paderborn, Paderborn, Germany

A square root raised-cosine window of OFDM symbols is suggested to enhance the efficiency of CO-OFDM systems instead of raised-cosine or rectangular windowing. Simulation results of CO-OFDM systems over 2400 km are investigated using VPItransmissionMakerTM.

TuR4-5 17:45 - 18:00

Improved U-S OFDM for Fiber Nonlinearity Mitigation in Long Haul Transmission

Xiang Li[1], Arokiaswami Alphones[1], Wen-De Zhong[1] and Changyuan Yu[2,3]

*[1] School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore, [2] Dept. of Electrical and Computer Engineering, Nat'l Univ. of Singapore, Singapore, [3] A*STAR Inst. for Infocomm Research, Singapore*

An improved unitary-spread OFDM is proposed to mitigate the fiber nonlinearity with small computational complexity. The simulation results show that U-S OFDMs based on two orthogonal transforms have better fiber nonlinearity tolerance than plain OFDM.

TuR4-6 18:00 - 18:15

An Experiment of Subband Spectral Shaping in DFT-Spread CO-OFDM systems

O. Jan[1], K. Puntsri[1], D. Sandel[1], A. Al-Bermani[1], C. Wordehoff[2], U. Ruckert[2] and R. Noé[1]

[1] Univ. of Paderborn, Paderborn, Germany, [2] Bielefeld Univ., CITEC, Bielefeld, Germany

We experimentally investigated the impact of laser phase noise on coherent optical DFT-spread OFDM with spectral shaping. We also propose a new spectral shaping to improve the system performance.

TuR4-7 18:15 - 18:30

Pilot-aided CD and PN Compensation Simultaneously in CO-OFDM Systems

K. Puntsri [1], O. Jan [1], A. Al-Bermani [1], D. Sandel [1], C. Wordehoff [2], S. Hussin [1], M. F. Panhwar [1], U. Ruckert [2], R. Noé [1]

[1] Univ. of Paderborn, EIM-E, ONT, Paderborn, Germany, [2] Cognitronics and Sensor Systems, CITEC, Bielefeld Univ., Bielefeld, Germany

Joint chromatic dispersion and phase noise compensation by the pilot-based method is presented. The 16-QAM modulated transmission reaches the FEC-limit for fiber length of 960 km at 28 Gs/s and laser linewidth of 200 kHz.

Room C-2 1F

[TuN4] 16:30 - 18:00 Symposium
High-density Photonic Integration Platforms and Their Applications (Application)
Session Chair: Meint K. Smit (Eindhoven Univ. of Technology, The Netherlands)

TuN4-1 16:30 - 17:00 Invited

Prospects and Challenges of High-Density Heterogeneous Photonic Integration

S. J. B. Yoo

Dept. of Electrical and Computer Engineering, Univ. of California, CA, USA

We will review the progress and impact of photonic integration, and address the progress, challenges, and future prospects of photonic-electronic integration in future information systems. Technologies include silicon CMOS photonics and InP, GaAs OEICs.

TuN4-2 17:00 - 17:30 Invited

High-density Optical Interposers Fully Integrated with Silicon Photonics

Y. Urino[1,2], J. Fujikata[1,2], T. Usuki[1,2], M. Ishizaka[1,2], K. Yamada[1,2], T. Horikawa[1,3], T. Nakamura[1,2], and Y. Arakawa[1,4]

[1] Inst. for Photonics-Electronics Convergence System Technology (PECST), [2] Photonics Electronics Technology Research Association (PETRA), Ibaraki, Japan, [3] Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Ibaraki, Japan, [4] Inst. of Industrial Science, The Univ. of Tokyo, Tokyo, Japan

High-density optical interposers integrated with complete optical components on single silicon substrate by using silicon photonics were demonstrated. Error-free data transmission at 12.5-Gbps and high bandwidth density of 6.6-Tbps/cm^2 were achieved with the optical interposers.

TuN4-3 17:30 - 18:00 Invited

Designing Processor-Memory Interfaces with Monolithically Integrated Silicon-photonics

Chen Sun, Yu-Hsin Chen, Vladimir Stojanović

Research Laboratory of Electronics, Massachusetts Inst. of Technology, MA, USA

We propose a monolithically-integrated processor-to-DRAM interface using thermally-stable Mach-Zehnder switches for optical power guiding. For a representative set of SPLASH-2 benchmarks, we achieve 18% lower energy-per-bit cost over the previous resonant ring-switched design.

Room F 1F

[TuA4] 16:30 - 18:00 Symposium
Novel Fiber Designs for Lasers II
Session Chair: Yoonchan Jeong (Seoul National Univ. Korea)

TuA4-1 16:30 - 17:00 Invited

Fourier Optics Along a Single Strand of Optical Fiber: A New Novel Laser Beam Shaping Technology

Jongki Kim, Sungrae Lee, and Kyunghwan Oh

Photonic Device Physics Laboratory, Dept. of physics, Yonsei Univ., Korea

A new fiber-optic beam shaping is proposed and demonstrated by realizing Fourier transformation along a single strand of composite fiber. Bessel-like-beam was generated in an all-fiber-device, and was applied to optical trapping, transporting of particles.

TuA4-2 17:00 - 17:30 Invited

New Prospect of Soft Glass Highly Nonlinear Microstructured Optical Fibers

Yasutake Ohishi

Research Center for Advanced Photon Technology, Graduate School of Engineering, Toyota Technological Inst., Nagoya, Japan

New prospect of soft glass, such as tellurite and chalcogenide glass, highly nonlinear microstructured optical fibers for supercontinuum generation and nonlinear applications including all-optical control of group velocity dispersion are presented.

TuA4-3 17:30 - 18:00 Invited

Getting the Most from Your Fluoride Fibres

S. D. Jackson, D. D. Hudson, J. F. Li, T. Hu and S. Crawford

Inst. of Photonics and Optical Science (IPOS) and Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS) School of Physics, A28 Univ. of Sydney, Camperdown, Australia

In this presentation, I will discuss these methods and offer some general rules-of-thumb that are applicable to the use of fluoride fibre.

Room G 1F

[TuB4] 16:30 - 18:30
Attosecond Physics II
Session Chair: Zenghu Chang (Univ. of Central Florida, USA)

TuB4-1 16:30 - 17:00 Invited

Attosecond Nonlinear Optics

M. Th. Hassan[1], T.T. Luu[1], A. Moulet[1], M. Garg[1], O. Razskazovskaya[2], N. Karpowicz[1], V. Pervak[2] F. Krausz[1,2] and E. Goulielmakis[1]
[1] Max-Planck-Institut für Quantenoptik, Garching, Germany, [2] Dept. für Physik, Ludwig-Maximilians-Universität, Garching, Germany

We report on the precise synthesis and control of intense isolated, optical attosecond pulses. With these pulses- the attosecond light transients- we demonstrate, ionization free, sub-femtosecond control of bound electrons.

TuB4-2 17:00 - 17:15

Attosecond Temporal Shape Manipulation by Arbitrarily Designing Spectral Phases

Kazumichi Yoshii, Nurul Sheeda Suhaimi, John Kiran Anthony, and Masayuki Katsuragawa
Dept. of Engineering Science, Univ. of Electro-Communications, Tokyo, Japan

We report a novel approach to generate an attosecond pulse train from a discrete spectrum in the UV-VIS-NIR range by positioning a set of thin dispersive materials on the optical path.

TuB4-3 17:15 - 17:30

Correlation-Driven Electron Dynamics in Attosecond Photoionization of Helium

Kenichi L. Ishikawa [1], Suren Sukiasyan [2], and Misha Ivanov [2,3]
[1] Photon Science Center, Graduate School of Engineering, The Univ. of Tokyo, Tokyo, Japan, [2] Dept. of Physics, Imperial College London, London, United Kingdom, [3] Max Born Inst., Berlin, Germany

We present attosecond dynamics of electron-electron correlation-driven knock-up/down process following photoionization of excited helium. Its time scale is linked to the time for the outgoing inner electron to traverse the orbit of the outer electron.

TuB4-4 17:30 - 17:45

Vibrational Wave-Packet Evolution of Hydrogen Molecular Ions Studied by the Pump-Probe Spectroscopy Using Harmonic Pulses

Y. Furukawa [1], T. Okino [2,1], Y. Nabekawa [1], A. Amani Eilanlou [1], E. J. Takahashi [1], K. Yamanouchi [2], and K. Midorikawa [1]
[1] Extreme Photonics Research Group, RIKEN Advanced Science Inst., Saitama, Japan, [2] Dept. of Chemistry, School of Science, the Univ. of Tokyo, Tokyo, Japan

We have investigated the vibrational wave-packet dynamics of hydrogen molecular ions by the pump-probe measurement using sub-10-fs harmonic pulses. The wave-packet evolution is observed in the time-dependent fragment kinetic energy distribution.

TuB4-5 17:45 - 18:00

Attosecond Control of Fragment Ion Angular Distribution of N_2 by a Few Attosecond Pulses

Tomoya Okino [2,1], Yusuke Furukawa [1], A. Amani Eilanlou [1], Yasuo Nabekawa [1], Eiji J. Takahashi [1], Kaoru Yamanouchi [2,1], Katsumi Midorikawa [1]
[1] Laser Technology Laboratory, RIKEN ASI, Saitama, Japan, [2] Dept. of Chemistry, School of Science, the Univ. of Tokyo, Tokyo, Japan

Interferometric autocorrelation of a-few-pulse attosecond pulse was measured with single-shot velocity map imaging ion spectrometer using two-photon dissociative ionization process of N2 and the variation of angular distribution of N+ is controlled within 200 attoseconds.

TuB4-6 18:00 - 18:15

Continuously tunable redshift of high-order harmonics from carbon plasma

Y. Pertot [1], X.-B. Bian [2], M. A. Fareed [1], A. D. Bandrauk [2] and T. Ozaki [1]
[1] Institut Nat'l de la recherche scientifique - Centre Énergie Matériaux Télécommunication, Québec, Canada, [2] Département de Chimie, Université de Sherbrooke, Québec, Canada

We observe continuous and strong redshift of high-order harmonics generated from carbon plasma, which may explain the high conversion efficiency that result from a resonance close to the pump laser wavelength.

TuB4-7 18:15 - 18:30

Fine Spectral Structure of High Order Harmonics Generated by Multi-Terawatt Femtosecond Lasers Focused to Gas Jet Targets

K. Ogura[1], M. Kando[1], T. Zh. Esirkepov[1], T. A. Pikuz[1,2], A. Ya. Faenov[1,2], Y. Hayashi[1], H. Kotaki[1], E. N. Ragozin[3,4], D. Neely[5,6], H. Kiriyama[1], T. Shimomura[1], M. Tanoue[1], Y. Nakai[1], M. Okamoto[1], S. Kondo[1], S. Kanazawa[1], J. K. Koga[1], Y. Fukuda[1], M. Nishikino[1], T. Imazono[1], N. Hasegawa[1], T. Kawachi[1], H. Daido[1], Y. Kato[1], P. R. Bolton[1], S. V. Bulanov[1], K. Kondo[1], and A. S. Pirozhkov[1]
[1] Advanced Beam Technology Division, Quantum Beam Science Directorate, Japan Atomic Energy Agency, Kyoto, Japan, [2] Joint Inst. for High Temperatures, Russian Academy of Sciences, Moscow, Russia, [3] P. N. Lebedev Physical Inst., RAS, Moscow, Russia, [4] Moscow Inst. of Physics and Technology (State Univ.), Moscow, Russia, [5] Central Laser Facility, Rutherford Appleton Laboratory, STFC, Oxon, UK, [6] Univ. of Strathclyde, Dept. of Physics, SUPA, Glasgow, UK, [7] Applied Laser Technology Inst., Tsuruga Head Office, Japan Atomic Energy Agency, Fukui, Japan, [8] The Graduate School for the Creation of New Photonics Industries, Shizuoka, Japan

We measured high-resolution spectra of high-order harmonics generated in relativistic interaction of multi-terawatt femtosecond lasers with gas jets. The spectra exhibit fine sub-eV structures, indicating temporal coherence of a few tens of femtoseconds.

Room H 1F

[TuF4] 16:30 - 18:15
Imaging and Metrology
Session Chair: Kaoru Minoshima (The University of Electro-Communication, Japan)

TuF4-1 16:30 - 17:00 Invited

Multi-dimensional Imaging Using Compressive Sensing

Ryoichi Horisaki and Jun Tanida
Graduate School of Information Science and Technology, Osaka Univ., Osaka, Japan

We have proposed and demonstrated multiple frameworks to acquire multi-dimensional optical information, containing three-dimensional positions, spectrums, polarizations, etc., with a single-shot based on compressive sensing. This paper describes an overview of these frameworks.

TuF4-2 17:00 - 17:15

Fiber-laser-based Stimulated Raman Microspectroscopy with Shot-Noise Limited Sensitivity

Keisuke Nose[1], Tatsuya Kishi[1], Yasuyuki Ozeki[1,2], Yasuo Kanematsu[1] and Kazuyoshi Itoh[1]
[1] Division of Advanced Science and Biotechnology, Osaka Univ., Osaka, Japan [2] PRESTO, Japan Science and Technology Agency (JST), Saitama, Japan

We generate second-harmonic Er-fiber laser pulses with suppressed intensity noise by collinear balanced detection technique, and Yb fiber laser pulses with a wide tunability (~250 cm^{-1}) to demonstrate fiber-laser-based stimulated Raman microspectroscopy of polymer beads.

TuF4-3 17:15 - 17:30

Measurements of the group delay dispersion with resonance scanning interferometer

V. Pervak [1,2], M. K. Trubetskov [3,4], M. von Pechmann [1], I. B. Angelov [3], O. Razskazovskaya [3], E. Fedulova [3], K. L. Vodopyanov [5], F. Krausz [1,3]
[1] Ludwig-Maximilians-Universitaet Muenchen, Garching, Germany, [2] Ultrafast Innovations GmbH, Garching, Germany, [3] Max-Planck Inst. of Quantum Optics, Garching, Germany, [4] Research Computing Center, Moscow State Univ., Moscow, Russia, [5] Univ. Central Florida, CREOL, College of Optics & Photonics, FL, USA

We developed a Resonance Scanning Interferometer for group delay dispersion measurements based on inter-mirror spacer resonances. High resolution is achieved by simultaneous processing of measurement scans obtained for different spacer thicknesses.

TuF4-4 17:30 - 17:45

Two wavelength-scanning interferometers for profile measurement of thin films by backpropagation of multiple-wavelength optical fields

Osami Sasaki, Xin Jian, Choi Samuel, and Takamasa Suzuki
Faculty of Engineering, Niigata Univ., Niigata-shi, Japan

An optical field is reconstructed by summing the multiple-wavelength fields backpropagated from a detecting point along the optical axis. The positions of a thin film surfaces can be measured by the reconstructed optical field.

TuF4-5 17:45 - 18:00

Long Range, High accuracy Absolute Distance Measurement by Improved Three-Wavelength Heterodyne Interferometry

Pei-Chi Huang, and Shang-Da Yang
Inst. of Photonics Technologies, Nat'l Tsing Hua Univ., Hsinchu, Taiwan

The complexity and non-ambiguity range (NAR) of the conventional three-wavelength heterodyne interferometry are improved by using one phase modulator and a mapping procedure, respectively. Experiments demonstrated 10-mm NAR and an estimated accuracy of 0.65 nm.

TuF4-6 18:00 - 18:15

Distance measurement over 30 km using highly sensitive two-photon detection

Yoshimi Kudo, Daichi Suzuki, Ken Kashiwagi, Yosuke Tanaka, and Takashi Kurokawa
Graduate School of Engineering, Tokyo Univ. of Agriculture and Technology, Tokyo, Japan

Elongation of distance measurement based on two-photon detection was achieved by using a lock-in amplifier. The multiple reflection points in an optical fiber distributed at 1 km to 30 km away was successfully identified.

Room I 2F

[TuQ4] 16:30 - 18:30
Next Generation Optical Networks
Session Chair: Takao Naito (Fujitsu Laboratories, Japan)

TuQ4-1 16:30 - 17:00 Invited

Open Architecture for a Packet-Optical Solution

G. Grammel [1] and S. Liu [2]
[1] Juniper Networks, Germany, [2] Juniper Networks, USA

PM-QPSK 100G coherent technology based packet optical solution is creating new multilayer convergence network architecture. A packet optical solution is reviewed and the operation model of the new network architecture based on packet optical solution is discussed.

TuQ4-2 17:00 - 17:30 Upgrade Invited

Development of a Common Path Control-Plane for Interoperating Hybrid Optical Packet- and Circuit-Switched Ring Networks and WSONs

Takaya Miyazawa, Hideaki Furukawa, Naoya Wada, and Hiroaki Harai
Nat'l Inst. of Information and Communications Technology, Tokyo, Japan

We develop a common path control-plane for interoperating hybrid optical packet- and circuit-switched ring networks and wavelength-switched optical networks, and experimentally show transparent end-to-end lightpaths can be dynamically established over the two types of networks.

TuQ4-3 17:30 - 17:45

Internet Access Demonstration Using Optical Packet Switching Network with 89 km Field Transmission of 100 Gbps Optical Packet

Hideaki Furukawa, Takaya Miyazawa, Naoya Wada and Hiroaki Harai
Nat'l Inst. of Information and Communications Technology, Tokyo, Japan

We constructed a multi-ring optical packet and circuit integrated network testbed with 89 km field-installed fibers. We transmitted 100 Gbps optical packets including IP packets and achieved Internet access through the testbed.

TuQ4-4 17:45 - 18:00

Design of Network Slice Exchange for Bridging Future Internet Testbeds

Shuichi Okamoto, Keisuke Kuroki, Nobutaka Matsumoto, and Michiaki Hayashi
KDDI R&D Laboratories Inc., Saitama, Japan

This paper describes the design and implementation of the exchange model-based slice expansion architecture with universal intermediate APIs to bridge future Internet testbeds, and shows the use case taking GENI and G-lambda architecture for instance.

TuQ4-5 18:00 - 18:15

Combatting dispersion effects in slotted optical rings

Y. Pointurier and S. Bigo
Alcatel-Lucent, Bell Labs, Nozay, France

We show that slotted WDM optical rings can be maintained synchronous with a single, bypassable dispersion compensation module (DCM) per node. Bypassed DCMs are determined with a proposed planning algorithm robust to parameter measurements uncertainties.

TuQ4-6 18:15 - 18:30

Hierarchical Timeslot Allocation for Optical Layer-2 Switch Network

Masahiro Nakagawa, Kyota Hattori, Naoki Kim ishima, Masaru Katayama, and Akira Misawa
NTT Network Service Systems Laboratories, NTT Corporation, Tokyo, Japan

We propose a novel timeslot allocation method that utilizes hierarchical calculation. This method has a shorter computation time and enables dynamic path control in 1K-node-scale optical layer-2 switch network system, leading to cost-effective metro networks.

Room J 2F

[TuS4] 16:30 - 18:00
Few Mode Fiber Technology

Session Chair: Masaharu Ohashi (Osaka Prefecture Univ., Japan)

TuS4-1 16:30 - 17:00 Invited

Hollow Core Fibres for High Capacity Data Transmission

F. Poletti [1], M.N. Petrovich [1], N.V. Wheeler [1] , N.K. Baddela [1], E. Numkam Fokoua [1], J.P. Wooler [1], D.R. Gray [1], S.R. Sandoghchi [1], J.R. Hayes [1], Y. Jung [1], R. Slavik [1], S.U. Alam [1], V.A.J.M. Sleiffer [2], M. Kuschnerov [3], and D.J. Richardson [1]

[1] Optoelectronics Research Centre, Univ. of Southampton, Southampton, UK, [2] COBRA Inst., Eindhoven Univ. of technology, Eindhoven, The Nederlands, [3] NSN Optical GmbH, Munich, Germany

We review our progress in developing, characterizing and handling hollow-core photonic bandgap fibers with improved transmission properties, targeted at high-capacity, low-latency data transmission in the current telecoms window and at the potentially lower-loss 2μm wavelengths

TuS4-2 17:00 - 17:15

Maximum number of transmission channels in mode division multiplexing fibers

Toshinori Komo [1], Kyohei Kojima [1], and Yasuo Kokubun [2]

[1] Graduate School of Engineering, Yokohama Nat'l Univ., [2] Faculty of Engineering, Yokohama National Univ., Yokohama, Japan

The maximum number of channels of heterogeneous uncoupled few mode multi-core fiber using three non-identical cores was analyzed and found to be almost equal to that of homogeneous uncoupled few mode multi-core fiber.

TuS4-3 17:15 - 17:30

Mode Division Multiplexed Transmission through Two-Mode Fiber Using Space-Optics Based Mode Multiplexer/Demultiplexer

Tomoki ISODA [1], Hiroki TERAUCHI [1], Keitaro TATSUMI [1], Akihiro MARUTA [1], Ryo MARUYAMA [2], Nobuo KUWAKI [2], Shoichiro MATSUO [2], and Ken-ichi KITAYAMA [1]

[1] Graduate School of Engineering, Osaka Univ., Osaka, Japan, [2] Optics and Electronics Laboratory, Fujikura Ltd.

We have demonstrated mode division multiplexed transmission using a space-optics based mode multiplexer/ demultiplexer. In the experiment, 10 Gb/s NRZ-OOK signal and interfering CW light were simultaneously transmitted through a 2km-long two-mode fiber with BER<10-9.

TuS4-4 17:30 - 17:45

Intermodal stimulated Brillouin scattering in two-mode fibers

Kwang Yong Song [1], Yong Hyun Kim [1], and Byoung Yoon Kim [2]

[1] Chung-Ang Univ., Seoul, Korea, [2] Korea Advanced Inst. of Science and Technology, Daejeon, Korea

Experimental characterization of stimulated Brillouin scattering between different modes are demonstrated in elliptic-core two-mode fibers using a mode-selective coupler.

TuS4-5 17:45 - 18:00

Modal Gain Controllable All-fiber Type Multimode Fiber Amplifier

M.Wada, T. Sakamoto, T. Mori, N. Hanzawa, T. Yamamoto, and F. Yamamoto

Access Network Service Systems Laboratories, NTT Corporation, Ibaraki, Japan

We investigate an all-fiber type multimode erbium-doped fiber amplifier and control mode-dependent gain (MDG) using a long period grating. Measurement results show that the MDG can be changed in at least the -7~5 dB range.

Room K 2F

[TuT4] 16:30 - 18:30
Integrated Devices for Optical Switching

Session Chair: Harm Dorren (Eindhoven Univ. of Technology, The Netherlands)

TuT4-1 16:30 - 17:00 Invited

III-V on Si components for packet switching

G. Morthier [1], M. Tassaert [1], P. Mechet [1], O. Raz [2], H. Dorren [2], D. Van Thourhout [1] and G. Roelkens [1]

[1] Photonics Research Group, Dept. of Information Technology, Ghent Univ.-imec, Ghent, Belgium, [2] Eindhoven Univ. of Technology, Eindhoven, The Netherlands

We discuss the use of active and passive InP membrane structures, heterogeneously integrated onto SOI passive circuits, for switching applications such as gating, wavelength conversion and all-optical flip-flopping.

TuT4-2 17:00 - 17:30 Upgrade Invited

Demonstration of Wavelength-Routed Switching for 25-Gbit/s Optical Packets Using a Parallel-Ring-Resonator Tunable Laser Integrated with an InGaAlAs EAM

Toru Segawa, Wataru Kobayashi, Tatsushi Nakahara, and Ryo Takahashi

NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

Error-free operation of high-speed wavelength-routed switching is demonstrated for 25-Gbit/s optical packets using 100 GHz-spaced arrayed-waveguide grating and a tunable transmitter that monolithically integrates a parallel-ring-resonator tunable laser with an electro-absorption modulator.

TuT4-3 17:30 - 17:45

Hybrid silicon optical gate for packet networks

G. de Valicourt [1], A. Le Liepvre [2], C. Simonneau [1], M. Lamponi [2], C. Jany [2], A. Accard [2], F. Lelarge [2], F. Van Dijk [2], F. Vacondio [1], J.-M. Fedeli [3], S. Messaoudene [3], D. Bordel [3], J. C. Antona [1], G. H. Duan [2] and S. Bigo [1]

[1] Alcatel-Lucent Bell Labs France, Nozay, France, [2] III-V Lab, Joint lab of 'Alcatel-Lucent Bell Labs France', 'Thales Research and Technology' and 'CEA Leti', Campus Polytechnique, Palaiseau, France, [3] CEA LETI, Minatec, Grenoble, France

We report a hybrid silicon optical gate. The gate shows a wide optical bandwidth, high extinction ratio with low internal noise factor and low insertion loss. We further study the gate performance under packet-switched operation.

TuT4-4 17:45 - 18:00

Multi-channel Format Conversion Based on a SOA and a Si Integrated Comb Filter and Demultiplexer

Lei Xiang, Yu Yu, Bingrong Zou and Xinliang Zhang

Wuhan Nat'l Laboratory for Optoelectronics, School of Optoelectronic Science and Engineering, Huazhong Univ. of Science and Technology, Wuhan, China

4*20Gb/s NRZ to RZ conversions are experimentally demonstrated using a single SOA and a silicon based integrated multi-channel comb filter and AWG. Bit error ratio measurements show the good performance for the proposed scheme.

TuT4-5 18:00 - 18:15

A Monolithically Integrated All-Optical Wavelength Converter

Stefano Faralli, Nicola Andriolli, Francesca Bontempi, and Giampiero Contestabile

Scuola Superiore Sant'Anna, Pisa, Italy

We report the fabrication and characterization of an InP monolithically integrated optical circuit for all-optical wavelength-conversion. The device is based on double stage cross-gain-modulation/compression in SOAs. We experimentally demonstrate 10Gb/s operation with low power penalty.

TuT4-6 18:15 - 18:30

Improvement of Extinction Ratio of Wavelength-Selective Switch Using Quantum Well Double-Series-Coupled Microring Resonators

Hiroki Ikehara, Hiroshi Kamiya, Taro Arakawa, and Yasuo Kokubun

Graduate School of Engineering, Yokohama Nat'l Univ., Kanagawa, Japan

We demonstrate a high-extinction-ratio hitless wavelength-selective switch with InGaAs/InAlAs multiple quantum well double-series-coupled microring resonators. It is also found that the change in coupling efficiency at couplers has a great effect on the switching characteristics.

Room 101 1F

[TuD4] 16:30 - 17:30 Symposium
High Power Lasers and Applications V

Session Chair: Sergei V. Bulanov (Japan Atomic Energy Agency, Japan)

TuD4-1 16:30 - 17:00 Invited

Target Effects on Focusing and Acceleration of Laser-Driven Ion Beams

C. McGuffey[1], J. Kim[1], R.B. Stephens[2], B. Qiao[1], M.S. Wei[2], and F.N. Beg[1]

[1] Center for Energy Research, Univ. of California-San Diego, California, USA, [2] General Atomics, California, USA

Energetic proton beams driven by picosecond lasers can be focused to densities ~10^{24} m^{-3} in vacuum, but complications arise as it enters solid material. We report evidence of strong material dependence on the volume heated.

TuD4-2 17:00 - 17:30 Invited

Studies of the Mechanisms of Powerful Terahertz Radiation From Laser Plasmas

Yutong Li [1] , Guoqian Liao [1], Weimin Wang [1], Chun Li [1], Luning Su [1], Yi Zheng [1], Meng Liu [1], Wenchao Yan [1], Mulin Zhou [1], Fei Du [1], J. Dunn [2], J. Hunter [2], J. Nilsen [2], Zhengming Sheng [3], Jie Zhang [3]

[1] Beijing Nat'l Laboratory for Condensed Matter Physics, Inst. of Physics, Chinese Academy of Sciences, Beijing, China, [2] Lawrence Livermore National Laboratory, CA, USA, [3] Key Laboratory for Laser Plasmas (MoE) and Dept. of Physics, Shanghai Jiao Tong Univ., Shanghai, China

Recently Terahertz (THz) radiation from laser-produced plasmas has attracted much interest since plasmas can work at arbitrarily high laser intensity. This paper will discuss the generation mechanisms of plasma-based THz radiation.

Room 103 1F

[Tul4] 16:30 - 18:30
Novel Phenomena in Nanophotonics
Session Chair: Takashi Asano (Kyoto Univ., Japan)

Tul4-1 16:30 - 17:00 Invited

Inducing Photonic Transitions for Enabling Next Generation Silicon Photonics

Michal Lipson
Cornell Univ. Kavli Inst., NY, USA

We show approaches for achieving several of the main building blocks of next generation silicon photonics including: CMOS compatible on-chip isolators and ultra-high speed and low power modulators.

Tul4-2 17:00 - 17:15

Bidirectional Dynamic Wavelength Conversion using Carrier Excitation/Depletion in Photonic Crystal Waveguide

K. Kondo [1] and T. Baba [1]
[1] Dept. of Electrical and Computer Engineering, Yokohama Nat'l Univ., Yokohama, Japan

We demonstrate the wavelength conversion of signal pulse to short/long sides using dynamic excitation/depletion of carriers induced by control pulse in photonic crystal waveguide. The wavelength shift increases with the interaction length of two pulses.

Tul4-3 17:15 - 17:30

High-Frequency Self-Induced Oscillations in a Silicon Photonic Crystal Cavity

X. Checoury, N. Cazier and P. Boucaud
Institut d'Electronique Fondamentale, CNRS Univ Paris Sud, Orsay Cedex, France

We experimentally show that self-induced oscillations at frequencies above GHz and with a high spectral purity can be obtained in a silicon photonic crystal nanocavity under quasi-continuous optical pumping.

Tul4-4 17:30 - 17:45

Efficient Scheme for On-Demand Light Transfer Between Distant Nanocavities

Ryotaro Konoike, Yoshiya Sato, Yoshinori Tanaka, Takashi Asano, and Susumu Noda
Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

We propose a robust and efficient scheme for on-demand light transfer between distant nanocavities. We obtained high efficiency of ~90% by numerical simulation. Our proposed scheme provides fundamentals for future optical or quantum information processing.

Tul4-5 17:45 - 18:00

Photonic Crystal Nanocavity Lifetime Enhancement by Slow Light Propagation and Carrier Induced Nonlinearities

K. Bencheikh [1], P. Grinberg [1], A.M. Yacomotti [1], P. Hamel [1], F. Raineri [1], I. Sagnes [1], Y. Dumeige [2], and J.A. Levenson [1]
[1] Laboratoire de Photonique et de Nanostrutures, CNRS UPR020, Marcoussis, France, [2] Universite Europeenne de Bretagne, CNRS Foton, Lannion cedex, France

Coherent population oscillations and carrier-induced nonlinear refractive index dispersion are implemented in an active semi-conductor photonic crystal nanocavity to increase its photonic lifetime and manipulate its optical response

Tul4-6 18:00 - 18:15

Optical Resonator Analog of a Topological Insulator

A. Yidong Chong and B. Guanquan Liang
Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological Univ., Singapore

A photonic topological insulator can be constructed from a lattice of ring resonators, without using aperiodic couplers or metamaterials. With gain and loss, the system can function as an optical diode for coupled resonator modes.

Tul4-7 18:15 - 18:30

Optomechanics with photonic crystals slab mirrors and cavities

R. Braive [1,2], I. Robert-Philip [1], I. Sagnes [1], I. Abram [1], A. Beveratos [1], T. Antoni [3], K. Makles [3], A. Kuhn [3], T. Briant [3], P.-F. Cohadon [3], A. Heidmann [3], E. Gavartin [4] and T.J. Kippenberg [4]
[1] Laboratoire de Photonique et Nanostructures LPN-CNRS UPR20, Marcoussis, France, [2] Universite Paris Diderot - F-75205 Paris, France, [3] Laboratoire Kastler Brossel, UPMC-ENS-CNRS, Paris, France, [4] Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland

We investigate optomechanical effects in photonic crystal slab membranes, either including a cavity or acting as an end-mirror in a Fabry-Perot cavity. We in particular demonstrate the non-linear behavior of the membranes fundamental mode.

Room 104A 1F

Room 104B 1F

Room C-1 1F

[WQ1] 9:00 - 10:00
Photonic Networking Technologies

Session Chair: Soichiro Araki (NEC Green Platform Research Laboratories, Japan)

WQ1-1 9:00 - 10:00 Tutorial

Challenges and Opportunities of Photonic Networking Technologies

Ken-ichi Sato

Nagoya Univ., Nagoya, Japan

Exploiting photonic technologies will be the best way to create bandwidth abundant and energy efficient future networks, however, their introduction remains limited. The barriers and possible solutions for future networks and node systems are discussed.

Room C-2 1F

[WI1] 8:30 - 10:00
Diamond Nano-photonics and Novel Resonators

Session Chair: Hisashi Sumikura (NTT Basic Research Laboratories, Japan)

WI1-1 8:30 - 9:00 Invited

Diamond Nanophotonics and Quantum Optics

Marko Lončar

School of Engineering and Applied Science, Harvard Univ., MA, USA

Design, fabrication and characterization of nanophotonic and nanomechanic devices fabricated in single crystal diamond substrates will be discussed, as well as their applications in quantum information processing and optoelectronics.

WI1-2 9:00 - 9:15

Coupling Diamond Nitrogen Vacancy Centers to Tapered Fibers: Toward Generation of Indistinguishable Single Photons

M. Fujiwara[1], T. Schröder[2,3], H.-Q. Zhao[1], T. Noda[1], S. Kamioka[1], O. Benson[2] and S. Takeuchi[1]

[1] RIES, Hokkaido Univ., Sapporo, Japan & ISIR, Osaka Univ., Osaka, Japan, [2] Nano-Optics Group, Inst. for Physics, Humboldt-Universität zu Berlin, Germany, [3] Present address: Laboratory for Quantum Photonics, RLE, MIT, USA

Nitrogen vacancy (NV) centers in nanodiamonds can be efficiently fiber coupled with tapered fibers. We report 689-kHz single photon NV emission into single-mode fibers at 293K and first cryogenic experiments towards indistinguishable single photon generation.

WI1-3 9:15 - 9:30

Position and Density Control of Nitrogen-vacancy Centers in Diamond Using Micropatterned Substrate for Chemical Vapor Deposition

Tomohiro Gomi[1], Syuhei Tomizawa[1], Kohei Ohashi[1], Kohei M. Itoh[1], Junko Ishi-Hayase[1], Hideyuki Watanabe[2], Hitoshi Umezawa[2], and Shinichi Shikata[2],

[1] Dept. of Applied Physics and Physico-Informatics, Keio Univ., Kanagawa, Japan, [2] Diamond Research Laboratory, Advanced Industrial Science and Technology (AIST), Ibaraki, Japan

We demonstrate a promising technique to control the position and density of nitrogen-vacancy centers in diamond thin film grown on a diamond substrate using nitrogen-doped isotopically-purified chemical vapor deposition.

WI1-4 9:30 - 9:45

Analysis and Experimental Measurement of the Q Factor of Hexagonal Microcavities Fabricated with Crystal Growth

Hiroshi Kudo[1], Ryo Suzuki[1], Takumi Kato[1], Atsushi Yokoo[2,3] and Takasumi Tanabe[1]

[1] Dept. of Electronics and Electronics Engineering, Faculty of Science and Technology, Keio Univ., Kanagawa, Japan, [2] NTT Nanophotonics Center, NTT Corporation, Kanagawa, Japan, [3] NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan

We numerically studied the characteristics of various modes excited in a whispering gallery mode cavity with a hexagonal cross-section. An experimental demonstration on the fabrication of hexagonal sapphire cavity is also presented.

WI1-5 9:45 - 10:00

High-Q Microdisk Resonator Having Sub-Wavelength Grating on Its Sidewall

Shohei Iijima, Yasuo Ohtera, and Hirohito Yamada

Graduate School of Engineering, Tohoku Univ., Sendai, JAPAN

A novel dielectric microdisk resonator having angular grating on its sidewall is proposed. The resonator exhibits high-Q mode confined by guided-mode resonance (GMR) by the sidewall.

Room F 1F

[WA1] 8:30 - 10:00
Femtosecond Fiber Lasers and Broadband Sources

Session Chair: Dingyuan Tang (Nanyang Technological Univ., Singapore)

WA1-1 8:30 - 8:45

Yb-Fiber Oscillator Based, Few-Cycle Ultrafast Source At 850nm

Hung-Wen Chen[1], Haider Zia[2], JinKang Lim[1], Guoqing Chang[1,2], and Franz X. Kartner[1,2]

[1] Dept. of Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Inst. of Technology, Cambridge, [2] Center for Free-Electron Laser Science, DESY and Dept. of Physics, Univ. of Hamburg, Hamburg, Germany

We demonstrate an Yb-fiber oscillator based, broadband (~170 nm) laser source centered at 850 nm. The spectrum generated by fiber-optic Cherenkov radiation produces ~11-fs compressed pulses after phase compensation using 8 double-chirped mirrors.

WA1-2 8:45 - 9:00

Octave Spanning Coherent Supercontinuum Generation by 51 Fs Pedestal Free High Power Ultrashort Pulse From Similariton Amplifier

Yuto Nozaki and Norihiko Nishizawa

Dept. of Electrical Engineering and Computer Science, Nagoya Univ., Nagoya, Japan

51 fs, 4.4 nJ pedestal free high power ultrashort pulse was generated using Er-doped similariton amplifier. An octave spanning coherent supercontinuum broadened from 1.05 to 2.1 um was generated in highly nonlinear normal dispersive fiber.

WA1-3 9:00 - 9:15

Generation of Sub-40fs Pulses From a Spectral-Breathing Self-Similar Fiber Amplifier

Sijia Wang, Bowen Liu, Minglie Hu, Lu Chai, and Chingyue Wang

Ultrafast Laser Laboratory, College of Precision Instruments and Opto-electronics Engineering, Key Laboratory of Optoelectronics Information Technology (Ministry of Education), Tianjin Univ., Tianjin, P.R.China

An all-fiber self-similar amplifier generating 37fs transform-limited pulses with 23.5W average power is demonstrated. The spectral-breathing behavior of negatively-chirped pulses during amplification can avoid gain-shaping disturbance and accelerate self-similar evolution in a high-gain short-length fiber.

WA1-4 9:15 - 9:30

Femtosecond fiber chirped- and divided-pulse amplification

Yoann Zaouter[1], Florent Guichard[1,2], Louis Daniault[2], Marc Hanna[2], Franck Morin[1], Clemens Honninger[1], Quentin Mocaer[1], Eric Mottay[1], Frederic Druon[2] and Patrick Georges[2]

[1] Amplitude Systemes, Pessac, France, [2] Laboratoire Charles Fabry, Institut d'Optique, CNRS, Universite Paris-Sud, Palaiseau Cedex, France

We implemented for the first time both chirped pulse and divided pulse amplification in the same femtosecond fiber amplifier setup leading to the generation of 430 µJ, 320 fs pulses at 100 kHz.

WA1-5 9:30 - 9:45

All Fiber Self-Similar Chirped-Pulse Amplifier for Directly Writing Single Polarization Photonic Crystal Waveguide

Sijia Wang, Yuerong Wang, Bowen Liu, Minglie Hu, Lu Chai, and Chingyue Wang

Ultrafast Laser Laboratory, College of Precision Instruments and Opto-electronics Engineering, Key Laboratory of Optoelectronics Information Technology (Ministry of Education), Tianjin Univ., Tianjin, P.R.China

A fiber-based amplifier seeded by similaritons producing uniform transform-limited pulses with variable repetition-rate is demonstrated. Employing this, a photonic crystal waveguide is written inside fused silica, supporting ~248µm^2 mode area and ~ 10 dB polarization-extinction-ratio.

WA1-6 9:45 - 10:00

Defect-Driven Fiber-Based UV-VIS Broadband White Light Generation

Chien-Chih Lai[1], Nai-Chia Cheng[2], Jeng-Wei Tjiu[3], Ming-Yi Lin[3] and Sheng-Yao Huang[4]

[1] Dept. of Physics, Nat'l Dong Hwa Univ., Hualien, Taiwan, [2] Inst. of Photonics and Optoelectronics, National Taiwan Univ., Taipei, Taiwan, [3] Dept. of Dermatology, National Taiwan Univ. Hospital and College of Medicine, National Taiwan Univ., Taipei, Taiwan, [4] Dept. of Physics, National Sun Yat-Sen Univ., Kaohsiung, Taiwan

This study reports a facile approach for the emission of ultraviolet-visible broadband from a Ti:sapphire crystalline-core fiber, using a laser-heated pedestal growth technique. White light with CIE (0.287, 0.333) is obtained via the F-Ti centers.

Room G 1F

[WE1] 8:30 - 10:00 Symposium
Biochip Fabrication by Femtosecond Laser I

Session Chair: Koji Sugioka (RIKEN, Japan)

WE1-1 8:30 - 9:00 Invited

Femtosecond Laser Processing of Active and Passive Devices for bio-MEMS

Y. Bellouard

Mechanical Engineering Dept., Eindhoven Univ. of Technology, Eindhoven, The Netherlands

Femtosecond laser processing of glass has been proven to be an efficient tool for fabricating waveguides and micro-channels. Here we show that monolithic integration in bio-Micro-Electro-Mechanical-Systems can be pushed forward by introducing additional functionalities.

WE1-2 9:00 - 9:30 Invited

Fabrication of Functional Micro- and Nanofluidics Embedded in Glass Using Femtosecond Laser Microprocessing

Y. Cheng [1], Y. Liao [1], and K. Sugioka [2]

[1] State Key Laboratory of High Field Laser Physics, Chinese Academy of Sciences, Shanghai, China, [2] Laser Technology Laboratory, RIKEN - Advanced Science Inst., Saitama, Japan

We resolve long-standing difficulties in fabrication of large-scale 3D microfluidics and demonstrate fabrication of nanochannels of a width of ~40 nm (~1/20 of writing beam wavelength) in glass with femtosecond laser pulses.

WE1-3 9:30 - 10:00 Invited

Bio-Lab on a Chip Fabricated by Femtosecond Laser

Ajoy K. Kar

Inst. of Photonics & Quantum Sciences, Heriot-Watt Univ., Edinburgh, UK

The nonlinear interactions of femtosecond laser pulses with transparent, biocompatible dielectric materials can be applied to engineer compact devices with bespoke functionalities for biophotonic applications. This paper reviews recent developments in this rapidly emerging field.

Room H 1F

[WF1] 9:00 - 10:00
New Trends in Frequency Comb: Application of Light with Ultraprecision I

Session Chair: Franz X. Kärtner (DESY-CFEL, Universität Hamburg / MIT, Germany / USA)

WF1-1 9:00 - 10:00 Tutorial

Frequency Combs and Applications

Thomas Udem

Max-Planck Inst. für Quantenoptik, Garching, Germany

Laser frequency combs are used for all kinds of high precision optical metrology. I will discuss its principles in detail and present the several applications.

Room I 2F

[WP1] 8:30 - 10:00
Novel WDM-PON

Session Chair: Hideaki Tamai (Oki Electric Industry Co., Ltd., Japan)

WP1-1 8:30 - 8:45

Ranging Method for λ-Tunable WDM/TDMPON Achieving Efficient Bandwidth Allocation

S. Kaneko, T. Yoshida, S. Tamaki, S. Kimura, and N. Yoshimoto

NTT Access Network Service Systems Laboratories, NTT Corporation, Kanagawa, Japan

We propose a ranging method for λ-tunable WDM/TDM-PONs enabling dynamic wavelength and bandwidth allocation with accurate round-trip times without re-ranging regardless of changes in wavelength assignment. Its effect on upstream bandwidth allocation is theoretically evaluated.

WP1-2 8:45 - 9:00

A Proposal for Cost-Effective 10-Gb/s, 10-GHz Spaced Ultra-Dense WDM PON

H. Mu, H. K. Shim, H. G. Choi, U. H. Hong, and Y. C. Chung

KAIST, Dept. of Electrical Engineering, Daejeon, Korea

We propose a cost-effective 10-Gb/s, 10-GHz-spaced ultra-dense RSOA-based coherent WDM PON by using an optical comb generator as the seed light source. For its feasibility demonstration, we experimentally evaluate the upstream performance in 20-km-long SMF.

WP1-3 9:00 - 9:15

40 Gb/s Uplink in WDM—PON using 4-ary Modulation and Nonlinear Equalization

Qi Guo and An V. Tran

Nat'l ICT Australia, Electrical and Electronics Engineering, Univ. of Melbourne, Australia

This paper applies 4-ary ASK and nonlinear equalizer in WDM-PON to realize high-speed dispersion-tolerant uplink. Error-free transmission of 40 Gb/s upstream signal over 30 km is experimentally demonstrated using a 20 GHz REAM.

WP1-4 9:15 - 9:30

Coherent UDWDM—PON Guard Band for Legacy Video and 10G-NRZ Systems

Ali Shahpari [1], Jacklyn D. Reis [1], Ricardo Ferreira [1], Darlene M. Neves [1], Zoran Vujicic [1], Mário Lima [1] and António L. Teixeira [2]

[1] Univ. of Aveiro and Instituto de Telecomunicações, Aveiro, Portugal, [2] Nokia Siemens Networks Portugal S.A., Amadora, Portugal

We experimentally analyze the required guard band of coherent UDWDM networks transporting 16x1.25Gb/s-QPSK at 3.125GHz grid to coexist with Video and 10G-NRZ transmissions. Using simple DSP based ONU, guard bands of only 0.8-1.6nm are achieved.

WP1-5 9:30 - 10:00 Invited

WDM-PON Technologies and Their Applications to Provide Multiple Services

San-Liang Lee, Ming-Hsueh Chuang, Chi-Hsien Sun, and Kuo-Chang Feng

Dept. of Electronic Engineering, Nat'l Taiwan Univ. of Science and Technology, Taiwan

WDM-PON technologies are reviewed and evaluated in terms of their potential applications ranging from ultra-short-reach to long-reach networks. The architectures for enabling large bandwidth with low cost and providing multiple services are proposed and analyzed.

Room J 2F

[WS1] 8:30 - 10:00 Symposium
Fiberoptic Technologies for the Next Era I (New Fiber Amplifiers)

Session Chair: John M. Fini (OFS Laboratories, USA)

WS1-1 8:30 - 9:00 Invited

Few-mode Erbium Doped Fiber Amplifiers

Massimiliano Salsi
Alcatel-Lucent Bell Labs, Nozay, France

We review recent work on fiber amplifiers for optical communication systems relying on mode-division multiplexing. This work includes results from a record 6-mode few-mode erbium doped amplifier demonstration.

WS1-2 9:00 - 9:30 Invited

Toward Single-Mode Crystalline Fiber Laser and Amplifier

K. Y. Hsu [1], D. Y. Jheng [1], S. C. Wang [1], S. L. Huang [1], Y. W. Lee [2], P. S. Yeh [3] and M. Dubinskii [4]
[1] Gratuate Inst. of Photonics and Optoelectronics, Nat'l Taiwan Univ., Taipei, Taiwan, [2] Dept. of Electro-Optical Engineering, National Taipei Univ. of Technology, Taipei, Taiwan, [3] Dept. of Electronic Engineering, National Taiwan Univ. of Science and Technology, Taipei, Taiwan, [4] US Army Research Laboratory, MD, USA

Crystalline fibers with various cladding techniques to reduce the mode numbers, enable cladding pump, and increase damage threshold will be addressed. Active dopants in the crystalline cores generate emissions from visible to infrared wavelength ranges.

WS1-3 9:30 - 10:00 Invited

Thulium Doped Fiber Amplifiers for 2 μm Telecommunications

S.U. Alam, Z. Li, J.M.O. Daniel, Y. Jung, A.M. Heidt and D.J. Richardson
Optoelectronics Research Centre, Univ. of Southampton, Southampton, UK

We report the first experimental realization of thulium doped fiber amplifier providing high gain (>40dB), noise figure as low as 5dB and over 100nm wide bandwidth around 2μm with maximum saturated output power of 400mW.

Room K 2F

[WO1] 8:00 - 9:15
Display

Session Chair:Takanori Nomura (Wakayama Univ., Japan)

WO1-1 8:00 - 8:30 Invited

200-inch Glasses-free 3D Display and Electronic Holography Being Developed At NICT

Naomi INOUE, Masahiro KAWAKITA, and Kenji YAMAMOTO
Nat'l Inst. of Information and Communications Technology(NICT)

a large-size glasses-free 3D display using super-multi-view 3D video technologies and an electronic holography system using laser light are introduced in this paper.

WO1-2 8:30 - 8:45

Metal-Complex-Doped Polymer/Liquid-Crystal Composite Film Operating At Wide Wavelength Range

Seiji Fukushima [1], Koki Yoshinaga [1], Hiroki Higuchi [2], Hirotsugu Kikuchi [2], Tomohiro Hachino [1], and Yasutaka Igarashi [1]
[1] Graduate School of Science and Engineering, Kagoshima Univ., Kagoshima, Japan, [2] Inst. for Materials Chemistry and Engineering, Kyushu Univ., Kasuga, Japan

Doping metal complex into polymer liquid-crystal composite film improves extinction ratio at visible wavelength and extends applicable wavelength to 1.5-um optical fiber communication band. The polarization dependent loss was measured as 0.32 dB or lower.

WO1-3 8:45 - 9:00

Dual Mode Operation of a Chiral-Nematic Liquid Crystal Cell Using Three-Terminal Electrodes

Seung-Won Oh, Byeong-Hun Yu, Sun-Wook Choi, Ki-Han Kim, and and Tae-Hoon Yoon
Dept. of Electronics Engineering, Pusan Nat'l Univ., Busan, Korea

We propose a chiral nematic liquid crystal cell using three-terminal electrodes that can be operated in both the dynamic and the memory modes.

WO1-4 9:00 - 9:15

The Influence of Inhomogeneous Birefringent Medium on the Polarization Properties of the LCD Backlight Unit

Jeomgmin Moon [1,2], Sungrae Lee [1], Sejin Lee [1], Woohyun Jung [1], and Kyunghwan Oh [1]
[1] Inst. of Physics and Applied Physics, Yonsei Univ., Seoul, South Korea, [2] R&D Laboratory, LG Display, Paju-shi, Kyongki-do, South Korea

The degree of polarization (DOP) of a LCD backlight unit was investigated by rotating a polarizer on it. The reduction of its DOP was mostly influenced by the inhomogeneous birefringence in the prism film.

Room 101 1F

Oral, Wednesday, July 3

Room 103 1F

[WG1] 8:30 - 10:00
Quantum Computation

Session Chair: Jörg Schmiedmayer (Vienna Center for Quantum Science and Technology, TU-Wien, Austria)

WG1-1 8:30 - 9:00 Invited

Cluster state generation with ageing qubits

Pieter Kok

Dept. of Physics & Astronomy, Univ. of Sheffield, Sheffield, United Kingdom

Cluster-states can be created with entangling operations of arbitrary success probability, which places a lower bound on the lifetime of the qubits. We present a simple estimate for the required coherence time of the qubits.

WG1-2 9:00 - 9:15

Hybrid system composed of a superconducting flux qubit and an electron spin ensemble in diamond: a theoretical analysis

Y. Matsuzaki [1], S. Saito [1], X. Zhu [1], R. Amsuss [2], K. Kakuyanagi [1], T. Shimooka [3], N. Mizuochi [3], K. Nemoto [4], W. J. Munro [1], and K. Semba [4]

[1] NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan, [2] Vienna Center for Quantum Science and Technology, Atominstitut, Vienne, Austria, [3] Graduate School of Engineering Science, Osaka Univ., Osaka, Japan, [4] Nat'l Inst. of Informatics, Tokyo, Japan

Here we analyze a theoretical model to describe superconducting flux qubit - electron spin ensemble hybrid systems. Analytical calculations and numerical simulations based on our model show excellent agreement between the theory and experiment.

WG1-3 9:15 - 9:30

Accurate Resource Estimation for Quantum Computation.

Simon J. Devitt [1], Ashley M. Stephens [1], William J. Munro [2] and Kae Nemoto [1]

[1] Nat'l Inst. of Informatics, Tokyo, Japan, [2] NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan

We detail how resource estimates should be made for large scale, error corrected computation. We detail the series of steps needed when compiling algorithms and illustrate how to estimate the qubit/time requirements of any computation.

WG1-4 9:30 - 9:45

Quantum Simulation of the Jaynes-Cummings-Hubbard Model Using Trapped Ions

K. Toyoda, Y. Matsuno, A. Noguchi, S. Haze, S. Urabe

Grad. School of Engineering Science, Osaka Univ., Osaka, Japan

We report an experiment on quantum simulation of the Jaynes-Cummings-Hubbard (JCH) model using two trapped ions. A JCH dynamics and an adiabatic transfer from an insulator to a superfluid has been observed.

WG1-5 9:45 - 10:00

Discord as a Consumable Resource

M. Gu[1], H. M. Chrzanowski[2], S. M. Assad[2], T. Symul[2], K. Modi[3,1], T. C. Ralph[4], V. Vedral[3,1,5], P. K. Lam[2]

[1] Center for Quantum Technology, Nat'l Univ. of Singapore, Republic of Singapore, [2] Centre for Quantum Computation and Communication Technology, Dept. of Quantum Science, The Australian National Univ., Canberra, Australia, [3] Atomic and Laser Physics, Clarendon Laboratory, Univ. of Oxford, Oxford, United Kingdom, [4] Centre for Quantum Computation and Communication Technology, Dept. of Physics, Univ. of Queensland, St Lucia, Australia, [5] Dept. of Physics, National Univ. of Singapore, Republic of Singapore

Quantum discord is conjectured to be a more general quantum resource than entanglement. We support this conjecture by showing, via experimental Gaussian optics, that quantum processors can harness discord to perform tasks classical counterparts cannot.

Room 104A 1F

[WK1] 8:30 - 10:00
Quantum Dot Device

Session Chair: Satoshi Iwamoto (The Univ. of Tokyo, Japan)

WK1-1 8:30 - 9:00 Invited

New Class of 1.55 μm Quantum Dot Lasers for Future High Data Rate Optical Communication

J.P. Reithmaier [1], V. Ivanov [1], V. Sichkovskyi [1], D. Gready [2] and G. Eisenstein [2]

[1] Inst. of Nanostructure Technologies and Analytics (INA), CINSaT, Univ. of Kassel, Kassel, Germany, [2] Dept. of Electrical Engineering, Haifa, Israel

A review will be given on the latest results on high-speed 1.55 μm quantum dot lasers, which can be operated at data rates beyond 20 Gbit/s.

WK1-2 9:00 - 9:15

Two-wavelength emission laser with semiconductor quantum dots

Kouichi Akahane [1], Naokatsu Yamamoto [1], Atsushi Kanno [1], Keizo Inagaki [1], Toshimasa Umezawa [1], Tetsuya, Kawanishi [1], Takashi Endo [2], Yasunori Tomomatsu [2], and Toshio Yamanoi [2]

[1] Nat'l Inst. of Information and Communications Technology, Tokyo, Japan, [2] Koshin Kogaku Co., Ltd., Kanagawa, Japan

A two-wavelength emission laser has been fabricated using semiconductor quantum dots as the gain medium. A beat signal of ~100 GHz was observed using Michelson interferometer configuration, indicating that these emissions occurred simultaneously.

WK1-3 9:15 - 9:30

Broad Bandwidth Emission From Hybrid QW/QD Structures

S. Chen[1], N. Peyvast[1], K. Zhou[1], N. Babazadeh[1], Z. Zhang[1], D.T. D. Childs[1], M. Hugues[2], O. Wada[1], R.A. Hogg[1,2], T. Kageyama[3], K. Nishi[3], K. Takemasa[3], and M. Sugawara[3]

[1] Dept. of Electronic and Electrical Engineering, Univ. of Sheffield, Centre for Nanoscience & Technology, Sheffield, UK, [2] EPSRC Nat'l Centre for III-V Technologies, Dept. of Electronic and Electrical Engineering, Univ. of Sheffield, Centre for Nanoscience & Technology, Sheffield, UK, [3] QD Laser Inc, Kanagawa, JAPAN

We previously demonstrated a hybrid QW/QD structure to enhance the gain and spontaneous emission bandwidth of a quantum dot active region. We now present new designs to further broaden the spontaneous emission from hybrid structure.

WK1-4 9:30 - 9:45

RF Response of PIN Photodiode with Avalanche Multiplication Using Quantum Dots

T. Umezawa, K. Akahane, A. Kanno, and T. Kawanishi

Nat'l Inst. of Information and Communication Technology (NICT), Tokyo, Japan

We fabricate a new PIN photodiode using InAs/InAlGaAs quantum dot absorption layer. Multiplication factors of M = 1 to M = 12 and the RF response over 10GHz are reported.

WK1-5 9:45 - 10:00

Control of Self-collimated Light-emitting Diodes with Negative Refraction by Photonic Crystal Nanohole Arrays

Yu-Feng Yin, Yen-Chen Lin, and JianJang Huang

Graduate Inst. of Photonics and Optoelectronics, Nat'l Taiwan Univ., Taipei, Taiwan

Negative refraction was demonstrated in the visible wavelength range by two-dimensional (2D) photonic crystals inscribed at the peripheral of a GaN-based light-emitting diode (LED). Self-collimated behaviors in TE polarization were observed in the far-field measurement.

Room 104B 1F

[WM1] 8:30 - 10:00
Si Photonics: Modulators and Active Devices

Session Chair:Nobuhiko Nishiyama (Tokyo Inst. of Technology, Japan)

WM1-1 8:30 - 9:00 Invited

Compact and Power-efficient Silicon Modulators Beyond 60 Gbit/s

Xi Xiao, Hao Xu, Xianyao Li, Tao Chu, Jinzhong Yu, Yude Yu

State Key Laboratory on Integrated Optoelectronics, Inst. of Semiconductors, Chinese Academy of Sciences, Beijing, China

Compact and high-speed silicon microring and Mach-Zehnder modulators are presented. Low-power serial 60 Gbit/s and 4λ×50 Gbit/s modulations are both experimentally demonstrated.

WM1-2 9:00 - 9:30 Upgrade Invited

Athermal Sub-100 μm Si Photonic Crystal Optical Modulator

Hong C. Nguyen, Naoya Yazawa, Satoshi Hashimoto, Toshihiko Baba

Dept. of Electrical and Computer Engineering, Yokohama Nat'l Univ., Yokohama, Japan

We demonstrate athermal operation at 10 Gb/s, across 19-124°C, in a 90 μm Si photonic crystal optical modulator. This is enabled by low-dispersion slow-light and the resulting 17.9 nm spectral operating bandwidth.

WM1-3 9:30 - 9:45

Si Photonic Wavelength Tunable Laser Diode for Digital Coherent Optical Communication

T. Kita [1], K. Nemoto [1], K. Watanabe [2], H. Yamazaki [2], and H. Yamada [1]

[1] Graduate School of Engineering, Tohoku Univ., Sendai, Japan, [2] NEC Yamanashi, Ltd, Yamanashi, Japan

We fabricated wavelength tunable laser diodes with Si photonic wire waveguide ring resonators as an external optical cavity. Less than 100 kHz narrow spectral linewidth was obtained with small footprint.

WM1-4 9:45 - 10:00

Microdisk with Embeded Ge Quantum Dots as Light Emitting Diode and Photodetector

Xuejun Xu, Taichi Chiba, Takuya Maruizumi, and Yasuhiro Shiraki

Research Center for Silicon Nano-Science, Advanced Research Laboratories, Tokyo City Univ., Tokyo, Japan

We demonstrate microdisk with embedded Ge quantum dots working as both light emitting diode and photodetector. Under forward bias, resonant electroluminescence peaks are observed. Under reverse bias, peak responsivity of 2 mA/W is obtained.

Room C-1 1F

[WR2] 10:30 - 12:00
Large Capacity Transmission

Session Chair: Kazuyuki Ishida (Mitsubishi Electric Corporation, Japan)

WR2-1 10:30 - 11:00 Invited

Ultra-High-Capacity Optical Transmission Using Multicore Space-Division-Multiplexing

Hidehiko Takara [1], Tetsuo Takahashi [2], Kazu hide Nakajima [3], and Yutaka Miyamoto [1]

[1] NTT Network Innovation Laboratories, NTT Corporation, Kanagawa, Japan, [2] NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan, [3] NTT Access Network Service Systems Laboratories, NTT Corporation, Ibaraki, Japan

The paper reviews recent works and issues on ultra-high-capacity transmission based on multi-core space-division-multiplexing. 1Pbit/s multi-core fiber transmission using space-division-multiplexing technology and multi-level modulation/demodulation technology is also described.

WR2-2 11:00 - 11:15

A Single-Channel 1.92 Tbit/s, 64 QAM Coherent Pulse OTDM Transmission over 150 km

David Odeke Otuya [1], Keisuke Kasai [1], Toshihiko Hirooka [1], Masato Yoshida [1], Masataka Nakazawa [1], Tokutaka Hara [2], and Satoshi Oikawa [2]

[1] Research Inst. of Electrical Communication, Tohoku Univ., Sendai, Japan, [2] New Technology Research Laboratories, Sumitomo Osaka Cement Co., Ltd., Funabashi, Japan

We demonstrate a single-channel 1.92 Tbit/s, 64 QAM coherent pulse OTDM transmission over 150 km. The QAM multiplicity was increased up to 64 by adopting a frequency domain equalization scheme to enhance waveformdistortion compensation.

WR2-3 11:15 - 11:30

Capacity of Space-Division Multiplexing with Heterogeneous Multi-Core Fibers

Feihong Ye, Christophe Peucheret, Toshio Morioka

DTU Fotonik, Dept. of Photonics Engineering, Technical Univ. of Denmark, Lyngby, Denmark

The capacity of heterogeneous multi-core fibers is explored, taking into account intra-core nonlinearities and inter-core crosstalk. Over 10 Pb/s transmission capacity can be anticipated for a densely-packed 93-core fiber with a 220 μm cladding diameter.

WR2-4 11:30 - 11:45

387.5Gb/s, 7.05b/s/Hz, 16QAM Transmission over 320km using Nyquist SCFDE Signals

Zhennan Zheng, Rui Ding, Fan Zhang, and Zhangyuan Chen

State Key Laboratory of Advanced Optical Communication Systems and Networks, Peking Univ., Beijing, China

We generate a 387.5Gb/s, 7.05b/s/Hz polarization division multiplexing (PDM) 16QAM Nyquist pulse shaping superchannel with single carrier frequency domain equalization (SCFDE). The BER for all subbands after 320km SSMF is lower than 1×10-3.

WR2-5 11:45 - 12:00

Eigenvalue Modulated Optical Transmission System Based on Digital Coherent Technology

Hiroki TERAUCHI and Akihiro MARUTA

Graduate School of Engineering, Osaka Univ., Osaka, Japan

The ideal information carrier is invariable quantity during propagation in nonlinear dispersive fiber. This is eigenvalues of the associated equation of the nonlinear Schrodinger equation. We show the eigenvalue demodulation based on digital coherent technology.

Room C-2 1F

[WI2] 10:30 - 12:00
Photonic Crystals

Session Chair: Yidong Huang (Tsinghua Univ., China)

WI2-1 10:30 - 11:00 Upgrade Invited

Single-mode, Narrowband Thermal Emitters Based on Quantum Wells and Photonic Crystals

Takuya Inoue, Menaka De Zoysa, Takashi Asano and Susumu Noda

Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

We demonstrate thermal emitters based on quantum wells and photonic crystals that have a single emission peak with a quality factor over 100. Our results will have potential applications to environmental sensors and thermo-photovoltaic systems.

WI2-2 11:00 - 11:15

Large Q Factor Enhancement of L*n* Nanocavity by a Unified Hole-shifting Rule

Eiichi Kuramochi [1,2], Elan Grossman [2], Kengo Nozaki [1,2], Koji Takeda [1,3], Akihiko Shinya [1,2], Hideaki Taniyama [1,2], and Masaya Notomi [1,2]

[1] NTT Nanophotonics Center, NTT Corporation, Kanagawa, Japan, [2] NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan, [3] NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

A new systematic hole-shifting rule enhances the Q factor of a Ln (n:2-5) nanocavity one order of magnitude both in theory and experiment. The simple rule allows experimental Q optimization without the help of simulations.

WI2-3 11:15 - 11:30

Four-Wave Mixing in Dispersion-Controlled Silica-Clad Photonic Crystal Slow Light Waveguides

Masanori Moro and Toshihiko Baba

Dept. of Electrical and Computer Engineering, Yokohama Nat'l Univ., Yokohama, Japan

Four-wave mixing (FWM) is enhanced by dispersion-controlled slow light in 800-micron-long silica-clad photonic crystal waveguides for both pulsed and cw inputs. The wavelength conversion is demonstrated for 40 Gb/s PRBS signal light.

WI2-4 11:30 - 11:45

Efficient Non-Collinear Second Harmonic Generation in Photonic Crystal Waveguides

S. Combrié[1], G. Lehoucq[1], K. Lenglé[2,3], L. Bramerie[2,3], M. Gay[2,3], J-C. Simon[2,3], and A. De Rossi[1]

[1] Thales Research and Technology France, Palaiseau, France, [2] Université Européenne de Bretagne (UEB), Rennes, France, [3] CNRS-Foton Laboratory (UMR 6082), Lannion, France

Using a 1-mm long photonic crystal waveguide made of Gallium Indium Phosphide, we generate a peak second harmonic power of 45μW, which correspond to a conversion efficiency of 2x10-4W-1

WI2-5 11:45 - 12:00

Design of Slow-Light Grating Waveguides for Silicon Raman Amplifier

Yi-Hua Hsiao, Satoshi Iwamoto, and Yasuhiko Arakawa

Inst. of Industrial Science (IIS), The Univ. of Tokyo, Tokyo, Japan

We propose and deign slow-light grating waveguides (GWGs) for high performance silicon Raman amplifier. The GWGs have simple shape structures for easy fabrication and also keep good performance for high gain amplifiers.

Room F 1F

[WA2] 10:30 - 12:00
Ultraviolet and Visible Lasers

Session Chair: Yushi Kaneda (The Univ. of Arizona, USA)

WA2-1 10:30 - 11:00 Invited

Room-temperature-bonding technology for laser and nonlinear crystals

Ichiro Shoji

Dept. of Electrical, Electronic, and Communication Engineering, Chuo Univ., Tokyo, Japan

We have developed composite lasers and nonlinear frequency-conversion devices using the room-temperature-bonding technology, which has a potential of realizing new high-power and highly efficient laser devices over a wide wavelength range.

WA2-2 11:00 - 11:15

179 nm Generation with Borate Crystal

Chen Qu [1,2], Masashi Yoshimura [1,2], Jun Tsunoda [1,2], Yushi Kaneda [1,2,3], Mamoru Imade [1], Takatomo Sasaki [1,2], and Yusuke Mori [1,2]

[1] Graduate School of Engineering, Osaka Univ., Osaka, Japan, [2] Core Research for Evolutional Science and Technology (CREST), Japan Science and Technology Agency (JST), Japan, [3] College of Optical Sciences, The Univ. of Arizona, USA

We demonstrated the generation of 179 nm vacuum-ultraviolet (VUV) lights with a solid-state laser system. It was realized in LiB3O5 crystal by mixing the deep-ultraviolet of 198.8 nm and the infrared of 1799.9 nm.

WA2-3 11:15 - 11:30

Efficient High-Energy Pulsed Pumped Passively Q-switched Nd:YLF/Cr^{4+}:YAG UV Laser At 351 nm with a Nearly Hemispherical Cavity

Yu-Jen Huang, Cheng-Yu Tang, Kuan-Wei Su, and Yung-Fu Chen

Dept. of Electrophysics, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

We utilize a nearly hemispherical cavity to develop a pulsed pumped passively Q-switched Nd:YLF/Cr^{4+}:YAG UV laser. The pulse energy and peak power at 351 nm are efficiently generated to be 360 μJ and 44.1 kW.

WA2-4 11:30 - 11:45

174W At 1kHz, 532nm SHG From LBO Crystals Using High Average Power Nd:YAG Laser

Yoshinori Tamaoki [1,2], Yoshinori Kato [1,2], Kohichi Iyama [1,2], Toshiyuki Kawashima [1,2], and Noriaki Miyanaga [3]

[1] HAMAMATSU PHOTONICS K.K., Shizuoka Pref., Japan, [2] Advanced Laser and Process Technology Research Association (ALPROT), Tokyo, Japan, [3] Inst. of Laser Engineering, Osaka Univ., Osaka, Japan

We have developed high average power MOPA with output power of 174W at the pulse width of about 100ns, the frequency of 1kHz, and the wavelength of 532nm.

WA2-5 11:45 - 12:00

Q-switch Mode-Locking of Pr^{3+}-doped YLF Laser At 639 nm with a Cr^{4+}-doped YAG Saturable Absorber

Ryo Abe, Junichiro Kojou, Kensuke Masuda, Kenichi Hirosawa, and Fumihiko Kannari

Dept. of Electronics and Electrical Engineering, Keio Univ., Yokohama, Japan

We experimentally prove that a Cr^{4+}:YAG crystal exhibits saturable absorption in visible wavelengths. We demonstrate the first passively Q-switch mode-locked Pr^{3+}:YLF laser with a Cr^{4+}:YAG at 639 nm pumped by InGaN diode lasers.

Oral, Wednesday, July 3

Room G 1F

[WE2] 10:30 - 12:00 Symposium
Biochip Fabrication by Femtosecond Laser II

Session Chair: Koji Sugioka (RIKEN, Japan)

WE2-1 10:30 - 11:00 Invited

Functional Lab-On-A-Chip Devices Produced by Two-Photon Microfabrication

Shoji Maruo

Dept. of Mechanical Engineering, Yokohama Nat'l Univ., Yokohama, Japan

Laser-driven lab-on-a-chip devices such as micropumps, microvalves and microtweezers have been developed by two-photon microfabrication. The microfluidic devices can be also replicated by a membrane-assisted molding process. This technique enables to mass-produce functional lab-on-a-chip devices.

WE2-2 11:00 - 11:30 Invited

Lab-on-a-chip for Optical Manipulation of Single Cells

Roberto Osellame

Inst. for Photonics and Nanotechnologies - Nat'l Research Council (CNR) Piazza L. da Vinci, Milano, Italy

We present a new class of integrated optical devices, fabricated by femtosecond laser micromachining, that allows for mechanical probing, fluorescence detection and sorting of single cells by means of optical forces inside a microfluidic chip.

WE2-3 11:30 - 12:00 Invited

Integrating Functional Components Into Microfluidic Channels by Laser Nanofabrication Technologies Toward High-performance *LoCs*

Bin-Bin Xu[1], Hong Xia[1], Qi-Dai Chen[1], Yong-Lai Zhang[1] and Hong-Bo Sun[1,2]

[1] State Key Laboratory on Integrated Optoelectronics, College of Electronic Science and Engineering, Jilin Univ., Changchun, People's Republic of China, [2] College of Physics, Jilin Univ., Changchun, People's Republic of China

As a powerful 3D processing tool, femtosecond laser fabrication shows great potential to prototype various micronanostructures towards a wide range of applications. Herein, we introduced the nanofabrication of high-performance microfluidic chip through integrating functional components.

Room H 1F

[WF2] 10:30 - 12:00 Symposium
New Trends in Frequency Comb: Application of Light with Ultraprecision II

Session Chair: Yohei Kobayashi (ISSP, The Univ. of Tokyo, Japan)

WF2-1 10:30 - 11:00 Invited

Precision Measurement with Optical Frequency Combs and Clocks

Feng-Lei Hong, Hajime Inaba, Kana Iwakuni, Yoshiaki Nakajima, Kazumoto Hosaka, Masami Yasuda, Takuya Kohno, Daisuke Akamatsu, Takehiko Tanabe, Sho Okubo, Tomonari Suzuyama, Masaki Amemiya and Atsushi Onae

Nat'l Metrology Inst. of Japan (NMIJ), National Institute of Advanced Industrial Science and Technology (AIST), Ibaraki, Japan

We have being developing optical frequency combs, especially fiber-based frequency combs with narrow linewidth, for laser frequency measurement and control. We are also working on Yb and Sr optical lattice clocks for precision frequency metrology.

WF2-2 11:00 - 11:30 Invited

Mode-locking in Optical Microresonators via Soliton Formation

T. Herr [1], V. Brasch [1], J.D. Jost [1], C.Y. Wang [1], N.M. Kondratiev [2], M.L. Gorodetsky [2], T.J. Kippenberg [1]

[1] Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland, [2] Faculty of Physics, M.V. Lomonosov Moscow State Univ., Moscow, Russia

We demonstrate mode-locking via soliton formation in a continuously pumped, non-linear optical MgF2 microresonator, resulting in low noise frequency comb spectra and ultra-short pulses of 200 fs duration with a repetition rate of 35.2 GHz.

WF2-3 11:30 - 12:00 Invited

Fiber Laser Driven Mid-Infrared Frequency Combs

Ingmar Hartl

DESY, Hamburg, Germany

There was a recent remarkable progress in frequencycomb spectroscopy in the molecular fingerprint region. One key enabling technology was the availability of novel mid- Infrared frequency comb sources driven by fiber-laser technology. We will review recent advances.

Room I 2F

[WP2] 10:30 - 12:00
Advanced Technologies for Access

Session Chair: Neda Cvijetic (NEC Laboratories America, USA)

WP2-1 10:30 - 11:00 Invited

End-to-end real-time DSP for high-speed optical access/metro links

R. P. Giddings and J. M. Tang

School of Electronic Engineering Bangor Univ., Bangor, UK

Implementation aspects of real-time digital signal processing in low-cost optical networks for future high-speed access and converged access/metro links are reviewed. Also reviewed is Bangor University's progress in demonstrating real-time DSP-based optical OFDM transmission systems.

WP2-2 11:00 - 11:15

16QAM Signal Transmission Experiment for Dynamic SNR Management on IM-DD OFDM-PON

Hideaki Kimura, Hirotaka Nakamura, Kota Asaka, Shunji Kimura, and Naoto Yoshimoto

NTT Access Network Service Systems Laboratories, NTT Corporation, Kanagawa, Japan

Dynamic SNR management is a promising technique for energy efficient OFDM-PON. We show the first experimental demonstration of the proposed technique. The experiments clarify calculation precision can be reduced according to the optical received power.

WP2-3 11:15 - 11:30

Demonstration of a real-time 16 QAM encoded 11.52 Gb/s OFDM transceiver for IM/DD OFDMA-PON systems

Seung-Hyun Cho, Kyong Whan Doo, Jie Hyun Lee, Jonghyun Lee, Seung Il Myong, Sang Soo Lee

ETRI, Optical Access Network Research Team, Daejeon, Korea

We successfully demonstrated real-time 16 QAM encoded 11.52 Gb/s optical OFDM transceiver and experimentally investigated the optical transmission performances for downstream transmission in OFDMA-PON systems.

WP2-4 11:30 - 12:00 Upgrade Invited

Demonstration of Hierarchical Star 8-QAM Designed for Coexistence of 10G-EPON and DSP-based PON with 30-dB Loss Budget

Noriko Iiyama, Jun-ichi Kani, Jun Terada, and Naoto Yoshimoto

NTT Access Network Service Systems Laboratories, NTT Corporation, Kanagawa Pref., Japan

Hierarchical modulation with star 8-QAM to upgrade the downlink of PONs is experimentally demonstrated. We confirm 30-dB loss budget in a condition that allows coexistence of standard 10G-EPON ONUs and 30-Gbps DSP-based ONUs.

Room J 2F

[WS2] 10:30 - 12:00 Symposium
Fiberoptic Technologies for the Next Era II (Mode Control Technology)
Session Chair: Peter M. Krummrich (TU Dortmund, Germany)

WS2-1 10:30 - 11:00 Invited

Scaling Capacity by Twisting Light Beams

Siddharth Ramachandran [1] and Poul Kristensen [2]
[1] Photonics Center and ECE Dept., Boston Univ., MA, USA, [2] OFS Fitel ApS, Brøndby, Denmark

Optical vortices, which carry orbital-angular-momentum, form infinite-dimensional basis-sets of orthogonal-states, which make them attractive for mode-division-multiplexing systems. We describe recent-demonstrations of successfully generating & propagating vortices in optical-fibers, and review recent transmission-experiments conducted with them.

WS2-2 11:00 - 11:30 Invited

Photonic Lanterns Multimode to Single-Mode Converters: From Astronomy to Communications

Sergio G. Leon-Saval
Inst. of Photonics and Optical Science, School of Physics, Univ. of Sydney, Australia

Photonic lanterns allow for transforming a multimode waveguide into a discrete number of single-mode ones. We will present the operating principle of these unique devices and their current and future applications in Astronomy and Telecommunications

WS2-3 11:30 - 12:00 Invited

Spatial Mode Excitation and Separation Using Spatial Phase Control Technology

Atsushi Okamoto, Akihisa Tomita, Kento Kawabata and Yuta Wakayama
Graduate School of Information Science and Technology, Hokkaido Univ., Sapporo, Japan

Computer-generated holography is actively used to generate the spatial mode distribution required for mode excitation and hologram writing. In addition, we propose a new transmission scheme using the phase conjugation technology.

Room K 2F

[WT2] 10:30 - 11:45
OXC and Related Technologies
Session Chair: Nicolas Fontaine (Bell-Laboratories, Alcatel-Lucent, USA)

WT2-1 10:30 - 11:00 Invited

Efficient Photonic I/O for Data Communication

O. Liboiron-Ladouceur
Dept. of Electr. & Comp. Eng., McGill Univ., QC, Canada

Efficient photonic input/output (I/O) can lead to high off-chip throughput. Photonic front-ends for scalable data communication are presented addressing challenges related to dimension and power efficiency, and transmission link scalability.

WT2-2 11:00 - 11:15

Evaluation of Hardware Requirements for Large-scale OXC Architecture Employing Wavelength Switching and Fiber Selection

Toshinori Ban, Hai-Chau Le, Hiroshi Hasegawa, and Ken-ichi Sato
Nagoya Univ., Nagoya, Japan

We evaluate hardware requirements for a newly proposed low-loss large-scale OXC architecture that utilizes two-stage routing. It is verified that the architecture attains significant hardware scale reduction and decreased loss.

WT2-3 11:15 - 11:30

Development of Ultra-Compact 8x8 Waveband Cross-connect

Kensuke Takaha [1], Toshinori Ban [1], Hiroshi Hasegawa [1], Ken-ichi Sato [1], Hiroshi Takahashi [2], and Masayuki Okuno [3]
[1] Nagoya Univ., Aichi, Japan, [2] NTT Photonics Laboratories, Kanagawa, Japan, [3] NTT Electronics, Kanagawa, Japan

We develop an ultra-compact 8x8 waveband cross-connect prototype which consists of eight optical couplers and eight 1x8 waveband selective switch modules that are monolithically integrated onto PLC chips. Experiments verify its transmission performance.

WT2-4 11:30 - 11:45

Fundamental Switching Operation of Polymer Three-Dimensional Optical Interconnection Switch

H. Kobayashi [1], T. Hoshina [1], G. Yuzawa [1], K.Wakamatsu [1], Y. Matsushima [2], and K. Utaka [1]
[1] Faculty of Science and Engineering, Waseda Univ., Tokyo, Japan, [2] Green Computing Systems Research Organization, Waseda Univ., Tokyo, Japan

We proposed a 2x2 polymer three-dimensional (3D) optical interconnection switch. The analysis of our device shows colorless and polarization-independent operation. We fabricated the proposed device, and it successfully operated at 1550nm wavelength.

Room 101 1F

[WH2] 10:30 - 12:00
DUV-LEDs and Efficiency Improvements
Session Chair: Yoshitaka Taniyasu (NTT Basic Research Laboratories, Japan)

WH2-1 10:30 - 11:00 Invited

Droop Studies for High-Performance InGaN Blue Light-Emitting Diodes

Jong-In Shim [1], Hyunsung Kim [1], Dong-Pyo Han [1], and Dong-Soo Shin [2]
[1] Dept. of Electronics & Communication Eng., Hanyang Univ., ERICA campus, Ansan, Republic of Korea, [2] Dept. of Applied Physics, Hanyang Univ., ERICA campus, Ansan, Republic of Korea

An origin of the efficiency droop has been suggested as the saturation of the radiative recombination rate in InGaN quantum well at low current and subsequent increase in the nonradiative recombination rates at high current.

WH2-2 11:00 - 11:15

AlGaN-based Deep-UV LEDs Fabricated on Connected-Pillar AlN Buffer

H. Hirayama [1], Y. Tomita [1,2], S. Toyoda [1,2], S. Fujikawa [1], and N. Kamata [2]
[1] RIKEN (The Inst. of Physical and Chemical Research), Saitama, Japan, [2] Saitama Univ., Saitama, Japan

Low threading dislocation density AlN connected-pillar buffer was fabricated on patterned sapphire substrate using epitaxial lateral overgrowth technique. 260 nm-band AlGaN-based deep-ultraviolet light-emitting diode was demonstrated fabricated on connected-pillar AlN buffer.

WH2-3 11:15 - 11:30

Improvement of Light-Extraction Efficiency of Deep-UV LEDs using Transparent p-AlGaN Contact Layer

Noritoshi Maeda and Hideki Hirayama
RIKEN, Saitama, Japan

We demonstrated deep-ultraviolet-light-emitting diodes with emission wavelengths at around 285nm using transparent p-AlGaN contact layer and reflective p-type electrode. The reflectivity of p-type electrode was increased from 30% to 70% by introducing Ni(1nm)/Al metal layers.

WH2-4 11:30 - 11:45

Numerical Investigation of Light Extraction Efficiency in AlGaN Deep Ultraviolet Light-Emitting Diodes

Han-Youl Ryu [1], Il-Gyun Choi [2], Hyo-Sik Choi [2,3], and Jong-In Shim [2]
[1] Dept. Physics, Inha Univ., Incheon, Korea, [2] Dept. of Electronics and Communication Engineering, Hanyang Univ., Ansan, Korea, [3] Seoul Opto Device Company, Ansan, Korea

Light extraction efficiency (LEE) in AlGaN deep ultraviolet light-emitting diodes is investigated using finite-difference time-domain simulations. LEE of transverse-magnetic modes is found to be more than ten times smaller than that of transverse-electric modes.

WH2-5 11:45 - 12:00

Development of Highly-Uniform 270-nm Deep-Ultraviolet Light-Emitting Diodes

T. Mino [1,2], H. Hirayama [1], N. Noguchi [1,2], T. Takano [1,2], and K. Tsubaki [1,2]
[1] The Inst. of Physical and Chemical Research (RIKEN), Saitama, Japan, [2] Eco Solutions Company, Panasonic Corporation, Osaka, Japan

Development of high-quality and highly-uniform AlN/sapphire templates by using a NH_3 pulsed-flow method enabled the fabrication of highly-uniform 270-nm AlGaN-based deep-ultraviolet light-emitting diodes with the external quantum efficiency of over 2%.

Room 103 1F

[WG2] 10:30 - 12:00
Quantum Communication
Session Chair: Akihisa Tomita (Hokkaido Univ., Japan)

WG2-1 10:30 - 10:45

Long-term Field Demonstration of WDM Quantum Key Distribution System with Stabilization Control

K. Yoshino [1], T. Ochi [1], M. Fujiwara [2], A. Tomita [3], M. Sasaki [2], and A. Tajima [1]
[1] NEC Corporation, Kawasaki, Japan, [2] Nat'l Inst. of Information and Communications Technology, Tokyo, Japan, [3] Hokkaido Univ., Sapporo, Japan

A wavelength-division multiplexing quantum key distribution system with stabilization control was demonstrated through a 22-km field fiber in five-day continuous operation. Quantum bit error rates were kept below 3% in all key blocks.

WG2-2 10:45 - 11:00

Real-world two-photon interference and proof-of-principle QKD immune to detector attacks

A. Rubenok [1], J. A. Slater [1], P. Chan [2], I. Lucio-Martinez [1], and W. Tittel [1]
[1] Inst. for Quantum Science & Technology and Dept. of Physics & Astronomy, Univ. of Calgary, Alberta, Canada, [2] Institute for Quantum Science & Technology and Dept. of Physics & Astronomy, Univ. of Calgary, Alberta, CANADA

We demonstrate Bell-state measurements between independent sources over deployed fiber. With this we demonstrate a new QKD protocol that provides security against any detector attack. Our demonstration removes an obstacle for quantum repeaters and networks.

WG2-3 11:00 - 11:15

High Secure Network Switch with Quantum Key Distribution System

M. Fujiwara [1], T. Domeki [2], R. Nojima [1], and M. Sasaki [1]
[1] Nat'l Inst. of Information and Communications Technology, Tokyo, Japan, [2] NEC communication systems, Miyagi, Japan

We have developed quantum key distribution based network switches. In the layer 2 switch, MAC addresses are encrypted to prevent illegal access from internal network. In layer 3, secure key are used in IPSEC protocol.

WG2-4 11:15 - 11:30

Ultrabroadband Quantum Interface for Telecom-wavelength Single-photon Qubits Using a Semiconductor Quantum Dot Ensemble

Kazumasa Suzuki [1], Kouichi Akahane [2], and Junko Ishi-Hayase [1]
[1] Dept. of Applied Physics and Physico-Informatics, Keio Univ., Kanagawa, Japan, [2] Nat'l Inst. of Information and Communications Technology (NICT), Tokyo, Japan

We succeeded in transfer and retrieval of 1-ps single photon pulse to quantum dot ensemble using photon echo technique in the telecommunication wavelength range. Our result shows the possibility of ultrabroadband quantum interfaces.

WG2-5 11:30 - 11:45

High Efficiency Single Photon Frequency Conversion in the Telecommunications Band

Alex S. Clark, Shayan Shahnia, Matthew J. Collins, Chunle Xiong, and Benjamin J. Eggleton
Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), the Inst. of Photonics and Optical Science (IPOS), Univ. of Sydney, Australia

We present the first near-unit efficiency demonstration of single photon frequency conversion through Bragg scattering four-wave mixing in a dispersion engineered highly nonlinear fiber.

WG2-6 11:45 - 12:00

Telecom-band Michelson-type Two-Photon Interferometer with Photon-Number-Resolving Single-Photon Detection

A. Yoshizawa, D. Fukuda, and H. Tsuchida
Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan

Experimental evaluation of a fiber-optic Michelson-type two-photon interferometer operating at 1550 nm was presented using a superconducting transition edge sensor as a photon-number-resolving single-photon detector. We monitored two-photon detection events to observe photon bunching.

Room 104A 1F

[WK2] 10:30 - 12:00
Modulator
Session Chair: Taro Arakawa (Yokohama National Univ., Japan)

WK2-1 10:30 - 11:00 Invited

High-speed low-driving-power electroabsorption modulator for microwave photonic communications

Yi-Jen Chiu and Jui-Pin Wu
Inst. of Electro-Optic Engineering, Nat'l Sun Yat-Sen Univ., Kaoshiung, Taiwan R.O.C

Progress of high-speed low-driving-power EAM has been reviewed. Microwave design issues have been addressed. Low power with less than 1Vpp and above 40Gb/s operation has been attained from special design of waveguide structure.

WK2-2 11:00 - 11:15

Low Driving Voltage InP-Based Mach-Zehnder Modulators for Compact 128 Gb/s DP-QPSK Module

Hideki YAGI, Takamitsu KITAMURA, Naoya KONO, Hirohiko KOBAYASHI, Naoko INOUE, Kazuhiko HORINO, Daisuke KIMURA, Kosuke FUJII, Yoshihiro YONEDA, Chie FUKUDA and Hajime SHOJI
Transmission Devices R & D Laboratories, Sumitomo Electric Industries, LTD., Yokohama, Japan

We demonstrated InP-based DP-QPSK modulators monolithically integrated with four Mach-Zehnder modulators planarized by benzocyclobutene polymer. Clear eye-opening under 32 Gb/s operation was achieved in all of Mach-Zehnder modulators at low driving voltage of 1.8 Vpp.

WK2-3 11:15 - 11:30

Low-Power Multi-level Modulation of InP MZM with In-line Centipede Structure Directly Driven by CMOS IC

Tomoyuki Yamase, Mineto Sato, Hidemi Noguchi, Kenji Sato and Tomoaki Kato
Green Platform Research Laboratories, NEC Corporation, Kawasaki, Japan

We proposed a methodology to drive in-line centipede electrode InP MZM to generate arbitrary waveform using both thermometer-code and DAC signals to achieve desired resolution without compromising footprint, operation speed, and power consumption.

WK2-4 11:30 - 11:45

Sub-1V and Sub-100μm Electro-absorption Modulator Based on Bragg Reflector Waveguide

Xiaodong Gu [1], Syouki Shimizu [1], Toshikazu Shimada [1], Akihiro Matsutani [2], and Fumio Koyama [1]
[1] Photonics Integration System Research Center, Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Yokohama, Japan, [2] Semiconductor and MEMS Processing Center, Technical Dept., Tokyo Inst. of Technology, Yokohama, Japan

An ultra-compact electro-absorption GaInAs/GaAs QW modulator based on a slow-light Bragg reflector waveguide was fabricated. A low driving voltage below 0.5V was demonstrated for a 50μm long device.

WK2-5 11:45 - 12:00

Sub-50μm Long Slow-light Electro-absorption Modulator Laterally Integrated with VCSEL

Toshikazu Shimada [1], Akihiro Matsutani [2], and Fumio Koyama [1]
[1] Photonics Integration System Research Center, Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Yokohama, Japan, [2] Semiconductor and MEMS Processing Center, Technical Dept., Tokyo Inst. of Technology, Yokohama, Japan

A compact GaInAs/GaAs electro-absorption modulator with slow-light Bragg reflector waveguide was laterally integrated with VCSEL. A driving voltage below 2V was demonstrated and a possibility of an ultra-compact modulator below 30μm was presented.

Room 104B 1F

[WM2] 10:30 - 12:00
Si Photonics: Passive Devices
Session Chair: Hitoshi Kawashima (National Inst. of Advanced Industrial Science and Technology, Japan)

WM2-1 10:30 - 10:45

Si Wire Array Waveguide Grating with Reduced Phase Error: Effect of advanced lithography process

H. Okayama [1], D. Shimura [1], H. Takahashi [1], M. Seki [2], M. Toyama [2], T. Sano [2], K. Koshino [2], N. Yokoyama [2], M. Ohtsuka [2], A. Sugiyama [2], S. Ishitsuka [2], T. Tsuchizawa [3], H. Nishi [3], K. Yamada [3], H. Yaegashi [1], T. Horikawa [2] and H. Sasaki [4]
[1] Inst. for Photonics-Electronics Convergence System Technology (PECST) and Photonics Electronics Technology Research Association (PETRA), Oki Electric Industry Co., Ltd., Saitama, Japan, [2] Inst. for Photonics-Electronics Convergence System Technology (PECST), Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Ibaraki, JAPAN, [3] Inst. for Photonics-Electronics Convergence System Technology (PECST) and Photonics Electronics Technology Research Association (PETRA), NTT Microsystem Laboratories, Kanagawa, Japan, [4] R&D Center, Oki Electric Industry Co., Ltd., Saitama, Japan

We report the Si wire AWG without systematic phase error generated at the curved waveguides. A 200GHz spacing 16 channel devices were fabricated by ArF immersion and EB lithography and the results are compared.

WM2-2 10:45 - 11:00

Ultra-Compact Arrayed Waveguide Grating Triplexer Based on Silicon-on-Insulator Platform

Jun Zou [1], Xianxin Jiang [1], Tingting Lang [2], and Jian-Jun He [1]
[1] State Key Laboratory of Modern Optical Instrumentation, Centre for Integrated Optoelectronics, Dept. of Optical Engineering, Zhejiang Univ., Hangzhou, China, [2] College of Optical and Electronic Technology, China Jiliang Univ., Hangzhou, China

We demonstrate an ultra-compact birefringence-compensated arrayed waveguide grating triplexer based on silicon nanowire waveguide. The cross-order design and angled star couplers are employed and the device has a small footprint of 0.18×0.12 mm^2.

WM2-3 11:00 - 11:15

Ultraviolet-induced Wavelength Trimming of BCB-buried Athermal Si Slot Wavelength Filters

Yuki Atsumi[1], Takeshi Sifer[1], JoonHyun Kang[1], Yusuke Hayashi[1], Nobuhiko Nishiyama[1], and Shigehisa Arai[1,2]
[1] Dept. of Electrical and Electronic Engineering, Tokyo, Japan, [2] Quantum Nanoelectronics Research Center Tokyo Inst. of Technology, Tokyo, Japan

Wavelength trimming for athermal Si-slot wavelength filter embedded with BCB using DUV exposure was demonstrated. The total shift of 1.21nm was obtained after exposing 14J/cm^2 of DUV-light without any degradation in athermal and propagation characteristics.

WM2-4 11:15 - 11:30

Micro-ring Silicon Nitride Resonators with Optical Feedback and Dispersion Engineering

J.M. Chavez Boggio [1], R. Eisermann [2], D. Bodenmuller [1], T. Fremberg [1], R. Haynes [1], L. Zimmermann [2], and M.M. Roth [1]
[1] innoFSPEC-VKS, Leibniz-Institut fur Astrophysik Potsdam (AIP), Potsdam, Germany, [2] Leibniz-Institut fur Innovative Mikroelektronik (IHP), Frankfurt (Oder), Germany

Dispersion-engineered silicon-nitride ring-resonators with optical-feedback are investigated. Numerically, we demonstrate ultra-flat dispersion -67±0.6ps/nm-km between 1380-2390nm and 0.8+/-5ps/nm-km at 1520-2400nm. Losses are estimated to be ~0.5dB/cm in the fabricated waveguides while dispersion is evaluated with spectral-interferometry.

WM2-5 11:30 - 11:45

Thermo-Optically Controlled Silicon Microring Resonator Mach-Zehnder Modulator with Cascaded and Push-Pull Microring Configuration

Rajdeep Gautam, Shintaro Ishihara, Hiroki Kaneshige, Taro Arakawa, and Yasuo Kokubun
Graduate School of Engineering, Yokohama Nat'l Univ., Kanagawa, Japan

We demonstrate low-driving power silicon microring Mach-Zehnder modulators (MZMs) driven by thermo-optic effect. The multiple-wavelength modulation is realized using a cascaded microring MZM. The driving voltage is reduced up-to 1/6 in a push-pull microring MZM

WM2-6 11:45 - 12:00

Triangular-Shaped Coupled Microrings for Tolerant Multi-/Demulti-plexing

Hiroyuki Ito, Norihiro Ishikura and Toshihiko Baba
Dept. of Electrical and Computer Engineering, Yokohama Nat'l Univ., Yokohama, Japan

Triangular-shaped microring resonators simplifies the inter-ring coupling and phase tuning, and realizes the box-like spectrum. A 3-nm-wide pass-band and 19-nm FSR were measured in 2nd and 4th-order series-coupled microrings with low-loss sharp bends.

Room C-1 1F

[WR3] 14:30 - 16:00
Subsystems for Optical Transmission Systems
Session Chair: Hoon Kim (National Univ. of Singapore, Singapore)

WR3-1 14:30 - 15:00 Upgrade Invited

Joint Symbol Synchronization and Dispersion Estimation in 16QAM Optical Fast OFDM

Jian Zhao [1], Ming Li [2], and Lian-Kuan Chen [2]
[1] Tyndall Nat'l Inst. and Univ. College Cork, Cork, Ireland, [2] Dept. of Information Engineering, the Chinese Univ. of Hong Kong, Shatin, Hong Kong

We show that joint symbol synchronization and channel estimation can be realized using single symbol with negligible penalty in 16QAM optical F-OFDM. This facilitates the application of F-OFDM for burst-mode transceivers in optical packet networks.

WR3-2 15:00 - 15:15

Improvement due to Optically Filtered Lasers in Parallel Decision-Directed Phase Recovery for 16-QAM

W. C. Ng [1], T. N. Huynh [3], A. T. Nguyen [1], S. Ayotte [2], C. S. Park [1], L. P. Barry [3] and L. A. Rusch [1]
[1] Centre d'optique photonique et laser, ECE Dept., Universitè Laval, Quèbec, Canada, [2] TeraXion, Quèbec, Canada, [3] The Rincè Inst., School of Electronic Engineering, Dublin City Univ., Dublin, Ireland

We experimentally show optically filtered lasers reduce OSNR penalty due to phase tracking error up to 3 dB for two parallel decision directed algorithms with feedback delay in an 11 Gbaud/s 16QAM coherent system.

WR3-3 15:15 - 15:30

Data-Aided Second-Order Polarization-Mode Dispersion Estimation for QPSK and 16-QAM Coherent Optical Systems

C. Do, A.V. Tran, T. Anderson and E. Skafidas
Victoria Research Laboratory, NICTA Ltd., Dept. of Electrical and Electronic Engineering, Univ. of Melbourne, Australia

We propose second-order-polarization-mode-dispersion estimation technique for polarization-multiplexed coherent single-carrier system using data-aided channel estimation and PMD model analysis. The technique is demonstrated for 25-Gbaud QPSK and 16-QAM systems, to accurately estimate various amount of SOPMD.

WR3-4 15:30 - 15:45

Experimental Demonstration of RF Carrier Allocation Based OFDM Signal Visible Light Transmission

Hyun-Seung Kim, Deok-Rae Kim, Se-Hoon Yang, Yong-Hwan Son, and Sang-Kook Han
Dept. of Electrical and Electronic Engineering, Yonsei Univ., Seoul, Korea

We experimentally demonstrate the wireless OFDM signal transmission of LED signal in order to overcome bandwidth limitation of carrier allocation - visible light communications.

WR3-5 15:45 - 16:00

40-krad/s-Fast Polarization Demultiplexing in a 430-km, 20-Gb/s-PDM-RZ-DPSK Transmission

B. Koch[1,2], R. Noe[1,2], V. Mirvoda[1], D. Sandel[1], K. Puntsri[1], O. Jan[1] and S. Hussin[1]
[1] Univ. of Paderborn Paderborn, Germany, [2] Novoptel GmbH, Paderborn, Germany

In PDM-DPSK systems, polarization interference depends on the unknown interchannel phase. We distribute the interchannel phase to reliably detect interference and demultiplex optical polarizations of a 20-Gb/s-PDM-RZ-DPSK signal at up to 40 krad/s polarization scrambling.

Room C-2 1F

[WI3] 14:30 - 16:00
Plasmonics I
Session Chair: Shangjr Gwo (National Tsing-Hua Univ., Taiwan)

WI3-1 14:30 - 15:00 Invited

Quantum Optics with Nanowires

V. Zwiller
Kavli Inst. of Nanoscience, TU Delft, The Netherlands

WI3-2 15:00 - 15:15

Electric and Magnetic Response in a Composite System of a Dielectric Photonic-crystal Nanocavity and Single Metallic Nanostructures

Y. Lee, T. Asano, Y. Tanaka, and S. Noda
Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

We demonstrate nanoscale interaction between dielectric and metallic nanocavities. The Q factor's change is affected by the location and the types of metallic nanocavities. These electric/magnetic local responses can be utilized for various photonic applications.

WI3-3 15:15 - 15:30

Volume Plasmon Polaritons and Subwavelength Interference in a Hyperbolic Medium

Satoshi Ishii[1,2], Alexander V. Kildishev[1], Evgenii Narimanov[1], Vladimir M. Shalaev[1], and Vladimir P. Drachev[1,3]
[1] Birck Nanotechnology Center, Purdue Univ., West Lafayette, USA, [2] Advanced ICT Research Inst., Nat'l Institute of Information and Communications Technology, Hyogo, Japan, [3] Dept. of Physics, Univ. of North Texas, Denton, USA

Experiments demonstrate that inside strongly anisotropic materials with hyperbolic dispersion, light diffracted from double slits propagates as volume plasmon polaritons and form subwavelength interference peaks that can be used in subwavelength photolithography and probes.

WI3-4 15:30 - 15:45

Non-local Optical Topological Transitions and Critical Points in Metamaterials

Satoshi Ishii [1,2] and Evgenii Narimanov [1]
[1] Birck Nanotechnology Center and School of Electrical and Computer Engineering, Purdue Univ., West Lafayette, USA, [2] Advanced ICT Research Inst., Nat'l Institute of Information and Communications Technology, Hyogo, Japan

We demonstrate that non-locality can induce a new type of optical topological transition in photonic metamaterials. We describe the corresponding critical state and analyze the optical properties of such media.

WI3-5 15:45 - 16:00

Anisotropic Transmission of Light Through a Plasmonic Bull's Eye with an Elliptical Aperture

M. Pournoury[1], H.E. Joe[2], T. Nazari[1], J. H. Park[3], Y. M. Sung[4], B.K. Min[2], S. Im[3], D. Kim[4], and K. Oh[1]
[1] Photonic Device Physics Laboratory, Inst. of Physics and Applied Physics, Yonsei Univ., Seoul, South Korea, [2] School of mechanical engineering, Yonsei Univ., Seoul, South Korea, [3] Electron Device Laboratory, Inst. of Physics and Applied Physics, Yonsei Univ., Seoul, South Korea, [4] Dept. of Chemistry, Yonsei Univ., Seoul, South Korea

Anisotropic transmission of light through a plasmonic bull's eye with an elliptical central aperture in a thin Au film is analyzed experimentally.

Room F 1F

[WA3] 14:30 - 16:00
Advanced Technologies for Nonlinear Optics
Session Chair: Takashige Omatsu (Chiba Univ., Japan)

WA3-1 14:30 - 15:00 Invited

Sub-wavelength Domain Engineering in KTP Isomorphs: QPM Devices with Counterpropagating Photons

C. Canalias, A. Zukauskas, C. Liljestrand, V. Pasiskevicius, and F. Laurell
Royal Inst. of Technology, Stockholm, Sweden

We review the recent advances in fabrication of ferroelectric-domain gratings of sub-μm periodicity in KTP and Rb-doped KTP for counter-propagating second-order nonlinear optical interactions. Their performance as QPM devices will be discussed.

WA3-2 15:00 - 15:15

Thermal management for high-power wavelength conversion

Sunao Kurimura[1], Hwan Hong Lim[1], Wataru Nagashima[1,2], Keisuke Noguchi[1,2], Ichiro Shoji[2]
[1] Nat'l Inst. for Materials Science, Tsukuba, JAPAN, [2] Chuo Univ., Tokyo, Japan

Thermal management is discussed in single-pass CW SHG in QPM Mg:SLT. Effective heat capacity in four-side heat removal module is quantitatively characterized by Phase-Matched Calorimetry and enhanced by 50% with narrowing device width.

WA3-3 15:15 - 15:30

Fabrication of AlGaAs/AlOx Waveguides with Inversion-Stacked Core Structure for Higher-Order Modal-Phase Matching Devices

T. Matsushita [1], Y. Nakamura [1], S. Matsumoto [2], T. Onda [2], I. Shoji [2], and T. Kondo [1]
[1] Dept. of Materials Engineering, The Univ. of Tokyo, Tokyo, Japan, [2] Dept. of Electrical, Electronic, and Communication Engineering, Chuo Univ., Tokyo, Japan

We have proposed and fabricated high-index-contrast AlGaAs/AlOx waveguides with inversion-stacked core structure for higher-order modal-phase-matched second- harmonic generation at 1.55 μm.

WA3-4 15:30 - 15:45

UV Laser-Induced Degradation in $CsLiB_6O_{10}$

K. Takachiho [1,2], M. Yoshimura [1,2], K. Masuda [1,2], Y. Takahashi [1,2], M. Imade [1], T. Sasaki [1,2], and Y. Mori [1,2]
[1] Graduate School of Engineering, Osaka Univ., Osaka, Japan, [2] CREST, JST, Tokyo, Japan

We investigated UV-induced degradation of $CsLiB_6O_{10}$ at 266 nm and discuss the mechanism and origin of the degradation. We found that reduction of the point defects distributed inside the crystal can slow down the degradation.

WA3-5 15:45 - 16:00

A Picosecond Near-IR Laser Source Based on a Self-seeded Optical Parametric Generator

Paul Kumar Upputuri, and Haifeng Wang
Dept. of Physics, Faculty of Science, Nat'l Univ. of Singapore, Singapore

We report a picosecond near-IR laser source based on an optical parametric generator seeded with a fraction of its own signal output. We have demonstrated its functionality through CARS imaging experiments.

Room G 1F

[WB3] 14:30 - 16:00
Ultrafast I

Session Chair: Eleftherios Goulielmakis (Max-Planck-Institut für Quantenoptik, Germany)

WB3-1 14:30 - 15:00 Upgrade Invited

Multi-mJ Parametric Synthesizer Generating Two-Octave-Wide Optical Waveforms

Shaobo Fang [1,3], Giovanni Cirmi [1,3], Shih-Hsuan Chia [1,3], Oliver D. Mücke [1,3], Franz X. Kärtner [1-4], Cristian Manzoni [5], Paolo Farinello [5] and Giulio Cerullo [5]

[1] Center for Free-Electron Laser Science, Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany, [2] Physics Dept., Univ. of Hamburg, Hamburg, Germany, [3] The Hamburg Center of Ultrafast Imaging, Hamburg, Germany, [4] Dept. of Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Inst. of Technology, Massachusetts, USA, [5] IFN-CNR, Dipartimento di Fisica, Politecnico di Milano, Milan, Italy

We demonstrate a phase-stable, multi-mJ 3-channel parametric synthesizer generating a 2-octave-wide spectrum (0.52-2.4μm). After two amplification stages, the combined 125-μJ output supports 1.9-fs waveforms. Energy scaling to 2 mJ is achieved after three amplification stages.

WB3-2 15:00 - 15:15

Broadband Conversion From Red to Mid-infrared in a High Power Femtosecond Fiber Laser-Pumped OPO

Minglie Hu, Chengling Gu, Limeng Zhang, Jingtao Fan and Ching-Yue Wang

Ultrafast Laser Laboratory, Key Laboratory of Opto-electronic Information Science and Technology of Ministry of Education, College of Precision Instruments and Opto-electronics Engineering, Tianjin Univ., Tianjin, China

We report highly efficient generation of wavelength tunable femtosecond pulses from red to mid-infrared based on intracavity second harmonic generation (SHG) and sum frequency generation (SFG) in a MgO:PPLN optical parametric oscillator (OPO).

WB3-3 15:15 - 15:30

Pulse characterization with absolute carrier-envelope phase value

T. Fuji and Y. Nomura

Inst. for Molecular Science, Okazaki, Japan

A new pulse characterization concept capable of measuring complete waveforms of ultrashort pulses has been demonstrated. Sub-single-cycle pulses were characterized including absolute carrier-envelop phase value by using the method.

WB3-4 15:30 - 15:45

Generation of Femtosecond Laser Pulse At 1053 nm with Contrast Ratio of 10^{11} by Optical-Parametric Amplification

Zhongwei Shen, Zhaohua Wang, Wei Zhang, Haitao Fan, Hao Teng, and Zhiyi Wei

Beijing Nat'l Laboratory for Condensed Matter Physics and Inst. of Physics, Chinese Academy of Sciences, Beijing, China.

We demonstrated a high contrast 1053 nm femtosecond laser by exchanging the signal and idler in two stages non-collinear optical-parametric amplifier, 60 μJ idler with measurement-limited contrast of 2.3×10^{11} was obtained within sub-10 ps.

WB3-5 15:45 - 16:00

Full-coherent HHG-seeded EUV-FEL Locked by EOS Timing Feedback

K. Ogawa [1], T. Sato [1], S. Matsubara [2], Y. Okayasu [2], T. Togashi [2], T. Watanabe [1,2], E. J. Takahashi [3], K. Midorikawa [3], M. Aoyama [4], K. Yamakawa [4], A. Iwasaki [5], S. Owada [5], K. Yamanouchi [5], T. Ohshima [1], Y. Otake [1,2], T. Hara [1,2], T. Tanaka [1,2], H. Tanaka [1,2], H. Tomizawa [1,2], M. Yabashi [1,2], T. Ishikawa [1]

[1] RIKEN, Harima Inst. SPring-8 Center, Hyogo, Japan, [2] Japan Synchrotron Radiation Research Inst., Hyogo, Japan, [3] RIKEN Advanced Science Inst., Saitama, Japan, [4] Japan Atomic Energy Agency, Kyoto, Japan, [5] The Univ. of Tokyo, Tokyo, Japan

We are developing full-coherent EUV-FEL seeded with HHG of Ti:Sapphire laser pulse. Using the monitor of overlap timing drift with EO sampling technique, seeded FEL pulse was obtained continuously half-day long.

Room H 1F

[WF3] 14:30 - 16:00 Symposium
New Trends in Frequency Comb: Application of Light with Ultraprecision III

Session Chair: Kaoru Minoshima (The University of Electro-Communication, Japan)

WF3-1 14:30 - 15:00 Invited

Attractive Natures of a Raman Frequency Comb in the Time and Frequency Domains

M. Katsuragawa[1], K. Yoshii[1], K. Shiraga[1], M. Arakawa[1], and F. L. Hong[2]

[1] Dept. of Engineering Science, Univ. of Electro-Communications, Tokyo, Japan, [2] Nat'l Inst. of Advanced Industrial and Technology, Ibaraki, Japan

We show attractive features of a Raman comb that is produced by an adiabatic Raman process. One is the features in the time domain and the other in the frequency domain.

WF3-2 15:00 - 15:30 Invited

High-Resolution, Dual-Comb Asynchronous Sampling Enabled by Dual-Wavelength Ultrafast Fiber Lasers and Its Applications

Zheng Zheng and Xin Zhao

School of Electronic and Information Engineering, Beihang Univ., Beijing, China

Novel dual-wavelength mode-locked fiber lasers could enable alternative asynchronous sampling schemes for some interesting dual-comb metrology applications including absolute distance measurement, spectroscopy and device characterization with a significantly simplified setup.

WF3-3 15:30 - 16:00 Invited

Development of Fiber Femtosecond Lasers for Advanced Metrological Space Missions

Young-Jin Kim, Keunwoo Lee, Seongheum Han, Yoon-Soo Jang, Heesuk Jang, and Seung-Woo Kim

Ultrafast Optics for Ultraprecision Group, Dept. of Mechanical Engineering, Korea Advanced Inst. of Science and Technology (KAIST), Daejeon, Korea

The recent advance of femtosecond lasers attracts much attention to extend today's space missions. In this presentation, we introduce how femtosecond lasers are being investigated for space explorations for the next generation space missions.

Room I 2F

[WQ3] 14:30 - 15:45
Virtual and Autonomic Networks

Session Chair: Takaya Miyazawa (National Inst. of Information and Communications Technology (NICT), Japan)

WQ3-1 14:30 - 15:00 Invited

Autonomic Network Engineering: Bridging the Gap Between Research, Standards and Industry

L. Ciavaglia

Alcatel-Lucent, Nozay, France

To fill the gaps between research, standards and industry, effort involving all stakeholders and a systematic roadmap are required. We highlight three essential requirements: a unified management framework,building trust from network operators and standardized interfaces.

WQ3-2 15:00 - 15:15

Distance-Adaptive Virtual Network Embedding in Software-Defined Optical Networks

Ankitkumar N. Patel, Philip N. Ji, Yue-Kai Huang, Ting Wang

NEC Laboratories America, Inc., Princeton, U.S.A

We address the first distance-adaptive virtual network embedding problem in software-defined optical networks, and propose a fragmentation-aware algorithm. The impacts of fixed and flexible grid transports are evaluated in the number of embedded virtual instances.

WQ3-3 15:15 - 15:30

A Managed Self-organization Method for Controlling Multiple Virtual Network Topologies

Shin'ichi Arakawa[1], Takashi Miyamura[2], Yuki Koizumi[1], Daisaku Shimazaki[2], Shohei Kamamura[2], Koji Sasayama[2], Kohei Shiomoto[2], Masayuki Murata[1]

[1] Graduate School of Information Science and Technology, Osaka Univ., Osaka, Japan, [2] NTT Network Service Systems Laboratories, NTT Corporation, Japan

We investigate what kind of information should be ex-changed for controlling multiple VNTs. Simulation results show number of reconfigurations to find good VNTs is significantly reduced with slightly increased, but still marginal, amount of information.

WQ3-4 15:30 - 15:45

Adaptability of Virtual Network Topology Control Based on Attractor Selection against Multiple Node Failures

Yuki Koizumi [1], Shin'ichi Arakawa [1], Shohei Kamamura [2], Daisaku Shimazaki [2], Takashi Miyamura [2], Atsushi Hiramatsu [2], and Masayuki Murata [1]

[1] Graduate School of Information Science and Technology, Osaka Univ., Osaka, Japan, [2] NTT Network Service Systems Laboratories, NTT Corporation, Tokyo, Japan

We propose an adaptive virtual topology control method. It is based on attractor selection, which models the adaptive behavior of biological systems. Simulation results indicate that our method is highly adaptive against node failures.

Room J 2F

[WS3] 14:30 - 16:00
Doped Fibers and Devices
Session Chair: Shoichiro Matsuo (Fujikura Ltd., Japan)

WS3-1 14:30 - 14:45

Experimental Study of Wavelength-dependent Dynamic Gain Offsets of AGC WDM EDFA

K. Ishii, K. Tanizawa, J. Kurumida, and S. Namiki
Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Network Photonics Research Center, Ibaraki, Japan

We observed surviving channel gain offsets of AGC EDFA which are induced differently depending on aggressive channel allocations by SHB and AGC imperfectness, then briefly discussed how to alleviate the impact on dynamic optical networks.

WS3-2 14:45 - 15:00

Fabrication of Ce-Doped Fibers by Using Rod-in-Tube Technique with Drawing Tower

Fang-Yen Lo [1], Chun-Nien Liu [1], Yi-Chung Huang [1], Wei-Lun Wang [1], Yen-Sheng Lin [2], Ta-Lung Chou [1], PiLing Huang [1], Sheng-Lung Huang [3], and Wood-Hi Cheng [1]
[1] Dept. of Photonics, Nat'l Sun Yat-sen Univ., Kaohsiung, Taiwan, [2] Dept. of Electronic Engineering, I-Shou Univ., Kaohsiung, Taiwan, [3] Graduate Inst. of Photonics and Optoelectronics, National Taiwan Univ., Taipei, Taiwan

The fabrication of Ce-doped fibers (CeDFs) employing drawing-tower method with rod-in-tube technique is demonstrated. The CeDFs exhibited a 160-nm broadband fluorescence spectrum which provides the potential for utilizing as broadband source for ultrahigh resolution OCT.

WS3-3 15:00 - 15:15

Micro-dispensing for three-dimensional direct fabrication of laser waveguides

Noboru Hirakawa [1], Hiroyuki Kubota [1], Hiroaki Yoshioka [1], Noriyasu Tarumi [2], Yoshio Kagebayashi [2] and Yuji Oki [1]
[1] Dept. of Electronics, School of I.S.E.E. Kyushu Univ., Fukuoka, Japan, [2] USHIO INC., Yokohama, Japan

Direct drawing of laser-waveguide with width of 20μm on unflat surface was demonstrated by using micro-dispensing technique. Highly viscous prepolymers form high aspect ratios such as 18μm width and 7μm height with one time dispensing.

WS3-4 15:15 - 15:30

A New Scheme of Hyperboloid Microlens

Jian-Li Chen [1],Wen-Hsuan Hsieh [1], Yi-Chung Huang [1], Yi-Cheng Hsu [2], Maw-Tyan Sheen [3], Ying-Chien Tsai [4], and Wood-Hi Cheng [1]
[1] Dept. of Photonics, Nat'l Sun Yat-sen Univ., Kaohsiung, Taiwan, [2] Dept. of Biomechatronics Engineering, National Pingtung Univ. of Science and Technology, Pingtung, Taiwan, [3] Dept. of Electronic Engineering, Yung-Ta Inst. of Technology and Commerce, Pingtung, Taiwan, [4] Dept. of Mechanical Engineering, Cheng-Shiu Univ., Kaohsiung, Taiwan

A new scheme of hyperboloid microlens (HM) having precise controlling minor radius of curvature is demonstrated. The HMs exhibited high-average coupling of 83% which was better than any other grinding techniques to form asymmetric microlenses.

WS3-5 15:30 - 15:45

Tunable Birefringence in One-line-filled Liquid-crystal Photonic Crystal Fibers

Chih-Lun Chiang and Chin-Ping Yu
Dept. of Photonics and Advanced Crystal Opto-electronic Research Center Nat'l Sun Yat-Sen Univ., Kaohsiung, Taiwan

We have successfully fabricated birefringent one-line-filled LCPCFs by using a selective infiltration method. Very high birefringence of 3.12×10^{-3} can be obtained at λ = 1170nm. The thermally tunable birefringence of the one-line-filled LCPCFs is also discussed.

WS3-6 15:45 - 16:00

Magneto-optic characteristics of gamma-ray irradiated Cu-doped optical fiber

Youngwoong Kim [1], Seongmin Ju [1], Seongmook Jeong [1], Myoung-Jin Jang [1], Jong-Yeol Kim [2], Nam-Ho Lee [2], Hyun-Kyu Jung [2] and Won-Taek Han [1]
[1] Dept. of Physics and Photon Science/School of Information and Mechatronics, Gwangju Inst. of Science and Technology, Gwangju, Republic of Korea, [2] Nuclear Convergence Technology Development Dept., Korea Atomic Energy Research Institute, Daejeon, Republic of Korea

Effect of gamma-ray irradiation on magneto-optic characteristics of Cu-doped optical fiber was investigated. Verdet constant at 660 nm under magnetic field of 0.142 T of the optical fiber increased about 1.46 times after the irradiation.

Room K 2F

[WT3] 14:30 - 15:30
Photonics in Future Computing Systems
Session Chair: Hiroyuki Uenohara (Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Japan)

WT3-1 14:30 - 15:30 **Tutorial**

The Role of Photonics in Future Computing Systems and Data Centers

S. J. Ben Yoo
Dept. of Electrical and Computer Engineering, Univ. of California, CA, USA

We discuss innovations in computing and data center systems rising from introduction of photonics. We will cover new computing architectures, control planes, productivity, performance enhancements based on simulation and experimental studies.

Room 101 1F

[WH3] 14:30 - 16:00
Blue-Green LDs, New Frequency Device
Session Chair: Yoichi Kawakami (Kyoto Univ., Japan)

WH3-1 14:30 - 15:00 **Invited**

1 W AlInGaN Based Green Laser Diodes

Shingo Masui, Takashi Miyoshi, Tomoya Yanamoto and Shin-ichi Nagahama
Nichia Corporation, Tokushima, Japan

We succeeded in demonstrating AlInGaN based 1W 525 nm green laser diodes on c face GaN substrates. The wall-plug efficiency was 14.1%. The lifetime was estimated to be over 15,000 h.

WH3-2 15:00 - 15:15

Local Photoluminescence Properties of InGaN Green Laser Structure on (0001) GaN Substrate

Akio Kaneta [1], Takayuki Hira [1], Yoon Seok Kim [1], Mitsuru Funato [1], Yoichi Kawakami [1], Takashi Miyoshi [2] and Shin-ichi Nagahama [2]
[1] Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan, [2] Nitride Semiconductor Research Laboratory, Opto-Electronics Division, Nichia Corporation, Tokushima, Japan

The spatial variation of the PL intensities and peak wavelengths are drastically suppressed in InGaN green laser structure fabricated on (0001) GaN substrate. This result is thought to contribute to low threshold current density.

WH3-3 15:15 - 15:30

Advances in single mode, high frequency and high power AlGaInN laser diodes

S.P. Najda[1], P. Perlin[1,2], T. Suski[2], L. Marona[2], M. Boćkowski[1,2], M. Leszczyński[1,2], A.Kafar[2], S.Stanczyk[2], P. Wisniewski[1,2], R. Czernecki[1,2], R. Kucharski[3], G. Targowski[3], S. Watson[4], M. Tan[4] and A.E.Kelly[4]
[1] TopGaN Ltd., Warsaw, Poland, [2] Inst. of High Pressure Physics PAS, Warsaw, Poland, [3] Ammono S.A., Warsaw, Poland, [4] School of Engineering, Univ. of Glasgow, Glasgow, U.K.

Latest developments in single mode, high frequency and high power AlGaInN laser diode technology are presented with single transverse mode operation up to 100mW cw. High powers up to 4W is achieved in a bar.

WH3-4 15:30 - 15:45

GaN Laser Structure with Semipolar Quantum Wells and Embedded Nanostripes

R.A.R. Leute[1], T. Meisch[1], J. Wang[1], J. Biskupek[2], U. Kaiser[2], M. Muller[3], P. Velt[3], F. Bertram[3], J. Christen[3], and F. Scholz[1]
[1] Inst. of Optoelectronics, Ulm Univ., Ulm, Germany, [2] Central Facility of Electron Microscopy, Ulm Univ., Ulm, Germany, [3] Inst. of Experimental Physics, Otto-von-Guericke-Univ. Magdeburg, Magdeburg, Germany

Using nanoimprint-lithography, we fabricate GaN nano-structures with semipolar quantum wells on 2-inch c-oriented substrates and embed them within a planar waveguide creating a separate-confinement-heterostructure. Electroluminescence, transmission-electron-microscopy and spatially resolved cathodoluminescence inside a scanning-TEM is applied.

WH3-5 15:45 - 16:00

GaN/AlGaN Based Quantum Cascade Laser Structures Emitting At 1.3-2.8 THz

W. Terashima[1,2] and H. Hirayama[1,2]
[1] Quantum Optodevice Laboratory, RIKEN, Saitama, JAPAN, [2] Terahertz Quantum Device Laboratory, RIKEN, Sendai, JAPAN

Terahertz emissions at 1.3 to 2.8 THz were achieved at GaN/AlGaN based quantum cascade laser structures. From investigations of polarization and voltage dependence electroluminescence (EL) measurements, we proved conclusively intersubband nature of the EL peak.

Room 103 1F

[WL3] 14:30 - 16:00
Inter Connection & Related Devices

Session Chair: Soichi Kobayashi (Chitose Inst. of Science and Technology, Japan)

WL3-1 14:30 - 14:45

Efficiency and Fabrication Tolerance of Half-Ridge InP/InGaAsP Polarization Converters

Masaru Zaitsu, Takuo Tanemura, and Yoshiaki Nakano

Research Center for Advanced Science and Technology (RCAST), The Univ. of Tokyo, Tokyo, Japan

Integrated InP/InGaAsP polarization converters based on half-ridge structure are studied numerically. We demonstrated that the fabrication tolerance can be extended significantly by optimizing the thickness of the residual InGaAsP layer at the ridge side.

WL3-2 14:45 - 15:00

A π-Phase-Shifted Long-Period-Waveguide-Grating on $LiNbO_3$ Fabricated by a Two-Step Proton Exchange

Ricky W. Chuang [1,2], Mao-Teng Hsu [1], and Rong-Wei Gong [1]

[1] Inst. of Microelectronics, Dept. of Electrical Engineering, Advanced Optoelectronic Technology Center, and Center for Micro/Nano Science and Technology, Nat'l Cheng Kung Univ., Tainan, Taiwan, [2] National Nano Device Laboratories, Tainan, Taiwan

M-section phase-shifted long-period grating (LPG) on $LiNbO_3$ is fabricated using a two-step proton exchange. The result shows (M-2) sidelobes are situated between the two dominant rejection bands which are increasingly separated with respect to M.

WL3-3 15:00 - 15:15

Proposal of Waveguide Interferometer for In-Line Wavelength-Selective Modulator

Tetsunosuke Miura [1], Ryotaro Mori [1], Kenji Kintaka [2], Kenzo Nishio [1], Yasuhiro Awatsuji [1], and Shogo Ura [1]

[1] Dept. of Electronics, Kyoto Inst. of Technology, Kyoto, Japan, [2] Nat'l Inst. of Advanced Industrial Science and Technology, Osaka, Japan

Simple integrated-photonic device capable of wavelength-selective optical modulation in a single straight waveguide is proposed and discussed. An interferometer is formed by three distributed Bragg reflectors. Construction of the interferometer was experimentally confirmed.

WL3-4 15:15 - 15:30

Reflection Characteristics of Cavity-resonator-integrated Guided-mode Resonance Mirror

Junichi Inoue [1], Tomonori Ogura [1], Tomohiro Kondo [1], Kenji Kintaka [2], Kenzo Nishio [1], Yasuhiro Awatsuji [1], and Shogo Ura [1]

[1] Kyoto Inst. of Technology, Kyoto, Japan, [2] Nat'l Inst. of Advanced Industrial Science and Technology, Osaka, Japan

A surface grating integrated in a channel waveguide on a high-reflection layer is discussed to provide a mirror having a large dependence of a reflection phase variation on wavelength.

WL3-5 15:30 - 16:00 Invited

High-Density Optical Multi-Chip Module on Waveguide-Integrated Carrier

Shigeru Nakagawa

IBM Research - Tokyo NANOBIC, Kanagawa, JAPAN

Optical multi-chip module enables the integration of high-bandwidth density optical I/Os with high-performance CMOS IC for next-generation high-performance computers by mounting optical and electrical chips directly on waveguide-integrated carrier.

Room 104A 1F

[WC3] 14:30 - 16:00
Terahertz QCLs & Frequency - Comb based Techniques

Session Chair: Junichiro Kono (Rice Univ., USA)

WC3-1 14:30 - 15:00 Invited

High-Power Terahertz Pulse Generation and Application to Nonlinear Spectroscopy

Koichiro Tanaka

Inst. for Integrated Cell-Material Sciences (iCeMS-WPI, and Dept. of Physics, Kyoto Univ. CREST, Japan Science and Technology Agency, Saitama, Japan

We have recently developed novel generation methods of intense terahertz single cycle pulses with the maximum electric field larger than 1 MV/cm, which enables us to perform nonlinear terahertz spectroscopy in solids.

WC3-2 15:00 - 15:15

Near-infrared Pulse Induced Modulation of Quantum Cascade Lasers

Y. Saksaegawa [1], S. Saito [1], N. Sekine [1], M. Ashida [2], and I. Hosako [1]

[1] Nat'l Inst. for Information and Communications Technology, Tokyo, Japan, [2] Graduate School of Engineering Science/ Osaka Univ., Osaka, Japan

We have demonstrated amplitude modulation of terahertz quantum cascade lasers by means of the injection of near-infrared laser pulses. Injected 818nm and 1350nm laser pulses had greatly suppressed the output power.

WC3-3 15:15 - 15:30

Operation Temperature and T_0 Improvement of GaAs/AlGaAs THz QCL by Utilizing Higher Al Composition Barriers

T.-T. Lin and H. Hirayama

Terahertz Quantum Device Laboratory, RIKEN, Sendai, Japan

The current earnest issue of THz QCLs is their limited Tmax near 200K. Here we propose the process of operation temperature performance improvement by utilizing high Al composition in AlGaAs THz QCLs.

WC3-4 15:30 - 15:45

Theoretical Study on Isotope-Selective Excitation of Diatomic Molecules by A Terahertz Frequency Comb

Akira Ichihara [1], Leo Matsuoka [1], Yuzuru Kurosaki [2], and Keiichi Yokoyama [1]

[1] Quantum beam Science Directorate, Japan Atomic Energy Agency, Kyoto, Japan, [2] Quantum beam Science Directorate, Japan Atomic Energy Agency, Ibaraki, Japan

Computer simulations were performed for studying isotope-selective excitation of lithium chloride using a terahertz frequency comb. The $^7Li^{35}Cl$ molecules could be excited selectively in gaseous mixture of $^7Li^{35}Cl$ and $^7Li^{37}Cl$ by adjusting pulse parameters.

WC3-5 15:45 - 16:00

Frequency-Locked Optical Two-Tone THz Signal Generation with Optical Frequency Comb and Injection-Locked Laser

Atsushi Kanno and Tetsuya Kawanishi

Nat'l Inst. of Information and Communications Technology, Tokyo, Japan

We propose an optical two-tone signal generation using an injection locking technique applied to an optical frequency comb source. An improved optical signal-to-noise ratio of greater than 10 dB is achieved.

Room 104B 1F

[WJ3] 14:30 - 16:00
Molecular Imaging and Manipulation

Session Chair: Eiji Okada (Keio Univ., Japan)

WJ3-1 14:30 - 15:00 Invited

Intravital Imaging of Ischemia and Reperfusion

Ian Liau

Dept. of Applied Chemistry and Inst. of Molecular Science, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

Timely evaluation of ischemia-reperfusion (IR) is important in elucidating the pathogenic mechanism underlying IR injury. We report the application of intravital microscopy to visualize ischemia and reperfusion of rat liver in real time *in vivo*.

WJ3-2 15:00 - 15:15

Visualization of Microvessels and Capillary Bed Associated with Brain Activation

Takahiro Kikuchi [1], Masashi Kusano [1], Hiroyuki Takuwa [2], Hiroshi Kawaguchi [2], Kazuto Masamoto [2,3], Iwao Kanno [2], Hiroshi Ito [2] and Eiji Okada [1]

[1] Dept. of Electronics and Electrical Engineering, Keio Univ., Yokohama, Japan, [2] Molecular Imaging Center, Nat'l Inst. of Radiological Science, Chiba, Japan, [3] Center for Frontier Science and Engineering, Univ. of Electro-Communications, Tokyo, Japan

Blood flow in the exposed brain of mice caused by whisker stimulations was measured by laser speckle flowgraphy. The microvessels and capillary bed associated with the brain activation were visualized.

WJ3-3 15:15 - 15:30

Femtosecond Laser-Assisted Estimation of Time Evolution of Cell-Cell Adhesion Force Between Neurite and Mast Cell

Takanori Iino [1], Man Hagiyama [2], Tadahide Furuno [3], Akihiko Ito [2], and Yoichiroh Hosokawa [1]

[1] Nara Inst. of Science and Technology, Nara, Japan, [2] Kinki Univ., Osaka, Japan, [3] Aichi-Gakuin Univ., Aichi, Japan

An impulse generated by focusing femtosecond laser under microscope was applied to investigation of time evolution of cell-cell adhesion force. From the result, we could discuss the sequential adhesion process with individual difference of cells.

WJ3-4 15:30 - 15:45

Time-Shared Multiple Optical Traps Using a Pulsed Laser Diode

Takamasa Suzuki [1], Hiroyuki Takayama [1], Osami Sasaki [2], and Samuel Choi [2]

[1] Niigata Univ., Graduate School of Science and Technology, Niigata, Japan, [2] Niigata Univ., Faculty of Engineering, Niigata, Japan

Multiple traps using a combination of a piezoelectric bimorph-type actuator and a pulsed laser diode are demonstrated. Three polystyrene beads were simultaneously trapped using a laser diode driven by a pulsed current.

WJ3-5 15:45 - 16:00

Laser Manipulation of Intracellular Molecular Dynamics in Hippocampal Neurons

C. Hosokawa [1,2], Y. Ueda [1,2], N. Takeda [1,2], S. N. Kudoh [2], and T. Taguchi [1]

[1] Health Research Inst., Nat'l Institute of Advanced Industrial Science and Technology, Osaka, Japan, [2] Graduate School of Science and Technology, Kwansei Gakuin Univ., Hyogo, Japan

We demonstrated laser manipulation of intracellular molecular dynamics in neurons to realize artificial control toward modulating synaptic transmission in a neuronal network.

Room C-1 1F

[WR4] 16:30 - 18:30
Nonlinear Compensation
Session Chair: Toshihiko Hirooka (Reserch Inst. of Electrical Communication, Tohoku Univ., Japan)

WR4-1 16:30 - 17:00 Upgrade Invited

Impact of Perturbation Back-propagation on Carrier Phase Recovery in 224 Gb/s DP-16QAM Transmission

Shoichiro Oda [1], Takeshi Hoshida [1], Hisao Nakashima [1], Yasuhiko Aoki [2], Zhenning Tao [3], Jens C. Rasmussen [2]
[1] Fujitsu Limited, [2] Fujitsu Laboratories Ltd., Kawasaki, Japan [3] Fujitsu R&D Center, Beijing, China

We experimentally investigate the impact of nonlinearity on cycle slip probability and demonstrate its reduction by perturbation back-propagation algorithm in 224 Gb/s DP-16QAM transmission with 50 and 37.5 GHz-grid over large-A_{eff} pure silica core fiber.

WR4-2 17:00 - 17:15

Complexity Reduction of Perturbation Pre-distortion by Term Combination

Zhenning Tao [1], Liang Dou [1], Takeshi Hoshida [2], and Jens C. Rasmussen [3]
[1] Fujitsu R&D Center, Beijing, China, [2] Fujitsu Limited, Kawasaki, Japan, [3] Fujitsu Laboratories Ltd., Kawasaki, Japan

By combining the similar perturbation terms, the complexity of perturbation pre-distortion is reduced significantly. The number of terms could be reduced from 9756 to 25, whereas the Q degradation is less than 0.1 dB.

WR4-3 17:15 - 17:30

Analytical OSNR Formulation Considering Nonlinear Compensation

Y. Yamamoto [1], M. Hirano [1], V.A.J.M. Sleiffer [2], and T. Sasaki [1]
[1] Sumitomo Electric Industries, Ltd., Yokohama, Japan, [2] COBRA Inst., Eindhoven Univ. of Technology, The Netherlands

We develop the analytical OSNR formulation to predict Q-factor improvement with nonlinear compensation. Fiber with Aeff of around 130 μm^2 is found to be optimum for transpacific submarine digital coherent systems upgraded with nonlinear compensation.

WR4-4 17:30 - 17:45

Demonstration of Four-wave-mixing induced Crosstalk Cancellation in 10-Gbit/s Phase Locked Multi-carrier Transmission

Akira Mizutori, Masamichi Sugamoto, and Masafumi Koga
Oita Univ., Oita, Japan

This paper demonstrated four-wave mixing induced crosstalk cancellation in 10Gbit/s OOK signal phase locked multi-carrier transmission. Successful transmission over dispersion-shifted fiber was achieved within 1dB power penalty even though the crosstalk was -15dB.

WR4-5 17:45 - 18:00

Marked Reduction of Depolarization-Induced Crosstalk in Ultrahigh-Speed Pol-MUX Transmission with an Optical Nyquist Pulse

Koudai Harako, Toshihiko Hirooka, and Masataka Nakazawa
Research Inst. of Electrical Communication, Tohoku Univ., Miyagi, Japan

We present an analytical and experimental demonstration of the depolarization-induced crosstalk of polarization-multiplexed ultrahigh-speed optical Nyquist pulses. A greatly improved PMD tolerance is demonstrated as compared with a Gaussian pulse.

WR4-6 18:00 - 18:15

Improving nonlinear degradation by combining optical and digital compensation techniques

Kohki Shibahara [1], Yohei Sakamaki [2], Takeshi Kawai [1], Kunihiko Mori [1], Hiroki Kishikawa [1], and Mitsunori Fukutoku [1]
[1] NTT Network Innovation Laboratories, NTT Corporation, Kanagawa, Japan [2] NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

We investigate the combined effect of optical and digital compensation techniques for nonlinear degradation by numerical simulation. Q-factor improvement by digital compensation increases when nonlinearity is optically suppressed in a dispersion-managed system.

WR4-7 18:15 - 18:30

Fiber Nonlinearity Compensation for Dispersion Unmanaged PDM 8-QAM CO-OFDM using Expectation Maximization

Yingkan Chen [1], Christian Ruprecht [2], Werner Rosenkranz [2] and Norbert Hanik [1]
[1] Inst. of Communication Engineering, Technische Universität München, Munich, Germany, [2] Chair for Communications, Christian-Albrechts-Universität, Kiel, Germany

Fiber nonlinearity compensation via expectation maximization is investigated for PDM CO-OFDM. An improvement in Q-factor of 0.33 dB is observed for 1400-km 100 Gb/s single channel and 1.44 dB for 1000-km 700 Gb/s WDM transmission.

Room C-2 1F

[WI4] 16:30 - 18:15
Plasmonics II
Session Chair: Val Zwiller (TU Delft, The Netherlands)

WI4-1 16:30 - 17:00 Invited

All-Color Plasmonic Nanolasers with Ultralow Thresholds

Yu-Jung Lu [1], Jisun Kim [2], Hung-Ying Chen [1], Wen-Hao Chang [3], Chih-Kang Shih [2], and Shangjr Gwo [1]
[1] Dept. of Physics, Nat'l Tsing-Hua Univ., Hsinchu, Taiwan, [2] Dept. of Physics, The Univ. of Texas at Austin, Texas, U.S.A., [3] Dept. of Electrophysics, National Chiao-Tung Univ., Hsinchu, Taiwan

Diffraction-unlimited all-color semiconductor nanolasers are demonstrated by using single shape-controlled InGaN/GaN core-shell nanorods as laser gain media on epitaxially grown Ag epitaxial layers.

WI4-2 17:00 - 17:15

Electrically Pumped Metallo-Dielectric Pedestal Nanolasers

Qing Gu [1], Brett Wingad [1], Felipe Vallini [2], Boris Slutsky [1], Michael Katz [1], Maziar P. Nezhad [1], Newton C. Frateschi [2] and Yeshaiahu Fainman [1]
[1] Dept. of Electrical and Computer Engineering, Univ. of California at San Diego, La Jolla, USA, [2] Dept. of Applied Physics, "Gleb Wataghin" Physics Inst., Univ. of Campinas - UNICAMP, Campinas, Brazil

Electrically pumped metallo-dielectric nanolasers are demonstrated. Employing a two-step InP chemical etching, we obtain straight pedestal sidewalls and preferentially reduce the diameter of the n-doped InP cladding more than the p-doped one for optimized performance.

WI4-3 17:15 - 17:30

Fabrication and Application of a Horizontal Plasmonic Air-Slot Ring Resonator

Jaehak Lee, Jung H Shin
Dept. of Physics at KAIST Room 2317, Daejeon, Korea

We report on an MIM-type plasmonic resonator with a 50-nm slot. The gap was defined using self-aligned deposition using conventional photolithography. The structure shows great promise for a biosensor, with tentatively 3.7 nm/nm surface sensitivity.

WI4-4 17:30 - 17:45

Active Plasmon Devices

Kenzo Yamaguchi [1], Masamitsu Fujii [2], Toshihiro Okamoto [3] and Masanobu Haraguchi [3]
[1] Kagawa Univ., Kagawa, Japan, [2] Toba Nat'l College of Maritime Technology, Mie, Japan, [3] The Univ. of Tokushima, Tokushima, Japan

We have developed an electrically controlled active plasmon device that consists of a metallic subwavelength grating modulated by a NEMS actuator. The device shifts the plasmon resonance wavelength, and the effect is explained by calculation.

WI4-5 17:45 - 18:00

Plasmonic Periodic Slits Enhanced Schottky Diodes

Long Xiao, Fang Liu, Yunxiang Li, and Yidong Huang
Dept. of Electronic Engineering, Tsinghua Nat'l Laboratory for Information Science and Technology, Tsinghua Univ., Beijing, China

A plasmonic enhanced schottky diode is proposed and investigated with metallic periodic slits. A narrow-band response (~40nm) could be tuned in a wide spectrum (800~1800nm) by varying the period of the slits.

WI4-6 18:00 - 18:15

Plasmonic Properties and Biosensing of Gold Elliptical Nanoring Arrays

Chia-Yang Tsai, Kai-Hao Chang, Che-Yao Wu, and Po-Tsung Lee
Dept. of Photonics & Inst. of Electro-Optical Engineering, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

We investigate the optical properties and biosensing of gold elliptical nanoring (ENR) arrays with various aspect ratios. Gold ENRs with 1.58 high aspect ratio show a total wavelength shift of 35 nm for molecule sensing.

Room F 1F

[WA4] 16:30 - 18:30
Passively Mode-Locked and Q-switched Lasers
Session Chair: Peter Wessels (Laser Zentrum Hannover e. V., Germany)

WA4-1 16:30 - 17:00 Invited

Low-dimensional Carbon Nanostructure-Based Saturable Absorbers for Ultrashort Pulse Lasers

Fabian Rotermund
Dept. of Physics & Division of Energy Systems Research, Ajou Univ., Suwon, Korea

Saturable absorbers based on low-dimensional carbon nanostructures have been successfully applied for mode-locking ultrafast lasers in a broad spectral range. Recent progress on mode-locked solid-state lasers employing these novel mode-locking devices will be presented.

WA4-2 17:00 - 17:15

Q-switched Mode-locking of an Erbium-Doped Fiber Laser Incorporating a Graphene Oxide-Deposited D-shaped Fiber

Junsu Lee [1], Joonhoi Koo [1], Pulak Debnath [2,3], Yong-Won Song [2], and Ju Han Lee [1]
[1] School of Electrical and Computer Engineering, Univ. of Seoul, Seoul, Republic of Korea, [2] Future Convergence Research Division, Korea Inst. of Science and Technology, Seoul, Republic of Korea, [3] Dept. of Nano-Electronics, Univ. of Science and Technology, Daejeon, Republic of Korea

We experimentally demonstrate a passively Q-switched, mode-locked fiber laser incorporating a graphene oxide (GO)-deposited side-polished D-shaped fiber.

WA4-3 17:15 - 17:30

In-Plane Saturable Absorption of Graphene on Silicon Waveguides

Zerui Shi, Chi Yan Wong, Zhenzhou Cheng, Ke Xu and Hon Ki Tsang
Dept. of Electronic Engineering, The Chinese Univ. of Hong Kong, Hong Kong

Using ultrafast pulses, in-plane saturable absorption in monolayer graphene placed on silicon waveguides is studied. A saturation response is observed at 15.8 pJ pulse energy and absorption decreases by 14.3% at 1.9 nJ pulse energy.

WA4-4 17:30 - 17:45

Mode-locking Using Right-angle Waveguide, Based Nanotube Saturable Absorber

G. Brown[1], R.R. Thomson[1], S.J. Beecher[1], R. Mary[1], D. Popa[2], Z. Sun[2], F. Torrisi[2], T. Hasan[2], S. Milana[2], F. Bonaccorso[2], A.C. Ferrari[2] and A.K. Kar[1]
[1] Inst. of Photonics and Quantum Sciences, Heriot-Watt Univ., Edinburgh, United Kingdom, [2] Cambridge Graphene Centre, Univ. of Cambridge, Cambridge, United Kingdom

We report passive mode-locking of an Er-doped fiber laser using carbon nanotubes deposited on the facet of a right-angle optical waveguide.

WA4-5 17:45 - 18:00

Passive Mode-locking of a Monolithic Waveguide Laser with Simultaneous Q-Switching

R. Mary [1], G. Brown [1], S. J. Beecher [1], S. Ohara [2], A. K. Kar [1]
[1] Inst. of Photonics and Quantum Sciences, School of Engineering and Physical Sciences, Heriot Watt Univ., Edinburgh, UK., [2] Asahi Glass Co., Ltd. Research Center, Kanagawa, Japan.

A compact waveguide laser in ytterbium doped bismuthate glass is demonstrated. Mode-locked pulses of 1.55 GHz pulse repetition rate are obtained within a Q-switched pulse envelope that follows at a repetition rate of 450 kHz.

WA4-6 18:00 - 18:15

Sub-Nanosecond Timing Jitter in a Passively Qswitched Microlaser by Active Q-Switched Laser Bleaching

Han-Sung Chan [1], Shao-Yu Wang [1], Shou-Tai Lin [3] and A. H. Kung [2,1]
[1] Inst. of Atomic and Molecular Sciences, Academia Sinica, Taipei, Taiwan, [2] Inst. of Photonics Technologies, Nat'l Tsing Hua Univ., Hsinchu, Taiwan, [3] Dept. of Photonics, Feng Chia Univ., Taichung, Taiwan

We report a diode-pumped, single frequency, low timing jitter passively Q-switched Nd:YAG/Cr^{4+}:YAG microlaser. 245 micro joules, sub-nanosecond pulses within 632 picosecond pulse-to-pulse timing jitter by optical bleaching using an actively Q-switched pulsed laser.

WA4-7 18:15 - 18:30

Wavelength Tuning of a Semiconductor-Based Mode-Locked Laser with a High Finesse Fabry-Perot Etalon

D. S. Seo [1], D. E. Leaird [2], and A. M. Weiner [2]
[1] Dept. of Electronics, MyongJi Univ., Kyonggi, Korea, [2] School of Electrical & Computer Engineering, Purdue Univ., W. Lafayette, USA

We report ~7 nm wavelength tuning of more than 200 comb lines spaced 10 GHz, which are obtained from a semiconductor-based mode-locked laser with an intra-cavity high finesse Fabry-Perot etalon.

Room G 1F

[WB4] 16:30 - 18:30
Ultrafast II

Session Chair: Satoshi Ashihara (Tokyo Univ. of Agriculture and Technology, Japan)

WB4-1 16:30 - 17:00 Invited

Producing octave-wide combs and few-cycle pulses in the mid-IR: frequency divide-and-conquer approach

Konstantin Vodopyanov

CREOL, College of Optics and Photonics, Univ. of Central Florida, FL, USA

More than one-octave-wide frequency combs are produced in the mid-infrared region of 2-6 microns via subharmonic optical parametric oscillation using ultrafast fiber lasers as a pump source. In time domain, sub-5-cycle mid-IR pulses were achieved.

WB4-2 17:00 - 17:15

Generation of High-Quality Supercontinuum Using Ultrashort Pulse Fiber Laser System with Carbon Nanotube

Atsushi Okamura[1], Youichi Sakakibara[2,3], Emiko Omoda[2], Hiromichi Kataura[2,3], Norihiko Nishizawa[1]

[1] Dept. of Electrical Engineering and Computer Science, Nagoya Univ., Nagoya, Japan, [2] Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, [3] Japan Science and Technology Agency (JST), CREST, Saitama, Japan

Widely broadened high-quality supercontinuum is generated using high power soliton from ultrashort pulse fiber laser system with carbon nanotube. Temporal distribution of generated SC was directly observed using cross-correlated frequency resolved optical gating technique.

WB4-3 17:15 - 17:30

Programmable Ultrashort Optical-vortex Pulse Generation Using Optical Parametric Amplification and 4-*f* Configuration

Keisaku Yamane, Asami Honda, Kyohhei Shigematsu, Yasunori Toda, and Ryuji Morita

Dept. of Applied Physics, Hokkaido Univ., and JST, CREST, Sapporo, Japan

We demonstrate the optical parametric amplification of optical-vortex pulses with the programmable topological-charge control. Combination of optical-parametric amplification and 4-*f* configuration overcomes the low-throughput drawback of the vortex converter, simultaneously compensating for the angular dispersion.

WB4-4 17:30 - 17:45

Nonlinear Coupling Between Radially- And Azimuthally-Polarized Modes of Ultrashort Optical Pulses in an Anisotropic Crystal

Masato Suzuki[1], Keisaku Yamane[1,2], Yasunori Toda[1,2], and Ryuji Morita[1,2]

[1] Dept. of Applied Physics, Hokkaido Univ., Sapporo, Japan, [2] JST, CREST, Sapporo, Japan

We investigate nonlinear propagation of ultrashort optical pulses with radially- and azimuthally-polarized modes in a uniaxial crystal. The energy exchange between the modes, ascribed to nonlinear four-wave-mixing effect with Gouy-phase shifts, is discussed.

WB4-5 17:45 - 18:00

Frequency-resolved Orbital Angular Momentum Spectrum Measurement of Ultra-broadband Optical Vortices

Zhili Yang[1], Keisaku Yamane[1,2], Yasunori Toda[1,2] and Ryuji Morita[1,2]

[1] Dept. of Applied Physics, Hokkaido Univ., Sapporo, Japan, [2] JST, CREST, Sapporo, Japan

We experimentally exhibit a high-precision method for measuring frequency-resolved orbital angular momentum (OAM) spectrum of femtosecond ultra-broadband optical-vortex pulses from fork-like interferograms. This method enables us to evaluate topological-charge dispersion of ultra-broadband optical-vortex pulses.

WB4-6 18:00 - 18:15

Observation of Continuously Tuning of the Phase-Difference and Separation of Bound Solitons From a Carbon-Nanotube Mode-Locked Fiber Laser

Zheng Gong, Xin Zhao, Qi Wang, Jiansheng Liu and Zheng Zheng

School of Electronic and Information Engineering, Beihang Univ., Beijing, China

Continuously tuning of the phase-difference and separation of bound solitons have been realized from a passively mode-locked fiber laser using a carbon nanotube modelocker through intracavity gain/loss tuning.

WB4-7 18:15 - 18:30

Surface-enhanced Broad-band Real-time Vibrational Spectroscopy

J. Du[1,2], T. Kobayashi[1,2], M. Virkki[3], and M. Kauranen[3]

[1] Ultrafast Laser Research Center, Univ. of Electro-Communications, Tokyo, Japan, [2] Core Research for Evolutional Science and Technology (CREST), Japan Science and Technology Agency, Tokyo, Japan, [3] Optics Laboratory, Dept. of Physics, Tampere Univ. of Technology, Tampere, Finland

Using the ultrafast excitation, surface enhancement effect on the dynamics of vibrational modes coupled to the electronic transition of the lowest excited state of MEH-PPV has been studied in MEH-PPV-functionalized nanoantennas for the first time.

Room H 1F

[WF4] 16:30 - 18:30
Holographic Metrology

Session Chair: Yasuyuki Ozeki (The Univ. of Tokyo, Japan)

WF4-1 16:30 - 17:00 Invited

High-Speed Holographic 3D Sensing for Fast Phenomena by Parallel Phase-Shifting Interferometry

Takashi Kakue[1] and Yasuhiro Awatsuji[2]

[1] Graduate School of Engineering, Chiba Univ., Chiba, Japan, [2] Graduate School of Science and Technology, Kyoto Inst. of Technology, Kyoto, Japan

Thanks to parallel phase-shifting digital holography using a high-speed camera, we succeeded in phase-shifting interferometry at the rate of up to 262,500 frames/s. Motion pictures of three-dimensional images of fast phenomena are demonstrated.

WF4-2 17:00 - 17:15

High-Speed Multi-Color Three-Dimensional Motion Picture Recording by Multi-Wavelength Parallel Phase-Shifting Digital Holography

Yasunori Ito[1], Tatsuki Tahara[1], Yonghee Lee[1], Peng Xia[1], Yasuhiro Awatsuji[1], Kenzo Nishio[2], and Shogo Ura[1]

[1] Graduate School of Science and Technology, Kyoto Inst. of Technology, Kyoto, Japan, [2] Advanced Technology Center, Kyoto Institute of Technology, Kyoto, Japan

We succeeded in recording multi-color and 3D motion picture of moving objects by parallel phase-shifting digital holography that simultaneously used 473nm and 532nm wavelength light beams. 3D motion picture was obtained at 20,000 fps.

WF4-3 17:15 - 17:30

Simultaneous Acquisition of 3D Shape and Multi-Spectral Image Based on Parallel Phase-Shifting Dual-Illumination Phase Unwrapping

Tatsuki Tahara[1], Yasuhiro Awatsuji[1], Peng Xia[1], Kenzo Nishio[1], Shogo Ura[1], Toshihiro Kubota[2], and Osamu Matoba[3]

[1] Kyoto Inst. of Technology, Kyoto, Japan, [2] Kubota Holography Laboratory, Kyoto, Japan, [3] Kobe Univ., Kobe, Japan

We propose an interferometric method for recording three-dimensional (3D) shape and multi-spectral image of objects simultaneously. The method is based on parallel phase-shifting dual-illumination phase unwrapping. The effectiveness of the proposed method was numerically verified.

WF4-4 17:30 - 17:45

Holographic-Diversity Interferometry for Reference-Free Phase Detection

Tomohiro Maeda[1], Atsushi Okamoto[1], Akihisa Tomita[1], Yuki Hirasaki[1], Yuta Wakayama[1], and Masatoshi Bunsen[2]

[1] Graduate School of Information Science and Technology, Hokkaido Univ., Sapporo, Japan, [2] Dept. of Electronics Engineering and Computer Science, Fukuoka Univ., Fukuoka, Japan

Reference-free phase detection is demonstrated using advanced holographic diversity interferometry in which a virtual light source is locally produced from an object light passed through testing samples to simultaneously generate two phase-shifted interferograms.

WF4-5 17:45 - 18:00

Method for Extending the Space Bandwidth in Parallel Phase-Shifting Digital Holography Using a Commercially Available Polarization-Imaging Camera

Tatsuki Tahara[1], Yasunori Ito[1], Peng Xia[1], Yasuhiro Awatsuji[1], Kenzo Nishio[1], Shogo Ura[1], Toshihiro Kubota[2], and Osamu Matoba[3]

[1] Kyoto Inst. of Technology, Kyoto, Japan, [2] Kubota Holography Laboratory, Kyoto, Japan, [3] Kobe Univ., Kobe, Japan

We propose a method for extending the space bandwidth in parallel phase-shifting digital holography using a commercially available polarization-imaging camera. The effectiveness of the proposed method was numerically and quantitatively verified.

WF4-6 18:00 - 18:15

Scattering Light From Several-ten Nanometer Defects of an Optical Diffractive Element

Manabu Hakko[1,2], Tomohiro Kiire[1], Daisuke Barada[1], Toyohiko Yatagai[1] and Yoshio Hayasaki[1]

[1] Center for Optical Research and Education (CORE), Utsunomiya Univ., Utsunomiya, Japan, [2] Optics Technology Development Center, Corporate R&D Headquarters, Canon Inc., Utsunomiya, Japan

Scattering light from several-ten nanometer defects of an optical diffractive element was investigated with a scatterometer. We firstly demonstrated an agreement between the measurements and computer simulations over 107 dynamic range.

WF4-7 18:15 - 18:30

High-frame-rate Wavefront Sensor Based on Flexible Read-Out Technique for C-MOS Image Sensor

Jiro Suzuki, Toshiyuki Ando, and Takao Endo

Information Technology R & D Center, Mitsubishi Electric Corporation, Kanagawa, Japan

High-frame-rate Shack Hartmann wavefront sensor with a C-MOS image sensor adopted the flexible read out technique.

Room I 2F

[WP4] 16:30 - 18:30 Symposium
Recent R&D Activities of Telecommunication Technologies for Resilient and Sustainable Society

Session Chairs: Katsumi Iwatsuki (Tohoku Univ., Japan) Junichi Kani (NTT, Japan)

WP4-1 16:30 - 17:00 Invited

Overview of Global FTTH Market and State-of-the-art Technologies

Shoichi Hanatani

Hitachi Ltd., Telecommunications & Network Systems Division, Kanagawa,Japan

This paper reviews global FTTH market trend last 10 years and finds Asia-Pacific (APAC) region has been a market leader, analyzing its market driving factors. FTTH technology trend is discussed, reviewing its deployment.

WP4-2 17:00 - 17:30 Invited

Towards Energy Efficient Wireline Networks, an Update from GreenTouch

P. Vetter[1], T. Ayhan[2], K. Kanonakis[3], B. Lannoo[4], K.L. Lee[5], L. Lefevre[6], C. Monney[7], F. Saliou[8], X. Yin[9]

[1] Bell Labs, Alcatel-Lucent, NJ, USA, [2] Stanford Univ., CA, USA, [3] AIT, Athens, Greece, [4] Ghent Univ. -IBBT, Ghent, Belgium, [5] CEET, Melbourne, Australia, [6] Inria, Lyon, France, [7] Swisscom, Bern, Switzerland, [8] Orange Lab, Lannion, France, [9] IMEC, Ghent, Belgium

The paper shows how a combination of different innovations can improve the power consumption per subscriber of a wireline access and aggregation network by 50x and the energy efficiency per transferred bit by 400x.

WP4-3 17:30 - 18:00 Invited

Optical Access Technologies for Rapidly Expanding Mobile Data Traffic Accommodation

Kosuke Nishimura, Akira Agata, and Shinobu Nanba

KDDI R&D Laboratories Inc., Saitama, Japan

To handle rapidly growing mobile data traffic, new BTS architecture called "C-RAN" is being introduced. In this paper, several technologies that are required for optical access line in C-RAN architecture are overviewed.

WP4-4 18:00 - 18:30 Invited

Elastic Lambda Aggregation Network (EλAN) -Proposal for Future Optical Access Network-

Shunji Kimura

NTT Access Network Service Systems Laboratories, NTT Corporation, Kanagawa, Japan

This paper proposes a future optical-access-network concept called the elastic lambda aggregation network. This network will form a common base for providing multiple access services such as residential, business, machine-to-machine, and mobile services.

Room J 2F

[WS4] 16:30 - 18:30
Fiber Nonlinearity

Session Chair: Radan Slavik (Optoelectronics Research Centre, Univ. of Southampton, United Kingdom)

WS4-1 16:30 - 16:45

Distributed In-line Mitigation of Optical Kerr Effects for 100GbE Transmission Systems

Rameez Asif, Adeel Akram and Ghulam Shabbir

Telecommunication Engineering Dept., Univ. of Engineering and Technology, Taxila, Pakistan

We report on the implementation of distributed in-line optical non-linear compensation (DIONL) modules in 112Gbit/s DP-QPSK coherent transmission. The impact of DIONL and DBP on the digital post-processing of optical Kerr effects is quantified.

WS4-2 16:45 - 17:00

Fiber Nonlinear Coefficient Measurement Based on Phase Mismatching FWM

G. Huang [1], Y. Yamamoto [2], M. Hirano [2], A. Maruta [1], T. Sasaki [2], and K. Kitayama [1]

[1] Graduate School of Engineering, Osaka Univ., Osaka, Japan, [2] Sumitomo Electric Industries, Ltd., Yokohama, Japan

Novel method for measuring nonlinear coefficient in optical fibers based on phase mismatching four-wave-mixing is proposed. With simple setup, we demonstrate measurements for both high nonlinearity dispersion-shifted fiber and low nonlinearity standard SMF.

WS4-3 17:00 - 17:15

Generation of 100 GHz bound-pulses in an asynchronous mode-locked Er-fiber laser with 10 GHz phase modulation

S.-S. Jyu, and Y. Lai

Dept. of Photonics and Inst. of Electro-Optical Engineering, Nat'l Chiao Tung Univ., Hsinchu, Taiwan, R.O.C

We experimentally demonstrate 100 GHz bound-pulse generation in an asynchronous mode-locked Er-fiber laser with 10 GHz phase modulation. The asynchronous mode-locking mechanism works well in the high repetition frequency for helping achieve stable laser operation.

WS4-4 17:15 - 17:30

Wavelength-Tunable Red-Shift Cherenkov Radiation in Photonic Crystal Fibers for Mid-Infrared Wavelength Generation

Lei Zhang, Sigang Yang, Hongwei Chen, Minghua Chen, and Shizhong Xie

Tsinghua Nat'l Laboratory for Information Science and Technology (TNList) Dept. of Electronic Engineering, Tsinghua Univ., Beijing, P. R. China

Cherenkov radiations at mid-infrared region are generated in photonic crystal fibers Experimentally. The wavelength of the Cherenkov radiation can be tunable from 1986-2279 nm, with the average input pump power increasing from 70-320 mW.

WS4-5 17:30 - 17:45

Suppression of fiber fuse propagation and its break in compact fiber fuse terminator

Kenji Kurokawa and Nobutomo Hanzawa

NTT Access Network Service Systems Laboratories, NTT Corporation, Ibaraki, Japan

We confirmed fiber fuse termination using a fiber fuse terminator consisting of a 1.4 mm-long HAF at a 22W input. We observed a break in fiber fuse suppression when the HAF was 0.4 mm long.

WS4-6 17:45 - 18:00

Detection and Termination System for Optical Fiber Fuse

Takahiro KINOSHITA [1], Norihiko SATO [2] and Makoto YAMADA [1]

[1] Osaka Prefecture Univ., Osaka, Japan, [2] Trimatiz Limited, Chiba, Japan

We propose a novel system that precisely detects and unfailingly stops a propagating optical fiber fuse (FF).

WS4-7 18:00 - 18:30 Invited

All-Optical Compensation of Fiber Nonlinearity by Phase Conjugation

Mark Pelusi

ARC Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS), IPOS, School of Physics, Univ. of Sydney, NSW, Australia.

Recent demonstrations of all-optical phase conjugation for compensating fiber nonlinear effects in long distance transmission are presented. Experimental measurements for a transmitter-based pre-compensation module in application to WDM and dual polarization-multiplexed RZ-DPSK signals are shown.

Room K 2F

[WO4] 16:30 - 18:00
Optical Signal Processing III

Session Chair: Seiji Fukushima (Kagoshima Univ., Japan)

WO4-1 16:30 - 17:00 Invited

Real-time, high fidelity conversion of ultrafast waveforms in a PPLN time-to-space processor

Dan M. Marom [1], Dror Shayovitz [1], Harald Herrmann [2], Wolfgang Sohler [2], Raimund Ricken [2] and Christine Silberhorn [2]

[1] Dept. of Applied Physics, Hebrew Univ. of Jerusalem, Jerusalem, Israel, [2] Dept. of Applied Physics, The Univ. of Paderborn, Paderborn, Germany

We demonstrate high temporal-resolution time-to-space conversion of 50ps extent ultrafast waveforms using SFG in PPLN. This technique enables serial-to-parallel demultiplexing of a Tbaud OTDM channel to multiple spatially parallel Gbaud tributaries, compatible with optoelectronic detection.

WO4-2 17:00 - 17:15

Correlation Matching Method for Optical Vortex Detection Using Shack-Hartmann Wavefront Sensor

H. Huang [1], C. Huang [2], H. Toyoda [1], and T. Inoue [1]

[1] Central Research Laboratory, Hamamatsu Photonics K. K., Shizuoka, Japan, [2] State Key Laboratory of Modern Optical Instrumentation, Zhejiang Univ., Zhejiang, China

We report a correlation matching algorithm for position detection of optical vortices using a Shack-Hartmann wavefront sensor. The accuracy experientially confirmed was 0.056, in units of lens-size of lenslet array used in the wavefront sensor.

WO4-3 17:15 - 17:30

Fabrication of MgO:$LiNbO_3$ Domain Inverted Structures with Short Period and Application to Electro-Optic Bragg Deflection Modulator

Toshiyuki Inoue, and Toshiaki Suhara

Graduate School of Engineering, Osaka Univ., Suita, Japan

We fabricated high-quality domain-inverted MgO:$LiNbO_3$ with short period. Keeping the crystal temperature at 150°C for 12 hours before applying voltage was effective for obtaining good uniformity. We demonstrated application to electro-optic Bragg deflection modulator.

WO4-4 17:30 - 17:45

Fourier transform optically controlled phased array antenna

Tomohiro Akiyama, Toshiyuki Ando and Yoshihito Hirano

Mitsubishi Electric Corporation, Kanagawa, Japan

Optically controlled beam forming techniques are effective for phased array antenna control. We have developed the Fourier transform (FT) optical beamformer and demonstrated in the C-band. These results show the feasibility of the optical beamfomer.

WO4-5 17:45 - 18:00

Crosstalk Reduction of a PLZT Arrayed- Waveguide Grating by Phase Error Compensation

Hideaki Asakura [1], Keiichi Nashimoto [2,3], David Kudzuma [3], Masahiko Hashimoto [3], and Hiroyuki Tsuda [1]

[1] School of Integrated Design Engineering, Graduate School of Science and Technology, Keio Univ., Kanagawa, Japan, [2] EpiPhotonics Corp., Kanagawa, Japan, [3] EpiPhotonics Corp., CA, USA

A 100-GHz-spacing, 8-channel, PLZT arrayed-waveguide grating was fabricated. The crosstalk was effectively reduced from -7.1 dB to -14.8 dB by phase error compensation achieved by a fine adjustment of the applied voltages to the electrodes.

Room 101 1F

[WH4] 16:30 - 18:30
Novel Emitting Devices

Session Chair: Akihiko Kikuchi (Sophia Univ, Japan)

WH4-1 16:30 - 17:00 Invited

Recent Development and Progress of ZnO-based Optoelectronic Devices

Ching-Ting Lee [1] and Hsin-Ying Lee [2]

[1] Inst. of Microelectronics, Dept. of Electrical Engineering, Advanced Optoelectronic Technology Center, Nat'l Cheng Kung Univ., Tainan, Taiwan, Republic of China, [2] Dept. of Photonics, National Cheng Kung Univ., Tainan, Taiwan, Republic of China

Novel vapor cooling condensation system was designed and used to grow ZnO-based thin films for fabricating optoelectronics devices with high quality. The performances of thin films, ultraviolet light-emitting diodes, and ultraviolet photodetectors were studied.

WH4-2 17:00 - 17:15

Design Analysis of Ultra-Short Cavity Silver-Clad Semiconductor Nano-Lasers

Z. A. Sattar and K. A. Shore

Bangor Univ., School of Electronic Engineering, Wales U.K.

Wave-guiding analysis of semiconductor lasers was performed for silver thicknesses in the range 5nm-20nm for wavelengths between 330nm and 830nm. Device lengths as short as 2μm were found to support lasing at 830nm.

WH4-3 17:15 - 17:30

Photoluminescent Study of High Indium Content Nanopyramid Light Emitting Diodes

Shih-Pang Chang [1], Jet-Rung Chang [3], Kuok-Pan Sou [1], Yun-Jing Li [3], Yuh-Jen Cheng [2], Hao-Chung Kuo [1], and Chun-Yen Chang [3]

[1] Dept. of Photonics, Nat'l Chiao Tung Univ., Hsinchu, Taiwan, [2] Research Center for Applied Sciences, Academia Sinica, Taipei, Taiwan, [3] Dept. of Electronic Engineering, National Chiao Tung Univ., Hsinchu, Taiwan

The radiative and non-radiative lifetime of high In content nanopyramid GaN LEDs are investigated by time resolved and temperature dependent photoluminescent measurement. The radiative recombination efficiency is much improved compared with the conventional c-plane LED.

WH4-4 17:30 - 17:45

P-type and Undoped InGaN Across the Entire Alloy Composition Range

Ke Wang [1], T. Araki [1], K. M. Yu [2], T. Katsuki [1], M. A. Mayer [2], E. Alarcon-Llado [2], J. W. Ager III [2], W. Walukiewicz [2], Y. Nanishi [1,3]

[1] Dept. of Photonics, Ritsumeikan Univ., Shiga, Japan, [2] Materials Sciences Division, Lawrence Berkeley Nat'l Laboratory, Berkeley, California, USA, [3] WCU Hybrid Materials Program, Dept. of Materials Science and Engineering, Seoul National Univ., Korea

We report a systematic study on undoped and Mg-doped InGaN grown by molecular beam epitaxy. Various experiments have been combined to demonstrate p-type InGaN across the entire alloy composition range.

WH4-5 17:45 - 18:00

Efficiency Improvement of GaN Light Emitting Diodes on Si by Double Island Growth Method

Hsueh-Hsing Liu [1], Lung-Chieh Cheng [1], Nien-Tze Yeh [1], Chen-Zi Liao [2], and Jen-Inn Chyi [1]

[1] Dept. of Electrical Engineering, Nat'l Central Univ., Jhongli, Taiwan, R.O.C., [2] Electronics and Optoelectronics Research Laboratories, Industrial Technology Research Inst., Hsinchu, Taiwan, R.O.C.

A self-aligned double island growth method for reducing threading dislocation density in GaN epilayers grown on (111) silicon substrates. The output power and wall-plug efficiency are enhanced by about 27 % and 34.5 %.

WH4-6 18:00 - 18:15

Characterization of Boron Nitride Thin Films

M. Chubarov [1], H. Pedersen [1], H. Hogberg [1], S. Filippov [1], JAA Engelbrecht [2], J. O'Connel [2], and A. Henry [1]

[1] Dept. of Physics, Chemistry and Biology, Linköping Univ., Linköping, Sweden, [2] Nelson Mandela Metropolitan Univ., Port Elizabeth, South Africa

Rhombohedral Boron Nitride layers were grown on sapphire substrate in a hot-wall CVD reactor. The characterization of those layers is reported and the results are discussed in correlation with the various growth parameters used.

WH4-7

Withdrawn

Oral, Wednesday, July 3

Room 103 1F

[WL4] 16:30 - 18:30
Passive Waveguide Devices

Session Chair: Kenji Kintaka (National Inst. of Advanced Industrial Science and Technology, Japan)

WL4-1 16:30 - 17:00 Invited

Optical Signal Processing Using AWGs

G. Cincotti

Engineering Dept., Univ. Roma Tre, Rome, Italy

Different AWG configurations are described, to implement the discrete Fourier transform and the discrete fractional Fourier transform for all-optical OFDM systems. Phased array switches and polarization multiplexers are presented, and new schemes for optical modulators.

WL4-2 17:00 - 17:15

Narrow-Passband Filter Based on Silicon Cascaded MZIs with Enhanced FSR

Hongchen Yu, Pengxiao Li, Minghua Chen, Sigang Yang, Hongwei Chen, Shizhong Xie

Dept. of Electronic Engineering ,Tsinghua Univ., Beijing, China Tsinghua Nat'l Laboratory for Information Science and Technology (TNList)

A tunable silicon narrow-bandwidth filter based on cascaded MZIs with enhanced FSR is proposed and experimentally demonstrated. A three-stage cascaded MZIs based filter is fabricated with bandwidth and FSR of about 1.536GHz and 13.5GHz, respectively.

WL4-3 17:15 - 17:30

Selective Excitation of Microring Resonances Using a Pulley-Coupling Structure

Jingya Xie, Linjie Zhou, Xiaomeng Sun, Zhi Zou, Lianqjun Lu, Haike Zhu, Xinwan Li, and Jianping Chen

State Key Laboratory of Advanced Optical Communication Systems and Networks, Dept. of Electronic Engineering, Shanghai Jiao Tong Univ., Shanghai, P. R. China

We present a method to selectively excite resonances in microring resonators by using a pulley-coupling structure. Experimental results reveal only certain resonances are excited, due to the dispersions of coupling-coefficient and microring internal-loss.

WL4-4 17:30 - 17:45

Reduction of Wavelength Dependence of Coupling Characteristics using Si/SiO_2 Optical Waveguide Bending Directional Coupler

Hisayasu Morino, Takeo Maruyama, and Koichi Iiyama

Graduate School of Natural Science and Technology, Kanazawa Univ., Ishikawa, Japan

We theoretically investigate the approach to enhance the bandwidth of couplers. We present a Si/SiO_2 bent 2×2 coupler. Its splitting ratio has a low sensitivity to wavelength and fabrication changes.

WL4-5 17:45 - 18:00

ZrO_2-SiO_2 Based Low Loss Ultra-High Δ PLC

Masanori Takahashi, Yasuyoshi Uchida, Shintaro Yamasaki, Hiroshi Kawashima, and Kazutaka Nara

Furukawa Electric Co., Ltd., Chiba, JAPAN

A ZrO_2-SiO_2 based ultra-high delta PLC is developed. Propagation loss of the PLC employing delta of 5% is less than 0.2dB/cm and basic performance is confirmed by results of trial fabrication of MMI couplers.

WL4-6 18:00 - 18:15

Low Temperature Hot-Wire Polysilicon Waveguides

Taha M. Ben Masaud [1], Antulio Tarazona [3], Xia Chen [2], Graham Reed [2], and H. M. H Chong [1]

[1] Nano Research Group, Electronics and Computer Science, Univ. of Southampton, UK, [2] Optoelectronics Research Centre, Univ. of Southampton, UK, [3] Echerkon Technologies

We fabricated and measured low loss polysilicon waveguides deposited using Hot-Wire Chemical Vapor Deposition (HWCVD) at 240°C. The optical propagation loss was measured to be 11.9 dB/cm at λ= 1550 nm.

WL4-7 18:15 - 18:30

Sub-micron Photonics Switches: Design, Fabrication and Characterization

H. N. J. Fernando [1], R. Eisermann [2], A. Stoll [1], S. H. N. Tharanga [1], R. Haynes [1], L. Zimmermann [2] and M. M. Roth [1]

[1] innnoFSPEC-Astrophysicalysches Institut Potsdam, Potsdam, Germany, [2] IHP, Frankfurt (Oder), Germany

Several Silicon-nitride sub-micron planar waveguide architectures were designed and fabricated with 15μm access waveguide separation to enable high-integration density. The first results show 3-4 dB device excess loss and less than 1dB/cm waveguide loss.

Room 104A 1F

[WC4] 16:30 - 18:30
Terahertz Science II

Session Chair: Chiko Otani (RIKEN Center for Advanced Photonics, Japan)

WC4-1 16:30 - 17:00 Invited

Terahertz Physics and Applications with Carbon Nanomaterials

Junichiro Kono

Dept. of Electrical and Computer Engineering and Dept. of Physics and Astronomy, Rice Univ., Texas, U.S.A.

Carbon nanotubes and graphene possess unique properties ideally suited for fundamental terahertz studies and applications. Here we summarize results of our recent studies of these materials using terahertz time-domain spectroscopy and Fourier-transform infrared spectroscopy.

WC4-2 17:00 - 17:15

Observation of Terahertz Resonant Absorption in Graphene Micro-Ribbon Arrays

Takayuki Watanabe [1], Tetsuya Fukushima [1], Paul A. Russel [2], Akira Satou [1], Daniel M. Mittleman [2], Junichiro Kono [2], and Taiichi Otsuji [1]

[1] Research Inst. of Electrical Communication, Tohoku Univ., Sendai, Japan [2] Dept. of Electrical and Computer Engineering, Rice Univ., Texas, USA

We designed and fabricated an epitaxially-grown graphene micro-ribbon array with 2.8-μm ribbon width, which revealed absorption peaks in the terahertz frequency range with a fundamental frequency of ~270 GHz.

WC4-3 17:15 - 17:30

Terahertz-Wave Absorbers Using a Photonic Crystal Slab

Ryoma Kakimi, Masayuki Fujita, Masaya Nagai, Masaaki Ashida, and Tadao Nagatsuma

Graduate School of Engineering Science, Osaka Univ., Osaka, Japan

We design and fabricate a thin planar terahertz-wave absorber using a carrier-doped silicon photonic crystal slab. High absorptivity (~96%) with broadband spectrum (0.1 THz) is successfully demonstrated at 0.3 THz.

WC4-4 17:30 - 17:45

Hydrogen Gas Response of Meta-Materials Made From the Catalytic Metal

Takuya Sono, Mitsuhiro Shinomiya, Kenji Sakai, Toshihiko Kiwa, and Keiji Tsukada

Graduate School of Natural Science and Technology, Okayama Univ., Okayama, Japan

Meta-materials with a catalytic metal are fabricated on Si substrate and hydrogen gas reaction in THz transmittance was measured. The results suggest that two different catalytic mechanisms contribute change in transmittance in different frequency region.

WC4-5 17:45 - 18:00

A Three-Dimensional THz Metamaterials Using Double Split-Ring Resonators

Yu-Sheng Lin [1], Fusheng Ma [1], You Qian [1], Piotr Kropelnicki [2], Zhen Liu [1], and Chengkuo Lee [1]

*[1] Dept. of Electrical & Computer Engineering, Nat'l Univ. of Singapore, Singapore, [2] Inst. of Microelectronics, A*STAR (Agency for Science, Technology and Research), Singapore*

A new actuation mechanism for a three-dimensional metamaterials is demonstrated. This reconfigurable three-dimensional metamaterials was constructed by double split-ring resonators. The achieved tuning range is 0.5 THz, while quality factor is improved as well.

WC4-6 18:00 - 18:15

Development of MEMS Electric Split-ring Resonator Arrays as Tunable THz Filters

Fusheng Ma [1], You Qian [1], Yu-Sheng Lin [1], Hongwei Liu [2], Xinhai Zhang [2], and Chengkuo Lee [1]

*[1] Dept. of Electrical and Computer Engineering, Nat'l Univ. of Singapore, Singapore, [2] Inst. of Materials Research and Engineering, A*STAR, Singapore*

Structurally reconfigurable metamaterials showing terahertz frequency tunability are presented, which employ deformable microelectromechanical curved cantilevers for tuning the resonance frequency of the electric split-ring resonators. The observed tunability can be applied in tunable metamaterial devices.

WC4-7 18:15 - 18:30

Surface Plasmon and Exciton Coupling :Plexiton at NIR in Oxide Semiconductors.

H.Tabata, M. Seki, and H. Matsui

The Univ. of Tokyo, Tokyo, Japan

Oxide plasmonics have received much attention to their new phenomena with potential applications in infrared and near infrared (NIR) wavelength regions. Light energy conversion between surface plasmon and exciton is also discussed.

Room 104B 1F

[WJ4] 16:30 - 18:30
Bioimaging II

Session Chair: Masato Ohmi (Osaka Univ., Japan)

WJ4-1 16:30 - 17:00 Invited

Full Range, Dual Depth Optical Coherence Tomography for Ophthalmology

Beop-Min Kim [1], Hyun-Woo Jeong [1], Jeehyun Kim [2], Sang-Won Lee [3], and Wonzoo Chung [4]

[1] Dept. of Biomedical Engineering, Korea Univ., Seoul, Korea, [2] School of Electronics Engineering, Kyungbuk Nat'l Univ., Daegu, Korea, [3] Division of Convergence Technology, Korea Research Inst. of Standards and Science, Daejun, Korea, [4] Dept. of Radio Communication Engineering, Korea Univ., Seoul, Korea

We present spectral-domain optical coherence tomography (SD-OCT) using a single spectrometer with dual illumination and interlaced detection at 830 nm, which can provide anterior segment and retinal tomograms simultaneously.

WJ4-2 17:00 - 17:30 Invited

***In Vivo* Three-Dimensional Investigation of Tissue Birefringence by Jones Matrix Tomography**

Yoshiaki Yasuno [1], Myeong-Jin Ju [1], and Young-Joo Hong [1], Shuichi Makita [1], and Masahiro Miura [2]

[1] Computational Optics Group, Univ. of Tsukuba, Ibaraki, Japan, [2] Tokyo Medical Univ. Ibaraki Medical Center, Ibaraki, Japan

A principle and application of Jones matrix tomography (MT) is presented. JMT is first measures three-dimensional distribution of the Jones matrices and derives back-scattering intensity, Doppler shift, and phase retardation from the Jones matrix tomography.

WJ4-3 17:30 - 17:45

Epidermal Cell Classification Via Mirau-based Full-Field Optical Coherence Tomography

Chien-Chung Tsai[1], Ming-Yi Lin[2], Chia-Kai Chang[1], Jeng-Wei Tjiu[2], and Sheng-Lung Huang[1]

[1] Graduate Inst. of Photonics and Optoelectronics, Nat'l Taiwan Univ., Taipei, Taiwan, [2] Dept. of Dermatology, National Taiwan Univ. Hospital and College of Medicine, National Taiwan Univ., Taipei, Taiwan

Via Mirau-based full-field optical coherence tomography using Gaussian-like spectrum light source from Ce^{3+}:YAG single-clad crystal fiber, melanocytes and keratinocytes are successfully classified with their shape dissimilarity and nucleus-cytoplasm ratio from epidermal primary cell culture.

WJ4-4 17:45 - 18:00

Cancer Cells Differentiation by Multi-color ZnO and TiO_2 Nanowires

Wei-Jen Li [1], Sheng-Chieh Yang [1], Yi-Chun Shen [1], Jian-Jang Huang [1], Tsung-Lin Yang [2]

[1] Graduate Inst. of Photonics and Optoelectronics, Nat'l Taiwan Univ., Taipei, Taiwan, [2] Dept. of Otolaryngology, National Taiwan Univ. Hospital and College of Medicine, National Taiwan Univ., Taipei, Taiwan

An innovative method for cancer cells differentiation by using ZnO and TiO_2 nanowires connected to antibodies as biomarkers is reported, and quantitative analyses show a high detection sensitivity to discriminate cancer cells from normal cells.

WJ4-5 18:00 - 18:15

Photonic DNA Processors with Fluorescence Resonance Energy Transfer-Based Signaling

T. Nishimura [1], Y. Ogura [1], H. Yamamoto [2], K. Yamada [3], and J. Tanida [1]

[1] Graduate School of Information Science and Technology, Osaka Univ., Suita, Japan, [2] Inst. of Technology and Science, The Univ. of Tokushima, Tokushima, Japan, [3] Graduate School of Medicine, Osaka Univ., Suita, Japan

This paper presents an implementation method of photonic DNA processor by using fluorescence resonance energy transfer (FRET). As fundamental techniques, we demonstrate logic operation of bio-molecular inputs by FRET-based signaling and optical switching of FRET.

WJ4-6 18:15 - 18:30

Optical Measurement of Peptide Hormone Using Artificial Hormone Receptor Cell-line

Hyun Seok Song, Jae Hun Kim, Deokha Woo and Seok Lee

Sensor System Research Center, Korea Inst. of Science and Technology, Seoul, Republic of Korea.

We develop the efficient tool for the optical measurement of peptide hormone using artificial cells expressing hormone specific receptor protein stably. This study offers an efficient optical detection method for monitoring of peptide hormone.

Room C-1 1F

Room C-2 1F

[ThI1] 8:30 - 10:00
Photonic Crystal Lasers

Session Chair: Chennupati Jagadish (Austrarian National Univ., Australia)

ThI1-1 8:30 - 8:45

Over One Thousand Large-Scale Array Integration of Photonic Crystal Nanolasers

T. Watanabe, H. Abe, Y. Nishijima, and T. Baba

Dept. of Electrical & Computer Engineering, Yokohama Nat'l Univ., Yokohama, JAPAN

We developed a uniform bonding process of GaInAsP photonic crystal slab on silica glass substrate. We fabricated an array of 1089 nanolasers with a 3 μm pitch and confirmed the lasing in all devices.

ThI1-2 8:45 - 9:00

Novel physics in photonic crystal nanolasers: Dynamics and Coherence

A. Lebreton, I. Abram, G. Beaudoin, I. Sagnes, R. Braive, I. Robert-Philip and A. Beveratos

Laboratoire de Photonique et Nanostructures LPN-CNRS UPR20, Marcoussis, France

Lasers of diffraction-limited volumes involve the interaction of small numbers of particles (photons and dipoles). We demonstrate that these small populations of discrete particles induce large intensity noise in the output of the laser.

ThI1-3 9:00 - 9:15

Single Mode Operation of Edge-Emitting Semiconductor Lasers with 2D Photonic Crystal

A. Watanabe [1], T. Sugiyama [1], Y. Kurosaka [1], K. Hirose [1] and S. Noda [2]

[1] Central research laboratory, Hamamatsu Photonics K.K., Shizuoka, Japan, [2] Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

Single transverse and longitudinal mode operation of a broad gain stripe edge-emitting laser are realized with 2D photonic crystals. Despite an emitting width of 350 μm, we obtain narrow horizontal FFP and a single spectrum.

ThI1-4 9:15 - 9:30

High Power Photonic-Crystal Surface-Emitting Lasers

K. Hirose [1], Y. Kurosaka [1], A. Watanabe [1], T. Sugiyama [1], Y. Liang [2], and S. Noda [2]

[1] Material Research Group, Central Research Laboratory, Hamamatsu Photonics K.K., Hamamatsu, Japan, [2] Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

We demonstrate the highest output power of 780 mW in single photonic crystal surface emitting lasers under continuous wave operation at room temperature. We also report the beam quality M^2 = 1.1.

ThI1-5 9:30 - 9:45

Photonic Crystal Surface Emitting Lasers Based on Epitaxial Regrowth

R. J. E. Taylor[1], D.M. Williams[1], L. R. Shepherd[1], D.T. D. Childs[1], B.J. Stevens[2], S. Khamas[1], K.M. Groom[1], R.A. Hogg[1,2], N. Ikeda[3], and Y. Sugimoto[3]

[1] Dept. of Electronic & Electrical Engineering, Univ. of Sheffield, Centre for Nanoscience & Technology, Sheffield, UK, [2] EPSRC Nat'l Centre for III-V Technologies, Dept. of Electronic & Electrical Engineering, Univ. of Sheffield, Centre for Nanoscience & Technology, Sheffield, UK, [3] Nanotechnology Innovation Center, National Inst. for Materials Science (NIMS), Ibaraki, Japan

Design optimization of semiconductor photonic crystal laser (PCSEL) structure discussed. Mode confinement is compared for all-semiconductor and void PCSELs. A re-grown PCSEL, lasing at room-temperature based on GaAs/InGaP re-growth is realised, and device characteristics described.

ThI1-6 9:45 - 10:00

Three-Dimensional Coupled-Wave Theory for Triangular-Lattice Photonic-Crystal Lasers

Y. Liang, C. Peng, K. Ishizaki, S. Iwahashi, K. Sakai, Y. Tanaka, K. Kitamura, and S. Noda

Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

We develop a three-dimensional coupled-wave theory to model triangular-lattice photonic-crystal surface-emitting lasers. Unlike previous theories, our presented theory is able to treat non-Γ-point modes. We compare our theoretical results with experiments and find good agreement.

Room F 1F

[ThA1] 8:30 - 10:00
Mid-Infrared Lasers

Session Chair: Shigeki Tokita (Osaka Univ., Japan)

ThA1-1 8:30 - 9:00 Invited

High Power Tm:fiber Laser and In-band Pumped Ho-doped Ceramic Lasers

D. Y. Shen [1], H. Chen [1], Y. Wang [2], J. Zhang [2], and D. Y. Tang [2]

[1] Dept. of Optical Science and Engineering, Fudan Univ., Shanghai, China, [2] School of Physics and Electronic Engineering, Jiangsu Normal Univ., Xuzhou, China

High power and efficient operation of holmium doped YAG and LuAG ceramic laser at around 2 um is demonstrated in both cw and Q-switched mode using a high power wavelength-locked Tm:fiber pump source at ~1907nm.

ThA1-2 9:00 - 9:15

FM-mode-locked fiber laser operating at 2.9 μm

Tomonori Hu, Darren D. Hudson and Stuart D. Jackson

Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS) and the Inst. of Photonics and Optical Science, School of Physics, Univ. of Sydney, Camperdown, Australia

Frequency modulation mode locking of a Ho^{3+}, Pr^{3+}-co-doped fluoride fiber laser is demonstrated. Pulses are produced at 20 MHz with a pulse width of 5 ps, at 2.9 μm.

ThA1-3 9:15 - 9:30

Q-switched Mode-locking of a Mid-infrared Tm:YAG Waveguide Laser with Graphene Film

Y. Y. Ren [1], S. J. Beecher [2], G. Brown [2], A. Rodenas [3], A. Lancaster [2], F. Chen [1] and A. K. Kar [2]

[1] School of Physics, State Key Laboratory of Crystal Materials and Key Laboratory of Particle Physics and Particle Irradiation (MOE), Shandong Univ., Jinan, China, [2] School of Engineering and Physical Sciences, Heriot-Watt Univ., Edinburgh, Scotland, [3] Departament de Química Física I Inorgánica, Universitat Rovira i Virgili, Tarragona, Spain

Wave-guiding was achieved in Tm^{3+} doped YAG cladding waveguide fabricated by Ultrafast laser inscription. With a graphene based saturable absorber mirror, Q-switched mode-locking operation in the 2 μm spectral region were realized from the waveguide.

ThA1-4 9:30 - 9:45

Mid-Infrared Cr:ZnSe Channel Waveguide Laser

S. J. Beecher [1], J. R. Macdonald [1], P. A. Berry [2], K. L Schepler [2], and A. K. Kar [1]

[1] Inst. of Photonics and Quantum Sciences, Heriot-Watt Univ., Edinburgh, UK, [2] Air Force Research Laboratory, Sensors Directorate, Wright Patterson Air Force Base, USA

Waveguides are fabricated in Cr:ZnSe, built into a cavity and lasing is demonstrated. A room temperature laser threshold of 700 mW is observed. Emission occurs at 2573 nm making this an attractive, compact mid-infrared source.

ThA1-5 9:45 - 10:00

Strongly Enhancing Cr^{4+} Broadband Emissions in Strained Crystalline Core of Cr:YAG Doubled-Clad Fiber Amplifier

C. C. Lai [1], S. L. Huang [2], S. H. Wang [3], W. C. Ho [4], S. K. Liu [5], and C. N. Tsai [3]

[1] Dept. of Physics, Nat'l Dong Hwa Univ., Hualien, Taiwan, [2] Inst. of Photonics and Optoelectronics, National Taiwan Univ., Taipei, Taiwan, [3] Inst. of Electronic Engineering, Cheng Shiu Univ., Kaohsiung, Taiwan, [4] Inst. of Electronic Engineering, National Kaohsiung Univ. of Apply Science, Kaohsiung, Taiwan, [5] Inst. of Photonics and Communication, National Kaohsiung Univ. of Apply Science, Kaohsiung, Taiwan

Over 90% enhancement of efficient Cr^{4+} emission in Ca,Cr:YAG doubled-clad crystal fiber is achieved by CaO perimeter deposition, followed by oxygen annealing treatment. The corresponding strain effects on the Cr^{2+} broadband emission are also discussed.

Room G 1F

[ThB1] 8:30 - 10:00
Nonlinear Phenomena I
Session Chair: Tsuneyuki Ozaki (INRS - EMT, Canada)

ThB1-1 8:30 - 9:00 Upgrade Invited

Ultrafast Strong-Field Photoemission From Plasmonic Nanoparticles

P. Dombi [1,2], A. Hörl [3], P. Rácz [1], I. Márton [1], A. Trügler [3], J. R. Krenn [3], and U. Hohenester [3]

[1] Wigner Research Centre for Physics, Budapest, Hungary, [2] Max-Planck-Institut fur Quantenoptik, Garching, Germany, [3] Institut für Physik, Karl-Franzens-Universität Graz, Graz, Austria

We demonstrate strong-field photoemission from plasmonic nanoparticles by ultrashort pulses. Significant (x110) field enhancement attributed to surface-plasmons enable 25-eV electron generation in nanolocalized fields around nanoparticles. Correlation between plasmonic resonance and electron spectra is shown.

ThB1-2 9:00 - 9:15

Withdrawn

ThB1-3 9:15 - 9:30

Electric-Field Enhancement of Mid-Infrared Light by Using Au Nano-Rod Structures

Fumiya Kusa and Satoshi Ashihara

Dept. of Applied Physics, Tokyo Univ. of Agriculture and Technology, Tokyo, Japan

We study resonant enhancement of mid-infrared fields by use of gold nano-rod structures. Such enhancement should be useful for nonlinear vibrational spectroscopy, molecular coherent controls, and other nonlinear optical phenomena.

ThB1-4 9:30 - 9:45

Remote Lasing in Air Driven by Strong Laser Field: Lasing or Nonlinear Frequency Conversion?

J. Ni [1], W. Chu [1], J. Yao [1], B. Zeng [1], H. L. Xu [2,1], S. L. Chin [3], Y. Cheng [1] and Z. Xu [1]

[1] State Key Laboratory of High Field Laser Physics, Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, Shanghai, China, [2] State Key Laboratory on Integrated Optoelectronics, College of Electronic Science and Engineering, Jilin Univ., Changchun, China, [3] Center for Optics, Photonics and Laser (COPL) & Dept. of Physics, Engineering Physics and Optics, Universite Laval, Quebec City, Canada

We demonstrated systematic investigations on the mechanism of remote coherent N_2^+ emission in air using a pump-probe configuration. Our experimental results suggest lasing action based on instantaneous population inversion is the most likely mechanism.

ThB1-5 9:45 - 10:00

Investigation of Physical Mechanism of Ultrafast Laser Glass Microwelding Using Double-pulse Irradiation

Si Zhu Wu, Dong Wu, Koji Sugioka, and Katsumi Midorikawa

Laser technology laboratory, RIKEN- Advanced Science Inst., Saitama, Japan

We experimentally and theoretically investigate the underlying physical mechanism of ultrafast laser glass microwelding using double-pulse irradiation based on transient absorption change of 2nd pulse with various pulse energy induced by 1st pulse irradiation.

Room H 1F

[ThF1] 8:30 - 10:00
Novel Fiber Sensor Network
Session Chair: Shigeru Yamaguchi (Tokai Univ., Japan)

ThF1-1 8:30 - 9:00 Invited

Fiber Optic Nerve Systems for Smart Structures and Smart Materials with Optical Correlation Domain Technologies

Kazuo Hotate

Dept. of Electrical Engineering and Information Systems, The Univ. of Tokyo, Tokyo, Japan

Distributed and multiplexed optical sensing using continuous wave has been developed by synthesis of optical coherence function. The technique has provided mm-order spatial resolution, kHz-order sampling rate, and random-accessibility to arbitrary point along a fiber.

ThF1-2 9:00 - 9:15

Experimental Evaluation of Vibration Sensor Based on Interferometer with Phase Modulated Light

Naoyuki Miyata, Yosuke Tanaka, and Takashi Kurokawa

Graduate School of Engineering, Tokyo Univ. of Agriculture and Technology, Tokyo, Japan

Simple and accurate vibration sensor using an interferometer with phase-modulated light is demonstrated. The measurement error is experimentally evaluated. The displacement measurement of a PZT mirror vibrating at 75 kHz is compared with conventional methods.

ThF1-3 9:15 - 9:30

Dual Core Photonic Crystal Fiber Based Mach-Zehnder Interferometer Assisted with Two Tapers for Bending Measurement

Zhilin Xu [1], Qizhen Sun [1,2] Xiaolei Li [1], Jianghai Wo [1], Weihua Jia [1], Deming Liu [1]

[1] Nat'l Engineering Laboratory for Next Generation Internet Access System, School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, Wuhan, China, [2] Aston Inst. of Photonic Technologies, Aston Univ., Birmingham, UK

A bending sensor is achieved by employing a singlemode fiber-dual core photonic crystal fiber- singlemode fiber (SDS) structure with two tapers at fusing points. Sensitivity of between the transmission spectra shift and curvature is demonstrated.

ThF1-4 9:30 - 9:45

Mechanical Vibration Sensing Using Cascaded Long Period Fiber Grating

Makoto Takeuchi, Satoshi Tanaka, Shingo Tekuramori, Atsushi Wada, Nobuaki Takahashi

Nat'l Defense Academy, Kanagawa, Japan

C-LPGs are fabricated by use of UV KrF laser, and examined in terms of axial strains. By adopting C-LPGs to an intensity-based demodulation scheme, highly sensitive mechanical vibration sensing is successfully demonstrated.

ThF1-5 9:45 - 10:00

Optically powered hybrid node controlling wired and wireless sensors for wide-area sensor network

Keisuke Saito, Yosuke Tanaka, and Takashi Kurokawa

Graduate School of Engineering, Tokyo Univ. of Agriculture and Technology, Tokyo, Japan

We demonstrate and investigate an optically powered hybrid sensor node that controls both wired and wireless sensors for wide-area fiber sensor network.

Room I 2F

[ThP1] 8:30 - 10:00
Operational Issues for Access Networks
Session Chair: Naoto Yoshimoto (NTT, Japan)

ThP1-1 8:30 - 8:45

Energy Saving Scheme Based On Traffic Forwarding For Optical Fiber Access Networks

G. Arturo Rodés López, J. Estaran, J.J. Vegas Olmos, and I. Tafur Monroy

Dept. of Photonics Engineering, Technical Univ. of Denmark (DTU) Ørsted Plads, Kgs. Lyngby, Denmark

We report on an energy saving block that regroups and powers off OLTs during low traffic periods, resulting in energy savings up to 87,5% in the central office of optical access networks.

ThP1-2 8:45 - 9:00

Calibration Technique for Optical-Comb-Based Frequency-Response Measurement Systems

Y. Fukada [1], J. Kani [1], J. Terada [1], N. Yoshimoto [1], and T.Otsuji [2]

[1] NTT Access Network Service Systems Labs., Kanagawa, Japan, [2] Research Inst. for Electrical Communication, Tohoku Univ., Sendai, Japan

Optical-comb-based frequency-response measurement systems can evaluate the high frequency response of photoelectric devices. However, such systems produce inaccurate evaluations due to polarization-state fluctuation. We propose a novel calibration technique for eliminating such inaccuracies.

ThP1-3 9:00 - 9:15

Novel Test Light Injection Tool for Fiber Identification below an Optical Splitter in a PON

H.Hirota, Y. Kawano, M. Shimpo, K. Noto, N. Honda, and T. Manabe

Access Network Service Systems Laboratories, NTT Corporation, Ibaraki, Japan

We propose a novel test light injection tool for fiber identification below an optical splitter in a passive optical network.

ThP1-4 9:15 - 9:30

Individual PON Monitoring Using Maintenance Band Pulsed Pump-Probe Brillouin Analysis

Hiroshi Takahashi, Kunihiro Toge, Chihiro Kito and Fumihiko Ito

NTT Access Network Service Systems Laboratories, NTT Corporation, Ibaraki, Japan

We demonstrate individual PON monitoring using maintenance band pulsed pump-probe Brillouin analysis that can measure the individual loss distribution of each tributary in a PON from a central office.

ThP1-5 9:30 - 10:00 Invited

Advanced Optical Performance Monitoring for Next Generation Access Networks

Calvin C. K. Chan

Dept. of Information Engineering, The Chinese Univ. of Hong Kong, Shatin, N.T., HONG KONG

Optical performance monitoring is crucial to monitor the network status and signal quality. In this paper, we discuss the requirements and various techniques of network and signal monitoring in next generation optical access networks.

Room J 2F

Room K 2F

Room 101 1F

[ThT1] 8:30 - 9:45
Free Space Optical Devices and Interconnects

Session Chair: Giampiero Contestabile (Scuola Superiore Sant'Anna, Italy)

ThT1-1 8:30 - 8:45

Compact Fan-in/Fan-out Optical Devices for Multi-core Fiber Transmission

Y. Tottori, T. Kobayashi, and M. Watanabe
OPTOQUEST CO.,LTD, Saitama, JAPAN

A compact fan-in/fan-out device is developed that connects 7-core multi-core fiber and seven single mode fibers. Characteristics of the insertion loss, polarization dependent loss and cross talk were good.

ThT1-2 8:45 - 9:00

Proposal of High-capacity and High-reliability Optical Switch Equipment with Multi-core Fibers

Kenji Hiruma, Toshiki Sugawara, Kenichi Tanaka, Etsuko Nomoto, and Yong Lee
Central Research Laboratory, Hitachi Ltd., Tokyo, Japan

We propose a concept for a novel optical switching system utilizing multi-core fibers for high-capacity/high-reliability data transmission, which is expected to recover within 50 ms from a fiber break.

ThT1-3 9:00 - 9:15

High-Speed Reconfigurable Card-to-Card Optical Interconnects with Multicasting Capability

Ke Wang[1,2], Ampalavanapillai Nirmalathas[1,2], Christina Lim[2], Efstratios Skafidas[1,2], and Kamal Alameh[3]
[1] Nat'l ICT Australia - Victoria Research Laboratory (NICTA-VRL), [2] Dept. of Electrical and Electronic Engineering, The Univ. of Melbourne, Australia, [3] Centre of Excellence for Micro Photonic Systems, Electron Science Research Inst., Edith Cowan Univ., Australia

A free-space-based high-speed reconfigurable card-to-card optical interconnect architecture with multicasting capability is proposed and experimentally demonstrated. Results show that 10 Gb/s data can be multicast to selected channels with receiver sensitivity better than -10.50 dBm.

ThT1-4 9:15 - 9:45 Invited

Wavelength Selective Crossconnects

Nicolas K. Fontaine, Roland Ryf, and David T. Neilson
Bell Laboratories/Alcatel-Lucent, NJ , USA

We show a NXM wavelength selective crossconnect (WSX) with flexible passbands that can route any wavelength between any input and output port without spectral gaps.

Room 103 1F

Room 104A 1F

[ThL1] 8:30 - 10:00
Optical Sensors and Fiber Devices
Session Chair: Toshio Katsuyama (Univ. of Fukui, Japan)

ThL1-1 8:30 - 8:45
Low Loss Silica High-Mesa Waveguide for Infrared Sensing
J. Chen[1], H. Hokazono[1], D. Nakashima[1], Y. Hashizume[2], M. Itoh[2], and K. Hamamoto[1]
[1] Interdisciplinary Graduate School of Engineering Sciences, Kyushu Univ., Fukuoka, Japan, [2] NTT Photonics Laboratories, Kanagawa, Japan
We propose low loss silica high-mesa waveguide, of which a certain portion of propagation light profiles out of the waveguide, for infrared absorption. The implemented device showed extremely low loss of 0.02dB/cm.

ThL1-2 8:45 - 9:00
A MEMS-Based 3-D Movable Metamaterials
Yu-Sheng Lin, Fusheng Ma, and Chengkuo Lee
Dept. of Electrical & Computer Engineering, Nat'l Univ. of Singapore, Engineering Drive, Singapore
A new shape of metamaterials and actuation mechanism are proposed and demonstrated. This reconfigurable metamaterials was constructed by electric split-ring resonators. The experimental results show this device reveals polarization dependence and blue shifting of spectrum.

ThL1-3 9:00 - 9:15
High-efficiency, double-clad fiber coupler, cladding mode sensor using a tilted fiber Bragg grating
MD. Baiad [1], M. Gagne [2], E. De Montigny [2], WJ. Madore [2], N. Godbout [2], C. Boudoux [2], and R. Kashyap [1,2]
[1] Dept. of Electrical Engineering, Polytechnique de Montreal, Montreal, Canada, [2] Dept. of Engineering Physics, Polytechnique de Montreal, Montreal, Canada
A high-efficiency sensor for reflected cladding modes over 80nm, generated by a tilted fiber Bragg grating is demonstrated using a double-clad fiber coupler taper spliced to a standard fiber.

ThL1-4 9:15 - 9:30
Two Dimensional Trapping Using Four Core Interference From a Lensed Multicore Fiber
A. L. Barron, A. K. Kar, A. J. Waddie, M. R. Taghizadeh and H. T. Bookey
Inst. of Photonics and Quantum Sciences, School of Engineering and Physical Sciences, Heriot Watt Univ., Edinburgh, UK
Two dimensional trapping of multiple particles in an interference pattern has been demonstrated using a four core lensed multicore fiber and a diffractive optical element.

ThL1-5 9:30 - 9:45
Efficient Spatial Aperture-Sampled Mode Multiplexer for Ring Fibers
Miri Blau and Dan M. Marom
Dept. of Applied Physics, Hebrew Univ., Jerusalem, Israel
Efficient space division multiplexing from single mode fibers to a few mode fiber is extended to specialty refractive index ring profile fibers. Optimizing the beam apertures achieves lower average coupling loss and mode dependent losses.

ThL1-6 9:45 - 10:00
Four-port Optical Circulator with a Narrow Waist of Faraday Rotator Window
Yung Hsu [1], Jing-Heng Chen [1], Kun-Huang Chen [2], Chien-Hung Yeh [3], and Jiun-You Lin [4]
[1] Dept. of Photonics, Feng Chia Univ., Taichung, Taiwan, [2] Dept. of Electrical Engineering, Feng Chia Univ., Taichung, Taiwan, [3] Information and Communications Research Laborites, Industrial Technology Research Inst. (ITRI), Hsinchu, Taiwan, [4] Dept. of Mechatronics Engineering, Nat'l Changhua Univ. of Education, Changhua, Taiwan
A new low-cost design of four-port optical circulator is proposed. By introduction of two pairs of confocal cylindrical lenses, a small size Faraday rotator is required. A prototype of the device was assembled and tested.

Room 104B 1F

[ThM1] 8:30 - 10:00
Si Photonics: Novel Functions and Applications
Session Chair: Hirohito Yamada (Tohoku Univ., Japan)

ThM1-1 8:30 - 9:00 Invited
Monolithic Source of Telecom-Band Polarization Entanglement on a Silicon Photonic Chip
Nobuyuki Matsuda[1,3], Hanna Le Jeannic[1], Hiroshi Fukuda[2], Tai Tsuchizawa[2], William John Munro[1], Kaoru Shimizu[1], Yasuhiro Tokura[1], Koji Yamada[2,3], Hiroki Takesue[1]
[1] NTT Basic Research Laboratories, NTT Corporation, Japan, [2] NTT Microsystem Integration Laboratories, NTT Corporation, Kanagawa, Japan, [3] Nanophotonics Center, NTT Corporation, Kanagawa, Japan
We present the first monolithic source that generates polarization entangled photon pairs integrated on a silicon photonic chip. The maximally-entangled photon pairs were generated with a state fidelity of 94% well above the classical limit.

ThM1-2 9:00 - 9:15
All-Optical 40 Gbit/s Regenerative Wavelength Conversion Based on Cross-Phase Modulation in a Silicon Nanowire
Asger S. Jensen, Hao Hu, Hua Ji, Minaho Pu, Lars H. Frandsen, Leif K. Oxenløwe
DTU Fotonik, Technical Univ. of Denmark, Lyngby, Denmark
We successfully demonstrate all-optical regeneration of a 40 Gbit/s signal based on cross phase modulation in a silicon nanowire. Bit-error-rate measurements show an average of 1.7dB improvement in receiver sensitivity after the regeneration.

ThM1-3 9:15 - 9:30
Nonlinear self polarization-flipping in silicon waveguides
Wen Qi Zhang [1], Max A. Lohe [1], Tanya M. Monro [1], Paolo Bettotti [2], Lorenzo Pavesi [2] and Shahraam Afshar V [1]
[1] Inst. for Photonics & Advanced Sensing, Univ. of Adelaide, SA, Australia, [2] Nanoscience Laboratory, Dept. of Physics, Univ. of Trento, Trento, Italy
We investigate the nonlinear interaction of the two polarizations in silicon waveguides and show that considering practical parameters, such as waveguide loss,dispersion and laser noise, these waveguides can show nonlinear self polarization flipping behavior.

ThM1-4 9:30 - 9:45
Optical Routing in a 4×4 Matrix of Fifth-order Ring Resonator Switches
P. DasMahapatra, A. Rohit, R. Stabile and K.A. Williams
COBRA Research Inst., Eindhoven Univ. of Technology, Eindhoven, The Netherlands
We present 10Gbps PRBS data routing through all sixteen paths of a 4×4 fifth-order resonator switch matrix with low optical power penalty. Thermal crosstalk between switch elements is shown to be low.

ThM1-5 9:45 - 10:00
Demonstration of 1×8 silicon photonic switch based on optical phased array
Chao Chen, Akio Higo, Myung-Joon Kwack, Takuo Tanemura, and Yoshiaki Nakano
Research Center for Advanced Science and Technology, the Univ. of Tokyo, Tokyo, Japan
A fully integrated silicon 1x8 switch based on thermo-optic phased array is designed, fabricated, and demonstrated for the first time. Static and dynamic switching characteristics are presented and possibilities for further improvements are discussed.

Room C-1 1F

[ThR2] 10:30 - 12:00
FEC
Session Chair: Takeshi Hoshida (Fujitsu Limited, Japan)

ThR2-1 10:30 - 11:00 Upgrade Invited

A Study of Rate-Adaptive Forward Error Correction in OTU Framing

S. Kametani, K. Kubo, T. Sugihara, T. Ichikawa, K. Koguchi and T. Mizuochi

Information Technology R&D Center, Mitsubishi Electric Corporation, Kamakura, Japan

The performance and feasibility of rate-adaptive FEC is studied by means of an OTU framing structure. When ODTU tributary slots are utilized to transmit parity, the assignment of up to 23 slots is feasible.

ThR2-2 11:00 - 11:15

Performance Improvement of a Triple-Concatenated FEC by a UEP-BCH Product Code for 100 Gb/s Optical Transport Networks

Yoshikuni Miyata, Kazuo Kubo, Kenya Sugihara, Toshiyuki Ichikawa, Wataru Matsumoto, Hideo Yoshida and Takashi Mizuochi

Information Technology R&D Center, Mitsubishi Electric Corporation, Kanagawa, Japan

We present an error-correction performance improvement of a triple-concatenated FEC by a UEP-BCH product code for OTU4V frame format. A simulation indicates an NCG of 11.0dB with 20.5% redundancy at a post-FEC BER of 10^{-15}.

ThR2-3 11:15 - 11:30

A Study on the Effectiveness of Turbo Equalization with FEC for Nonlinearity Compensation in Coherent WDM Transmissions

Takafumi Fujimori [1], Toshiaki Koike-Akino [2], Takashi Sugihara [1], Kazuo Kubo [1], Kazuumi Koguchi [1], Takashi Mizuochi [1], Chihiro Ohshima [3], Hisao Nakashima [4], Takeshi Hoshida [4]

[1] Information Technology R&D Center, Mitsubishi Electric Corporation, Kamakura, Japan, [2] Mitsubishi Electric Research Laboratories, Massachusetts, USA, [3] Fujitsu Laboratories Ltd., Kawasaki, Japan, [4] Fujitsu Limited, Kawasaki, Japan

We evaluate the performance improvement in the presence of fiber nonlinearity obtained using a Turbo equalizer. Numerical simulation shows that Turbo equalization offers an improvement of 0.8 dB in a 100 Gb/s NZ-DSF transmission.

ThR2-4 11:30 - 11:45

On the Pragmatic Turbo Equalizer for Optical Communications

Yequn Zhang[1,2], Shaoliang Zhang[1] and Ivan B. Djordjevic[2]

[1] NEC Laboratories America, Princeton, USA, [2] Univ. of Arizona, ECE Dept., Tucson, USA

Two types of pragmatic turbo equalizers are implemented and evaluated with either histogram approach or multivariate Gaussian approximation. The latter is found to be more suitable due to its low complexity and less performance degradation.

ThR2-5 11:45 - 12:00

Orthogonal Polynomials based Hybrid Coded-Modulation for Multi-Tb/s Optical Transport

Ivan B. Djordjevic [1] and Ting Wang [2]

[1] Univ. of Arizona, ECE Dept., Tucson, USA, [2] NEC Laboratories America, Princeton, USA

Orthogonal polynomials based single-carrier hybrid coded-modulation is proposed as multi-Tb/s enabling technology while employing the commercially available electronics. The proposed scheme can simultaneously solve the limited bandwidth and high energy consumption of information infrastructure problems.

Room C-2 1F

[ThI2] 10:30 - 12:00
Nanocarbon & Metamaterials
Session Chair: Marko Lončar (Harvard Univ., USA)

ThI2-1 10:30 - 11:00 Invited

Ultrafast Refractive Index Control of Terahertz Graphene Metamaterials

Seung Hoon Lee [1], Jeongmook Choi [2], Hyeon-Don Kim [1], Hyunyong Choi [2], and Bumki Min [1]

[1] Dept. of Mechanical Engineering, KAIST, Daejeon, Republic of Korea, [2] School of Electrical and Electronic Engineering, Yonsei Univ., Seoul, Republic of Korea

We present an ultrafast dynamics of THz graphene-metamaterial hybrid devices, where the refractive index and the conductivity are largely modulated by electrical and optical methods.

ThI2-2 11:00 - 11:15

Terahertz Plasmonic Responses in Graphene Hybridized Systems

A. Ishikawa [1] and T. Tanaka [1,2]

[1] Metamaterials Lab., RIKEN, Saitama, Japan, [2] Research Inst. for Electronic Science, Hokkaido Univ., Sapporo, Japan

We experimentally and numerically investigate terahertz plasmonic responses in a coupled system of structured graphene and a heavily-doped Si substrate. Gate-voltage-controllable magnetic plasmon resonances arising from the plasmon hybridization are demonstrated at terahertz frequencies.

ThI2-3 11:15 - 11:30

Tip-enhanced Raman Scattering Study of Metalized-Semiconducting Carbon Nanotube

Yoshito Okuno [1], Yuika Saito [1], Satoshi Kawata [1,2] and Prabhat Verma [1]

[1] Dept. of Applied Physics, Osaka Univ., Osaka, Japan, [2] RIKEN, Saitama, Japan

We visualized that semiconducting single wall carbon nanotubes (SWCNTs) represent metallic property at a point where a few tubes crossed each other, by tip-enhanced Raman scattering (TERS) microscopy.

ThI2-4 11:30 - 11:45

Nanocavity-Enhanced Raman Scattering of Single-Walled Carbon Nanotubes

Hisashi Sumikura [1,2], Eiichi Kuramochi [1,2], Hideaki Taniyama [1,2], and Masaya Notomi [1,2]

[1] NTT Nanophotonics Center, NTT Corp., Kanagawa, Japan, [2] NTT Basic Research Laboratories, NTT Corp., Kanagawa, Japan

We have demonstrated that a photonic crystal nanocavity resonantly enhances the Raman scattering of single-walled carbon nanotubes. The enhanced Raman intensity is 10 times larger than the intensity of nanotubes on flat silicon.

ThI2-5 11:45 - 12:00

Fano Resonance in a Composite Metamaterial of Superlattice and Isotropic Metamaterials

Y.U. Lee [1], E.Y. Choi [1], E.S. Kim [1], J.H. Woo [1], B. Kang [1], J. Kim [1], B.C. Park [2], J.H. Kim [2], and J.W. Wu [1]

[1] Dept. of Physics and Quantum Metamaterials Research Center, Ewha Womans Univ., Seoul, Korea, [2] Dept. of Physics, Yonsei Univ., Seoul, Korea

By embedding polarization-independent four-rod resonators into polarization-dependent double-split ring resonator superlattice metamaterial, a polarization-dependent Fano resonance is experimentally demonstrated in THz regime.

Room F 1F

[ThA2] 10:30 - 12:00
Advanced Near-Infrared Lasers
Session Chair: Sunao Kurimura (NIMS, Japan)

ThA2-1 10:30 - 11:00 Invited

High Power 1100 - 1200 nm Semiconductor Disk Lasers

T. Leinonen, E. Kantola, S. Ranta, M. Tavast, V.-M. Korpijärvi, and M. Guina

Optoelectronics Research Centre, Tampere Univ. of Technology, Tampere, Finland

We review our results of SDLs in the range of 1100-1200nm. In particular, we highlight our recent demonstrations of output power of more than 20W at around 1180nm and SHG of more than 10W.

ThA2-2 11:00 - 11:15

Influence of High-Order Modes in Starting Self-Mode-Locked Optically Pumped Semiconductor Laser

Hsing-Chih Liang, Yi-Chun Lee, Jung-Chen Tung, Kuan-Wei Su, Yung-Fu Chen, and Kai-Feng Huang

Dept. of Electrophysics, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

We explored the influence of pump-to-mode size ratios on optically pumped semiconductor laser. With a large pump-to-mode size ratio, the output beam was self-mode-locked with 1.17 ps pulse duration at a repetition rate of 1.8GHz.

ThA2-3 11:15 - 11:30

1240-nm Distributed-feedback Lasers with High-density InAs/GaAs Quantum Dots

Kan Takada[1,2], Takeo Kageyama[1,3], Hayato Kondo[1], Reio Mochida[1,3], Yasunari Maeda[1], Kenichi Nishi[1,3], Keizo Takemasa[1,3], Tsuyoshi Yamamoto[1,2], Mitsuru Sugawara[1,3], and Yasuhiko Arakawa[2]

[1] QD Laser Inc., Kanagawa, Japan, [2] Fujitsu Laboratories Ltd., Kanagawa, Japan, [3] The Univ. of Tokyo, Tokyo, Japan

1240-nm quantum-dot (QD) distributed-feedback (DFB) lasers are developed for the optical time-domain reflectometer. Fabricated DFB lasers with high-density QDs show excellent temperature-stable lasing characteristics in single-longitudinal-mode operation between 0°C and 70°C.

ThA2-4 11:30 - 11:45

Self-mode Locking in Diode-pumped Nd:YVO_4 Self-Raman Lasers

Y. C. Lin, C. Y. Lee, K. W. Su, and Y. F. Chen

Dept. of Electrophysics, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

We experimentally explore the temporal dynamics of diode-pumped Nd:YVO_4 CW self-Raman lasers. In the single-transverse-mode operation, we find that the real-time trace of the self-Raman laser displays the characteristics of self-mode locking.

ThA2-5 11:45 - 12:00

Single Crystalline YAG-core Fiber with a Lanthanum Dense Flint Glass Cladding

Kuang-Yu Hsu [1], Mu-Han Yang [1], Dong-Yo Jheng [1], Sheng-Lung Huang [1], Karl Mennemann [2], Volker Dietrich [2], and Mark Dubinskii [3]

[1] Gratuate Inst. of Photonics and Optoelectronics, Nat'l Taiwan Univ., Taipei, Taiwan, [2] Advanced Optics, Schott AG, Mainz, Germany, [3] US Army Research Laboratory, Adelphi, USA

The crystalline YAG-core fiber cladded by high-index N-LaSF9 glass has been fabricated to significantly reduce the number of guided modes. The selective propagation of the LP_{01} and LP_{11} modes was successfully demonstrated at 633 nm.

Room G 1F

[ThB2] 10:30 - 12:00
Nonlinear Phenomena II
Session Chair: Takao Fuji (Inst. of Molecular Science, Japan)

ThB2-1 10:30 - 10:45
Saturable Absorption in Multiple Sheets of Monolayer Graphene for Optical Switching
M. Takahashi, W. Ueda, N. Goto, and S. Yanagiya
Dept. of Optical Science and Technology, The Univ. of Tokushima, Tokushima, Japan
Optical saturable absorption in multiple sheets of monolayer graphene was investigated for pico-second optical switching application. Saturable absorption for a 1.56μm femto-second laser was measured in graphene which was vertically placed between optical fibers.

ThB2-2 10:45 - 11:00
Pump-degenerate Phase Sensitive Amplification in Chalcogenide Waveguides
Y. Zhang[1], R. Neo[1], J. Schröder[1], C. Husko[1], S. Lefrancois[1], D.-Y. Choi[2], S. Madden[2], B. Luther-Davies[2], and B. J. Eggleton[1]
[1] Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), School of Physics, Univ. of Sydney, Australia, [2] CUDOS, Laser physics centre, The Australian Nat'l Univ., Canberra, Australia
We demonstrate phase sensitive amplification based on pump-degenerate four-wave mixing in a dispersion-engineered chalcogenide waveguide. An extinction ratio of the on-chip gain of 11.4dB is achieved by slicing the pump/signal/idler waves from a single source.

ThB2-3 11:00 - 11:15
Measurements of Phase-matching Spectral Phase and Domain Period Distribution by Nonlinear Spectral Interferometry
Chia-Lun Tsai [1], Ming-Chi Chen [1], Jui-Yu Lai [1,2] and Shang-Da Yang [1]
[1] Inst. of Photonics Technologies, Nat'l Tsing Hua Univ., Hsinchu, Taiwan, [2] HC Photonics Corp., R&D Division, Hsinchu, Taiwan
Phase-mating spectral phases of aperiodic quasi-phase matched gratings are experimentally measured by nonlinear spectral interferometry and microscopic images, respectively. The former enables accurate reconstruction of domain length distributions with 810-μm resolution.

ThB2-4 11:15 - 11:30
Healing Block-assisted Quasi-phase Matching
Jui-Yu Lai [1,2], Cheng-Wei Hsu [1], Dong-Yi Wu [2], Sheng-Bang Hung [2], Ming-Hsien Chou [2], and Shang-Da Yang [1],
[1] Inst. of Photonics Technologies, Nat'l Tsing Hua Univ., Hsinchu, Taiwan, [2] HC Photonics Corp., R&D Division, Hsinchu, Taiwan
A new QPM structure is proposed to improve the efficiency when the first-order QPM domain length is too short to be fabricated. SHG efficiency 4.69 times higher than the third-order QPM is experimentally demonstrated.

ThB2-5 11:30 - 11:45
Observation of Beam Breakup During Cascaded Four-Wave Mixing Process
Jinping He[1], Takayoshi Kobayashi[1,2,3,4]
[1] Advanced Ultrafast Laser Research Center, Univ. of Electro-Communications, Tokyo, Japan, [2] JST, CREST, Tokyo, Japan, [3] Dept. of Electrophysics, Nat'l Chiao-Tung Univ., Hsinchu, Taiwan, [4] Inst. of Laser Engineering, Osaka Univ., Osaka, Japan
Beam breakup together with cascaded four-wave mixing is observed in several third-order nonlinear crystals. Bright two-dimensional multicolored arrays are generated due to the two nonlinear processes.

ThB2-6 11:45 - 12:00
Microwave Photonic Notch Filter using On-Chip Stimulated Brillouin Scattering
David Marpaung[1], Ravi Pant[1], Blair Morrison[1], Enbang Li[1], Duk-Yong Choi[2], Steve Madden[2], Barry Luther-Davies[2], and Benjamin J. Eggleton[1]
[1] Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS), Inst. of Photonics and Optical Science (IPOS), School of Physics, Univ. of Sydney, NSW, Australia, [2] CUDOS, Laser Physics Centre, Australian Nat'l Univ., ACT, Australia
We report the first integrated tunable microwave photonic notch filter based on on-chip stimulated Brillouin scattering. The notch filter has a high-resolution with 3-dB and 6-dB bandwidths of 126 MHz and 78 MHz, respectively.

Room H 1F

[ThF2] 10:30 - 12:00
Fiber Sensing Devices
Session Chair: Kazuo Hotate (The Univ. of Tokyo, Japan)

ThF2-1 10:30 - 10:45
Polarization Independent Camera Node Based on Fiber Optic Power Supply
Yuya Tanaka, Yosuke Tanaka, and Takashi Kurokawa
Graduate School of Engineering, Tokyo Univ. of Agriculture and Techechnology, Tokyo, Japan
We introduce that we hold down a decrement of the light power with a polarization beam splitter when we transmit the image which we acquired in a camera node to the monitoring side as signal.

ThF2-2 10:45 - 11:00
The Thermoluminescence Response of Undoped Silica PCF for Dosimetry Application
Mostafa Ghomeishi [1], Ghafour Amouzad Mahdiraji [1], and Faisal Rafiq Mahamd Adikan [1], Suhairul Hashim [2]
[1] Photonics Research Group, Dept. of Electrical Engineering, Faculty of Engineering, Univ. of Malaya, Kuala Lumpur, Malaysia, [2] Physics Dept., Faculty of Science, Univ. Teknologi Malaysia, Johor, Malaysia
This work concerns the suitability of PCF as dosimeter. The dosimetric capabilities of PCF for thermoluminescence and dose response have been investigated and compared with the single mode fibre subjected to 6 MeV electron irradiations.

ThF2-3 11:00 - 11:15
Development of Acquisition and Tracking System for Next-Generation Optical Inter-Satellite Communication
Seiichi Shimizu [1], Kazuhide Kodeki [1], Katsumasa Miyatake [1], Toshiyuki Ando [2], Jiro Suzuki [2], Masateru Nagase [3], Tatsuyuki Hanada [4], and Shiro Yamakawa [4]
[1] Mitsubishi Electric Corporation, Hyougo, Japan, [2] Mitsubishi Electric Corporation, Kanagawa, Japan, [3] Mitsubishi Electric Corporation, Kanagawa, Japan, [4] Japan Aerospace Exploration Agency (JAXA), Ibaraki, Japan
In this paper, The specifications and configuration of the acquisition and tracking system are described.

ThF2-4 11:15 - 11:30
Simultaneous Measurement of Curvature and Temperature Based on Mach-Zehnder Interferometer with Lateral Offset and Ultraabrupt Taper
Lili Mao[1,2], Ping Lu[1,2], Zefeng Lao[3] and Deming Liu[1,2]
[1] Nat'l Engineering Laboratory for Next Generation Internet Access System, Huazhong Univ. of Science and Technology(HUST), Wuhan, China, [2] Wuhan National Laboratory for Optoelectronics, School of optical and electronic information, HUST, Wuhan, China, [3] College of Electrical&Electronic Engineering, Huazhong Univ. of Science and Technology, Wuhan, China
A novel sensor for simultaneous measurement of curvature and temperature is proposed, which consists of a lateral offset and a ultra-abrupt taper. By measuring wavelength shifts of two dips, we can discriminate the two parameters.

ThF2-5 11:30 - 11:45
Optimized Four-Section-Dark-Pulse Brillouin Distributed Optical Fiber Sensor
Zhisheng Yang, Xiaobin Hong, Jian Wu, Hongxiang Guo and Jintong Lin
Beijing Univ. of Posts and Telecommunications, Beijing, China
An analytical model is presented in four-section-dark-pulse Brillouin optical time-domain sensor. The proposed model provides a full physical insight into the SBS process, and is a significant tool to optimize the parameters in the system.

ThF2-6 11:45 - 12:00
Noise Immunity-optimized Polarimeter Using Modified Polarization State Analyzer
Ping-Hsun Tsai, and Shang-Da Yang
Inst. of Photonics Technologies, Nat'l Tsing Hua Univ., Hsinchu, Taiwan
A new figure of merit (Poincare angular error gradient) is proposed to optimize the noise immunity of polarimeter. The typical polarization state analyzer is modified to experimentally realize the optimized scheme.

Room I 2F

[ThP2] 10:30 - 12:00
TDM-PON
Session Chair: Tohru Kazawa (Hitachi Ltd., Japan)

ThP2-1 10:30 - 11:00 Invited
DWDM Based EPON Reach Extension: Technology, Cost, Performance, and Trial
Sangsoo Lee, and Kwang Ok Kim
Electronics and Telecommunications Research Inst., Daejeon, Korea
In this paper, we propose and experimentally show a 16 channel DWDM based EPON reach extender for high capacity next generation long reach PON application.

ThP2-2 11:00 - 11:15
Performance Evaluation of 10G-EPON System in 128 Subscribers Environment
Takashi Nishitani, Takeshi Suehiro, Satoshi Yoshima and Hiroaki Mukai
Information technology R&D Center, Mitsubishi Electric Corporation, Kanagawa, Japan
Performance evaluation of 10G-EPON system with DBA is described. We confirm the priority control function of proposed DBA, and the improvement of 15.4% throughput employing burst-mode XFP transceiver and CDR in 128 subscribers environment.

ThP2-3 11:15 - 11:30
Optimum Multicast Time Slot Allocation in Active Optical Access Network
Yuji Shimada, Takehiro Sato, Kazumasa Tokuhashi, Hidetoshi Takeshita, Satoru Okamoto and Naoaki Yamanaka
Graduate School of Science and Technology, Keio Univ., Yokohama, Japan
This paper proposes an optimum multicast time slot allocation scheme in the active optical access network. The proposed scheme combines multi-level modulation and distribution mode that optical switch acts like optical coupler.

ThP2-4 11:30 - 11:45
A Proposal of Novel Power-saving Scheme Employing Watchdog ONUs in Redundant PON Systems
Kenji Minefuji, Ryusuke Kawate, and Hiroaki Mukai
Information Technology R&D Center, Mitsubishi Electric Corporation, Kanagawa, Japan
This paper presents a novel power-saving scheme using watchdog ONUs in redundant PON systems. A numerical simulation reveals the power-saving of 17% in the transmitter-sleep mode, and 36% of the transmitter/receiver-sleep mode was obtained respectively.

ThP2-5 11:45 - 12:00
A Proposal for Single-handed Power-saving by ONU in EPON Systems
Fumihiko Tano, Akihiro Yamashita, Takeshi Suehiro, and Hiroaki Mukai
Information Technology R&D Center, Mitsubishi Electric Corporation, Kanagawa, Japan
We propose a novel ONU power-saving scheme called single-handed type ONU power saving scheme. Proposed scheme does not require any power saving functions in EPON OLT. We also present evaluation results of proposed scheme.

Room J 2F

[ThS2] 10:30 - 11:30
Optical Fiber Cable Technology

Session Chair: Shu Namiki (National Inst. of Advanced Industrial Science and Technology, Japan)

ThS2-1 10:30 - 11:30 Tutorial

Optical Fiber Cable Technology and Related Study Items Toward Space Division Multiplexing

Masaharu Ohashi

Osaka Prefecture Univ., Osaka, Japan

We review recent progress on optical fiber cable technology including multi-core fiber design and measurement techniques. Moreover, we also describe study items related to optical fiber cable technology and aimed at the space division multiplexing.

Room K 2F

[ThO2] 10:30 - 11:30
Optical Signal Processing IV

Session Chair: Takaaki Ishigure (Keio Univ., Japan)

ThO2-1 10:30 - 10:45

Spectral compression of a DWDM grid using optical time-lenses

E. Palushani, H. C. H. Mulvad, M. Galili, F. D. Ros, H. Hu, P. Jeppesen and L. K. Oxenløwe

DTU Fotonik, Technical Univ. of Denmark, Lyngby, Denmark

We experimentally demonstrate the compression of a dense wavelength-division multiplexing (DWDM) grid via a spectral imaging system based on two time-lenses. A 100-GHz DWDM-grid is compressed to 50-GHz with error-free performance for all channels.

ThO2-2 10:45 - 11:00

Laser Spectral-Purity Impact in Optical Processing of QPSK Signals in PPLN Waveguide

G. Serafino [1], A. Malacarne [2], and A. Bogoni [2]

[1] Scuola Superiore Sant'Anna, Pisa, Italy, [2] CNIT, Pisa, Italy

Performance of a PPLN-based, integratable optical scheme performing phase addition of two 40Gb/s QPSK signals, has been experimentally investigated in terms of the spectral-purity of the laser employed as pump in the scheme

ThO2-3 11:00 - 11:15

Electro-Optic Double-Antenna-Coupled Electrode Modulator Suspended to Low-k Substrate for 60GHz Band Wireless Signal

Naohiro Kohmu, Hiroshi Murata, and Yasuyuki Okamura

Graduate School of Engineering Science, Osaka Univ., Osaka, Japan

We propose $LiNbO_3$ double-antenna-coupled electrode modulators suspended to a low-k substrate. The basic operations of the proposed device at 58GHz were demonstrated successfully with an improvement of 5dB compared to our previous works.

ThO2-4 11:15 - 11:30

Optical homodyne BPSK receiver with Doppler shift compensation for LEO-GEO optical communication

T. Ando [1], E. Haraguchi [1], K. Tajima [1], Y. Hirano [1], T. Hanada [2], and S. Yamakawa [2]

[1] Mitsubishi Electric Corporation, Kanagawa, Japan, [2] Japan Aerospace Exploration Agency (JAXA), Ibaraki, Japan

This paper presents Bread Board Model of 7.2Gbps-homodyne BPSK (Binary Phase Shift Keying) receiver with an optical phase locked loop and a Doppler shifts compensator for inter-satellite optical communication link.

Room 101 1F

[ThG2] 10:30 - 12:00
Entangled Photons

Session Chair: Shigeki Takeuchi (R.I.E.S., Hokkaido Univ., Japan)

ThG2-1 10:30 - 11:00 Invited

Protecting Entanglement From Decoherence Via Weak Quantum Measurement

Y.-S. Kim, Jong-Chan Lee, Osung Kwon, and Yoon-Ho Kim

Dept. of Physics, Pohang Univ. of Science and Technology, Pohang, Korea

We demonstrate a novel scheme to protect entanglement from decoherence. Our entanglement protection scheme makes use of the quantum measurement itself for actively battling against decoherence and it can effectively circumvent even entanglement sudden death.

ThG2-2 11:00 - 11:15

Quantum-Enhanced Spatial Interference with the Three-Photon N00N State

Yong-Su Kim [1], Osung Kwon [1], Sang Min Lee [2], Jong-Chan Lee [1], Heonoh Kim [3], Sang-Kyung Choi [2], Hee Su Park [2], and Yoon-Ho Kim [1]

[1] Dept. of Physics, Pohang Univ. of Science and Technology (POSTECH), Pohang, Korea, [2] Division of Convergence Technology, Korea Research Inst. of Standards and Science, Daejeon, Korea, [3] Dept. of Physics, Pusan Nat'l Univ., Busan, Korea

We report the experimental demonstration of the Young's double-slit type spatial quantum interference of the three-photon N00N state, showing three times denser non- classical spatial interference fringes than that of the single- photon state.

ThG2-3 11:15 - 11:30

Non-classical Interference Between Two Telecom Photons with Wavelength Conversion

Toshiki Kobayashi [1], Rikizo Ikuta [1], Hiroshi Kato [1], Shigehito Miki [2], Taro Yamashita [2], Hirotaka Terai [2], Mikio Fujiwara [3], Takashi Yamamoto [1], Masato Koashi [4], Masahide Sasaki [3], Zhen Wang [1], and Nobuyuki Imoto [1]

[1] Graduate School of Engineering Science, Osaka Univ., Osaka, Japan, [2] Advanced ICT Research Inst., Nat'l Inst. of Information and Communications Technology (NICT), Kobe, Japan, [3] Advanced ICT Research Inst., National Inst. of Information and Communications Technology (NICT), Tokyo, Japan, [4] Photon Science Center, The Univ. of Tokyo, Tokyo, Japan

We converted the wavelength of two photons from visible to telecom range by a PPLN. The indistinguishability of two converted photons is observed by the HOM-interference visibility of 0.76±0.12, which surpasses the classical limit.

ThG2-4 11:30 - 11:45

Physical Approximation of the Partial Transpose and Its Application to Entanglement Detection

Hyang-Tag Lim [1], Yong-Su Kim [1], Young-Sik Ra [1], Joonwoo Bae [2], and Yoon-Ho Kim [1]

[1] Dept. of Physics, Pohang Univ. of Science and Technology (POSTECH), Pohang, Korea, [2] School of Computational Sciences, Korea Inst. for Advanced Study, Seoul, Korea

We report the first experimental implementation of an approximate partial transpose operation for photonic two-qubit systems. Direct detection of entanglement using the partial transpose operation is also demonstrated without performing quantum state tomography.

ThG2-5 11:45 - 12:00

Experimental Demonstration of Photon Number Squeezing with a Noisy Fiber Amplifier Source by Balanced Detection Technique

Shota Sawai, Hikaru Kawauchi, Kenichi Hirosawa, and Fumihiko Kannari

Dept. of Electronics and Electrical Engineering, Keio Univ., Yokohama, Japan

We demonstrated photon number squeezing at 1.55 μm using a noisy erbium-doped fiber laser, making use of collinear balanced detection technique, where intensity noise at a specific radio-frequency is canceled between two pulses.

Room 103 1F

[ThK2] 10:30 - 12:00
Photonic Active Device I

Session Chair: Meint K. Smit (Eindhoven Univ. of Technology, The Netherland)

ThK2-1 10:30 - 11:00 Invited

Lateral Current Injection Type Membrane DFB lasers

Shigehisa Arai [1,2], Nobuhiko Nishiyama [2], Tomohiro Amemiya [1], Takahiko Shindo [1], Mitsuaki Futami [2], and Kyohei Doi [2]

[1] Quantum Nanoelectronics Research Center, Tokyo Inst. of Technology, [2] Dept. Electrical and Electronic Engineering, Tokyo Institute of Technology, Tokyo, Japan

Lateral current injection (LCI) type membrane distributed feedback (DFB) lasers, proposed as light sources for on-chip optical wiring in LSIs, were theoretically investigated from aspects of low power consumption operation and high-speed direct modulation capability. It was confirmed that the LCI-membrane-DFB laser can be a good candidate for a low-pulse-energy (100 fJ/b) light source at high-speed operation (10 Gb/s), but the series resistance was found to be an important issue for low power consumption operation as well as a small footprint.

ThK2-2 11:00 - 11:15

Spectral Characteristics under Various Operation Conditions of 1.3-μm npn-AlGaInAs/InP Transistor Laser

Masashi Yukinari[1], Noriaki Sato[1], Nobuhiko Nishiyama[1], and Shigehisa Arai[1,2]

[1] Dept. of Electrical and Electronic Engineering, [2] Quantum Nanoelectronics Research Center Tokyo Inst. of Technology, Tokyo,Japan

The spectral characteristics of a 1.3-μm npn-AlGaInAs/InP transistor laser were studied by varying collector-base voltage and emitter current. Spectrum shifts as a function of output power by voltage control and current control show opposite behavior.

ThK2-3 11:15 - 11:30

Enhanced Modulation Bandwidth in Photon- Lifetime-Modulated Strongly Injection-Locked Semiconductor Ring Lasers

Gennady A. Smolyakov and Marek Osiński

Center for High Technology Materials, Univ. of New Mexico, NM, USA

A novel method for modulation bandwidth enhancement is presented, involving strongly injection-locked whistle-geometry semiconductor ring laser modulated through photon lifetime. Advantages of photon-lifetime modulation over conventional injection-current modulation are confirmed through numerical modeling.

ThK2-4 11:30 - 11:45

Photocurrent Generation in a Silicon Waveguide Integrated with Periodically Interleaved P-N Junctions

Haike Zhu, Linjie Zhou, Xiaomeng Sun, Jingya Xie, Zhi Zou, Liangjun Lu, Xinwan Li, and Jianping Chen

State Key Laboratory of Advanced Optical Communication Systems and Networks, Dept. of Electronic Engineering, Shanghai Jiao Tong Univ., Shanghai, P. R. China

We investigate the photocurrent generation in a silicon waveguide embedded with interleaved p-n junctions. Due to the surface-state absorption and the high built-in electrical-field, the responsivity reaches ~14.9 mA/W and the bandwidth is 11.5 GHz.

ThK2-5 11:45 - 12:00

Intersubband All-Optical Switch with Bandgap Control of InGaAs/AlAsSb Quantum Wells

Jijun Feng, Ryoichi Akimoto, Shin-ichiro Gozu, Teruo Mozume, Toshifumi Hasama, and Hiroshi Ishikawa

Network Photonics Research Center, Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Ibaraki, Japan

Bandgap control of ion-induced intermixing on InGaAs/AlAsSb coupled double quantum wells is studied. Moreover, a monolithic all-optical Michelson interferometer gating switch integrated with two different bandgap energies is developed based on the area-selective method.

Room 104A 1F

[ThL2] 10:30 - 12:00
Optical Modulators and Polymer Devices

Session Chair: Yasuyuki Inoue (NTT Photonics Labs., Japan)

ThL2-1 10:30 - 11:00 Invited

Electro-Optic Polymer Modulators Based on Hybrid and Multilayer Slot Waveguides

Y. Enami [1] and A. K-Y. Jen [2]

[1] Research Inst. for Nanodevice and Bio Systems, Hiroshima Univ., Hiroshima, Japan, [2] Dept. of Materials Science and Engineering, Univ. of Washington, WA, USA

We propose and demonstrate a hybrid directional coupler modulator and a novel electro-optic (EO) polymer/TiO_2 multilayer slot waveguide modulator for high-speed operations.

ThL2-2 11:00 - 11:15

Titanium Dioxide/electro-optic Polymer Hybrid Rib-Waveguide Modulators

Feng Qiu and Shiyoshi Yokoyama

Inst. for Materials Chemistry and Engineering, Kyushu Univ., Fukuoka, Japan

In this study, we report a TiO_2/electro-optic polymer hybrid rib-waveguide with a low figure of merit of 4 V·cm. The waveguide possesses a relatively low propagation loss of 3.0 dB/cm and a straightforward fabrication process.

ThL2-3 11:15 - 11:30

All Electro-Optic Polymer Waveguides Towards Vertical Integration of Modulators and Switches

Akira Otomo [1], Rieko Ueda, Isao Aoki [1], Kohei Ota [1], Toshiki Yamada, Shin-ichiro Inoue [1], Yoshinari Awaji [2], and Tetsuya Kawanishi [2]

[1] Advanced ICT Research Inst., NICT, Hyogo, Japan, [2] Photonic Network Research Institute, NICT, Tokyo, Japan

All-polymer electro-optic (EO) waveguides were fabricated by using cross-linkable EO polymers for both core and clad layers. Such formation has advantages in making multilayered integration of EO devices for the multicore fiber communication system.

ThL2-4 11:30 - 11:45

0.018pm/°C Athermal Silicon Nitride Ring Resonator by Polymer Cladding

S. Yokoyama, F. Qiu, Y. Feng, A. M. Spring, and K. Yamamoto

Inst. for Materials Chemistry and Engineering Kyushu Univ., Fukuoka, Japan

We report a simple and effective method for the postfunctionalization trimming of athermal ring resonators overcoming the highly demanded fabrication. The resonator shows the reduction of the temperature-dependent wavelength shift from -9.8 to -0.018 pm/°C.

ThL2-5 11:45 - 12:00

60GHz Electro-Optic Modulator Suspended to Patch-Antennas Embedded with a Gap on Low-*k* Dielectric Material

Y. N. Wijayanto, H. Murata, and Y. Okamura

Graduate School of Engineering Science, Osaka Univ., Osaka, Japan

We propose electro-optic modulators suspended to patch-antennas embedded with a narrow-gap on low-*k* dielectric materials. The analysis and experimental results of the proposed devices for 60GHz bands are presented with measured modulation efficiency of ~50dB.

Room 104B 1F

Room C-1 1F

[ThR3] 13:30 - 15:30
Advanced Signal Processing for Coherent Receiver

Session Chair: Itsuro Morita (KDDI R&D Laboratories, Japan)

ThR3-1 13:30 - 14:00 Invited

DSP for Mode Division Multiplexing

Sebastian Randel and Peter Winzer
Bell Laboratories, Alcatel-Lucent, New Jersey, USA

We discuss possible architectures and complexity scaling of SDM interfaces that include multiple-input multiple-output digital signal processing (DSP) to deal with coupling between spatial and polarization modes.

ThR3-2 14:00 - 14:15

Slip-State Estimation by Polarization-Phase Constellation Monitoring in Phase-Shift Keyed Transmission

Tsuyoshi Yoshida, Takashi Sugihara, Kazuyuki Ishida, and Takashi Mizuochi
Information Technology R&D Center, Mitsubishi Electric, Kanagawa, Japan

We propose novel slip-state estimation by constellation monitoring of the carrier recovered signal in the polarization-phase domain. In the presence of random noise, the proposed method is over 1 dB more sensitive than differential decoding.

ThR3-3 14:15 - 14:30

In-Service Method of Path Length Alignment in SDM Systems with Self-Homodyne Detection

R. S. Luis [1], B. J. Puttnam [1], J. M. D. Mendinueta [1], J. Sakaguchi [1], W. Klaus [1], Y. Awaji [1], N. Wada [1], A. Kanno [2] and T. Kawanishi [2]
[1] Photonic Network System Laboratory, [2] Lightwave Devices Laboratory Nat'l Inst. of Information and Communications Technology, Tokyo, Japan

An in-service path length alignment subsystem for phase noise cancellation in self-homodyne coherent detection systems is proposed and demonstrated for spatial division multiplexing multi-core fiber links. Sub-centimeter resolution is demonstrated with penalties below 0.5dB.

ThR3-4 14:30 - 14:45

Reduced Oversampling Rate for Adaptive Search Based Blind FD CD Estimation

M. F. Panhwar [1], C. Wördehoff [2], K. Puntsri [1], S. Hussin [1], U. Rückert [2] and R. Noé [1]
[1] ONT, EIM-E, Univ. of Paderborn, Paderborn, Germany, [2] CITEC, Bielefeld Univ., Bielefeld, Germany

An adaptive blind CD estimation algorithm in frequency-domain is analyzed at reduced sampling rates. 112 Gb/s PDM-QPSK and 224 Gb/s PDM-16-QAM systems are simulated to evaluate the performance of our resource efficient CD estimation algorithm.

ThR3-5 14:45 - 15:00

Energy Efficient Carrier Phase Recovery for Self-Homodyne Polarization-Multiplexed QPSK

J. M. Delgado Mendinueta [1], B. J. Puttnam [1], J. Sakaguchi [1], R. S. Luis [1], W. Klaus [1], Y. Awaji [1], N. Wada [1], A. Kanno [2] and T. Kawanishi [2]
[1] Photonic Network System Laboratory, [2] Lightwave Devices Laboratory Nat'l Inst. of Information and Communications Technology (NICT), Tokyo, Japan.

A reduction of up to 10^3 times in the carrier-phase estimation rate is demonstrated for self-homodyne, space-division multiplexed, PDM-QPSK systems. This enables a significant energy saving in receiver DSP for self-homodyne systems.

ThR3-6 15:00 - 15:15

A Linear-MMSE *M*th Power-Law Phase Estimator for Symmetric Lévy-Process Phase Noise in *M*-PSK Transmission

Go Ito [1], Yuki Yoshida [1], Toshiharu Ito [2], Kiyoshi Fukuchi [2] and Ken-ichi Kitayama [1]
[1] Graduate School of Engineering, Osaka Univ., Osaka, JAPAN, [2] Green Platform Research Laboratories, NEC Corporation, Kawasaki, JAPAN

An *M*th power-law phase estimator using the Su-Wong-Ho filter; the optimal linear filter for symmetric Lévy-process phase noise, is proposed for optical *M*-PSK receivers, and is demonstrated experimentally in 20Gbps optical QPSK transmissions.

ThR3-7 15:15 - 15:30

Blind Equalization and Carrier-Phase Recovery in QPSK Coherent Optical Receivers Based on Modified Constant-Modulus Algorithm

Md. Saifuddin Faruk [1] and Kazuro Kikuchi [2]
[1] Dept. of Electrical and Electronic Engineering, Dhaka Univ. of Engineering and Technology, Gazipur, Bangladesh, [2] Dept. of Electrical Engineering and Information Systems, The Univ. of Tokyo, Tokyo, Japan

We propose and experimentally verify a fully-blind scheme for equalization and carrier-phase recovery in QPSK coherent optical receivers, which is based on the modified CMA. Its computational complexity is much less than the conventional approach.

Room C-2 1F

[ThI3] 13:30 - 15:30
Nanowires & Nanoparticle

Session Chair: Bumki Min (KAIST, Korea)

ThI3-1 13:30 - 14:00 Invited

Compound Semiconductor Nanowires for Optoelectronic Devices

Q. Gao, N. Jiang, H. Joyce, S. Paiman, J. Wong-Leung, Y.-H. Lee, L. Fu, H. H. Tan and C. Jagadish
Dept. of Electronic Materials Engineering, Research School of Physics and Engineering The Australian Nat'l Univ., ACT, Australia

We review various III-V compound semiconductor nanowires grown by MOCVD, mainly focusing on their phase control, optical and structural properties and some prototype optoelectronic devices based on these nanowires including solar cells and lasers.

ThI3-2 14:00 - 14:15

Position Controlled Nanocavity Using a Single Nanowire in Photonic Crystals.

M. D. Birowosuto [1,2], A. Yokoo [1,2], G. Zhang [1], E. Kuramochi [1,2], H. Taniyama [1,2], M. Takiguchi [1,2], K. Tateno [1], M. Ono [1,2], and M. Notomi [1,2]
[1] NTT Basic Research Laboratories, NTT Corporation, Kanagawa, Japan, [2] NTT Nanophotonics Center, NTT Corporation, Kanagawa, Japan.

We propose a position controlled nanocavity from a single semiconductor nanowire inside a slot of photonic crystals, which is created by modifying the refractive index in the line defect using nanowires. Preliminary experiments are shown.

ThI3-3 14:15 - 14:30

One-Dimensional Photonic Crystal Ring Lasers on SiO_2 Substrate

Tsan-Wen Lu, Wei-Chi Tsai, Che-Yao Wu, and Po-Tsung Lee
Dept. of Photonics & Inst. of Electro-Optical Engineering, Nat'l Chiao Tung Univ., Hsinchu, Taiwan

One-dimensional photonic crystal ring resonators are utilized in realizing *InGaAsP/SiO*$_2$ hybrid lasers via adhesive bonding technique. Low threshold single-mode lasing properties are investigated and further altered via inducing a nanocavity.

ThI3-4 14:30 - 14:45

Fabrication of Photonic Crystal on Tapered Nanofibers Using a Femtosecond Laser

K. P. Nayak and K. Hakuta
Center for Photonic Innovations Univ. of Electro-Communications, Tokyo, Japan

We demonstrate that thousands of periodic nano-craters are fabricated on a tapered optical nanofiber, by irradiating with just a single femtosecond laser pulse. The periodic nano-craters on the nanofiber, act as a 1-D photonic crystal.

ThI3-5 14:45 - 15:00

Mechanistic Study on Plasmon-based Optical Trapping of Hard and Soft Nanoparticles

Tatsuya Shoji [1] and Yasuyuki Tsuboi [1,2]
[1] Dept. of Chemistry, Graduate School of Science, Hokkaido Univ., Sapporo, Japan, [2] JST, PRESTO, Japan

We demonstrated that localized surface plasmon enables to efficient optical trapping of nanoparticles and polymer chains due to the enhancement effect of an incident resonant electromagnetic field at the surfaces of noble metallic nanostructures.

ThI3-6 15:00 - 15:15

Direct imaging of localized fields in a gold nanostructure using a scattering-type near-field microscope

Hideki Fujiwara, Yoshito Tanaka, and Keiji Sasaki
Research Inst. for Electronic Science, Hokkaido Univ., Sapporo, Japan

Localized optical fields in metal nanostructures with a nanometer-size gap were measured with high spatial resolution beyond the diffraction limit by using a scattering-type near-field microscope.

ThI3-7 15:15 - 15:30

High-Temperature ZnSe:Mn/ZnS Nanophosphors with Very High Quantum Efficiency for White LEDs

Brian A. Akins [1], Sergei A. Ivanov [2], John B. Plumley [1], Samantha M. Stephens [1], Nathaniel C. Cook [1], Gennady A. Smolyakov [1], and Marek Osiński [1]
[1] Center for High Technology Materials, Univ. of New Mexico, NM, USA, [2] Center for Integrated Nanotechnologies, New Mexico, USA, and Los Alamos Nat'l Laboratory, NM, USA

We have synthesized ZnSe:Mn/ZnS doped core/shell quantum dots with high temperature stability and 91.0% quantum efficiency at the 597 nm emission with 412 nm excitation, very attractive as nanophosphors for white LEDs.

Room F 1F

[ThA3] 13:30 - 15:30
Novel Solid State Laser Technologies

Session Chair: Jianlang Li (Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China)

ThA3-1 13:30 - 14:00 Invited

120W Solar-Pumed Laser with Record-High Collection Efficiency

Tomomasa Ohkubo [1], Thanh Hung Dinh [1], Yasuaki Takenaka [1], Naoki Marukawa [1], Takashi Yabe [1], Yoshiaki Okamoto [2] and Takagimi Yanagitani [3]
[1] Tokyo Inst. of Technology, Tokyo, Japan, [2] Okamoto Optics Works, Kanagawa, Japan, [3] Konoshima Chemical, Co., Ltd, Kagawa, Japan

We developed solar-pumped laser with record-high collection efficiency. We used Fresnel lens as a primary solar concentrator and developed new 2nd and 3rd concentrators. 120W of laser output and collection efficiency of 30W/m^2 was realized.

ThA3-2 14:00 - 14:15

Nd^{3+}/Yb^{3+} Co-doped Bi_2O_3-B_2O_3-TeO_2 Glass for Solar Pumped Lasers

Yuya Shimada, and Seiki Ohara
Asahi Glass Co., Ltd, Yokohama, JAPAN

We have studied Nd^{3+}/Yb^{3+} co-doped Bi_2O_3-B_2O_3-TeO_2 glasses for solar pumped lasers, and compared to Nd^{3+}-doped Bi_2O_3-B_2O_3-TeO_2 glasses. Nd^{3+}/Yb^{3+} co-doped Bi_2O_3-B_2O_3-TeO_2 glasses show large emission intensity compared to Nd^{3+}-doped Bi_2O_3-B_2O_3-TeO_2 glasses.

ThA3-3 14:15 - 14:30

Yb^{3+}-Doped $Lu_3Al_5O_{12}$ Ceramic Thin-Disk Laser

Hiroaki Nakao [1,3], Akira Shirakawa [1], Ken-ichi Ueda [1], Hideki Yagi [2], Takagimi Yanagitani [2], Birgit Weichelt [3], Katrin Wentsch [3], Marwan Abdou Ahmed [3], and Thomas Graf [3]
[1] Inst. for Laser Science, Univ. of Electro-Communications, Tokyo, Japan, [2] Takuma Works, Konoshima Chemical Co., Ltd., Kagawa, Japan, [3] Institut für Strahlwerkzeuge (IFSW), Universität Stuttgart, Stuttgart, Germany

First laser oscillation of Yb^{3+}-doped $Lu_3Al_5O_{12}$ ceramic thin-disk laser is demonstrated. Maximum output power of 101 W was obtained from a 300-μm thick disk and 55% slope efficiency was obtained from a 150-μm thick disk.

ThA3-4 14:30 - 14:45

Development of a Sub-400-fs High-Average- Power Thin-Disk Ring Oscillator

A. Amani Eilanlou [1], Yasuo Nabekawa [1], Makoto Kuwata-Gonokami [2,3], and Katsumi Midorikawa [1,2]
[1] RIKEN Advanced Science Inst., Saitama, Japan, [2] Photon Science Center, The Univ. of Tokyo, Tokyo, Japan, [3] Graduate School of Science, The Univ. of Tokyo, Tokyo, Japan

We have generated 15.8-MHz, sub-400-fs pulses with a power of 460 W in a thin-disk ring oscillator under development for intra-cavity high-order harmonic generation.

ThA3-5 14:45 - 15:00

Development of High-energy, Phase-controlled Picosecond Yb:YLF CPA Laser for Adaptive Pulse Shaping on Few-cycle OPCPA

Y. Akahane [1,2], K. Ogawa [1,2], and K. Yamakawa [1,2]
[1] Japan Atomic Energy Agency, Kyoto, Japan, [2] JST-CREST, Kyoto, Japan

Cryogenically-cooled Yb:YLF chirped-pulse regenerative amplifier has been developed for pumping OPCPA. 107 mJ pulses were obtained and compressed down to 2.2 ps without pedestals. Adaptive phase control is newly implemented for precise idler phase compensation.

ThA3-6 15:00 - 15:15

Directly InGaN-laser Diode Pumped Ti:Sapphire Laser

Shota Sawai, Hikaru Kawauchi, Kenichi Hirosawa, and Fumihiko Kannari
Dept. of Electronics and Electrical Engineering, Keio Univ., Yokohama, Japan

We report InGaN-laser diode pumped Ti:Sapphire laser using a 2.5-mm-long crystal with a figure-of-merit (FOM) of ~100. CW lasing at wavelength of 800 nm with a maximum average output power of 28.6 mW is obtained.

ThA3-7 15:15 - 15:30

Mode-locked Nd:LGS Laser with Femtosecond Pulse Duration

Qing Wang [1], Zhiyi Wei [1], Jiaxing Liu [1], Zhaohua Wang [1], Zhiguo Zhang [1], Huaijin Zhang [2], Jiyang Wang [2]
[1] Beijing Nat'l Laboratory for Condensed Matter Physics and Inst. of Physics, Chinese Academy of Sciences, Beijing, China, [2] State Key Laboratory of Crystal Material and Institute of Crystal Material, Shandong Univ., Jinan, China

A mode-locked Nd^{3+}:LGS laser of running with femtosecond pulse was demonstrated. By using SF10 prism pair for dispersion compensation, 278 fs transform-limited pulse trains at the central wavelength of 1084 nm have been obtained.

Room G 1F

[ThE3] 13:30 - 15:15
Nanostructures and Micro/ Nano Processing

Session Chair: Nilesh J. Vasa (Indian Inst. of Technology Madras, India)

ThE3-1 13:30 - 13:45

Dependence on Repetition Rate in Post-Laser Annealing Process of Ion-Implanted ZnO Nanorods Using KrF Excimer Laser

T. Shimogaki, T. Ofuji, M. Higashihata, H. Ikenoue, D. Nakamura, T. Asano and T. Okada

Information Science and Electrical Engineering, Kyushu Univ., Fukuoka, Japan

P-implanted ZnO nanorods were annealed by a KrF excimer laser at different repetition rate. The entire implanted region of ZnO nanorods was annealed beyond the optical-absorption length at high repetition rate.

ThE3-2 13:45 - 14:00

Optical Properties Evaluation of Sb-doped ZnO Nanorods Using UV Laser Doping

T. Ofuji, T. Shimogaki, K. Okazaki, H. Ikenoue, M. Higashihata, D. Nakamura, T. Okada

Graduate School of Information Science and Electrical Engineering, Kyushu Univ., Fukuoka, Japan

We synthesized *n*-ZnO nanorods by nanoparticle-assisted pulsed laser deposition, and attempt to fabricate *p*-type Sb-doped ZnO by a laser doping technique. The *I-V* property of produced experimentally *p-n* homo junction diode showed rectification.

ThE3-3 14:00 - 14:15

Influence of Grit-Size and Sintering Temperature on SiC TargetDuringPulsed Laser Deposition

Venkataramesh Bhimasingu, Emmanuel Pannirselvam and Nilesh J. Vasa

Indian Inst. of Technology Madras, Tamil Nadu, India

Pulsed laser deposition of SiC thin films on N-type Si (100) substrate was studied by using an Nd^{3+}: YAG laser. SiC target with a grit-count of 500 and sintered at 1600 °C was found suitable.

ThE3-4 14:15 - 14:30

Controlled Growth of ZnO Nanocrystals Using Laser Interference Irradiation

Y. Muraoka [1], T. Sugie [1], T. Shimogaki [1], M. Higashihata [1], D. Nakamura [1], Y. Nakata [2], and T. Okada [1]

Graduate School of Information Science and Electrical Engineering, Kyushu Univ., Japan, [2] Inst. of Laser Engineering, Osaka Univ., Japan

We succeeded in position-controlled growth of ZnO nanocrystals using a ZnO buffer layer irradiated by laser interference pattern. In addition, large-sized ZnO nanowall-arrays and nanorings were fabricated with increasing the growth time.

ThE3-5 14:30 - 14:45

Laser Cutting of Carbon Fiber Reinforced Plastics (CFRP) by Fiber Laser Irradiation

Hiroyuki Niino [1,2], Yoshizo Kawaguchi [1,2], Tadatake Sato [1,2], Aiko Narazaki [1,2], Ryozo Kurosaki [1], Mayu Muramatsu [1,2], Yoshihisa Harada [1,2], Koji Wakabayashi [1,3], Takahiro Nagashima [1,3], Zyunpei Kase [1,3], Masafumi Matsushita [1,4], Koichi Furukawa [1,4], Michiteru Nishino [1,3]

[1] Advanced Laser and Process Technology Research Association (ALPROT), Tokyo, Japan, [2] Nat'l Inst. of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, [3] MIYACHI CORPORATION, Tokyo, Japan, [4] Shin Nippon Koki Co., Ltd., Osaka, Japan, [5] Mitsubishi Chemical Corporation, Tokyo, Japan

Laser cutting of CFRP with a cw 1kW IR fiber laser. A well-defined cutting of CFRP was performed by the laser irradiation with a fast beam scanning on a multiple-scan-pass method.

ThE3-6 14:45 - 15:00

Surface Modification of Iron Thin Films Into Corrosion Resistant Property by F_2 Laser

M. Okoshi [1], Y. Awaihara [1], T. Yamashita [2], and N. Inoue [1]

[1] Dept. of Electrical and Electronic Engineering, Nat'l Defense Academy, Kanagawa, Japan, [2] Dept. of Material and Life Science, Kanto Gakuin Univ., Kanagawa, Japan

A vacuum-UV F_2 laser of 157 nm wavelength induced strong oxidation of Fe thin film surface to show the chemical resistance to pseudo seawater and HNO_3 aqueous solution for selective metallization on silica glass substrate.

ThE3-7 15:00 - 15:15

Kalman Filter Based Estimation of Decay Time for a Multimode Optical Cavity

M. Yanagisawa, A. G. Kallapur, P. C. Kuffner, I. R. Petersen and C. C. Harb

School of Engineering and Information Technology Univ. of New South Wales at the Australian Defense Force Academy Canberra, ACT, Australia

We develop an extended Kalman filter to estimate the ring-down time of a multimode Fabry-Perot optical cavity with a pulse train input.

Room H 1F

[ThF3] 13:30 - 15:30
Bio and Chemical Sensing

Session Chair: Yasuhiro Awatsuji (Kyoto Inst. of Technology, Japan)

ThF3-1 13:30 - 13:45

Super-luminescent Diode Based CO_2 Sensing for Combustion Applications

K. Sulochana [1], K. Akash [1], N.V. Ravi Teja [1], Nilesh J. Vasa [1] and M. Kumaravel [2]

[1] Dept. of Engineering Design, Indian Inst. of Technology Madras, Chennai, India, [2] Dept. of Electrical Engineerin, Indian Inst. of Technology Madras, Chennai, India

Super-luminescent diode (1535nm) based absorption spectroscopy is proposed for C_2H_2 and CO_2 measurements. The experiment is performed with pure C_2H_2, CO_2, mixture of C_2H_2 and CO_2 and biogas and the results are presented here.

ThF3-2 13:45 - 14:00

Self-Mixing Sensing Under Strong Feedback Using Multimode Semiconductor Lasers

T.B. Pham [1], H.C. Seat [1], O. Bernal [1], F. Surre [2] and T. Bosch [1]

[1] CNRS, LAAS, Universite de Toulouse, INP, Toulouse, France, [2] City Univ. London, London, United Kingdom

The use of bi-mode semiconductor lasers is demonstrated as a candidate to solve the problems of self-mixing sensing under strong feedback. Experimental results show the recovery of fringes when the laser is in bi-mode regime.

ThF3-3 14:00 - 14:15

A Study of Trace Gas Detection Based on Cavity Enhanced Absorption Spectroscopy (CEAS) for Power Transformer Diagnosis

Ryuta Someya [1,2], Takeshi Imamura [1], Yukio Kanazawa [1], Hiroshi Hatano [1], Hazime Takahashi [2], Kazuyoku Tei [2], and Shigeru Yamaguchi [2]

[1] Toshiba Corp, Kanagawa, Japan, [2] Tokai Univ., Kanagawa, Japan

We apply CEAS technique to monitor trace acetylene gas in oil as marker of power transformer diagnosis. Developed CEAS sensor can detect trace acetylene gas as low as 8ppb in a few seconds.

ThF3-4 14:15 - 14:30

Novel Biosensing Method Based on Symmetry Breaking

M. L. Juan, X. Vidal, and G. Molina-Terriza

Dept. of Physics and Astronomy, Macquarie Univ., NSW, Australia and ARC Center of Engineered Quantum Systems, Macquarie Univ., NSW, Australia

We propose a novel detection method based on the symmetry breaking induced by the bio-molecule to be detected. This optical method provides substantial advantages over current approaches for the conception of biosensors.

ThF3-5 14:30 - 14:45

Biochemical Sensors Based on Dual Antiresonant Reflecting Optical Waveguides

Cheng-Han Lee [1], Hsin-Feng Hsu [1], Ming-Feng Lu [2], and Yang-Tung Huang [3]

[1] Dept. of Electronics Engineering and Inst. of Electronics, Nat'l Chiao Tung Univ., Hsinchu, Taiwan, [2] Dept. of Electronics Engineering, Minghsin Univ. of Science and Technology, Hsinchu, Taiwan, [3] Dept. of Electronics Engineering and Institute of Electronics, and the Dept. of Biological Science and Technology, National Chiao Tung Univ., Hsinchu, Taiwan

Design, fabrication, and characterization of biochemical sensors based on dual ARROW structures are studied. A succession of NaCl solutions with different concentration can be investigated in real time. Sensitivity of this sensor is 1305 micrometer/RIU.

ThF3-6 14:45 - 15:00

Kinetic Analysis of Graphene Oxide Sheet and Protein Interactions Using Surface Plasmon Resonance Biosensors

Teng-Yi Huang [1], Nan-Fu Chiu [1], Hsin-Chih Lai [2]

[1] Inst. of Electro-Optical Science and Technology, Nat'l Taiwan Normal Univ., Taipei, Taiwan, [2] Dept. of Medical Biotechnology and Laboratory Science, Chang Gung Univ., Taoyuan, Taiwan

This paper is intended to demonstrate that graphene oxide (GO) on Au films based surface plasmon resonance technique for protein kinetic analysis. The results show that the detection limits of GO sheets were dramatically improved.

ThF3-7 15:00 - 15:15

Pulse Beat Monitoring Using Dual-polarization DBR Fiber Laser

Jianghai Wo[1], He Wang[1], Qizhen Sun[1,2], Xiaolei Li[1], Deming Liu[1], Perry Ping Shum[1,3]

[1] Nat'l Engineering Laboratory for Next Generation Internet Access System, School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, Wuhan, China, [2] Aston Inst. of Photonic Technologies, Aston Univ., Birmingham, UK, [3] OPTIMUS Centre, School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore

By tracing the beat frequency between two polarization modes generated from a DBR fiber laser, a novel human pulse monitoring device is demonstrated. The results show the device could be very useful for healthcare.

ThF3-8 15:15 - 15:30

Spectroscopic Measurements of Fiber Tip Heat Source Excited by a Semiconductor Laser

Yusuke Imai, Takahiro Fujimoto, Kazuyoku Tei, Shigeru Yamaguchi

Tokai Univ., Kanagawa, Japan

High temperature heat source at a tip of optical fiber can be formed by depositing TiO_2. The temperature was measured to be more than 3000K with time resolved spectroscopy based on two-color thermometry.

Room I 2F

[ThP3] 13:30 - 15:00
Radio Over Fiber

Session Chair: Katsumi Iwatsuki (Tohoku Univ., Japan)

ThP3-1 13:30 - 14:00 Invited

100-Gbps Hybrid Optical Fiber-wireless Transmission

Xiaodan Pang, Antonio Caballero, Lei Deng, Xianbin Yu, R. Borkowski, V. Arlunno, Anton Dogadaev, Darko Zibar, L. Frejstrup Suhr, J. J. Vegas Olmos, Idelfonso Tafur Monroy

Technical Univ. of Denmark, Lyngby, Denmark

We present experimental results on using optical transmission technologies such as I&Q modulators, digital coherent receivers, heterodyne up-conversion in fast photodiodes, to generate, transmit and detect high capacity wireless transmission. Both OFDM and QAM modulation formats are tested in the W-achieving capacities up to 100- Gbps with seamless optical fiber-wireless conversion.

ThP3-2 14:00 - 14:15

RoF Uplink Transmission Scheme with Reflective-SOA for Remotely Beam-Steerable Photonic Array-Antenna

Masayuki Oishi, Kosuke Nishimura, and Shigeyuki Akiba

KDDI R&D Laboratories Inc., Saitama, JAPAN

RoF uplink transmission scheme for remotely beam steerable photonic array-antennas utilizing reflective semiconductor optical amplifiers was proposed. Our proposed scheme would be able to realize cost effective photonic antenna systems with a simple structure.

ThP3-3 14:15 - 14:30

Photonic Array-Antenna in Millimeter-Wave Band by Wavelength Division Multiplexed Radio over Fiber

Yoshihiro Nishikawa [1], Masayuki Oishi [2], Shigeyuki Akiba [2], Jiro Hirokawa [1] and Makoto Ando [1]

[1] Dept. of Electrical and Electronic Eng., Tokyo Inst. of Technology, Tokyo, Japan, [2] KDDI R&D Laboratories, Inc., Saitama, Japan

We demonstrated beam steering of array-antenna in millimeter-wave band at 39 GHz by WDM Radio over Fiber. The proposed photonic antenna can realize future ultra-broadband and smart antenna systems by a novel photonic approach.

ThP3-4 14:30 - 14:45

Centralized Optical Routing based on Digitized Radio-over-Fiber Technique for Wireless Backhauling

A. HyunDo Jung [1], and B. KyungWoon Lee [2]

[1] Bell Labs Seoul, DMC R&D Center, Seoul, Korea, [2] Korea Univ., Seoul, Korea

We demonstrated centralized optical routing based on digitized RoF technique for wireless backhaul-networks. Digitized RoF system showed constant performance with EVM (3.75%) while the performance of analog counterpart is highly dependent on optical link conditions.

ThP3-5 14:45 - 15:00

Analysis of Uplink Radio Signal Transmission on Millimeter-Wave-Over-Fiber Systems

Pham Tien Dat, Atsushi Kanno, and Tetsuya Kawanishi

Nat'l Inst. of Information and Communications Technology, Tokyo, Japan

The performance of an uplink radio signal on millimeter-wave-over-fiber using RF self-homodyned is numerically analyzed. The maximum wireless distance is derived considering the effects of fading in wireless channel and noise, distortion in radio-over-fiber link.

Room J 2F

[ThS3] 13:30 - 15:30
Novel Fibers

Session Chair: Yoshinori Yamamoto (Sumitomo Electric Industries, Ltd., Japan)

ThS3-1 13:30 - 14:00 Invited

Novel Fibers for Data Centers and High Performance Computing

S. Bickham [1], D. Butler [2]

[1] Corning Optical Fiber and Cable, NY, USA, [2] Corning Science and Technology, NY, USA

We present modeling results showing that a multimode fiber optimized for long wavelengths can address bandwidth and connectivity issues in optical backplanes. A multicore fiber with 2x4 cores facilitates coupling to linear transceiver arrays.

ThS3-2 14:00 - 14:15

Numerical and experimental analysis of trenchassisted bend-insensitive multimode fibers

T. Aiba [1], H.Ishida [2], M. Tanaka [3], and Y. Koyamada [1]

[1] Ibaraki Univ., Ibaraki, JAPAN, [2] YAZAKI Corporation, Kanagawa, JAPAN, [3] Mitsubishi Cable Industries, LTD., Hyogo, JAPAN

We numerically analyze the guided modes and leaky modes of bend-insensitive multimode fibers assisted with a deep refractive-index trench. The impact of the leaky modes on the transmission characteristics is clarified numerically and experimentally.

ThS3-3 14:15 - 14:30

Bandwidth Measurement of MMF by Using Phase-sensitive Fiber Interferometric Technique

Chan-Young Kim, Il-Shin Song, and Tae-Jung Ahn

Dept. of Photonic Engineering, Chosun Univ., Gwangju, South Korea

In this study, the bandwidth of multimode fibers (MMFs) is determined using the measured modal dispersion through a phase-sensitive optical fiber interferometric technique.

ThS3-4 14:30 - 14:45

Web-Structured All-Solid PBG Fiber

Ryuichiro Goto [1], Shoichiro Matsuo [1], Kazuki Matsubara [2], and Kunimasa Saitoh [2]

[1] Optics and Electronics Laboratory, Fujikura Ltd., Chiba, Japan, [2] Graduate School of Information Science and Technology, Hokkaido Univ., Sapporo, Japan

We present a design and manufacture of a web-structured all-solid PBG fiber. We show experimentally that the loss can be reduced to a practical level (~7 dB/km) with an appropriate design of the web structure.

ThS3-5 14:45 - 15:00

SBS suppression fiber with nonuniform Brillouin frequency shift distribution realized by controlling its fictive temperature

Lin Ma, Kyozo Tsujikawa, Nobutomo Hanzawa, and Fumihiko Yamamoto

Access Network Service Systems Laboratories, NTT Corporation, Ibaraki, Japan

We demonstrate a single-mode fiber with nonuniform Brillouin frequency shift distribution realized by controlling its fictive temperature. This technique is useful for suppressing stimulated Brillouin scattering and estimating the fictive temperature of silica-based fibers.

ThS3-6 15:00 - 15:15

Low Similar Splice Loss of A_{eff}-Enlarged Pure-Silica-Core Fiber

Yuki Kawaguchi, Yoshinori Yamamoto, Masaaki Hirano, and Takashi Sasaki

Sumitomo Electric Industries, Ltd., Yokohama, Japan

Low similar splice loss between pure-silica-core fibers with enlarged effective area of 110 μm^2 are demonstrated. The fiber is suitable for terrestrial long-haul transmission owing to its low attenuation, splice loss and macro-bending loss.

ThS3-7 15:15 - 15:30

Weighted Coupling of Electromagnet-Driven Long-Period Fiber Gratings

Tomohiro Harada, Masahiro Tomiki, and Hajime Sakata

Shizuoka Univ., Hamamatsu, Japan

We present long-period fiber gratings induced by electromagnet with a coil spring. Spectral tailoring is attained by attaching the tapered rods to the coil spring. Filter bandwidth can be controlled without changing the grating length.

Room K 2F

[ThO3] 13:30 - 15:15
Optical Signal Processing V

Session Chair: Tsuyoshi Konishi (Osaka Univ., Japan)

ThO3-1 13:30 - 14:00 Invited

Signal Processing Subsystems for Optical Interconnects

A. Melloni [1], F. Morichetti [1], P. Orlandi [2], P. Bassi [2], M.J. Strain [3] and M. Sorel [3]

[1] DEIB - Politecnico di Milano, Milano, Italy, [2] DEI, Universita di Bologna, Bologna, Italy, [3] School of Engineering, Univ. of Glasgow, Glasgow, United Kingdom

Progresses in design, realization and management of passive, tunable and reconfigurable silicon photonics circuits are reported. The need for a control layer with suitable probes, control strategies, signal monitoring and actuators is discussed.

ThO3-2 14:00 - 14:15

Experimental Demonstration of Wavelengthshift-free Optical Phase Conjugation Using Orthogonal Pumps

Shohei Inudo, Yuki Yoshida, Akihiro Maruta, and Ken-ichi Kitayama

Graduate School of Engineering, Osaka Univ., Suita, Japan

The wavelength-shift-free optical phase conjugation technique using orthogonal pumps is verified experimentally via the coherent detection technique. 20Gbps optical QPSK signal and its conjugate are simultaneously demodulated as a polarization-multiplexed signal.

ThO3-3 14:15 - 14:30

System Tolerance of PSA Based Optical Phase Regeneration to Chromatic Dispersion and Polarization Misalignment

Youichi Akasaka, Jeng-Yuan Yang, and Motoyoshi Sekiya

Fujitsu Laboratories of America, Inc., Richardson, U.S.A.

System tolerance of m-PSK optical phase regeneration was investigated. Chromatic dispersion tolerance shows strong dependence on signal's baud-rate and m-number. Polarization mismatch between pumps and signal reduces gain but has no impact on phase regeneration.

ThO3-4 14:30 - 14:45

Investigation of phase-sensitive amplification in a dual pump bi-directional PPLN-based PSA

A. A. C. Albuquerque [1], B. J. Puttnam [2], M. V. Drummond [1], Á. Szabó [3], D. Mazroa [3], S. Shinada [2], R. N. Nogueira [1] and N. Wada [2]

[1] Instituto de Telecomunicações, Campus Universitário de Santiago, Aveiro, Portugal, [2] Photonic Network System Laboratory, NICT, Tokyo, Japan, [3] Dept. of Telecommunications & Media Informatics, Budapest Univ. of Technology & Economics, Budapest, Hungary

In this work the phase sensitive properties of a dual pump phase sensitive amplifier based on a bi-directional periodically poled lithium niobate are numerically and experimentally investigated.

ThO3-5 14:45 - 15:00

Analysis of DFG-based Millimeter-Wave Signal Generation and Proposal of Optical Cross Correlator

Yusuke Takashima, Hiroshi Murata, and Yasuyuki Okamura

Graduate School of Engineering Science, Osaka Univ., Osaka, JAPAN

We report the detail analysis of difference frequency generation in millimeter-wave rectangular waveguides embedded with a nonlinear optical crystal. Based on the analysis results, we propose new optical cross correlation devices.

ThO3-6 15:00 - 15:15

100 km Transmission of 40 Gbit/s RZ-OOK Signal Using Optical Phase Conjugation in a QD-SOA

Ryota Seki [1] and Motoharu Matsuura [2]

[1] Dept. of Information and Communication Engineering, [2] The Center for Frontier Science and Engineering, The Univ. of Electro-Communications, Tokyo, Japan

We demonstrated 40 Gbit/s signal transmission by midspan optical phase conjugation in a quantum-dot semiconductor optical amplifier. We successfully achieved error-free operation after the 100 km transmission.

Room 101 1F

[ThG3] 13:30 - 15:15
Single Photons

Session Chair: Ryosuke Shimizu (Univ. of Elecrto - Communications, Japan)

ThG3-1 13:30 - 13:45

Near-Infrared Spectroscopy on a Single Photon Level

Michael Förtsch[1,2,3], Thomas Gerrits[4], Martin J. Stevens[4], Josef U. Fürst[1,2], Gerhard Schunk[1,2], Florian Sedlmeir[1,2], Harald G. L. Schwefel[1,2], Dmitry Strekalov[1,2], Sae Woo Nam[4], Gerd Leuchs[1,2], Christoph Marquardt[1,2]

[1] Max Planck Inst. for the Science of Light, Erlangen, Germany, [2] Institut für Optik, Information und Photonik, Univ. of Erlangen-Nuremberg, Erlangen, Germany, [3] SAOT, School in Advanced Optical Technologies, Erlangen, Germany, [4] Nat'l Institute of Standards and Technology, Boulder, USA

We present a spectroscopy technique on the single photon level by combining a widely wavelength tunable single photon source based on a crystalline whispering gallery mode resonator with an energy resolving transition edge sensor.

ThG3-2 13:45 - 14:00

Room Temperature Single Photon Emission From Zinc Oxide Nanoparticles Formed by Ion Implantation in Silica

Kelvin Chung [1], Timothy J. Karle [1], Brant C. Gibson [1], David A. Simpson [1], Hiroshi Amekura [2], Aleksandra B. Djurišić [3], and Snjezana Tomljenovic-Hanic [1]

[1] School of Physics, Univ. of Melbourne, Victoria, Australia, [2] Quantum Beam Unit, Nat'l Inst. for Materials Science (NIMS), Ibaraki, Japan, [3] Dept. of Physics, Univ. of Hong Kong, Pokfulam Road, Hong Kong

We report room temperature single photon emission from optical emitters in zinc oxide nanoparticles formed using ion implantation and thermal oxidation in a silica substrate.

ThG3-3 14:00 - 14:15

Nonequilibrium Phases of Photons in Coupled Cavity QED Array

Tatsuro Yuge, Kenji Kamide, Makoto Yamaguchi, Yusuke Kondo, and Tetsuo Ogawa

Dept. of Physics, Osaka Univ., Osaka, Japan

We clarify the nonequilibrium phase diagram in cavity QED arrays under incoherent pumping and loss. In coherent phase, plateau regions of the photon frequency appear. In incoherent phase, the excitation number takes non-integer discrete values.

ThG3-4 14:15 - 14:30

All Photons are Equal but Some Photons are More Equal Than Others

F. Töppel, A. Aiello, and G. Leuchs

Max Planck Inst. for the Science of Light, Erlangen, Germany and Institute for Optics, Information and Photonics, Erlangen, Germany

Distinct photons may differ in several degrees of freedom as polarization, frequency, mode-function, etc. Coincidence probability in a Hong-Ou-Mandel experiment quantifies photon distinguishability as a function of the photon degrees of freedom.

ThG3-5 14:30 - 14:45

Nonmonotonicity in Quantum-to-classical Transition in Multiparticle Interference

Young-Sik Ra [1], Malte C. Tichy [2,3], Hyang-Tag Lim [1], Osung Kwon [1], Florian Mintert [2,4], Andreas Buchleitner [2], and Yoon-Ho Kim [1]

[1] Dept. of Physics, Pohang Univ. of Science and Technology, Pohang, Korea, [2] Physikalisches Institut, [3] Lundbeck Foundation Theoretical Center for Quantum System Research, Dept. of Physics and Astronomy, Univ. of Aarhus, Aarhus C, Denmark, [4] Freiburg Inst. for Advanced Studies, Albert-Ludwigs-Universität, Freiburg, Germany

We observed nonmonotonic dependence of a many-particle detection probability on the particles' mutual distinguishability. Such nonmonotonicity is a generic feature of the quantum-to-classical transition in multiparticle systems.

ThG3-6 14:45 - 15:00

Scheme for Directly Observing the Noncommutativity of the Position and Momentum Operators with Interference

Jong-Chan Lee [1] Yong-Su Kim [2] Young-Sik Ra [1], Hyang-Tag Lim [1], and Yoon-Ho Kim [1]

[1] Dept. of Physics, Pohang Univ. of Science and Technology (POSTECH), Pohang, Korea, [2] Information Technology Laboratory, Nat'l Inst. of Standards and Technology, Gaithersburg, USA

In this paper, we propose and analyze an experimental scheme for directly observing the noncommutativity of the position and the momentum operators using single-photon quantum interference.

ThG3-7 15:00 - 15:15

Generation of O-Band Heralded Single-Photons Using a Silicon Wire Waveguide

Mao Tong Liu[1], Ying Huang[1,2], and Han Chuen Lim[1,3]

*[1] School of Electrical and Electronic Engineering, Nanyang Technological Univ., Nanyang Avenue, Singapore, [2] Currently with Inst. of Microelectronics, Agency for Science, Technology and Research (A*STAR), Science Park Road, Singapore, [3] Emerging Systems Division, DSO Nat'l Laboratories, Science Park Driv, Singapore*

We generate O-band heralded single-photons from a 2.6-mm-long dispersion-tailored silicon wire waveguide. The broadband nature of the source suggests potential for simultaneous generation of multi-wavelength heralded single-photons.

Room 103 1F

[ThK3] 13:30 - 15:30
Photonic Active Device II

Session Chair: Valery Tolstikhin (OneChip Photonics, Inc, Canada)

ThK3-1 13:30 - 14:00 Invited

Ultralow-Threshold Electrically Driven Photonic-Crystal Nanocavity Laser

T. Sato[1,3], K. Takeda[1,3], A. Shinya[2,3], K. Nozaki[2,3], H. Taniyama[2,3], K. Hasebe[1,3], T. Kakitsuka[1,3], M. Notomi[2,3], and S. Matsuo[1,3]
[1] NTT Photonics Labs., [2] NTT Basic Research Labs., [3] Nanophotonics Center, NTT Corporation, Kanagawa, Japan

We demonstrate an electrically driven photonic-crystal nanocavity laser with an InAlAs sacrificial layer. The laser exhibits an ultralow threshold current of 7.8 μA and an energy cost of 14 fJ/bit with 12.5-Gbit/s direct modulation.

ThK3-2 14:00 - 14:15

Modulation of Spatial Intensity Distribution of Laterally Coupled Twin VCSELs

Hamed Dalir [1], Akihiro Matsutani [2] and Fumio Koyama [1]
[1] Photonics Integration System Research Center, Tokyo Inst. of Technology, Yokohama, Japan, [2] Semiconductor and MEMS Processing Center, Tokyo Inst. of Technology, Yokohama, Japan

We propose a twin coupled cavities VCSELs using a bow-tie shape connection for increasing the modulation bandwidth. The electrical modulation of spatial intensity distribution offers large modulation bandwidth beyond the relaxation oscillation frequency limit.

ThK3-3 14:15 - 14:30

Signal Quality Enhancement of Directly-Modulated VCSELs Using a Micro-Ring Resonator Transfer Function

Y An [1], M. Muller [2], J. Estaran [1], S. Spiga [2], F. Da Ros [1], C. Peucheret [1] and M.-C. Amann [2]
[1] Dept. of Photonics Engineering, Technical Univ. of Denmark, Lyngby, Denmark, [2] Walter Schottky Institut, Technische Universität Munchen, Garching, Germany

A microring resonator transfer function is used to enhance the quality of signals generated using directly modulated VCSELs. The scheme is demonstrated up to 25Gbit/s with a 17.6GHz VCSEL, with up to 10dB sensitivity improvement.

ThK3-4 14:30 - 14:45

Over 25,000 hours operation of 1060 nm Vertical Cavity Surface Emitting Lasers

S. Kamiya [1], T. Kise [2], M. Funabashi [2], T. Suzuki [2], A. Imamura [2], K. Hiraiwa [2], T. Nakamura [2], H. Shimizu [2], T. Ishikawa [1], and A. Kasukawa [2]
[1] Reliability First Group, Furukawa Electric Co., Ltd., Yokohama, Japan, [2] Photonic Device Research Center, Furukawa Electric Co., Ltd., Chiba, Japan

High reliability, high transmission speed and low power consumption laser diodes are required for optical interconnect. We have developed 1060 nm VCSELs with InGaAs/GaAs strained quantum wells, oxide-confined and double intra-cavity structures for the requirement.

ThK3-5 14:45 - 15:00

3.8dB Noise Figure in Bulk Semiconductor Optical Amplifier

K. Carney [1], R. Lennox [2], R. Maldonado-Basilio [1], S. Philippe [1], F. Surre [3], L. Bradley [2] and P. Landais [1]
[1] The Rince Inst., School of Engineering, Dublin City Univ., Glasnevin, Dublin, Ireland, [2] School of Physics, Trinity College Dublin, Dublin, Ireland, [3] School of Engineering and Mathematical Sciences, City Univ. London, London, United Kingdom

The present paper reports numerical and experimental investigation of noise figure of a multi-section semiconductor optical amplifier. The designed amplifier shows a 3.8dB noise figure, which seems to be the lowest figure reported.

ThK3-6 15:00 - 15:15

Theoretical investigation of high speed SOA using recombination-controlled carrier reservoir

M. Sorimachi, H. Iwasaki, and T. Miyamoto
Photonics Integration System Research Center, P&I Lab., Tokyo Inst. of Technology, Yokohama, Japan

We propose a new operation mode for high speed SOA. An evaluation parameter for the signal distortion is introduced and a SOA using recombination controlled carrier reservoir showed the characteristics superior to the conventional SOA.

ThK3-7 15:15 - 15:30

Phase Transparent Amplification of 40 Gbps 16 QAM Signals Using a QD-SOA

S. Lange[1,2,3], Y. Yoshida[1], G. Contestabile[2], and K. Kitayama[1]
[1] Dept. of Electrical, Electronics and Information Engineering, Osaka Univ., Osaka, Japan, [2] TeCIP Inst., Scuola Superiore Sant'Anna, Pisa, Italy, [3] Now with Fraunhofer Heinrich-Hertz-Institute, Berlin, Germany

We experimentally demonstrate 25 dB transparent amplification of 40 Gbps optical coherent 16-QAM signals with 10 dBm output power using a Columnar Quantum Dot Semiconductor Optical Amplifier which avoids the undesired pattern dependent phase distortions.

Room 104A 1F

[ThL3] 13:30 - 15:30
Optical Switches

Session Chair: Toshikazu Hashimoto (NTT Photonics Laboratories, Japan)

ThL3-1 13:30 - 14:00 Invited

LCOS Based Reconfigurable Switches for Dynamic Optical Processing

J. Schröder [1], L.B. Du [2], M.A.F. Roelens [3], S. Frisken [3], A.J. Lowery [1] and B.J. Eggleton [1]
[1] Centre for Ultrahigh bandwidth Devices for Optical Systems, The School of Physics A28, The Univ. of Sydney, NSW, Australia, [2] CUDOS, Dept. of Electrical and Computer Systems Engineering, Monash Univ., VIC, Australia, [3] Finisar Australia, NSW, Australia

We review recent advances of using liquid crystal on Silicon based WSS technology for advanced functionality in communication systems such as an all-optical DFT filters for multiplexing and demultiplexing optical OFDM signals.

ThL3-2 14:00 - 14:15

Proposal for an Integrated 40-λ 1×4 Wavelength Selective Switch

Takemasa Yoshida [1], Hideaki Asakura [1], Takayuki Mizuno [2], Hiroshi Takahashi [2], and Hiroyuki Tsuda [1]
[1] Graduate School of Science and Technology, Keio Univ., Kanagawa, Japan

We propose a new implementation of an integrated 1×4 wavelength selective switch using a silica planar lightwave circuit. The channel spacing is 100 GHz and the number of channels is 40.

ThL3-3 14:15 - 14:30

Silicon-Silica Hybrid Thermo-Optic Switch using Multi-Chip Integration Technique

S. Katayose, Y. Hashizume, and M. Itoh
NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

We propose a silicon-silica hybrid thermo-optic switch with a multi-chip configuration. The use of a silicon rib waveguide improved the response time of the silica thermo-optic switch from 2.6 msec to 20 μsec.

ThL3-4 14:30 - 14:45

Power Consumption Analysis of PLC-Based Optical Switches and Variable Attenuators for Variable Gain Optical Fiber Amplifier

Hirotaka Ono, Toshio Watanabe, Kenya Suzuki, Atsushi Mori, Tetsuo Takahashi, and Tadashi Sakamoto
NTT Photonics Laboratories, NTT Corporation, Kanagawa, Japan

We investigated the power consumption of optical SWs and VOAs integrated on a silica-based PLC that is employed as a variable gain optical fiber amplifier with a wide gain range and a small NF variation.

ThL3-5 14:45 - 15:00

Switching operation using 220nm thickness Si waveguides with Ferroelectric Liquid Crystal

Y. Hayama, T. Nonaka, A. Kato, K.Nakatsuhara, and T.Nakagami
Dept. of Electrical and Electronic Engineering, Kanagawa Inst. of Technology, Kanagawa, Japan

Switching operations were demonstrated using 220nm-thickness Si waveguides with ferro-electric liquid crystal cladding. The phase shift coefficient was evaluated from the switching characteristics to be 3.84 pi rad/mm, which is higher than the conventional value.

ThL3-6 15:00 - 15:15

A sampled grating in an SOI waveguide for narrow-band tunable wavelength filters

A. Kato, K. Nakatsuhara, and T. Nakagami
Dept. of Electrical and Electronic Engineering, Kanagawa Inst. of Technology, Atsugi-shi, Japan

We presented a sampled grating in a silicon-on-insulator waveguide having ferro-electric liquid crystal cladding for tunable transmission filters. Bistable tuning operation of narrow-stop-band, which was due to the sampled grating, was obtained.

ThL3-7 15:15 - 15:30

Potential-Tailored Strained InGaAs Quantum Well for Polarization-Dependent Optical Switch

Hiroki Tominaga, Joo-Hyong Noh, and Taro Arakawa
Graduate School of Engineering, Yokohama Nat'l Univ., Kanagawa, Japan

We propose a strained InGaAs/InAlAs five-layer asymmetric coupled quantum well (FACQW) for polarization-independent optical switches. A potential-tailored QW structure with combination of the strained FACQWs and asymmetric CQWs is also investigated for actual devices.

Room 104B 1F

TuPH-1
Withdrawn

TuPH-2
Dip-shaped AlGaN/AlN Quantum Well Structures with high TE-polarized Optical Gain

Seoung-Hwan Park[1] and Joing-In Shim[2]
[1] Catholic Univ. of Daegu, Dept. of Electronics Engeering, Hayang, Kyeongbuk, Korea, [2] Dept. of Electrical and Computer Engineering, Hanyang Univ., Ansan, Republic of Korea

For dip-shaped UV AlGaN/AlN QW structures, with the inclusion of the lower bandgap AlGaN layer, the polarization property changes from TM-polarization to TE-polarization with a small wavelength change for a high Al composition of 0.85.

TuPH-3
Nanoindentation Hardness and Elastic Modulus of AlGaN Alloys

Y. Tokumoto[1], H. Taneichi[1], Y. Ohno[1], K. Kutsukake[1], H. Miyake[2], K. Hiramatsu[2], and I. Yonenaga[1]
[1] Inst. for Materials Research, Tohoku Univ., Sendai, Japan, [2] Dept. of Electrical and Electronic Engineering, Mie Univ., Tsu, Japan

Nanoindentation hardness tests were conducted on $Al_xGa_{1-x}N$ alloys grown by MOVPE. AlGaN showed the hardness of 16.5-19.5GPa strongly dependent on the alloy composition with a maximum at x~0.5.

TuPH-4
Fabrication of UV-LED Using ZnO Nanowires Directly Grown on p-GaN Film by NAPLD

N. Tetsuyama, Y. Ishida, M. Higashihata, D. Nakamura, and T. Okada
Graduate School of Information Science and Electrical Engineering, Kyushu Univ., Fukuoka, Japan

We report the direct of ZnO nanowires on a p-GaN film by Nano-particle Assisted Pulsed Laser Deposition (NAPLD) and the ultra-violet electroluminescence characteristic from the fabricated p-n heterojunction LED.

TuPH-5
Photoluminescence From InN Nanorod Arrays with a Critical Size

K.-Y. Chang[1], Y.-S. Liu[1], S. Gwo[2], and H. Ahn[1]
[1] Dept. of Photonics and Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Hsinchu, Taiwan, [2] Dept. of Physics, National Tsing Hua Univ., Hsinchu, Taiwan

Abnormal temperature dependence of peak energy and bandwidth of photoluminescence spectra was observed for InN nanorods with a diameter <30 nm, which is of the same order of the thickness of surface electron accumulation layer.

TuPH-6
White Light Emission From InGaN/organic Molecule Light-Emitting Diode

Zhounan Yue[1], Yuk Fai Cheung[2], Hoi Wai Choi[2], Zujin Zhao[3], Ben Zhong Tang[3], Kam Sing Wong[1]
[1] Dept. of Physics and Inst. of Molecular Functional Materials, The Hong Kong Univ. of Science and Technology, Kowloon, Hong Kong, [2] Dept. of Electrical and Electronic Engineering, Univ. of Hong Kong, Pokfulam Road, Hong Kong, [3] Dept. of Chemistry and Inst. of Molecular Functional Materials, The Hong Kong Univ. of Science and Technology, Kowloon, Hong Kong

Hybrid white light emitters constructed with InGaN LED and AIE molecule BTPETD are demonstrated. The fabricated device shows CIE coordinates of (0.32, 0.33) and optical extraction efficacy of 45.4% with leakage fraction of 17.3%.

TuPH-7
Evaluation of Internal Quantum Efficiency in Blue and Green Light-Emitting Diodes Using Rate Equation Model

Geun-Hwan Ryu, Hyun-Joong Kim, Won-Bo Yang, and Han-Youl Ryu
Dept. Physics, Inha Univ., Incheon, Korea

A convenient and reliable method for the determination of internal quantum efficiency in GaN-based light-emitting diodes was developed by analyzing the carrier rate equation model.

TuPH-8
Study of Light Emission Polarization Properties of Semipolar InGaN/GaN Quantum Well Under Different Strain Conditions

Shu-Ting Yeh and Yuh-Renn Wu
Graduate Inst. of Photonics and Optoelectronics and Dept. of Electrical Engineering, National Taiwan Univ., Taipei, Taiwan

In this paper, the light emission polarization ratios of the (11-22), and (20-21) semipolar plane InGaN/GaN quantum well LED with different In compositions and strain relaxation were numerical studied for future device design.

TuPH-9
Fiber-optic Photoluminescence Measurement System for Evaluation of InGaN/GaN LED Epi-Wafer Morphology

Woohyun Jung[1], Jongki Kim[1], Hang-Eun Joe[2], Byung-Kwon Min[2], and Kyunghwan Oh[1]
[1] Inst. of Physics and Applied Physics, Yonsei Univ., Seoul, South Korea, [2] Dept. of Mechanical Engineering, Yonsei Univ., Seoul, South Korea

We proposed a compact photoluminescence measurement system based on fiber-optic probes that can be scanned over wide area with high spatial resolution. We applied the system in morphological study of GaN epi-layers for LED applications

TuPH-10
Hydrogen Environment Anisotropic Thermal Etching (HEATE) of GaN for the Fabrication of High-Aspect Nanostructure

Hiroki Hachiya[1], and Akihiko Kikuchi[1,2]
[1] Sophia Univ., Tokyo, Japan, [2] Sophia Nanotechnology Research Center, Tokyo, Japan

High temperature hydrogen etching properties of (0001) GaN under various hydrogen pressures and temperature was systematically investigated. We found a specific selective etching condition with high-anisotropy which applicable for the fabrication of high-aspect nanostructures.

TuPI-1
Surface Nanocavities in 3D Photonic Crystals

Kenji Ishizaki, Kou Gondaira, Yuji Ota, Katsuyoshi Suzuki, and Susumu Noda
Dept. of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

We design and demonstrate nanocavities with TE-like and TM-like polarizations at the surface of 3D photonic crystals using 3D design freedom in a 3D structure and the polarization-independent surface-mode gap.

TuPI-2
Ultrahigh Q TM-Polarized Photonic Crystal Nano-Fishbone Nanocavity

Tsan-Wen Lu, Pin-Tso Lin, and Po-Tsung Lee
Dept. of Photonics & Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Hsinchu, Taiwan

A novel photonic crystal nano-fishbone is proposed, which confines ultrahigh Q (~ 1.6×10^7) transverse magnetic mode with smaller mode volume, device size, surface area, and higher confinement factor than those in photonic crystal nanobeam.

TuPI-3
Modal Volume Control of a Photonic Crystal Nanocavity

K. Kojima, K. Hikoyama, T. Nakamura, T. Kojima, T. Asano, and S. Noda
Kyoto Univ., Kyoto, Japan

We propose a method to control the modal volume of a photonic crystal nanocavity. This method provides a large amount of freedom to control cavity quantum electrodynamics in solid state without energy dissipation.

TuPI-4
Structural Dependence of Nonlinear Characteristics in Slot Waveguides Composed of Photonic Crystal Nanobeam Cavities

Shuntaro Makino, Yuhei Ishizaka, Kunimasa Saitoh, and Masanori Koshiba
Division of Media and Network Technologies, Graduate School of Information Science and Technology, Hokkaido Univ., Sapporo, Japan

We investigate structural dependence of nonlinear characteristics in slot waveguides composed of photonic crystal nanobeam cavities. Numerical results show that our proposed structure can realize a high effective nonlinear coefficient.

TuPI-5
InP Heterostructure Photonic Crystal Waveguide Fabricated by High-aspect-ratio ICP Etching

Kaiyu Cui, Yongzhuo Li, Xue Feng, Fang Liu, Yidong Huang, and Wei Zhang
Dept. of Electronic Engineering, Tsinghua National Laboratory for Information Science and Technology, Tsinghua Univ., Beijing, China

InP heterostructure photonic crystal waveguide (PCW) is fabricated by ICP etching with high-aspect-ratio of 45. Structure-dependent transmission-dip about 17dB and micro-photoluminescence linewidth of only 73nm are demonstrated in a 17-μm-long heterostructure PCW.

TuPI-6
Waveguide Coupled Air-Slot Photonic Crystal Nanocavity for Optomechanics

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[1] Inst. of Industrial Science, The Univ. of Tokyo, Tokyo, Japan, [2] Inst. for Nano Quantum Information Electronics, The Univ. of Tokyo, Tokyo, Japan

A GaAs-based waveguide coupled air-slot PhC nanocavity was proposed for optomechanical systems. The measured light coupling efficiency of 2% indicates that this system can be used as monolithic optomechanical systems with simple vertical input/output configuration.

TuPI-7
Super-resolution Imaging of Gold Nanoparticles Based on Saturation of Plasmonic Light Scattering

R. Oketani[1], T. Y. Su[2], Y. Yonemaru[1], H. Lee[2], M. Yamanaka[1], M. Y. Lee[2], S. Kawata[1], S. W. Chu[2], and K. Fujita[1]
[1] Dept. of Applied Physics, Osaka Univ., Osaka, Japan, [2]Dept. of Physics, National Taiwan Univ., Taipei, Taiwan

We observed the saturation of plasmonic light scattering on gold nanoparticles. Extracting the nonlinear signals due to the saturation, we demonstrated super-resolution imaging of two nearby gold nanoparticles.

TuPI-8
Spatiotemporal Control of Femtosecond Plasmon with Spectral Interferometry NSOM

Kazunori Toma, Shutaro Onishi, Miyuki Kusaba, Kenichi Hirosawa, and Fumihiko Kannari
Dept. of Electronics and Electrical Engineering, Keio Univ., Yokohama, JAPAN

Based on a plasmon response function in both amplitude and phase measured by a spectral interferometry combined with a near-field scanning optical microscopy (NSOM), the femtosecond plasmon pulse at gold nanostructures is deterministically tailored.

TuPI-9
Blue-Shifted Blackbody Radiation From Nano-Structured Multi-Layer Emitter

Takahiro Matsumoto[1,2,3,4] and Makoto Tomita[5]
[1] Research and Development Center, Stanley Electric Corporation, Tsukuba, Japan, [2] Center for Quantum Science and Technology under Extreme Conditions, Osaka Univ., Osaka, Japan, [3] Research Inst. of Electronics, Shizuoka Univ., Hamamatsu, Japan, [4] National Inst. of Advanced Industrial Science and Technology, Tsukuba, Japan, [5] Dept. of Physics, Faculty of Science, Shizuoka Univ., Suruga, Japan

Using the proposed nano-structured multi-layer emitter, we demonstrated blue-shifted black body radiation spectrum. The conversion efficiencies from input electric power to visible light radiation in excess of 95% could be produced.

TuPI-10
Binary Surface Plasmon Hologram: An In-plane Airy Plasmon Generator

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[1] Singapore Inst. of Manufacturing Technology, Singapore, Singapore, [2] Inst. of Materials Research and Engineering, Singapore, [3] School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore

In this paper, we report on a binary holographic technique to store and retrieve surface plasmon waves. As an example, the in-plane Airy plasmon is reconstructed by launching surface plasmon waves from subwavelength hologram pattern.

TuPI-11
Withdrawn

TuPI-12
Switchable Beaming From Metal Slit by Controlling Excitation Phase of Surface Plasmons

Kyuho Kim, Seung-Yeol Lee, Jun-Bum Park and Byoungho Lee
National Creative Research Center for Active Plasmonics Application Systems, Inter-Univ. Semiconductor Research Center and School of Electrical Engineering, Seoul National Univ., Seoul, Korea

We propose a beam-switching method from nanoslit surrounded by metal gratings. The underlying mechanism is based on controlling the phase of incident lights, by adjusting the relative position between the interference pattern and the slit.

TuPI-13
Numerical Study on the Generation of Low-Noise, Cylindrical Surface Plasmons by a Trenched Metal Nano-Slit Structure

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[1] Laser Engineering and Applications Laboratory, School of EECS, Seoul National Univ., Seoul, Korea, [2] Photonic Systems Laboratory, School of EECS, Seoul National Univ., Seoul, Korea

We numerically analyze the cylindrical surface plasmons generated by a trenched metal nano-slit implemented on an optical fiber platform via a multi-pole cancellation method, which eventually yields a great enhancement in signal-to-noise ratio by 20-dB.

TuPI-14
The Excitation of the Surface Plasmon Polariton with the GaP-Au Contact and Application to Chemical Sensors

S. Nakamura[1], A. Motogaito[1,2], H. Miyake[1,2], and K. Hiramatsu[1,2]
[1] Graduate school of Engineering Mie Univ., Tsu, Japan, [2] The Center of Ultimate Technology on nano-Electronics Mie Univ., Tsu, Japan

In order to apply the GaP-Au contact to chemical sensors, the excitation of surface plasmon polariton (SPP) is investigated. The SPP excitation of Air, H_2O, and C_2H_5OH are found in simulations and experiments.

TuPI-15
Localized Surface Plasmons Coupled in U-Shaped Nano-Cavity with High Sensitivity

Ya-Lun Ho, Yaerim Lee, Etsuo Maeda, and Jean-Jacques Delaunay
School of Engineering, The Univ. of Tokyo, Tokyo, Japan

We present simulations of a novel U-shaped cavity supporting the coupling of cavity modes with plasmon resonances. The resonances with optical vortices exhibit strong and sharp reflectance dips having high sensitivity to their environments.

TuPI-16
Propagation Length and Coupling Characteristics of a Hybrid Plasmonic Waveguide with a Uniform Silica Layer

Masaru Nagai, Yuhei Ishizaka, Kunimasa Saitoh, and Masanori Koshiba
Division of Media and Network Technologies, Graduate School of Information Science and Technology, Hokkaido Univ., Sapporo, Japan

We propose a hybrid plasmonic waveguide with a uniform silica layer and evaluate its propagation length and coupling characteristics. Numerical results show that we should carefully choose structural parameters to obtain a longer propagation length.

TuPI-17
Surface Enhanced Infrared Absorption Measurements with Micro Metal Hole Array

Y. Nishijima[1], L.Rosa[2], and S. Juodkazis[2,3]
[1] Dept. of electrical and computer Engineering, Graduate School of engineering, Yokohama National Univ., Yokohama, Japan, [2] Centre for Micro-Photonics, Faculty of Engineering and Industrial Sciences, Swinburne Univ. of Technology, Hawthorn, Australia, [3] Melbourne Centre for Nanofabrication, Clayton, Australia

SEIRA spectroscopic measurement using the metal hole array (MHA) is demonstrated with high spectral selectivity. The molecular IR absorption peaks are enhanced up to 10 times at the transmission peak of MHA structure.

TuPI-18
Measurement and Analysis of Scattering of an Evanescent Wave by a Pt-coated Thin Fiber on a Pt-coated Prism

F. Tajima and Y. Nishiyama
Yokohama National Univ., Yokohama, Japan

Scattering of an evanescent wave by a Pt-coated thin fiber above a Pt-coated prism is measured and analyzed by the modified bicylinder model. It shows good agreement between them and the model is quantitatively verified.

TuPI-19
Nanoplasmonic Optical Filter Based on Complementary Split-ring Resonator

Fusheng Ma and Chengkuo Lee
Dept. of Electrical and Computer Engineering, National Univ. of Singapore, Singapore

A novel nanoplasmonic optical filter is presented, in which the non-integer modes can be excited as well as the integer modes. The transmission-spectra can be efficiently modified by manipulate the nano-wall inside the MIM ring.

TuPI-20
Coupling Modes of Quasi-periodic Remote Grating Plasmonic Nanostructures

Tzu-Hao Weng, Shih-Wen Chen, and Jia-Han Li
Dept. of Engineering Science and Ocean Engineering, National Taiwan Univ., Taipei, Taiwan

The coupling modes and their field intensities of remote grating plasmonic nanostructures with periodic and quasi-periodic arrangements are studied numerically by comparing their transmissions, reflections, and extinctions.

TuPI-21
Highly Polarization Dependent Enhanced Optical Transmission Through Polygonal Plasmonic Apertures

Tavakol Nazari, Sahar Hosseinzadeh Kassani, Reza Khazaeinezhad, and Kyunghwan Oh
Photonic Device Physics Laboratory, Inst. of Physics and Applied Physics, Yonsei Univ., Seoul, Republic of Korea

We investigated enhanced optical transmission through polygonal aperture surrounded by polygonal grooves, to find its strong polarization dependence, and effects of symmetry. Results show that incident light with Y direction polarization has impressive enhanced transmission.

TuPI-22
Explore the Blue Shift Phenomena in Single Size and Mixed-size Nanophotonic Arrays

Hsin Her Yu[1], Hsueh-Ping Weng[2]
[1] Dept. of Biotechnology, [2] Inst. of Electro-Optical and Materials Science, National Formosa Univ., Yunlin, Taiwan

Polystyrene (PS) nanophotonic arrays were synthesized and then arranged self-assembly to a regular structure by dip-drawing method. The reflectance of PS nanophotonic arrays were shifted to lower wavelength directions as the view angles increased.

TuPI-23
Optical Properties of Periodic/Random Pattern of Au Nanodiscs

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[1] Dept. of electrical and computer Engineering, Graduate School of engineering, Yokohama National Univ., Yokohama, Japan, [2] Centre for Micro-Photonics, Faculty of Engineering and Industrial Sciences, Swinburne Univ. of Technology, Hawthorn, Australia, [3] Melbourne Centre for Nanofabrication, Clayton, Australia

The plasmon resonance of periodic/random arrays of Au-nanodiscs has been investigated experimentally and numerically. We found the electro-magnetic field enhancement 10-102 times in the random patterns.

TuPI-24
Optical Properties of Au/Ag Alloy Nanostructures

Y. Nishijima
Dept. of electrical and computer Engineering, Graduate School of engineering, Yokohama National Univ., Yokohama, Japan

Optical properties of localized surface plasmon resonance (LSPR) in Au/Ag alloy were investigated experimentally and numerically. It was found that LSPR spectra of nanostructures at near-infrared wavelengths changed drastically at the 50% Au/Ag mole fraction.

TuPI-25
High-Efficient Two-Photon Up-Conversion in an Antenna-Molecule Complex System

Yoshiki Osaka, Nobuhiko Yokoshi, Masatoshi Nakatani, and Hajime Ishihara
Dept. of Physics and Electronics, Osaka Prefecture Univ., Osaka, Japan

We theoretically analyzed two-photon up-conversion process on four-level diamond-shaped systems coupled with an optical antenna, and found significant enhancement of the up-conversion.

TuPI-26
Linear and Nonlinear Optical Properties of Nano-Porous Gold film

Marjan Akbari and Teruya Ishihara
Dept. of Physics, Tohoku Univ., Sendai, Japan

We investigate optical response of nano-porous gold (NPG) in the visible frequencies. Reflectivity reduces significantly in the red range of the spectrum. Possibility for observation of photo-rectification is discussed.

TuPI-27
Tunable Hot Spot Based on the VO_2 Phase Transition Materials

Jun-Bum Park, Il-Min Lee, Seung-Yeol Lee, and Byoungho Lee
National Creative Research Center for Active Plasmonics Application Systems Inter-Univ. Semiconductor Research Center and School of Electrical Engineering Seoul National Univ., Seoul, Korea

We propose a novel approach to generate and tune a hot spot in a dipole nanostructure of vanadium dioxide (VO_2) laid on a gold (Au) substrate by inducing a phase transition of the VO_2.

TuPI-28
Size-dependent Upconversion Luminescence in Er^{3+}/Yb^{3+} Codoped $LiYF_4$ Nano/Microcrystals

Xiaojie Xue, Shinya Uechi, Rajanish N. Tiwari, Zhongchao Duan, Meisong Liao, Masamichi Yoshimura,Takenobu Suzuki, and Yasutake Ohishi
Graduate School of Engineering, Toyota Technological Inst., Nagoya, Japan

Er^{3+}/Yb^{3+} codoped $LiYF_4$ nano/microcrystals were controllable synthesized via a facile solvothermal method. Based on the emission spectra and quantum efficiencies under 976 nm pumping, size-dependent upconversion luminescence was studied.

TuPI-29
Fabrication and Application of Structured Nanofiber on Chip

Kazuhiro Yamamoto[1], Shiyoshi Yokoyama[1], and Akira Otomo[2]
[1] Inst. for Materials Chemistry and Engineering (IMCE), Kyushu Univ., Fukuoka, Japan, [2] Advanced ICT Research Inst., National Inst. of Information and Communications Technology (NICT), Kobe, Japan

We proposed the fabrication method of nanofibers on Si substrate using FIB milling and selective wet etching for integrated optical applications. The diameter of nanofiber could be well-controlled from 2μm to 300nm.

TuPI-30
The Fabrication and Characterization of Dye-sensitized Solar Cells with ZnO Nanorods

Shou-Yi Kuo [1], Jui-Fu Yang [2]
[1] Dept. of Electronic Engineering, Chang Gung Univ., Tao-Yuan, Taiwan, [2] Dept. of Photonics Engineering, Yuan-Ze Univ., Chung-Li, Taiwan

In this study, the DSSCs with ZnO nanorods grown by hydrothermal method were fabricated and investigated in detail. Optimal length of ZnO nanorods has yielded a 96% enhancement in power conversion.

TuPI-31
Withdrawn

TuPI-32
Using Surface Plasmon Resonance to Detect the Deoxidized Process of Graphene Oxide

Chun-Chuan Kuo [1], Nan-Fu Chiu [1], Chih-Hao Chen [2], and Wei-Hsiu Hung [2]
[1] Inst. of Electro-Optical Science and Technology, National Taiwan Normal Univ., Taipei, Taiwan, [2] Dept. of Chemistry, National Taiwan Normal Univ., Taipei, Taiwan

We present a surface plasmon resonance real-time detection method to monitor the deoxidized process of graphene oxide converted to reduced graphene oxide by electrochemistry. This may pave the way to new development in rGO-based application.

TuPI-33
An Even-symmetry Optical Guided Mode in a Graphene

Myunghwan Kim, Chang-Yeong Jeong, Hyungjun Heo, and Sangin Kim
Dept. of Electrical and Computer Engineering, Ajou Univ., Suwon, Korea

We investigate properties of an even-symmetry guided mode in a dielectric/graphene/dielectric structure and propose a means to control the properties of the structure.

TuPI-34
Theory for Ultra-high-accuracy Nano Optical Separation Assisted by Thermal Fluctuations

Mamoru Tamura [1,2], Takuya Iida [1]
[1] Nanoscience & Nanotechnology Research Center, Osaka Prefecture Univ., Osaka, Japan, [2] Dept. of Physics and Electronics, Osaka Prefecture Univ., Osaka, Japan

We have theoretically clarified principles for the screening of different-sized nanoparticles by combination of light and fluctuations, where several tens nanometers-sized nanoparticles in diameter can be separated with significantly high accuracy of a few nanometers.

TuPI-35
Control of Population Dynamics by Three-body Self-consistent Interplay

Ryosuke Hata [1], Nobuhiko Yokoshi [1], Hiroshi Ajiki [2], and Hajime Ishihara [1]
[1] Dept. of Physics and Electronics, Osaka Prefecture Univ., Osaka, Japan, [2] Photon Pioneers Center, Osaka Univ., Osaka, Japan

We investigate population dynamics in coupled oscillators, which is driven by external field. Especially, we focus on the self-consistent motion among three bodies, e.g., photons, a targeted system, and an auxiliary system such as cavities.

TuPI-36
Nucleation of Optical Vortex Pairs in Disordered Nonlinear 2D Photonic Lattices

Yeong-Kwon Cho, Dong-Il Yeom, and Kihong Kim
Division of Energy Systems Research, Ajou Univ., Suwon, Korea

We study numerically the propagation of optical vortex beams through disordered nonlinear 2D photonic lattices. We find that due to disorder, new optical vortex-antivortex pairs are nucleated at the positions of perfect destructive interference.

TuPI-37
Transmission characteristic of visible light through tapered glass capillaries towards microbeams

Kyohei Katoh[1], Wei-Guo Jin[1], Tatsuya Minowa[1], and Tokihiro Ikeda[2]
[1] Dept. of Physics, Faculty of Science, Toho Univ., Chiba, Japan, [2] Atomic Physics Laboratory, RIKEN, Saitama, Japan

Towards production of microbeams, propagation of visible light through a tapered glass capillary has been studied. Transmittance has been measured for capillaries with different outlet diameters.

TuPI-38
Stimulated Scattering in Nanostructures

A. D. Kudryavtseva, N. V. Tcherniega
P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Moscow, Russia

Stimulated low frequency Raman scattering caused by laser pulses interaction with localized acoustic vibrations of nanoparticles and stimulated Raman scattering with high conversion efficiency have been experimentally studied in different nanomaterials.

TuPI-39
Symmetries and Asymmetries in Optical Activity

Xavier Vidal [1], Ivan Fernandez-Corbaton [1,2], Alex Barbara [1], Nora Tischler [1,2], Xavier Zambrana-Puyalto [1,2], Mathieu L. Juan [1,2] and Gabriel Molina-Terriza [1,2]
[1] QsciTech and Dept. of Physics and Astronomy, Macquarie Univ., NSW, Australia, [2] ARC Centre of Excellence on Engineered Quantum Systems (EQuS)

We show the relation between optical activity and helicity for the scattering of chiral particles. The results show how to design chiral structures for an omnidirectional optically active response independent of the incident polarization.

TuPK-1
High-Efficiency 3D CMOS Image Sensor

Oscal T.-C. Chen, Kuan-Hsien Lin and Zhe Ming Liu
Dept. of Electrical Engineering, National Chung Cheng Univ., Chia-Yi, Taiwan

A 44×36-pixel 3D CMOS image sensor is developed based on the time-of-flight scheme where N-well_P-substrate photo-diodes with a large breakdown voltage are adopted. Additionally, breakdown voltages of photo-diodes are well explored with consideration of crosstalk.

TuPK-2
Vacuum Ultraviolet Light Emitting Device Consisting of Nd^{3+}:LuF_3 Thin Film as Phosphor

Takayuki Tsuji[1], Mirai Ieda[1], Shingo Ono[1], Yuui Yokota[2], Takayuki Yanagida[3] and Akira Yoshikawa[2]
[1] Nagoya Inst. of Technology, Aichi, Japan, [2] Inst. for Materials Research, Tohoku Univ., Sendai, Japan, [3] Kyushu Inst. of Technology, Kitakyushu, Japan

Nd^{3+}:LuF_3 thin film was grown by pulsed laser deposition (PLD). Additionally, a vacuum-ultraviolet (VUV) light emitting device was demonstrated by consisting of Nd^{3+}:LuF_3 thin film as phosphor and carbon-nanofibers (CNFs) field electron emitter.

TuPK-3
Effect of SCH/Barrier Layer Thickness on K-factor of Quantum Dot Lasers

Nami Yasuoka[1], Mitsuru Ishida[3], Mitsuru Ekawa[3], Tsuyoshi Yamamoto[3], Masaomi Yamaguchi[3], Kenichi Nishi[1], Mitsuru Sugawara[4], and Yasuhiko Arakawa[1,2]
[1] Inst. of Nano Quantum Information Electronics, [2] Inst. of Industrial Science, The Univ. of Tokyo, Tokyo, JAPAN, [3] Fujitsu Laboratories Limited, Atsugi, JAPAN, [4] QD Laser, Inc., Kawasaki, JAPAN

The effect of the SCH/barrier layer region on the K-factor of quantum-dot lasers was investigated. It was found that thinner SCH/barrier layers lead to a shorter effective capture/relaxation time and a reduced K-factor.

TuPK-4
Characterization of 24 Stacked InGaAs Quantum Dot Laser Fabricated by Ultrahigh-rate MBE Growth Technique

F. Tanoue[1,2], H. Sugawara[1], K. Akahane[2], and N. Yamamoto[2]
[1] Graduate School of System Design, Tokyo Metropolitan Univ., Tokyo, Japan, [2] National Inst. of Information and Communications Technology, Tokyo, Japan

Highly stacked of 24 InGaAs/GaAs quantum dot laser was prepared using ultrahigh-rate MBE growth technique and observed laser emission at 1070nm, and its internal quantum efficiency evaluated to be 22.0%.

TuPK-5
Effect of Inhomogeneous Linewidth on RMS Spectral Width of Quantum Dot Laser Devices for O-band Optical Communication

A. H.Shahid[1], B. D.T.D.Childs[2], C. M.A.Majid[2], D. B.J.Stevens[2], E. K.Kennedy[2], F. R.Airey[2], G. R.A.Hogg[2], H. E.Clarke[2], J. R.Murray[3], and H. M.M.A. Bhutta[1]
[1] Faculty of Engineering, Univ. of Engineering & Technology, Punjab, Pakistan, [2] Dept. of Electronic & Electrical Engineering, Univ. of Sheffield, Centre for Nanoscience & Technology, Sheffield, UK, [3] Physics Dept., Imperial College, London, UK

Linewidth of an optical transmitter is key in determining the dispersion limit. The effect of inhomogeneous linewidth on the RMS spectral linewidth of AlInGaAs/GaAs quantum dot laser transmitters thus suitability for telecommunication is discussed empirically.

TuPK-6
Mode Stability and Wavelength Selection in Dual-λ QD lasers

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[1] Cardiff University, School of Physics and Astronomy, Cardiff, UK, [2] EPSRC National Centre for III-V Technologies, University of Sheffield, Sheffield, UK

Dual-mode monolithic lasers emitting in the range of 655-720nm have been demonstrated, which were designed to exploit the properties offered by quantum dot material. The criteria determining wavelength selection and mode stability are discussed.

TuPK-7
Demonstration of resonance frequency enhancement effect by using split pumping region in active multi-mode interferometer laser diode

Mohammad Nasir Uddin[1], Takaaki Kizu[1], Yasuhiro Hinokuma[1], Akio Tajima[3], Kazutoshi Kato[2] and Kiichi Hamamoto[1]

[1] Interdisciplinary Graduate School of Engineering Science, Kyushu Univ., Fukuoka, Japan, [2] Graduate School of Information Science and Electrical Engineering, Kyushu Univ., Fukuoka, Japan, [3] Green Platform Research Laboratories, NEC Corporation, Kanagawa Japan

We demonstrate for the first time, the resonance frequency enhancement effect by using split pumping region in active multi-mode interferometer laser diode (active MMI LD).

TuPK-8
Numerical Analysis of the Noise Reduction Effect by Superposition of High Frequency Current in Semiconductor Lasers

A. Sazzad M.S. Imran and B. Minoru Yamada

Division of Electrical and Computer Engineering, Graduate School of Natural Science and Technology Kanazawa Univ., Ishikawa, Japan

Suppression phenomena of optical feedback noise in semiconductor lasers by the superposition of high frequency current have been numerically analyzed and explained with approximated but analytical equations. Correspondence between experiment and simulation is also demonstrated.

TuPK-9
An External Modulator Model for Optical Injection-locked Semiconductor Lasers

Peng Guo, Lixin Zhu, Anshi Xu, and Zhangyuan Chen

State Key Laboratory of Advanced Optical Communication Systems and Networks, School of Electronics Engineering and Computer Science, Peking Univ., Beijing, China

An external modulator model is proposed to analyze the optical injection-locked semiconductor lasers. This model provides a novel perspective of many characteristics of OIL-SLs, including negative chirp modulation, phase modulation, and all-optical RF-conversion.

TuPK-10
Lasing Characteristics Dependence on In Composition of 850 nm (In)GaAs TQWs VCSELs with Low Power Consumption for Optical Interconnects

T. Kondo, K. Takeda, H. Nakayama

Electrical Device Engineering, Production Technology, Fuji Xerox Co., Ltd., Kanagawa, Japan

We investigated lasing characteristics of (In)GaAs TQWs VCSELs with different In composition in terms of low power consumption. The bias current of 10 Gbps operation was reduced by using InGaAs TQWs.

TuPK-11
Low Switching Power Polarization Bistability in Optically Injected VCSELs

Abdulqader A. Qader, Yanhua Hong and K. Alan Shore

Bangor Univ., School of Electronic Engineering, Wales, UK

Polarization bistability in VCSEL subject to orthogonally polarized optical injection is studied experimentally. It is shown that the VCSEL may exhibits a low power (2.8 μW) polarization switching and ultra-wide hysteresis cycle beyond 150 GHz.

TuPK-12
Investigation on Polarization Features of Broad-Area Square-Shaped VCSELs with Different Frequency Detuning: High-Order Modes Assisted in Stable Polarization Emission

Yan-Ting Yu, Pi-Hui Tuan, Kuan-Wei Su, and Yung-Fu Chen

Dept. of Electrophysics, National Chiao Tung Univ., Hsinchu, Taiwan

We experimentally confirm frequency detuning is the crucial factor for being capable of polarization switching in broad-area square-shaped VCSELs. Intriguingly, the VCSEL can exhibit stable polarization in light output for relatively large frequency detuning.

TuPK-13
Noise Suppression Characteristics of Negative Feedback Optical Amplifier Using an Optical Triode

Azmi M.Syafiq, Yuma Fujikawa, Azizan S.Aisyah, Yoshinobu Maeda

School of Science and Engineering, Kinki Univ., Higashi Osaka, Japan

We investigate the relationship of negative feedback signal intensity with bit error rate using optical triode. It was found out that power penalty was improved by 15 dB and noise suppression characteristic was obtained.

TuPK-14
Lasing Characteristic of ZnO Microsphere Prepared by a Simple Laser Ablation Method

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Graduate School of Information Science and Electrical Engineering, Kyushu Univ. Motooka, Fukuoka, Japan

We succeeded in synthesizing ZnO microspheres by a simple atmospheric laser ablation method. The ZnO microsphere has a completely spherical in shape, and a whispering gallery mode lasing from the microsphere was observed.

TuPK-15
Experimental and Theoretical Study on Digital-Alloy $In(Ga_{1-z}Al_z)As$ Structure

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[1] Korea Electrotechnology Research Inst., Ansan, Korea, [2] Korea Inst. of Science and Technology, Seoul, Korea

To fully understand optical properties of digital-alloy $(InGaAs)_{1-z}$ $(InAlAs)_z$ grown on InP by MBE, we theoretically calculate the emission energies of digital-alloy $(InGaAs)_{1-z}(InAlAs)_z$ using 4x4 k·p Hamiltonian and compare them with photoluminescence data.

TuPK-16
Withdrawn

TuPK-17
Withdrawn

TuPK-18
Performance Enhancement of a Biasing-ITO-AR-Electrode MOS-Structure Silicon Solar Cells

Jia-Ying Wu, Wen-Jeng Ho, Jheng-Jie Liu, Yuan-Tsz Chen, Yi-Yu Lee, Min-Chun Huang, Po-Hung Tsai, Chi-He Lin, and Po-Yueh Cheng

Dept. of Electro-Optical Engineering, National Taipei Univ. of Technology, Taipei, Taiwan

We demonstrate MOS-structure silicon solar-cells using a biasing antireflective-ITO-electrode to enhance the photovoltaic performance. The enhancement of the short-circuit-current and conversion-efficiency was confirmed by the light-current-voltage and induced-junction-capacitance measurements when applied 0-2.5 V-biasing on ITO-electrode.

TuPK-19
Characterization of Plasmonics Silicon Solar Cells Using the Novel Indium Nanoparticles on Matrix-Profile TiO2 Coating

Yuan-Tsz Chen[1], Wen-Jeng Ho[1], Yi-Yu Lee[1], Jia-Ying Wu[1], Chin-Cing Liao[1], Yung-Ching Chiu[1], Chi-He Lin[1], Po-Hung Tsai[1] and Hung-Pin Shiao[2]

[1] Dept. of Electro-Optical Engineering, National Taipei Univ. of Technology, Taipei, Taiwan, [2] Win Semiconductor Corp., Taoyuan, Taiwan

We demonstrate the performances of Si-solar-cells using the plasmonics of the indium-nanoparticle deposited on the matrix-profile-TiO_2 layers. The short-circuit-current, conversion-efficiency and external-quantum-efficiency of the cell with indium-nanoparticles-plasmonics are measured and characterized, compared to the bare-solar-cell.

TuPK-20
Enhancing the Efficiency of Inverted Organic Solar Cells by Employing Solution Processed Blocking Layers

Hui-Hsuan Lee, Shui-Hsiang Su, Wen-Kai Lin, Che-Chun Liu and Meiso Yokoyama

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Inverted organic solar cells (IOSCs) employing solution-processed blocking layers have been fabricated and characterized. It demonstrates JSC and PCE of 9.25 mA/cm^2 and 2.04%, while an OSC without the blocking layers has PCE of 0.56%.

TuPL-1
Control of Quantum Well Intermixing in III-V Semiconductors

Usman Younis

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The control of quantum well intermixing has been investigated. Blue shift up to 78 nm is achieved with 2.5 cm^{-1} transmission loss in ridge waveguides. A lateral ion straggle of ~1.2 μm is observed.

TuPL-2
Highly efficient green light generation in compact second-harmonic module with a periodically poled MgO-doped lithium niobate planar waveguide

Jun-Hee Park[1], Tai-young Kang[1], Hae-nam Jeon[2], Boobin Yim[3], and Han-Young Lee[1]

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We reported continuous-wave 528mW at 532nm from a compact visible-laser module. The green light was achieved from single-pass second harmonic generation with a periodically poled MgO-doped lithium niobate planar waveguide.

TuPL-3
Modification of Modal Field Distribution by Gamma-Ray Irradiation

Hsin-Shun Huang[1], Wan-Shao Tsai[2], and Way-Seen Wang[3]

[1] Graduate Inst. of Photonics and Optoelectronics, National Taiwan Univ., Taiwan, [2] Dept. of Applied Materials and Optoelectronic Engineering, National Chi Nan Univ., Taiwan, [3] Dept. of Electrical Engineering, National Taiwan Univ., Taiwan

Ridge structures are fabricated on gamma-ray irradiated lithium niobate substrates to modify the modal field distributions of titanium-diffused waveguides. Experimental results show the measured modal field distributions are very close to that of a fiber.

TuPL-4
Withdrawn

TuPL-5
Secondary-Ion-Mass Spectrometry and Refractive Index Profile Studies of Zn:Ni:$LiNbO_3$ Optical Waveguides

T.-Y. Chiang, L.-Y. Liu, and W. S. Tsai

Dept. of Applied Materials and Optoelectronics Engineering, National Chi-Nan Univ., Nantou County, Taiwan

Optical waveguides of zinc and nickel co-diffused on lithium niobate substrates were measured with secondary-ion-mass spectrometry for metal ion concentrations and differential optical-fields for refractive index profiles. Correlation between compositional and optical properties was studied.

TuPL-6
Ultrasensitive Microtaper with an Air-gap Microcavity Fiber Fabry-Pérot Interferometer

Ching-Yi Tai[1,2], Chien-Lin Chen [1], Pin Han[2] and Cheng-Ling Lee[1]

[1] Dept. of Electro-Optical Engineering, National United Univ., Taiwan, [2] Gradustion Inst. of Precision Engineering, National Chung Hsing Univ., Taichung , Taiwan

This paper demonstrates a microfiber incorporated with an air-gap microcavity fiber Fabry-Perot-interferometer to achieve an ultrasensitive sensing characteristic. An extremely high sensitivity is achieved when the hybrid configuration operated under a fundamental-mode cutoff (FMC) condition.

TuPL-7
Fiber-Optic Twist Sensor Based on a Tapered Fiber Mach-Zehnder Interferometer

Chai-Ming Li, Chen-Wei Chan, Jing-Shyang Horng, Jui-Ming Hsu, and Cheng-Ling Lee

Dept. of Electro-Optical Engineering, National United Univ., Miaoli, Taiwan

All-fiber in-line twist sensor based on an ultrasensitive fiber-Mach-Zehnder-interferometer with cascaded two fiber tapers is proposed. Experimental results show wavelength shifts and spectral loss of the measured interference fringes are correlated with the twist angles.

TuPL-8
Phenomenon of Hygroscopicity in a Fiber Fabry-Pérot Interferometer with an Absorbent Polymer Cavity

Chien-Chih Liu[1], Yan-Wun You[1], Lih-Gen Sheu[2], Jui-Ming Hsu[1] and Cheng-Ling Lee[1]

[1] Dept. of Electro-Optical Engineering, National United Univ., Miaoli, Taiwan, [2] Dept. of Electro-Optical Engineering, Vanung Univ., Taoyuan, Taiwan

We experimentally measure the hygroscopicity of liquid by using ultracompact fiber Fabry-Pérot interferometers (FFPIs) with an absorbent polymer-microcavity in a hollowcore-fiber. Experimental results of Adsorption and desorption behaviors show a hysteresis phenomenon during the processes.

TuPL-9
Optical Waveguide Resonator for Refractive Index Change Sensor Using Arrayed Waveguide with Grating to Couple Light Beam

H. Irikawa[1], H. Okayama[1,2], N. Fujiwara[1], T. Ooka[1] and H. Nakajima[1]

[1] Waseda Univ., Shinjyuku, Japan, [2] Oki Electric Industry, Saitama, Japan

We report waveguide optical sensor using wire waveguide array. Grating coupler is used to couple waveguide modes with input and output light beam. The cavity is formed by new reflector structure or ring waveguide.

TuPL-10
Dispersion Model for AWG-Based Filters Under the Influence of Random Phase Errors

Koichi Maru

Dept. of Electronics and Information Engineering, Faculty of Engineering, Kagawa Univ., Kagawa, Japan

A statistical model of chromatic dispersion (CD) in filters using arrayed waveguide gratings (AWGs) with random phase errors is proposed. The average and variance of CD in the passband can be calculated using simple expressions.

TuPL-11
Variable Time Delay Experiments in Serially Cascaded Ring Resonator All-Pass Filters

Jaeseong Kim, Yoonyoung Ko, Hyosuk Kim, and Youngchul Chung

Dept. of Electronics and Communications Engineering, Kwangwoon Univ., Seoul, Republic of Korea

Serially cascaded single-ring resonator APF's (All-Pass Filters) are implemented in polymer waveguide for the realization of variable optical delay device. When all of 8 rings are resonannt, the delay is measured to be about 160ps.

TuPL-12
Waveguide Optical Triplexer with Cascaded Multi-Mode Interference Couplers

Ryosuke Yokote, Yuta Kojima, Hideki Yokoi

Dept. of Electronic Engineering, Shibaura Inst. of Technology, Tokyo, Japan

An optical triplexer with cascaded multi-mode interference couplers was proposed in an optical access system. The optical triplexer on a silicon-on-insulator substrate was designed by beam propagation method. The optical triplexer was fabricated and evaluated.

TuPL-13
Design, Fabrication and Properties of Optical Large Core Polymer Planar 1x2 Splitter

V. Prajzler, R. Mastera, and V. Jerabek

Dept. of Microelectronics, Faculty of Electrical Engineering, Czech Technical Univ. in Prague, Prague, Czech Republic

We report about properties of multimode polymer 1x2 optical planar splitter. The splitters have the insertion loss around 6.96 dB for a structure comprising POF fibers and 4.38 dB (650 nm) with FG910LEC fibers.

TuPL-14
Quasi-LP21 Mode Converter by Using Simple Step-Core Structure

Yutaka Chaen [1], Zhao Zhao [1], Yuuta Satou [2] and Kiichi Hamamoto [1]

[1] Interdisciplinary Graduate School of Engineering Science, Kyushu Univ., Japan, [2] Faculty of Engineering, Kyushu Univ., Japan

We propose multi-mode interference (MMI) based multi-mode converter for future spatial multi-mode multiplexing transmission. The designed MMI multi-mode converter could convert 0th mode up to LP21 mode.

TuPL-15
Fast Mode Splitting in Engineered Multimode Waveguides

Shuo-Yen Tseng, Chi-Shung Yeih, and Kai-Hsun Chien

Dept. of Photonics, National Cheng Kung Univ., Tainan, Taiwan

We propose fast mode splitting in multimode waveguides based on Lewis-Riesenfeld invariant theory. Mode converters are designed using computer-generated planar holograms to implement the coupling coefficients obtained from the dynamical invariants.

TuPL-16
SESAM-Based Ring-cavity All-normal-dispersion Tunable Ytterbium Mode-locked Fiber Laser

Doudou Gou[1], Sigang Yang[1], Feifei Yin[2], Lei Zhang[1], Fangjian Xing[1], Hongwei Chen[1], Minghua Chen[1], and Shizhong Xie[1]

[1] Tsinghua National Laboratory for Information Science and Technology (TNList) Dept. of Electronic Engineering, Tsinghua Univ., Beijing, P.R.China, [2] State Key Laboratory of Information Photonics & Optical Communications (Beijing Univ. of Posts and Telecommunications), Beijing, China

Based on a SEMSAM, an all-normal-dispersion ring cavity, tunable (1033-1069nm), Ytterbium-doped passively mode-locked fiber laser is demonstrated (repetition rate: 25.4MHz). The output pulse is compressed from 34.85ps to 15.45ps by using single-channel grating pairs.

TuPL-17
Characteristics of Glass Phosphor with Ce^{3+}:YAG Particle Coated SiO_2 by Sol-Gel Method

Wei-Chih Cheng[1], Chun-Chin Tsai[1,2], Shi-Sheng Hu[1], Jin-Kai Chang[1], Yu-Lun Lin[2], Li-Yin Chen[1], Yi-Chung Huang[1], Yi-Cheng Hsu[3], and Wood-Hi Cheng[1], IEEE Fellow

[1] Dept. of Photonics, National Sun Yat-sen Univ., Kaohsiung, Taiwan, [2] Dept. of Optoelectronic Engineering, Far East Univ., Tainan, Taiwan, [3] Dept. of Biomechatronics Engineering, National Pingtung Univ. of Science and Technology, Taiwan

The characteristics of sol-gel glass phosphor have been investigated. The sol-gel glass phosphor showed 1.5% and 9.5% more efficient in quantum efficiency and luminous efficiency respectively than sintered glass phosphor.

TuPL-18
Formation of Holographic Memory by Recording of Multi-context in Liquid Crystal Composites

Akifumi Ogiwara[1], Hikaru Maekawa[1], Minoru Watanabe[2], and Retsu Moriwaki[2]

[1] Dept. of Electronic Engineering, Kobe City College of Technology, Kobe, Japan, [2] Faculty of Engineering, Dept. of Electrical and Electronic Engineering, Shizuoka Univ., Hamamatsu, Japan

A holographic polymer-dispersed liquid crystal (HPDLC) memory to record multi-context information for an optically reconfigurable gate array is formed by a successive laser exposure in LC composites.

TuPL-19
Ultracompact Narrowband Three-Dimensional Hybrid Plasmonic Waveguide Bragg Grating

Yin-Jung Chang and Chun-Yu Chen

Dept. of Optics and Photonics, National Central Univ., R.O.C. (Taiwan)

A novel ultracompact three-dimensional waveguide plasmonic Bragg grating in metal/multi-insulator/metal configuration is investigated. Narrowband characteristics (FWHM bandwidth: 10.8 nm, extinction ratio: 11.91 dB) are numerically demonstrated within a footprint of <17 um^2.

TuPL-20
G-s_0 Mode Converter for Nano Plasmonic Integrated Circuits

Dong Hun Lee[1], Jung-Han Son[1], Hae-Ryeong Park[2], Min-su Kim[3] and Myung-Hyun Lee[1]

[1] School of Information and Communications Engineering, Sungkyunkwan Univ., Suwon, Korea, [2] CAE Group, LCD R&D Center, LCD Business, Samsung Electronics Co. Ltd., Gyeonggi-Do, Korea, [3] Electronics & Telecommunications Research Inst., Daejeon, Korea

We propose a G-s_0 mode-size converter (MC) from the Ss_0 mode to the G-s_0 mode at a wavelength of 1.55 um.

TuPM-1
High-Extinction Si Photonic-Crystal Optical Modulators At 10 Gb/s

Naoya Yazawa, Hong C. Nguyen, Satoshi Hashimoto, Toshihiko Baba

Dept. of Electrical and Computer Engineering, Yokohama National Univ. Tokiwadai, Yokohama, Japan

We optimized the 10 Gb/s operation in Si photonic crystal optical modulators with 50-200 μm phase-shifter lengths. By incorporating additional phase-tuners, we obtained over 10 dB extinction ratio and error-free operation.

TuPM-2
GHz Response of MSM InGaAs Photodetector on Si Substrate by BCB Bonding

Kazuaki MAEKITA, Takeo MARUYAMA, and Koichi IIYAMA

Graduate School of Natural Science and Technology, Kanazawa Univ., Ishikawa, JAPAN

We fabricated an InGaAs MSM-PD bonded on Si substrate by BCB bonding. The responsivity of 0.035A/W and the dark current of 29nA were obtained. The bandwidth of 3GHz was obtained at 10V.

TuPM-3
Selectable Heterogeneous Integrated III-V /SOI Single Mode Laser Based on Vernier Effect

Zhao Huang, Yi Wang

Wuhan National Laboratory for Optoelectronics, Huazhong Univ. of Science and Technology, Wuhan, China

A novel heterogeneous integrated III-V/SOI single mode laser is proposed. Owing to vernier effect between Fabry-Perot resonator and split silicon racetrack resonator, single longitudinal mode can be obtained and selected by thermally tuned silicon waveguide.

TuPM-4
Luminescence of $Er_xY_{2-x}SiO_5$ in Si Slot Waveguide Structures

Y. Terada, S. Ban, Z. I. Bin Zulkefli, T. Nakajima, T. Kimura, and H. Isshiki

Dept. of Engineering Science, The Univ. of Electro-Communications, Tokyo, Japan

Strong optical confinement to the low-index slot, such as $Er_xY_{2-x}SiO_5$, is expected for TM mode in Si slot waveguide. We have fabricated slab Si-slot waveguides with Er_2SiO_5 slot layers.

TuPM-5
An Equivalent Circuit with a Noise Source for 850-nm Si Avalanche Photodetector and Optimal Design of Si OEIC Receiver

Jin-Sung Youn[1], Myung-Jae Lee[1], Kang-Yeob Park[1], Holger Rücker[2], and Woo-Young Choi[1]

[1] Dept. of Electrical and Electronic Engineering, Yonsei Univ., Seoul, Korea, [2] IHP, Frankfurt (Oder), Germany

Equivalent circuit model including noise current source is developed for 850-nm Si avalanche photodetector (APD). The measured APD signal-to-noise characteristics are modeled with circuit parameters and used for realizing the optimal 12.5-Gbps Si OEIC receiver.

TuPM-6
Enhanced Dispersive and Nonlinear Properties of Coupled Ring Resonators by Using an Embedded Microrings Configuration

Xiaoyan Zhou[1], Lin Zhang[2], Andrea M. Armani[3], Hao Zhang[1], and Wei Pang[1]

[1] State Key Laboratory of Precision Measuring Technology and Instruments, Tianjin Univ., Tianjin, China, [2] Microphotonics Center and Dept. of Materials Science and Engineering, Massachusetts Inst. of Technology, Cambridge, USA, [3] Mork Family Dept. of Chemical Engineering and Materials Science, Univ. of Southern California, Los Angeles, USA

We study both the intensity and phase responses in embedded rings operated in analogy to electromagnetically induced transparency. Different phase regimes have been identified, which correspond to different optical nonlinear enhancement characteristics.

TuPM-7
Systematic Comparison of FWM Conversion Efficiency in Silicon Waveguides and MRRs

Meng Xiong[1,2], Yunhong Ding[2], Haiyan Ou[2], Christophe Peucheret[2], and Xinliang Zhang[1]

[1] Wuhan National Laboratory for Optoelectronics, School of Optoelectronics Science and Engineering, Huazhong Univ. of Science and Technology, Wuhan, Hubei, People's Republic of China, [2] Dept. of Photonics Engineering, Technical Univ. of Denmark, Lyngby, Denmark

Wavelength conversion based on four-wave mixing is theoretically compared in silicon micro-ring resonators and nanowires under the effect of nonlinear loss. The impact of the bus waveguide length and MRR position are also quantified.

TuPM-8
Permanent Tuning of high-Q Silicon Microring Resonators by Fs Laser Surface Modification

D. Bachman, Z. Chen, R. Fedosejevs, Y.Y. Tsui, and V. Van
Dept. of Electrical and Computer Engineering, Univ. of Alberta, Alberta, Canada

Post-fabrication tuning of silicon microring resonators is accomplished using single fs laser pulses at 400nm with a tuning rate of 20nm/J·cm^{-2}. The resonance mismatch of a 2nd-order microring filter is also corrected.

TuPM-9
Low Loss Delay Line Design and Characterization on SOI Platform

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We design and experimentally demonstrate 50ps low loss delay lines on SOI platform. The delay line unit consists of straight rib waveguides and strip bend sections. The excess loss of ~0.7 dB /unit is achieved.

TuPM-10
Low-Crosstalk Waveguide Crossing Based on 1×1 MMI Structure of Silicon-Wire Waveguide

Sang-Hun Kim, Guangwei Cong, Hitoshi Kawashima, Toshifumi Hasama, and Hiroshi Ishikawa
Network Photonic Research Center, National Inst. of Advanced Industrial Science and Technology, Ibaraki, Japan

Waveguide crossing based on a tilted multimode-interference (MMI) structure in high-index-contrast silicon wire is reported. The measured crosstalk with the optimal crossing angle of 110 degree is -44 dB at wavelength of 1550 nm.

TuPM-11
Design and Fabrication of a Polarization-Independent HCG

Kazuhiro Ikeda, Kentaro Takayose, Takeo Katayama, and Hitoshi Kawaguchi
Graduate School of Materials Science, Nara Inst. of Science and Technology, Ikoma, Japan

We show a design of a single layer cross stripes HCG with polarization-independent broadband reflectivity at 1.55 um and also fabrication of the HCG on silicon-on-insulator (SOI), which demonstrates the polarization-independent reflectivity as designed.

TuPM-12
Analysis of Various Whispering Gallery Modes in an Octagonal Silica Toroidal Microcavity

Takumi Kato, Ryo Suzuki, and Takasumi Tanabe
Dept. of Electronics and Electrical Engineering, Faculty of Science and Technology, Keio Univ., Yokohama, Japan

We studied a whispering-gallery mode octagonal silica toroidal microcavity and found two different modes, one of which exhibits a high Q of a 8.8×10^6. We also demonstrated it experimentally and obtained a Q of 2.2×10^4.

TuPM-13
Effects of Sensing Layer Thickness on Biosensing Using Partially-Slotted Si Photonic Crystal Waveguides

Takahiro Araki[1], Kakuro Hirai[1], Jingnan Cai[1], Yasuhiko Ishikawa[1], Kazumi Wada[1] Katsuyoshi Hayashi[2], Tsutomu Horiuchi[2], Yuzuru Iwasaki[2], Yuko Ueno[2], Emi Tamechika[2]
[1] Univ. of Tokyo, Tokyo, Japan, [2] NTT MI Labs, Kanagawa, Japan

One-dimensional Si photonic crystal waveguides having a partial slot resonator are investigated for biosensing. The thickness of sensing layer for antigen-antibody reactions is found to be one of the critical parameters to enhance the sensitivity.

TuPM-14
High-sensitivity Silicon-on-insulator Double-ring Sensor Operating in Transverse-magnetic Mode

Xianxin Jiang, Mingyu Li, and Jian-Jun He
State Key Laboratory of Modern Optical Instrumentation, Zhejiang Univ., Hangzhou, China

We report the experimental results of a high-sensitivity silicon photonic biosensor based on two cascaded-ring resonators operating in transverse-magnetic mode. The sensitivities of wavelength and intensity interrogation methods reach 24,300 nm/RIU and 2,430 dB/RIU, respectively.

TuPM-15
Performance of Silicon Coupled Resonator Waveguides for Integrated Nyquist Filter

Ke Xu, Chi Yan Wong, Zhenzhou Cheng, and Hon Ki Tsang
Dept. of Electronic Engineering, The Chinese Univ. of Hong Kong, Hong Kong

We propose an integrated optical Nyquist filter based on silicon coupled resonator waveguides. The filter is designed for converting the 28 Gbaud QPSK spectrum to a low roll-off raised cosine shape with baud rate bandwidth.

TuPO-1
Phase-Preserving Amplitude Regeneration of a Two-Amplitude-Level Modulation Format

Tobias Roethlingshoefer [1,2,3], Thomas Richter [4], Colja Schubert [4], Georgy Onishchukov [1,3], Bernhard Schmauss [3,5] and Gerd Leuchs [1,2,3]
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It has been experimentally shown that a modified nonlinear loop mirror can be used for all-optical star8-QAM processing. An amplitude noise reduction of 2.2 dB could be demonstrated for the high-power states.

TuPO-2
Wide range and multi-channel all-optical clock recovery using a silicon microring resonator assisted by a semiconductor optical amplifier

Yu Yu, Lei Xiang, Bingrong Zou, Ming Li and Xinliang Zhang
Wuhan National Laboratory for Optoelectronics, School of Optical and Electrical Information, Huazhong Univ. of Science and Technology, Wuhan, China

An all-optical clock recovery scheme with wide range of ~12GHz is proposed and demonstrated using a silicon microring resonator assisted by an amplitude equalizer. Single and dual channel clock recovery at 40Gb/s has been achieved.

TuPO-3
RZ-OOK to RZ-DPSK Format Conversion With All-Optical Clock Generation

Naoya Oka[1] and Motoharu Matsuura[2]
[1] Dept. of Information and Communication Engineering, [2] The Center for Frontier Science and Engineering, The Univ. of Electro-Communications, Tokyo, Japan

We demonstrated RZ-OOK to RZ-DPSK format conversion using all-optical clock generation without a conventional clock recovery circuit and pulse source. This scheme successfully achieved low-power penalty operation in comparison with a conventional scheme.

TuPO-4
All-optical, low-power 2R regeneration of 10Gb/s NRZ signals using a III-V on SOI microdisk laser

P. Méchet[1], T. Spuesens[1], N. Olivier[2], J.-M. Fedeli[2], P. Regreny[3], D. Van Thourhout[1], G. Roelkens[1] and G. Morthier[1]
[1] Photonics Research Group, Dept. of Information Technology, Ghent Univ.-imec, Ghent, Belgium, [2] CEA-LETI, Grenoble, France, [3] Université de Lyon, Institut des Nanotechnologies de Lyon INL-UMR5270, CNRS, Ecole Centrale de Lyon, Ecully, France

We demonstrate an all-optical low-power 2R regenerator of 10Gb/s NRZ data based on a 10-µm diameter microdisk laser, heterogeneously integrated onto silicon-on-insulator and processed in a CMOS pilot-line. The scheme works for sub-milliWatt input signals.

TuPO-5
Recognition of 16QAM Codes by Maximum Output with Optical Waveguide Circuits

K. Inoshia, N. Goto, and S. Yanagiya
Dept. of Optical Science and Technology, The Univ. of Tokushima, Tokushima, Japan

We proposed optical waveguide circuits for recognition of optical QAM codes, where QAM codes were recognized by null output port. In this report, we propose a circuit to recognize optical QAM codes by maximum output.

TuPO-6
Multi-functional Photonic Differentiators based on Versatile Demodulation of Phase Signals

Aoling Zheng, Jianji Dong, Siqi Yan, Ting Yang, and Dexiu Huang
Wuhan National laboratory for optoelectronics, Huazhong Univ. of Science and Technology, Wuhan, China

We demonstrate a multifunctional photonic differentiation (DIFF) using a phase modulator and two delay interferometers (DIs), including 1st order intensity DIFF, 1st order field DIFF and its inversion, 2nd order field DIFF.

TuPO-7
Optical Flip-Flop Operation with a Single SOA in Orthogonal Polarization States

K. Takase, R. Uehara, N. Goto, and S. Yanagiya
Dept. of Optical Science and Technology, The Univ. of Tokushima, Tokushima, Japan

Flip-flop operation with a single SOA using two orthogonal polarization states is proposed and analyzed. Polarization dependence of SOA is considered in the analysis of a single wavelength operation, and the simulated results are presented.

TuPO-8
Radio-over-Fiber Transmission With Optical Power Supply Using a Double-Clad Fiber

Jun Sato[1] and Motoharu Matsuura[2]
[1] Dept. of Information and Communication Engineering, [2] The Center for Frontier Science and Engineering, The Univ. of Electro-Communications, Tokyo, Japan

We presented radio-over-fiber transmission with optical power supply using a 100 m double-clad fiber. We successfully achieved high uplink and downlink transmission performances with 4 Watt (W) optical feeding.

TuPO-9
Serial Photonic Channelized RF Frequency Measurement Based on Optical Coherent Frequency Scanning

Ruiyue Li, Cheng Lei, Yunhua Liang, Hongwei Chen, Minghua Chen, Sigang Yang, and Shizhong Xie
Dept. of Electronic Engineering, Tsinghua Univ., China Tsinghua National Laboratory for Information Science and Technology (TNList)

Based on optical coherent frequency scanning, a serial photonic channelized RF frequency measurement scheme is proposed and experimentally demonstrated. An 8-channel, 2-GHz-interval channelizer for multiple frequencies measurement in 16-GHz range is realized.

TuPO-10
A Wideband Tunable Optoelectronic Oscillator Based on Stimulated Brillouin Scattering

Tao Sun, Cheng Zhang, Xiaopeng Xie, Peng Guo, Xiaoqi Zhu, Lixin Zhu, Weiwei Hu and Zhangyuan Chen
State Key Laboratory of Advanced Optical Communication System and Networks, Peking Univ., Beijing, P. R. China

A wideband tunable optoelectronic oscillator (OEO) based on stimulated Brillouin scattering is presented in this paper. Microwave signals generation range from 10.98 GHz to 39.98 GHz is demonstrated successfully in our experiment.

TuPO-11
Electro-Absorption Modulator Integrated Laser Application to A Cube Satellite Earth Station

Seiji Fukushima, Naomasa Miura, Takayuki Shimaki, Kota Yamashita, Taishi Funasako, Tomohiro Hachino, and Yasutaka Igarashi
Graduate School of Science and Engineering, Kagoshima Univ., Kagoshima, Japan

Because of mission extensions, a cube satellite uses several frequencies and its earth station suffers from cabling around antennas. We report an earth station employing an electro-absorption modulator integrated laser in a RoF system.

TuPO-12
Photonic Frequency Up-Conversion based on RSOA for 20-GHz Radio Signal Transmission

Zaineb Al-Qazwini and Hoon Kim
Dept. of Electrical & Computer Engineering, National Univ. of Singapore, Singapore

We demonstrate the transmission of 1.25-Gb/s 20-GHz radio signals generated by a low-cost reflective semiconductor optical amplifier. A significant improvement in the system bandwidth and dispersion tolerance is achieved by using a delay interferometer.

TuPO-13
All-optical Generation of UWB Pulses with Flexible Tunability of Central Frequency and 10-dB Bandwidth

Kang Tan, Junqiang Sun, Jian Wang, Ya Gao
Wuhan National Laboratory for Optoelectronics, School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, Wuhan, China

We report a novel scheme for all-optical generation of polarity-inverted ultra-wideband pulses with central frequency and 10-dB bandwidth all-optically tuned from 5 to 10 GHz and 3 to 10 GHz, respectively.

TuPO-14
Withdrawn

TuPO-15
A Broadband Optical Source Based Optoelectronic Oscillator with Widely Tunable Frequency Range

Chenjun Liu, Weiwen Zou, Guiling Wu, Jianping Chen
State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Key Laboratory of Navigation & Location Based Services, Shanghai Jiao Tong Univ., Shanghai, China

An optoelectronic-oscillator (OEO) with widely-tunable-frequency range is experimentally demonstrated. A single band-pass microwave photonic filter based on a broadband source serves as an oscillating-mode selector. The proposed OEO is notching-free due to the non-carrier-suppression effect.

TuPO-16
Single Shot Ghost Imaging

Shinji Hozawa, Kouichi Nitta, and Osamu Matoba
Dept. of Systems Science, Graduate of System Informatics, Kobe Univ., Kobe, Japan

A novel method for ghost imaging is proposed. Single shot imaging is achieved by a measurement based on wavelength multiplexing. Usefulness of the proposed method is verified by numerical analysis.

TuPO-17
An Angularly Positioned LED-based Spatial-temporal Color Separation System

Chi-Hung Lee[1], Shih-Hsin Ma[2], and Chia-Hsien Yang[1]
[1] Dept. of Electrical Engineering, Feng Chia Univ., Taichung, Taiwan, [2] Dept. of Photonics, Feng Chia Univ.

A display method, two-field driving scheme based on angularly positioned color LEDs, is proposed for field sequential color liquid crystal displays (LCDs) without color filters.

TuPO-18
Asymmetric Diffraction Orders Based on Axicon and Helical Phase Combination

M. Mihailescu[1], L. Preda[1], A. Gheorghiu[1], M. Kusko[2], O. Curcan[3] and C. Kusko[2]
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We digitally generate holograms with an axicon phase distribution placed in the object beam. The resulted asymmetric phase masks are optically combined with helical phase distributions to obtain structured beams with asymmetric peak and hole.

TuPO-19
White Upconversion Luminescence of $CaWO_4$:Ho^{3+}/Tm^{3+}/Yb^{3+} Excited by IR Laser

J.H. Ryu[1,2] and Jung-Il Lee[1]
[1] Dept. of Materials Science and Engineering, Korea National Univ. of Transoportation, Chungbuk, Korea, [2] Regional Innovation Center (RIC), Korea National Univ. of Transoportation, Chungbuk, Korea

Under the laser excitation of a 980 nm, Ho^{3+}/Tm^{3+}/Yb^{3+} co-doped $CaWO_4$ shows the bright white upconversion emission visible to the naked eyes.

TuPP-1
A Proposal of the Compact Transceiver with High Extinction Capability for WDM/TDM-PON

H. Iwamura, M. Sarashina, H. Saito, H. Tamai, S. Kobayashi, N. Minato, and M. Kashima
Oki Electric Industry Co. Ltd., Corporate R&D Center, Chuo, Saitama, Japan

We clarified the relationship between the extinction ratio of upstream burst signals and Q factor of received signals to evaluate the impact of beat noise caused by residual noise interferences.

TuPP-2
Energy-Efficient Dynamic Bandwidth Allocation Algorithm with Fixed Polling Cycle Times

Maluge Pubuduni Imali Dias and Elaine Wong
National ICT Australia, Victoria Research Laboratory, Dept. of Electrical and Electronic Engineering, The Univ. of Melbourne, VIC, Australia

A just-in-time dynamic bandwidth allocation algorithm exploiting the sleep/doze capabilities of a VCSEL ONU is proposed for 10 Gbps EPON. The algorithm uses fixed polling cycle times to achieve substantial energy-savings at low network loads.

TuPP-3
Effects of OLT Activation Control on Quality of Communication Services in Virtualized PON

IMANAKA Norihiro, NAKAHIRA Yoshihiro, and KASHIMA Masayuki
Corporate Research & Development Center, Oki Electric Industry Co., Ltd. Osaka, Japan

Virtualized PON is a next generation optical access system which reduces energy consumption by sleeping OLTs according to traffic volume. Simulation results show the number of activated OLTs has a relationship with TCP control mechanisms.

TuPP-4
Remotely-Pumped WDM-PON Systems Using ASE Sources for Upstream Transmission

San-Liang Lee, Ming-Hsueh Chuang, Chi-Hsien Sun, Meng-Ru Lee, Kuo-Chang Feng, and Chih-Wei Lee
Dept. of Electronic Engineering, National Taiwan Univ. of Science and Technology, Taipei, Taiwan

We demonstrate a potentially low-cost solution for WDM-PON systems by using ASE sources as seeding lights for upstream transmission. By applying remote pumping scheme, the upstream can carry 2.5 Gb/s over 25-km LEAF fiber.

TuPP-5
Impact of Splitter Configuration Strategies on Power Consumption in PON

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We analyze the impact of different types of splitter structures on resource sharing and power consumption in long reach PON. Using Cascaded splitter and Extender Box, power efficiency increases especially in low take rate areas.

TuPP-6
Bidirectional 10 Gb/s Coherent WDM-PON with Colorless ONUs and Extended Reach

Qi Guo and An V. Tran
National ICT Australia, Electrical and Electronics Engineering, Univ. of Melbourne, Australia

We demonstrate a bidirectional 10 Gb/s WDM-PON with 100 km reach and RSOA-based ONUs using heterodyne detection. The proposed network can support 640 customers at the rate of 1.25 Gb/s via TDM hybrid.

TuPP-7
3. 3 Gbps x 3TDM IR signal transmission for UWB over Combined Fiber and Wireless Link

Saeko Oshiba, Hiroshi Miura, Yuri Ohara, and Hitoshi Shimasaki
Dept. of Electronics, Kyoto Inst. of Technology, Kyoto, Japan

3. 3 Gbps x 3TDM IR signal transmission in combined 10 km SMF and wireless link with UWB band of 7.25-10.25GHz is demonstrated.

TuPP-8
A Time Domain Wavelength Interleaved Passive Optical Access Network with Simplified ONU Processing and Enhanced Physical Layer Security

Zhensen Gao, Qingjiang Chang, and Zhongji Hu
Research and innovation center (Bell Laboratory Shanghai), Alcatel-lucent Shanghai Bell Co. Ltd, Shanghai, P. R. China

We proposed and verified a novel time domain wavelength interleaved passive optical access network architecture to simplify ONU electronic processing and enhance physical layer security in a two-channel, 1.25Gb/s optical system with 20km fiber span.

TuPP-9
Upgrading from TDM-PON to Signal-Remodulated WDM-PON with Rayleigh Backscattering Mitigation

C. W. Chow[1], C. H. Yeh[2], and J. Y. Sung[1]
[1] Dept. of Photonics and Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Hsinchu, Taiwan, [2] Information and Communications Research Laboratories, Industrial Technology Research Inst. (ITRI), Hsinchu, Taiwan

We propose and demonstrate a migrating scheme from TDM-PON to WDM-PON using downstream differential-phase-shift-keying (DPSK) and upstream wavelength-shifted-amplitude-shift-keying (WS-ASK) signals. An optical-filter is pre-installed in the optical-networking-unit (ONU) for DPSK demodulation. Rayleigh-backscattering is also mitigated.

TuPP-10
VCSEL sources for optical fiber-wireless composite data links at 60GHz

J.J. Vegas Olmos, X. Pang, A. Lebedev, and I. Tafur Monroy
Technical Univ. of Denmark, DTU Fotonik, Ørsted Plads, Lyngby, Denmark

This paper presents a performance assessment of 60-GHz mm-wave signal generation using photonic upconversion employing a VCSEL as source. The system reaches 10^{-9} BER over a variety of optical fibers for data rates of 1.25-Gbit/s.

TuPP-11
2.5 Gb/s Injection Seeded DWDM - PON Using Feed Forward Noise Suppression

Sang-Rok Moon, Myeong Gyun Kye, Byung-Il Seo, and Chang-Hee Lee
Dept. of Electrical Engineering, Korea Advanced Inst. of Science and Technology, Daejeon, Republic of Korea

We propose an injection seeded dense WDM-PON employing feed forward loop for 2.5 Gb/s transmission at 50 GHz channel spacing. We achieved the error free transmission with -12 dBm injection power for 20 km transmission.

TuPP-12
Seamless Optical Fiber-Wireless Millimeter- Wave Transmission Link for Access Networks

Xiaodan Pang, Alexander Lebedev, J.J. Vegas Olmos, and Idelfonso Tafur Monroy
Technical Univ. of Denmark, DTU Fotonik, Ørsted Plads, Lyngby, Denmark

This paper presents an experimental demonstration of a millimeter-wave wireless bridge in the W-band for transparent broadband fiber access in the sub-urban areas, where full fiber connections are impracticable.

TuPQ-1
Prototype Implementation and Verification of Optical Network Management System Providing QoS-Aware Wavelength Path Set-up Using OpenFlow

Akira Fukushima, Masashi Takada, Yosuke Tanigawa, Hideki Tode
Dept. of Computer Science and Intelligent Systems Osaka Prefecture Univ., Osaka, Japan

In this paper, we implement a prototype for an optical network management system with scalable architecture that can quickly reply user's QoS request using OpenFlow and evaluate its effectiveness in the experimental-environment.

TuPQ-2
Multi-fiber based Dynamic Spectrum Resource Allocation for Multi-domain Elastic Optical Networks

Yusuke Hirota[1], Hideki Tode[2], and Koso Murakami[1]
[1] Osaka Univ., Osaka, Japan, [2] Osaka Prefecture Univ., Osaka, Japan

We demonstrate a dynamic end-to-end Routing and Spectrum Assignment exploiting multiple fibers in multi-domain elastic optical networks. Performance evaluation shows the proposed RSA enhances the statistical multiplexing effects with multiple fibers and improves blocking probability.

TuPQ-3
A Mathematical Model for Network Coding Aware Optimal Routing in 1+1 Protection for Destination's Node Degree >= 2

Pham Vu Phong, Abu Hena Al Muktadir, and Eiji Oki
Dept. of Information and Communications Engineering The Univ. of Electro-Communications, Tokyo, Japan

This paper introduces a mathematical programming model to minimize the network resource utilization of applying 1+1 protection, in scenarios with two sources and common destination, using network coding with the destination's node degree >= 2.

TuPQ-4
A Study on Fast Pre-planned Restoration in Optical Networks

Hitomi Yoshimura, Sota Yoshida, Ryusuke Kawate and Takashi Mizuochi
Information Technology R&D Center, Mitsubishi Electric Corporation,, Kanagawa, Japan

To reduce time for recovery from failures of protection in optical networks, we propose a pre-planned restoration mechanism which monitors backup paths. Numerical simulation revealed its effectiveness and estimated the appropriate number of backup paths.

TuPQ-5
Field Trial of 40 Gb/s Optical Transport Network using Open WDM Interfaces

Anna Manolova Fagertun[1], Sarah Ruepp[1], Martin N. Pedersen[1] and Bjarke Skjoldstrup[2]
[1] DTU Fotonik, Oersteds Plads, Kongens Lyngby, Denmark, [2] TDC A/S, Address, Denmark

An experimental field-trail deployment of a 40Gb/s open WDM interface in an operational network is presented, in cross-carrier interconnection scenario. Practical challenges of integration and performance measures for both native and alien channels are outlined.

TuPQ-6
A Fairness-Aware Dynamic Spectrum Allocation Scheme in Elastic Optical Networks

Songwei Ma, Yan Wang, Bingli Guo, Xin Chen, Juhao Li, Zhangyuan Chen, and Yongqi He
State Key Lab. of Advanced Optical Communication Systems and Networks, Peking Univ., Beijing, China

Service fairness of traffic with different granularities in elastic optical networks is addressed and correspondingly a fairness-aware spectrum allocation scheme is proposed. Simulation results imply that it achieves service fairness without significant blocking performance deterioration.

TuPR-1
Experimental Demonstration of Employing Implicit Training in Long-Haul Polarization-Multiplexed Coherent Optical Systems

Chen Zhu, An V. Tran, Trevor Anderson and Efstratios Skafidas
Victoria Research Laboratory, NICTA Ltd., Electrical and Electronic Engineering, Univ. of Melbourne, Australia

Employing implicit training for channel estimation in long-haul single-carrier polarization-multiplexed coherent optical systems has been experimentally demonstrated. By comparing with conventional blind equalization scheme, implicit training shows good performance in both QPSK and 16-QAM experiments.

TuPR-2
Effects of Carrier Phase Estimation on Front-end IQ Mismatch Compensation in DP-QPSK Coherent Receiver

Hwan Seok Chung, Sun Hyok Chang, Kwangjoon Kim, Jong Hyun Lee
Optical Internet Research Dept., Daejon, Korea

We investigate and compare effects of carrier phase estimation on IQ mismatch compensation. Decision-directed carrier phase estimator could compensate significant amount of IQ mismatch without employing additional compensation technique, and relaxes requirement of ADC resolution.

TuPR-3
300-km SSMF Transmission of 10-Gb/s Chirp Managed Laser Signal with Pre-emphasis

Wei Jia and Chun-Kit Chan
Dept. of Information Engineering, The Chinese Univ. of Hong Kong, Shatin, N. T., Hong Kong SAR

We demonstrate the 10-Gb/s 300-km SSMF transmission at BER of 10^{-9}, using a directly modulated chirp managed laser (CML) with a simple and passive pre-emphasis driver, without any optical or electronic dispersion compensation.

TuPR-4
Dual-loop Optoelectronic Oscillator for Generation of Stable and Ultralow Timing-jitter Electrical and Optical Clock

Jizhao Zang, Yan Li, Miao Yu, Deming Kong, Jian Wu, Wei Li, Hongxiang Guo and Jintong Lin
State Key Laboratory of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, Beijing, China

We propose and demonstrate a novel dual-loop OEO employing balanced photo-detection. 40GHz ultra-stable electrical and optical clock with timing-jitter of 33.59fs are generated and further used to obtain short optical pulses with FWHM of 2.1ps.

TuPR-5
Frequency Pre-distortion for Coherent Optical MIMO System over MMF

Ziran Zhang, Yuanquan Wang, Rongling Li, Wuliang Fang, Yufeng Shao, Nan Chi
Dept. of Communication Science & Engineering, State Key Laboratory of ASIC & System, Fudan Univ., Shanghai, China

We establish a complete analytical model for coherent optical MIMO systems over MMF with ring launching and receiving. 10Gb/s QPSK signal with pre-distortion is successfully transmitted over 2.5km MMF with EVM less than 0.08

TuPR-6
Optical Carrier Extraction for Homodyne Detection of BPSK Signals

Masayuki Matsumoto
Wakayama Univ., Faculty of Systems Engineering, Sakaedani, Wakayama, Japan

Optical carrier extraction from carrier-less BPSK signals is demonstrated, where homodyne detection, modulation stripping, and injection locking of laser diode are performed in a feedback loop. Clear eye opening is observed in the homodyne-detected signal.

TuPR-7
Experiment on Phase Sensitive Amplification of BPSK Signal Using Phase-lock Costas Loop Circuit

Yuya Sakai[1], Masamichi Sugamoto[2], Eiki Nakatani[1], Akira Mizutori[2], Atsushi Takada[1] and Masahumi Koga[2]
[1] Univ. of Tokushima, Tokushima-shi, Japan, [2] Oita Univ., Dannoharu, JAPAN

Phase-sensitive amplification (PSA) of BPSK signal using decision-driven phase-lock Costas loop for pump light is successfully demonstrated. Power penalty due to phase error of pump light in PSA is also estimated theoretically.

TuPR-8
Residual Carrier-Aided Frequency Offset Estimation for Square 16-QAM Systems

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We present a frequency offset estimation using a residual carrier that is a by-product of our previous generation technique[1]. The offset range is extended to half of the symbol rate and is resilient to filtering.

TuPR-9
Withdrawn

TuPR-10
Employing NRZI Code for Reducing Background Noise in LED Visible Light Communication

Y. F. Liu[1], C. H. Yeh[2,3], Y. C. Wang[1], and C. W. Chow[1]
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We demonstrate that non-return-to-zero-inverted (NRZI) code reduces the background optical interference effectively in low frequency band. The comparison between non-return-to-zero (NRZ) code and NRZI code was performed in a visible-light-communication (VLC) system.

TuPR-11
Blind Maximum-likelihood Frequency Offset Estimation for Coherent Fast OFDM Receivers

Ming Li[1], Jian Zhao[2], and Lian-Kuan Chen[1]
[1] Dept. of Information Engineering, The Chinese Univ. of Hong Kong, Hong Kong SAR, China, [2] Tyndall National Inst. and Univ. College Cork, Cork, Ireland

We propose blind maximum-likelihood carrier frequency offset (CFO) estimation for coherent fast OFDM receivers. Simulation results show that the estimation algorithm can greatly enhance the CFO tolerance, and is insensitive to chromatic dispersion.

TuPR-12
640Gbit/s Dual-polarization DQPSK OTDM Transmission over 410km Using EAM-based Pulse Source and Clock Recovery

Jizhao Zang, Yan Li, Deming Kong, Siyuan Zhou, Jian Wu, Wei Li, Yong Zuo, Hongxiang Guo and Jintong Lin
State Key Laboratory of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, Beijing, China

We experimentally demonstrate a 640Gbit/s dual-polarization DQPSK OTDM system using EAM-based pulse source and clock recovery. Error free transmission over 410km fiber link is realized with power penalty of 4.46dB.

TuPR-13
A Simple Receiving System Design for a 172.8-Gb/s Double-Sided Multiband Direct-Detected O-OFDM System

Jhih-Heng Yan[1], You-Wei Chen[1], Kai-Ming Feng[1], and Yuan-Wei Chang[2]
[1] Inst. of Photonics Technologies, National Tsing Hua Univ., Hsinchu, Taiwan, (R.O.C.), [2] Inst. of Communication Engineering, National Tsing Hua Univ., Hsinchu, Taiwan, (R.O.C.)

We propose and experimentally demonstrate a simple doubled-sided multiband direct-detection optical OFDM receiving system. An aggregated 172.8-Gb/s data rate and a 2.73-b/s/Hz spectral efficiency of total 6 signal bands are carried by one optical carrier.

TuPR-14
Least Radial Distance Based Carrier Phase Recovery for 16-QAM Coherent Optical Systems

Md. Ibrahim Khalil[1], Md. Mosaddek Hossain Adib[1], Arshad M Chowdhury[1,2], Md. Saifuddin Faruk[3], and Gee-Kung Chang[2]
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We propose and demonstrate least radial distance based carrier-phase recovering method for 16-QAM coherent optical systems. Through numerical analysis, we found proposed scheme has less than 2dB OSNR penalty when laser linewidth-symbol-duration-product $\Delta\upsilon T_s$=1×10^{-4} range.

TuPR-15
A phase noise estimation and suppression algorithm for PDM CO-OFDM

Xi Fang, Chuanchuan Yang and Fan Zhang
State Key Laboratory of Advanced Optical Communication Systems and Networks, Peking Univ., Beijing, China

In this paper, we propose to use an efficient laser phase noise suppression algorithm for PDM CO-OFDM, which can compensate both CPE and ICI. The proposed method can significantly promote the system robustness against laser phase noise.

TuPR-16
Performance of Adaptive Maximum Likelihood Sequence Detection with Nonlinear Phase Noise

Zhuoran Xu[1], Changyuan Yu[1,2], Pooi-Yuen Kam[1]
[1] Dept. of Electrical & Computer Engineering, National Univ. of Singapore, [2] National Univ. of Singapore (Suzhou) Research Inst., China

Adaptive maximum likelihood sequence detection is applied to compensate for nonlinear phase noise in coherent optical transmission systems. It can automatically achieve the optimal performance and thus tolerate longer transmission distance.

TuPR-17
Partial Pilot Filling for Phase Noise Compensation in Coherent Optical OFDM Systems

S. Hussin, K. Puntsri, M.F. Panhwar and R. Noé
Optical Communication and High Frequency Engineering Dept., Univ. Paderborn, EIM-E, Paderborn, Germany

We present a partial pilot filling method to mitigate the effect of phase noise in coherent optical OFDM. This method uses linear interpolation between constant pilot frequencies. Phase noise effect from laser linewidth is investigated.

TuPR-18
Wavelength Conversion of Two Different Wavelength Signals using an Optical Single-SideBand Modulator

Hiroyuki Mima and Katsushi Iwashita
Electrical and Photonic System Engineering, Kochi Univ. of Technology, Kochi, Japan

Wavelengths of two signals with different wavelengths are simultaneously converted using the proposed wavelength converter. 75-GHz wavelength conversions for intensity modulated signals are demonstrated using 25-GHz channel spacing AWG and OSSB performing three time conversion.

TuPR-19
Self-homodyne Detection of Phase Modulated Signals using Quadrature-phase-modulated and Polarization-multiplexed Pilot Carrier

Hiroshi Mizukami, Yasuhiro Okamura, and Masanori Hanawa
Univ. of Yamanashi, Yamanashi, Japan

Simple self-homodyne detection for optical BPSK signals using a quadrature-phase-modulated and polarization-multiplexed pilot carrier is proposed and experimentally demonstrated. The simple receiver configuration for IQ discrimination makes the use of phase modulation in PON possible.

TuPS-1
Connection Characteristics of Multicore Fiber Connector

Katsuyoshi Sakaime[1], Ryo Nagase[1], Kengo Watanabe[2], and Tsunetoshi Saito[2]
[1] Chiba Inst. of Technology, Tsudanuma, Narashino, Chiba, Japan, [2] Furukawa Electric, Co., Ltd., Chiba, Japan

We have developed a 7-core-fiber connector. To maintain both the ferrule floating mechanism and precise alignment around the ferrule axis, we employed Oldham's coupling mechanism and realized an average insertion loss of 0.13 dB.

TuPS-2
Implementation of Variable Optical Delay Line Using Metal-coated Optical Fibers

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[1] Centre of Excellence for Biosensors, Instrumentation and Process Control, Solkan, Slovenia, [2] Univ. of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia

By applying an electrical current to the metal-coated fiber, a relation between the applied power and the delay difference was measured. The temperature coefficient and the rise time exceed those of other optical-fiber delay-line implementations.

TuPS-3
Fabrication of Polarization-Maintaining Photonic Crystal Fiber Optical Attenuator Using Air Hole Diameter Control

Hirohisa YOKOTA, Naoya INOUE, Yuto KOBAYASHI, and Yoh IMAI
Graduate School of Science and Engineering, Ibaraki Univ., Ibaraki, Japan

Polarization-maintaining photonic crystal fiber optical attenuators were fabricated using air hole diameter control with CO_2 laser irradiation technique. The desired attenuation could be obtained by the air hole diameter control with the laser power adjustment.

TuPS-4
Characteristics of Photoactive Photonic Liquid Crystal Fiber Used in Communication Wavelength

Hsin-Rung Lee, and Vincent K. S. Hsiao
Dept. of Applied Materials and Optoelectronic Engineering, National Chi Nan Univ., Taiwan

In this conference paper, we demonstrate photoactive photonic liquid crystal fiber (PLCF) consisted of an azobenzene based photoactive LC (Azo-LC) and solid core photonic crystal fiber (SC-PCF).

TuPS-5
All-optical tunable comb filters using ytterbium doped fibers and an LPG pair

Yune Hyoun Kim [1], Bok Hyeon Kim [2], Swook Hann [1], Young-Eun Im [1], Jung Woon Lim [1], Jong-Sup Kim [1], Jeong Ho Kim [1], Ju Young Lim [1], and Won-Taek Han [3]
[1] Laser-IT Research Center, KOPTI, South Korea, [2] Advanced Photonics Research Inst., GIST, South Korea, [3] Graduate Program of Photonics and Applied Physics, School of Information and Communications, GIST, South Korea

We have demonstrated a new type all-optical tunable comb filter by using a long-period fiber gratings(LPG) pair spliced with an ytterbium doped fiber. The optical comb filter was tunable with an optical pumping.

TuPS-6
Passively Q-switched Erbium-Doped Fiber Laser Using a Side-polished Birefringent Fiber

Joonhoi Koo and Ju Han Lee
School of Electrical and Computer Engineering, Univ. of Seoul, Seoul, Republic of Korea

We experimentally demonstrate a passively Q-switched erbium-doped fiber laser incorporating a side-polished birefringent fiber with index matching gel spread on the flat side as a passive Q-switch.

TuPS-7
Comparison Of Time-lens Configurations Under Different Repetition Rate

Chi Zhang, P. C. Chui, and Kenneth K. Y. Wong
The Photonic Systems Research Laboratory, Dept. of Electrical and Electronic Engineering The Univ. of Hong Kong, Hong Kong

We review the theoretical models and the performance of two existing time-lens configurations, and compare them under different repetition rate in different aspects: the focal group delay dispersion (GDD), and the temporal numerical aperture (NA).

TuPS-8
Optical Analog Multiplier based on Phase Sensitive Amplification

T. Fujita, Y. Toba, Y. Miyoshi and M. Ohashi
Osaka Prefecture Univ., Osaka, Japan

We propose an optical multiplier based on phase sensitive amplification. This optical multiplier will be overcome the speed limitation of signal processing. The linearity can be less than 4%FS at the signal power of 1mW.

TuPS-9
Optical Amplification at 1.3 μm with Bi Doped Fiber Fabricated by VAD Method

M. Takahashi [1], T. Fujii[1], Y. Saito[1], Y. Fujii[2] and S. Kobayashi[1]
[1] Chitose Inst. of Science and Technology, Hokkaido, Japan, [2] Photonic Science Technology, Inc., Hokkaido, Japan

An optical amplification with BDF fabricated by the VAD method is presented. The measured amplified gain was 6 dB with input low laser power at 1.3 μm using a double cladding BDF of 2 m.

TuPS-10
Superbroadband Emission from Pr^{3+}-doped Germanate Glasses

B.J. Chen[1], H. Lin[2], and E.Y.B. Pun[1]
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Superbroadband emission covering 1300 to 1700nm wavelength has been obtained in Pr^{3+}-doped aluminum germanate glasses. A maximum emission cross-section of $6.04\times10^{-21}cm^2$ is obtained, and K^+-Na^+ ion-exchanged glass channel waveguides have been fabricated in these glasses.

TuPS-11
Optical Frequency Comb Block Generation from a Bismuth-Based Harmonically Mode-Locked Fiber Laser

Yutaka Fukuchi and Joji Maeda
Dept. of Electrical Engineering, Faculty of Engineering, Tokyo Univ. of Science, Tokyo, Japan

We propose optical frequency comb block generation from a harmonically mode-locked laser using a bismuth-based erbium-doped fiber and a bismuth-based highly nonlinear fiber. A 10GHz-spaced frequency comb with a 10dB bandwidth of 300GHz is obtained.

TuPS-12
Control of Population Inversion in a Fiber Amplifier with Pulse Sequences

A. Suzuki, K. Kuroda , and Y. Yoshikuni
Dept. of Physics, School of Science, Kitasato Univ., Kanagawa, Japan

We report control of population inversion in a fiber amplifier with pulse sequences. Induced population change was probed by using a pump-probe method, showing that the change is determined by the total photon number.

TuPS-13
Polymer-Based Waveguide Optical Sensor with Tin Oxide Thin Film for Gas Detection

Jung Woon Lim[1], Seon Hoon Kim[1], Jong-Sup Kim[1], Jeong Ho Kim[1], Yune Hyoun Kim[1], Ju Young Lim[1], Young-Eun Im[1], Boo-Gyoun Kim[2], and Swook Hann[1]
[1] Korea Photonics Technology Inst., Gwangju, Korea, [2] School of Electronics Engineering, Soongsil Univ., Seoul, Korea

We proposed optical sensor based on polymer waveguide with tin oxide thin film on the top of core layer exposed by removing upper cladding layer. This device was fabricated by the nano imprint lithography technique.

TuPS-14
Volatile organic compound detection using twin-core photonic crystal fiber with selectively sealed air holes in-reflection interferometer

Khurram Naeem[1], Bongkyun Kim[1], Linh Viet Nguyen[2], and Youngjoo Chung[1]
[1] School of Information & Communication, Gwangju Inst. of Science and Technology (GIST), Gwangju, Korea, [2] The Inst. for Photonics & Advanced Sensing, The Univ. of Adelaide, Adelaide, Australia

We present twin-core photonic crystal fiber with selectively-sealed air holes in-reflection interferometer for high sensitivity volatile organic compound detection.

TuPS-15
Distributed High Temperature Sensing in Large-Scale Plants by LPFG with Multiplexed Resonant Wavelengths

Osanori Koyama, Saburo Kasahara, Hikaru Sumiana, Yoshikazu Toyooka, and Yutaka Katsuyama
Osaka Prefecture Univ., Osaka, Japan

Ten resonant wavelengths could be multiplexed in one fiber successfully by writing LPGs with different grating pitches for distributed temperature sensing in a large-scale plant. The performance of the multiplexed LPFG was investigated.

TuPS-16
Highly Sensitive Fiber-Optic Thermometer Using an Air Micro-Bubble in a Liquid Core Fiber Fabry-Pérot Interferometer

Han-Jung Chang, Yang-Chen Zheng, Chia-Lien Ma and Cheng-Ling Lee
Dept. of Electro-Optical Engineering, National United Univ., Miaoli, Taiwan

We proposed a novel, miniature and ultrasensitive fiber-optic thermometer based on an air-micro-bubble drifted in a liquid-core-fiber Fabry-Pérot-interferometer. The proposed sensor has an ultrahigh sensitive and linear spectral response with -9.0 nm/°C in temperature measurement.

TuPS-17
Probe Typed Microcavity Fiber Fabry-Pérot Interferometer for High Temperature Measurement

Chien-Lin Chen[1], Cheng-Hung Hung[1], Lin-Gen Sheu[2], Jing-Shyang Horng[1] and Cheng-Ling Lee[1]
[1] Dept. of Electro-Optical Engineering, National United Univ., Miaoli, Taiwan, [2] Dept. of Electro-Optical Engineering, Vanung Univ., Taoyuan, Taiwan

We propose two kinds of probe typed, microcavity fiber Fabry-Pérot interferometers (MCFFPIs) for high temperature measurement (HTM). Experimental results show high stable sensing properties with linear spectral responses of the MCFFPIs for the HTM

TuPS-18
Fiber-optic Micro-bending Sensor Using the Multimode Interference

Guei-Ru Lin[1], Lung-Shiang Huang[2], Jin-Hone He[2], Ming-Yue Fu[3], Wen-Fung Liu[3], and Raman Kashyap[4]
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A fiber micro-bending sensor is presented with multimode interference effects created by splicing a piece of no-core fiber between two single-mode fibers. The micro-bending measurement is experimentally demonstrated with a sensitivity of -183.788 nm/m-1.

TuPS-19
Holey Fiber based Plasmonic Sensor for Simultaneously Detecting of Multiple Analytes

Li Xia, Binbin Shuai, and Deming Liu
Wuhan National Laboratory for Optoelectronics, National Engineering Laboratory for Next Generation Internet Access System, School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, Wuhan, China

A holey fiber based plasmonic sensor capable of simultaneously detecting multiple analytes is numerically characterized through the finite element method. A maximum sensitivity of 10200nm/RIU is demonstrated.

TuPS-20
Highly Sensitive Bending and Airflow Sensor Based on an In-Line Multimode Fiber Interferometer

Yung-Chang Jen, Wen-Cheng Shih, Chia-Ling Hsu, and Cheng-Ling Lee
Dept. of Electro-Optical Engineering, National United Univ., Miaoli, Taiwan

This study demonstrates a novel and sensitive bending and airflow sensor based on an in-line, reflective multimode fiber interferometers cantilever (RMMFIC). Interference fringes shifts of the RMMFIC from bending/airflow are effectively detected and experimentally investigated.

TuPT-1
Proposal of Optical Spatial Mode Switch Using Symmetric Y-junction Waveguides

Makoto Jizodo, Asuka Fujino, and Kiichi Hmamoto
I-EggS, Kyushu Univ., Fukuoka, Japan

We newly propose optical spatial mode switch using symmetric Y-junction waveguides. The estimated mode-crosstalk is less than -30dB with less than 0.1dB excess loss at the wavelength of 1550nm.

TuPT-2
Investigation of an Interleaver for All-Optical Analog-to-Digital Conversion

Hiroyuki Uenohara
Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Kanagawa, Japan

Operation of an interleaver for all-optical digital-to-analog conversion with an interferometer and a sampling pulses has been investigated. Preliminary results of the multi-level intensity was sampled according to the analog intensity of the input signal.

TuPT-3
Novel Optical Labeling Scheme for Ultra-High Bit Rate Data Packets

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DTU Fotonik, Dept. of Photonics Engineering, Technical Univ. of Denmark, Lyngby, Denmark

We propose and verify by simulations an optical in-band labeling scheme for ultra-fast optical switching. The scheme is able to label more than 60 different 640-Gbit/s OTDM packets with eye opening penalty <1 dB.

TuPT-4
An Optical Packet Switch Using Forward-Shift Switched Delay Lines

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A 32×32 optical packet switch design using only four packets of variable delay is shown 95% as efficient as electronic switching using simulated Poisson Internet traffic. Our forward-shift approach is 10-30% better than a backward-shift.

TuPT-5
Simultaneous detection of 10-Gbit/s QPSK × 4-channel FE-SOCDM signals

Yasuhiro Okamura[1], Osamu Iijima[1], Satoshi Shimizu[2], Naoya Wada[2], Tomoya Hagihara[1], and Masanori Hanawa[1]
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Simultaneous detection of 10-Gbit/s Quadrature phase Shift keying (QPSK) x 4-channel Fourier-encoded synchronous optical code division multiplexing signals is experimentally demonstrated. At every received channel, constellations of QPSK signals have been observed successfully.

TuPT-6
Digital Compensation of Phase and Wavelength Errors in FBG Encoders for FE-SOCDM system

Osamu Iijima, Yasuhiro Okamura, and Masanori Hanawa
National Univ. Corporation, Univ. of Yamanashi, Yamanashi, Japan

A digital compensation scheme for phase and wavelength errors in FBG encoders for Fourier-encoded synchronous OCDM system is proposed. The numerical results well demonstrate effectiveness of the proposed scheme for both errors.

TuPT-7
High-resolution Delay Measurement between Duplicated Transmission Lines

Masaaki Inoue, Tetsuya Manabe, Ka zutaka Noto, Kazunori Katayama, Nazuki Honda, and Yuji Azuma
NTT Access Network Service Systems Laboratories, NTT, Ibaraki, Japan

We present a technique for measuring a picosecond-order time delay between duplicated transmission lines and a gigabit Ethernet-passive optical network (GE-PON) with a digital phase/frequency detector, and determining whether the delay is positive or negative.

TuPT-8

Computing Flow Completion Time in Optical Path/ Packet Integrated Networks

Onur Alparslan, Shin'ichi Arakawa, Masayuki Murata

Graduate School of Information Science and Technology, Osaka Univ., Osaka, Japan

Using an analytical model to compute the flow transfer times in a hybrid path/packet switching WDM network, we show that the transfer time of TCP flows can minimized by using only a few packet-switching wavelengths.

TuPT-9

Modulation-Format-Aware Power Equalization for Heterogeneous Elastic Optical Networks

Yingying Xu, Juhao Li, Yucheng Zhong, Ping Zhang, Paikun Zhu, Yongqi He and Zhangyuan Chen

State Key Laboratory of Advanced Optical Communication Systems & Networks, Peking Univ., Beijing, China

We propose a modulation-format-aware power equalization method for heterogeneous elastic optical networks. We show the benefit by simulation based on an optical OFDM superchannel with mixed modulation formats.

TuPF-1

The pH Sensor with the Poly-Silicon Nanowire

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In this paper, we demonstrated the dimensional properties of the poly-Si nanowire pH sensor with numerical simulation and fabricated the pH sensor based on the theoretical prediction.

TuPF-2

Optical Constant Measurement of GOx Thin Film with Circular Heterodyne Interferometry

Hsiang Chang, Shu-Yu Chen, Chia-Yun Lee, and Cheng-Chih Hsu

Dept. of Photonics Engineering, Yuan Ze Univ., Chung-Li, Taiwan

This study develops a precision circular heterodyne interferometer to measure RI and thickness of GOx immobilized on the glass substrate.

WPA-1
Intracavity Frequency Doubling At 261nm of an Actively Q-switched Pr:$LiYF_4$ Laser

Junichiro Kojou, Ryo Abe, Akira Sakurai, Fumihiko Kannari
Dept. of Electronics and Electrical Engineering, Keio Univ., Yokohama, Japan

We report actively Q-switched deep ultra-violet laser operation at 261nm by intracacity frequency doubling of InGaN laser diode pumped Pr:$LiFY_4$ laser. We obtained a maximum peak power of 61.6W(8.7 μJ/pulse) at 261 nm.

WPA-2
Dual-Wavelength Q-switched Laser by Cascaded Electro-Optic Periodically Poled Lithium Niobate Crystal

Shou-Tai Lina[1], Shang-Yu Hsua[1], and Yen-Yin Linb[2]
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A dual-wavelength Q-switched laser by a cascaded electro-optic periodically poled lithium niobate crystal was reported. At 24 W diode power, we generated 320 and 100 uJ pulse energy at 1063 and 1342 nm, respectively.

WPA-3
Pulsed Single-Longitudinal-Mode Nd-laser with an Electro-Optic Periodically Poled Lithium Niobate Bragg Modulator

Shou-Tai Lin, Bo-Cheng Chen, Po-Chun Liu, and Shin-Han Yu
Dept. of Photonics, Feng Chia Univ., Taichung, Taiwan

We report a periodically poled lithium niobate crystal for both laser Q-switching and single-longitudinal-mode seeding generation in a Nd-laser system. Combing the volume Bragg grating, a wavelength tunable, pulsed single-longitudinal-mode laser source has been generated.

WPA-4
Development of a Diode-Pumped Yb:YAG Chirped-Pulse Oscillator

Sadao Uemura and Kenji Torizuka
Electronics and Photonics Research Inst. (ESPRIT), National Inst. of Advanced Industrial Science and Technology (AIST), Ibaraki, Japan

We developed an Yb:YAG chirped-pulse oscillator, where we employed a different type of multiple-pass cavity that makes the alignment and operation easier and observed laser spectral broadening by reducing the positive intracavity group delay dispersion.

WPA-5
Efficient Diode-Pumped Solid-State Laser At 266 nm

Cheng-Yu Tang, Yu-Jen Huang, Kuan-Wei Su, and Yung-Fu Chen
Dept. of Electrophysics, National Chiao Tung Univ., Hsinchu, Taiwan

We performed the extracavity fourth harmonic generation to verify that the extracavity second harmonic generation is more advantageous in generating DUV than the intracavity one. The maximum output power at 266 nm is 1.67 W.

WPA-6
Multiple-beam Nd:YVO_4 Laser Based on Dammann Grating

Kegui Xia, Junjie Yu, Yao Yao, Changhe Zhou, Jianlang Li
Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, Shanghai, China

An arrayed-output Nd:YVO_4 laser is demonstrated in which the collimated pumping light is split into 2×2 array by a Dammann grating and thus forms four independent pumping areas in one single laser crystal.

WPA-7
UV Laser Writing with 2-Step Voltage Application to Form MgO:$LiNbO_3$ Domain-Inverted Gratings for Waveguide QPM Devices

Masatoshi Fujimura, Eri Kitado, and Toshiaki Suhara
Graduate School of Engineering, Osaka Univ., Suita, JAPAN

Ultra-violet laser beam writing technique with 2-step voltage application was developed for formation of MgO:$LiNbO_3$ domain-inverted structures. Domain-inverted gratings were fabricated and applied to waveguide quasi-phase-matched second-harmonic generation devices to demonstrate the effectiveness.

WPA-8
Withdrawn

WPA-9
Double Pulse Operation of Synchronously Intracavity Pumped Ring Parametrical Oscillator

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[1] Czech Technical Univ. in Prague, Faculty of Nuclear Sciences and Physical Engineering, Prague, Czech Republic, [2] Univ. of New Mexico, Dept. of Physics and Astronomy and Center for High Technology Materials, New Mexico, USA

A ring optical parametrical oscillator generating counterpropagating trains of picosecond pulses at the wavelength 1540 nm was realized. Operation stability of the system was investigated.

WPA-10
Nondiffracting Superlattice Beams

Chia-Han Tsou, Tai-Wei Wu, Jung-Chen Tung, Hsing-Chih Liang, Kuan-Wei Su, and Yung-Fu Chen
Dept. of Electrophysics, National Chiao Tung Univ., Hsinchu, Taiwan

We introduce optical superlattices that are formed by two sets of wave-vectors with single wave number but different azimuths. By a collimated light to illuminate a mask with multiple apertures, we generate nondiffracting superlattice beams.

WPA-11
Efficient Emission of Laguerre-Gaussian Beam From Nd-doped Yttrium Vanadate Laser

Yao Yao, Minqiang Kang, Kegui Xia, Ruxin Li, Jianlang Li
Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, Shanghai, China

An laser-diode (LD) end-pumped Nd-doped Yttrium Vanadate (Nd:YVO4) laser was demonstrated to emit the first order Laguerre-Gaussian (LG01) mode. This LG01-mode laser is compact and efficient.

WPA-12
Speckle-suppressed Partial Random Laser Illumination System by Vibrating a Phase-only Random Phase Diffuser

Shih-Yu Tu and Hoang Yan Lin
Graduate Inst. of Photonics and Optoelectronics and Dept. of Electrical Engineering, National Taiwan Univ., Taipei, Taiwan

The extremely small angle speckle-suppressed partial random laser illuminating system with ~0.1deg. divergence angle is realized. The speckle contrast of 8.5% in a 16 ms is reached. 0.55 mW CW partial random laser is achieved.

WPA-13
Realization of Single-Mode Random Lasing Within a Zinc Oxide Nanoparticle Film

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An unique random laser exhibiting quasi-single-mode, low background emission spectrum, and low lasing threshold is developed by a homogenized submicrometer-sized zinc oxide particle film dispersed with intentionally introduced polymer particles as point defects.

WPA-14
Lasing Behavior of Dye Doped Liquid Crystal Within Glass Cell

Hsing-Ru Tsai, Min-Song Lin, Chen-Hsiu Wu, Ja-Hon Lin, and Jin-Jei Wu
Dept. of Electro-optical Engineering, National Taipei Univ. of Technology, Taipei, Taiwan

We demonstrate the output characteristics such as intensity and polarization of stimulated emission light from dye-doped nematic liquid crystal will change obviously in glass cell whose polyimide rubs in both and one side of plate.

WPA-15
Temperature Dependent Color Cone Lasing in Cholesteric Liquid Crystal

Po-Yen Chen, Kuan-Cheng Liao, Ja-Hon Lin, Yao-Hui. Chen, Shwu-Yun Tsay Tzeng and Jin-Jei Wu
Dept. of Electro-optical Engineering, National Taipei Univ. of Technology, Taipei, Taiwan

We investigate the color cone lasing behavior from dye-doped cholosetric liquid crystal (CLC) and find the central wavelength as well as intensity contrast of long and short emission peaks will change as temperature varies.

WPA-16
Optical Deposition of Molybdenum Disulfide on a Fiber Facet

Reza Khazaeinezhad[1], Sahar Hosseinzadeh Kassani[1], Tavakol Nazari[1], Jongki Kim[1], Kyujin Choi[2], Jae Hoon Kim[2] and Kyunghwan Oh[1]
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We could successfully deposit MoS_2 on a fiber facet. The deposition was done by a 1552nm fiber laser. The results obtained by SEM shows that the core area of the fiber was completely covered.

WPA-17
High Repetition Rate, High Average Power Nanosecond Laser Using Two Yb-doped PCF Rod Fibers.

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A high-peak and high-average power Yb-doped fiber laser system has been achieved to 360W at a wavelength of 1064 nm by a 100 um PCF-rod type fiber.

WPA-18
Development of All-Waveguide Type High-efficient and Compact Ultra-violet Generator Using Pr-doped Visible Fiber Laser

T.Suzuki [1], M.Yoshida [1], Y.Fujimoto [2], G.Brown [3], and A.K.Kar [3]
[1] Kinki Univ., Osaka, Japan, [2] Inst. of Laser Engineering, Osaka Univ., Osaka, Japan, [3] Heriot-Watt Univ., Physics Dept., Edinburgh, UK.

We propose an all-waveguide type UV generator using a Pr-doped waterproof fluoride glass fiber and a waveguide inscribed BBO crystal with an intracavity frequency doubling method. It will realize a high-efficient and compact UV source.

WPA-19
High-Peak-Power and High-Average-Power Pico-Second Mode-Locked All-Fiberized MOPA with Near Diffraction-Limited Beam Quality

Rumao Tao, Xiaolin Wang, Pu Zhou, Lei Si and Zejin Liu
College of Optoelectric Science and Engineering, National Univ. of Defense Technology, Changsha, China

We demonstrate a high power mode-locked all-fiber pico-second laser based on a MOPA configuration. The average and peak power were as much as 196.5 W and 15.89 kW. The beam quality is near diffraction-limited (M^2<2).

WPA-20
A Simple Tellurite Photonic Bandgap Fiber Based on One Array of Rings

Tonglei Cheng, Zhongchao Duan, Meisong Liao, Weiqing Gao, Dinghuan Deng, Takenobu Suzuki, and Yasutake Ohishi
Research Center for Advanced Photon Technology, Toyota Technological Inst., Nagoya, Japan

A simple tellurite photonic bandgap fiber is proposed and fabricated in the paper. The core and cladding are made from the TZNL glass and the high-index rings are made from the TLWMN glass.

WPA-21
Dynamic Lightwave Propagation Control in Tellurite All Solid Photonic Bandgap Fibers

Yukiko Sakai, Tonglei Cheng, Hiroyasu Kawashima, Takenobu Suzuki, and Yasutake Ohishi
Research Center for Advanced Photon Technology, Toyota Technological Inst., Nagoya, Japan

Dynamic lightwave propagation control in all solid photonic bandgap fibers made of tellurite and chalcogenide glasses by refractive index changes due to the optical Kerr effect is proposed in the paper.

WPA-22
Stable Optical Clock Generation in SOA-Based Fiber Lasers with Figure-Eight Cavity

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Stable optical clocks are obtained from 1.3-μm and 1.5-μm SOA-based fiber lasers using passive technology. The waveforms depend on SOA currents, and the repetition rates can be tuned by varying the relative length of sub-cavities.

WPA-23
Development of a Simple Mode-Locked Yb-Doped Fiber Laser Under Normal Dispersion

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In this investigation, we demonstrate a simple mode-locked Yb-doped fiber laser without any special filtering and dispersion compensation devices. A polarization controller was used for a kind of spectral filters and mode-locking was successfully achieved.

WPA-24
L-Band Multi-Wavelength Fiber Laser Utilizing Reflective Semiconductor Optical Amplifier with a Linear Cavity

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We first demonstrate an L-band multi-wavelength source only using a C-band reflective semiconductor optical amplifier (RSOA) and a linear cavity formed by a fiber coupler, a polarization controller and a reflected fiber mirror.

WPA-25
Compression of Chirp Pulses From a Picosecond Fiber Based Amplifier

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We demonstrate the pulse compression of the picosecond laser system with an all fiber master oscillator power amplifier configuration containing a chirped volume Bragg grating (CVBG) at 1064 nm.

WPA-26
WKB Analysis of Fourier Domain Mode Locked Fiber Lasers

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We apply multi-scale analysis to the Fourier domain mode-locked fiber laser model and reduce the simulation time by 100 times for the same accuracy. We calculate the point spread functions to characterize the coherence length.

WPA-27
Compact All-Normal-Dispersion Yb:fiber Laser with Periodical Tunable Spectrum From 1020 nm to 1050 nm

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Assisting by nonlinear polarization evolution and spectral filtering, a 55 MHz all-normal-dispersion Yb:fiber oscillator was demonstrated. Preliminary experiments showed the wavelength is tunable from 1020 nm to 1050 nm and pulse duration is 230 fs.

WPA-28
Control of Band Bap Guidance in Hybrid Photonic Crystal Fibers

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Photonic Device Physics Laboratory, Inst. of Physics and Applied Physics, Yonsei Univ., Seoul, Republic of Korea

We present some properties of new designs of hybrid photonic crystal fibers including two rows of high-index silica rod and three rows of high-index silica rod which are numerically simulated by commercial finite element program.

WPA-29
Influences of Amplified Spontaneous Emission on Fiber Laser Amplifier Chain

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[1] Dept. of Physics, National Central Univ., Jungli, Taiwan, [2] Inst. of Photonics and Optoelectronics, National Taiwan Univ., Taipei, Taiwan

The time-dependent coupled rate equations based on the multi-channel treatment has been applied to study the influences of amplified spontaneous emission on fiber laser amplifier with the experimental verification and practical solutions for suppressing ASE.

WPA-30
Transient Process of Dissipative Soliton Generation in Normal Dispersion Fiber Lasers

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The transient process of dissipative soliton generation is numerically revealed in normal dispersion fiber lasers designed for generating high-energy optical pulses. It is shown that the gain dispersion is critical for the dissipative soliton generation.

WPA-31
Withdrawn

WPA-32
Stable and Self-Starting Passively Mode-Locked Fiber Laser for 1.06 μm and 1.55 μm by Using Graphene Oxide Saturable Absorber

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Graphene oxide/PVA film is used as saturable absorber for mode locking erbium-doped and ytterbium-doped fiber laser. Mode-locked pulses are obtained for both lasers confirming that graphene oxide is cost-effective for 1.06-μm and 1.55-μm pulse generations

WPA-33
Waveguide-type Saturable Absorber Based on Single Walled-Carbon Nanotubes for Laser Mode-Locking

Hwanseong Jeong [1], Sun Young Choi [1], Eun Il Jeong [2], Sang Jun Cha [2], Fabian Rotermund [1] and Dong-Il Yeom [1]
[1] Dept. of Physics and Division of Energy Systems Research, Ajou Univ., Suwon, Republic of Korea, [2] FiberPro Inc, Daejeon, Republic of Korea

We successfully report the waveguide-type saturable absorber using single walled-carbon nanotubes for ultrafast fiber mode-locking. The mode-locked laser delivers stable 602 fs pulses with average output power of 8.6 mW at 11.25 MHz repetition rate.

WPA-34
Dual-wavelength Soliton Fiber Laser with A Graphene-based Mode Locker

Ling Yun, Xueming Liu, Dong Mao, Dongdong Han
State Key Laboratory of Transient Optics and Photonics, Xi'an Inst. of Optics and Precision Mechanics, Chinese Academy of Sciences, Xi'an, China

We demonstrate the dual-wavelength soliton emission at 1532 and 1558 nm in a fiber laser mode locked with a graphene-based saturable absorber.

WPA-35
Thinning the SWCNT Doped PVA Film for Improved Passive Mode-Locking of Fiber Laser

Jui-Yung Lo, Kuang-Nan Cheng, Yung-Hsiang Lin and Gong-Ru Lin
Graduate Inst. of Photonics and Optoelectronics, and Dept. of Electrical Engineering, National Taiwan Univ., Taipei, Taiwan, Republic of China

The single-walled carbon nanotube (SWCNT) polymer with thickness of 30 um is demonstrated to passively mode-lock the erbium-doped fiber laser (EDFL) with the optimized pulsewidth of 792 fs under a pumping power of 52.5 mW.

WPA-36
Chirp Control of 10-GHz Harmonic Mode-Locked Weak-Resonant-Cavity Fabry-Perot Laser Diode with Reduced End-Facet Reflectance

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Graduate Inst. of Photonics and Optoelectronics, Dept. of Electrical Engineering, National Taiwan Univ., Taipei, Taiwan, Republic of China

Pulse shortening and frequency chirp reduction of a 10-GHz directly modulated and harmonic mode-locked weak-resonant-cavity laser diode incorporated with self-feedback dual fiber ring architecture is demonstrated by detuning its end-face reflectance and feedback ratio.

WPA-37
Using Injection-Locked Fabry-Perot Laser Diode with 10% Frond-Facet Reflectivity for 10 Gbps Upstream PON Access

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We demonstrate a 10-Gbit/s upstream 16-QAM OFDM signal transmission using injection-locked Fabry-Perot laser diode with 10% frond-facet reflectivity for the long-reach PON access. Moreover, the relationship of BER and injection power is also analyzed.

WPA-38
Singlemode-Emitting Plastic Laser Fabricated by Waveguide Self-formation and Interference Exposure Processes

Takashi Kawaguchi and Kenichi Yamashita
Dept. of Electronics, Kyoto Inst. of Technology, Kyoto, Japan

We have fabricated a singlemode-emitting plastic waveguide laser by using the light-induced self-formation process. This laser device had a distributed feedback cavity, which was fabricated by the interference exposure process.

WPB-1
Observation of Super-luminescent Jet Beam From Femtosecond Laser-induced Air Plasma

Zhijun Xu, Xiaonong Zhu, Nan Zhang, and Yang Yu
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Super-luminescent jet beam associated with four-wave mixing at distorted conical emission site and being rather different from optical filaments is observed emanating from micro air plasma excited by focused 50 fs millijoule laser pulses.

WPB-2
Characteristics of Electron Density in Air Plasma Produced by Tightly-Focused 50 Fs Laser Pulses

Yang Yu, Zhijun Xu, Nan Zhang, and Xiaonong Zhu
Inst. of Modern Optics, Nankai Univ., Key Laboratory of Optical Information Science and Technology, Ministry of Education, Tianjin, China

Time evolution and spatial distribution of electron density in the air plasma induced by tightly-focused 50 fs laser pulses is numerically simulated. A simplified model is proposed to explain the strong divergence of conical emission.

WPB-3
Ionization of Metastable Neon by Ultra-Fast Laser Pulses

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In this work we observe the interaction of metastable neon with 6fs laser pulses. This work shows a higher ion yield for metastable neon at lower intensities than ground state neon: an expected qualitative result.

WPB-4
Displacement of Rotational-State Distribution in Diatomic Molecules with a Train of Femtosecond Laser Pulses

Fumiko Yoshida, Tatsuya Kasajima, Leo Matsuoka, and Keiichi Yokoyama
Quantum beam Science Directorate, Japan Atomic Energy Agency, Kyoto, Japan

Displacement of rotational-state distribution is demonstrated for atmospheric nitrogen using an eight-pulse train of femtosecond laser pulses. To measure the rotational-state distribution, time-resolved coherent anti-Stokes Raman scattering (CARS) spectroscopy is employed.

WPB-5
Tomographic Imaging for Asymmetric Molecules Using Bichromatic Multicycle Laser Field

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[1] Wuhan National Laboratory for Optoelectronics and School of Physics, Huazhong Univ. of Science and Technology, Wuhan, China, [2] MOE Key Laboratory of Fundamental Quantities Measurement, Wuhan, China

We demonstrate a scheme for tomographic reconstruction of asymmetric molecular orbitals based on high-order harmonic generation with bichromatic multicycle laser field. This releases the stringent requirement of single-cycle pulses for tomographic imaging of asymmetric orbitals.

WPB-6
Construction of a Beat-Wave Pulse Train for Quasi-Phase-Matched High-Harmonic Generation

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A beat-wave pulse train with 66-fs pulse separation is generated from a two-color Ti:sapphire amplifier system. It can be used for quasi-phase-matched high-harmonic generation at 3-nm wavelength under 1.0×10^{18} cm^{-3} plasma density.

WPB-7
Spectral Measurement of Picosecond Optical Pulses by Optogalvanic Spectroscopy

Leo Matsuoka[1], Kenta Ogawa[2], and Keiichi Yokoyama[1]
[1] Quantum beam Science Directorate, Japan Atomic Energy Agency, Kyoto, Japan, [2] Graduate School of Engineering, Univ. of Fukui, Fukui, Japan

We measured power spectrum of the picosecond pulses generated from a homemade Ti:Sapphire narrow-band laser by using optogalvanic spectroscopy of argon, which is a lower-cost method than using optical spectrum analyzers.

WPB-8
Study of Picosecond Nonlinear Refraction in $C_2H_4Cl_2$ and $C_2H_4Br_2$ with Z-scan Technique

Yu-Ting Kuo, Yi-Ci Li, Jaw-Luen Tang, Tai-Huei Wei
Dept. of Physics, National Chung Cheng Univ., Chiayi, Taiwan

We investigated picosecond nonlinear refraction of simple liquids $C_2H_4Cl_2$ and $C_2H_4Br_2$ with the Z-scan technique and explained the results in virtue of various molecular motions verified by femtosecond RIKE technique.

WPB-9
Impedance of a Short Pulse-Induced Solute Migration by a Temperature Gradient Applied Along the Light Propagation Direction

Po-Yuan Huang, Che-Kai Chang, Tai-Huei Wei
Dept. of Physics, National Chung Cheng Univ., Ming Hsiung, Chiayi, Taiwan

A short laser pulse with energy exceeding a threshold can induce the outward solute migration. In this study we further verify that application of a temperature gradient along the light propagation direction impedes this migration.

WPB-10
Compact Conical Optical Beam Source Based on the Nonlinear Čerenkov Radiation in Intracavity Excited $KTiOA_sO_4$ Crystal

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The laser diode pumped composite Nd:YAG/Cr^{4+}:YAG laser is exploited in the KTA nonlinear Čerenkov radiation (NCR) configuration, providing a very simple and compact approach for the NCR driving source.

WPB-11
Generation of High-Repetition-Rate Ultrashort Pulse Train At 850 nm

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A simple method for generation of 160 GHz soliton-like ultrashort pulse train at 850 nm is proposed and demonstrated numerically.

WPB-12
Multi-colour OPO Based on Second Order Cascaded Nonlinear Interaction

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Intra-cavity second-order cascaded nonlinear interaction is utilized in a BBO based OPO for generation of multi-colour radiation simultaneously. Theoretical investigation extracts the induced effective third order susceptibility and explains the experimental observations.

WPB-13
Optical Nonlinear Properties of Lanthanum-Modified Lead Titanate Thin Film Investigated by Femtosecond Z-scan Technique

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We used the Z-scan technique for measuring the nonlinear optical properties of lanthanum-modified lead titanate thin films. The n2 and the three-photon absorption coefficient were estimated to be $(1.41\pm0.19)\times10^{-10}$ esu and $(7.0\pm1.5)\times10^{-27}$ m^3/W^2, respectively.

WPB-14
Spectral Phase Retrieval by Dispersion-distorted Frequency-resolved Optical Gating Traces

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A new algorithm is proposed to accurately reconstruct the spectral phase from frequency-resolved optical gating (FROG) traces seriously distorted by crystal dispersion and rippled phase-matching spectrum for the fist time (to our best knowledge).

WPB-15
Thresholdless Crescent Waves in an Elliptical Ring

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By introducing symmetry-breaking geometry, we reveal the existence of thresholdless crescent waves, i.e., nonlinear surface modes pinged to the boundary of a curvature, in an elliptical ring and illustrates their formation through curvilinear transformation.

WPB-16
Thermodynamical Properties in Spontaneous Optical Pattern Formations

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With a detailed series of spontaneous optical pattern formations, we reveal the existence of thermodynamical properties in nonlinear optical systems by defining the configurational entropy from the measured patterns.

WPB-17
Synthesis and Two-photon Properties of Small Dendritic Chromophores Containing Functionalized Quinoxalinoid Heterocycles

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Three dendritic chromophores containing functionalized quinoxalinoid units has been synthesized and experimentally shown to possess strong two-photon absorption in the near-IR region and could be promising candidates for optical-power-limiters against laser pulses with long duration.

WPB-18
Study of Simulated Brillouin Scattering Threshold for Ultra-Wideband Impulse Radar Pulses Distributed Over Fiber

Xiyin Yan, Juanjuan Yan, Zhenya Xia and Zheng Zheng
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SBS thresholds for monocycle and doublet pulses are investigated. It is found that doublet pulses having a higher SBS threshold are more suitable for distribution over fiber to extend operating distance of UWB impulse radar.

WPB-19
Bandwidth-Adjustable Ultra-Flat Brillouin Scattering Spectrum in Optical Fiber

Y. Mizuno, N. Hayashi, and K. Nakamura
Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Yokohama, Japan

We obtained broad and flat Brillouin gain spectrum (BGS) in optical fibers. By modulating the driving current of pump laser, BGS with <0.3 dB gain variation over >200 MHz was achieved (flattest BGS ever reported).

WPB-20
Numerical Study on Fiber-Based Supercontinuum Generation in Anomalous Dispersion Pumping Regimes

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Laser Engineering and Applications Laboratory, School of EECS, Seoul National Univ., Seoul, Korea

We numerically study the dynamics of supercontinuum generation for four types of conventional fiber laser pulses. Our results show that in anomalous dispersion pumping regimes a dechirped parabolic pulse generates the broadest output spectrum.

WPB-21
Dark Soliton Operation Fiber Lasers

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Dark soliton formation in erbium-doped fiber ring lasers with normal cavity dispersion is experimentally demonstrated. We found the dark soliton operation is a generic feature of the normal dispersion cavity fiber lasers under strong pumping.

WPB-22
Carrier Dynamics in InN Nanorod Arrays

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A fast initial decay was observed from InN nanorods with ~30 nm diameter, the lifetime of which is much shorter than the carrier cooling time, demonstrating the substantial surface-associated influence on carrier relaxation in nanorods.

WPB-23
Ultrafast Dynamics of the Interlayer Shearing Mode in Au Graphite Nanostructures

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[1] Dept. of Physics, Graduate School of Engineering, Yokohama National Univ., Yokohama, Japan, [2] Dept. of Applied Physics, National Defense Academy, Yokosuka, Japan

We researched the effect on gold nanostructures have in the transient reflectivity signal deposited in highly ordered pyroelectric graphite, by measuring coherent phonon spectroscopy with ultrashort laser pulses.

WPB-24
Ultrafast Spin and Lattice Dynamics in a Multiferroic Cupric Oxide

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[1] Graduate School of Science, Kobe Univ., Kobe, Japan, [2] Graduate School of Engineering, Saga Univ., Saga, Japan

The ultrafast spin and lattice dynamics in a multiferroics CuO were studied using polarization spectroscopy with the pump-probe technique. Terahertz damped oscillations in the circular birefringence and the relaxation in the linear birefringence were discussed.

WPB-25
Spatial and Temporal Dynamics of Polaron Diffusion in $SrTiO_3$

T. Kohmoto, D. Ikeda, X. Liang, and T. Moriyasu
Graduate School of Science, Kobe Univ., Kobe, Japan

The relaxation and diffusion dynamics of optically induced lattice distortion in the relaxed excited state of $SrTiO_3$ are studied by using the pump-probe technique. The spatial and temporal dynamics of polaron diffusion were observed directly.

WPB-26
Ferroelectric Domain Morphology in MgO Doped Stoichiometric Lithium Niobate

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Asymmetric inward and outward domain wall morphology comes from that the interaction range between lattices is longer than that to the nearest neighborhood by the simulation based on an Ising-model of lattice structure of $LiNbO_3$.

WPB-27
Transient Photostriction in $Bi_{0.8}La_{0.2}Fe_{0.99}Nb_{0.01}O_3$ Thin Films Modulated with Strain

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The coherent longitudinal acoustic phonons $BiFeO_3$ films are investigated by ultrafast spectroscopy. The generation mechanism of the phonons is attributed to the transient photostriction effect, a combination of the optical rectification and the electrostriction effects.

WPB-28
Optical Kerr Effect of Confined Excitons Coherently Coupled with Radiation Wave

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Optical Kerr spectrum in a high-quality CuCl thin film has been investigated. The spectral shape reflects radiative corrections due to a harmonized coupling between the light and excitonic waves over a range of multiple wavelengths.

WPC-1
Observation of Antiferromagnetic Magnons and Magnetostriction in NiO and MnO

T. Moriyasu, S. Wakabayashi, and T. Kohmoto
Graduate School of Science, Kobe Univ., Kobe, Japan

The dynamics of the antiferromagnetic magnons in NiO and MnO were observed using the pump-probe technique and THz-TDS. The lattice and magnetostrictive contributions to the refractive index are discussed.

WPC-2
Broadband THz Time-Domain Spectroscopy of Halogen-Bridged Platinum Complexes

Takuya Ohshima, Yasuo Minami, Ikufumi Katayama and Jun Takeda
Graduate School of Engineering, Yokohama National Univ., Yokohama, Japan

We have measured polarized transmittance spectra of quasi one- dimensional halogen-bridged platinum complexes (Pt-X) using broadband THz time-domain spectroscopy. We could successfully identify infrared active phonon modes of Pt-X chain.

WPC-3
Observation of THz Emissions From Various Types of Solar Cells Using Laser Terahertz Emission Microscope

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We examined various types of solar cells using laser terahertz emission microscope. As a result, we could observe the differences among various solar cells, e.g. grain size, material.

WPC-4
Nondestructive inspection of SiGe films using laser terahertz emission microscopy

Akihiro Nakamura, Ken Omura, Kenji Sakai, Toshihiko Kiwa, and Keiji Tsukada
Graduate School of Natural Science and Technology, Okayama Univ., Okayama, Japan

Laser terahertz emission micropcopy was applied to investigate the SiGe film on the Si substrate. In this study, the THz emission properties of the strained-SiGe were measured.

WPC-5
Non-Contact Resistance Measurement of a Flexible Display Substrate by Terahertz Time Domain Spectroscopy

Tze-An Liu, Yuh-Chuan Cheng, Shih-Fang Chen, and Jin-Long Peng
Center for Measurement Standards, Industrial Technology Research Inst., Hsinchu, Taiwan, R.O.C.

The non-contact sheet resistance of the flexible display substrate is measured by Terahertz time domain spectroscopy. It is reasonable agree with the DC 4-point probe method, which proof the online inspection opportunity.

WPC-6
Surface Carrier Recombination of Optically Excited Silicon Studied by Terahertz Time-Domain Spectroscopy

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Inst. of Laser Engineering, Osaka Univ., Osaka, Japan

We investigated surface recombination of photoexcited carriers at silicon surface by terahertz time-domain spectroscopy (THz-TDS),and evaluated surface recombination velocity (SRV) under UV laser illumination.

WPC-7
Distribution Variation of Carbon Black in Tensile-Tested Rubbers Estimated by Terahertz Time-Domain Spectroscopy

Yasuyuki Hirakawa [1], Yoshitomo Ohno [1], Toyohiko Gondoh [1], Tetsuo Mori [1], Tsuyoshi Noguchi [2], Masayoshi Tonouchi [3], Hideyuki Ohtake [4], Tomoya Hirosumi [4]
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The dependence of a carbon black (CB) dispersion in a tensile-tested specimen of a vulcanized rubber on the compounding ratio of CB was evaluated by terahertz time-domain spectroscopy (THz-TDS).

WPC-8
Terahertz Emission From Graphene-Coated InP (100) Surface

Y. Sano [1], M. Tabata [1,2], K. Salek [1], I. Kawayama [1], M. Wang [2], R. Vajtai [3], J. Kono [2], P. M. Ajayan [3] and M. Tonouchi [1]
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We observed THz radiation from the graphene-coated InP (100) surface and found the drastic change of the waveforms of THz radiation with time, which was not explained by the simple absorption of graphene.

WPC-9
Geometry Dependence of Low-Temperature Grown GaAs Photoconductive Switches for Terahertz Detector

Kenta Mizui, Naohide Tomita, Iwao Kawayama, Hironaru Murakami, Masayoshi Tonouchi
Inst. of Laser Engineering, Osaka Univ., Osaka, Japan

We investigated the geometry dependence of photoconductive dipole antennas fabricated on the same low-temperature-grown GaAs substrate to clarify the effect of the antenna width and the excitation laser power.

WPC-10
Evaluation of Nano Slot Antenna for Mid-Infrared Detectors

Junsei Horikawa [1], Akira Kawakami [2], Masaharu Hyodo [2], Shukichi Tanaka [2], and Hisashi Shimakage [1]
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To improve the response performance of superconducting infrared detectors, we propose an nano slot antenna with a NbN load element. Results of simulation and experiment were showed qualitative agreement.

WPC-11
A Generation Method for Arbitrary Patterned Pulse Train in the THz Region by Spectral Synthesis of Optical Combs

Isao Morohashi, Takahide Sakamoto, Tetsuya Kawanishi, Iwao Hosako
National Inst. of Information and Communications Technology, Tokyo, Japan

We propose a generation method for arbitrary patterned THz pulse trains by photomixing of spectrally-synthesized optical combs generated by a Mach-Zehnder-modulator-based flat comb generator combined with a pulse picker driven by a pulse pattern generator.

WPC-12
Precise Frequency Measurement of Continuous-Wave Terahertz Radiation Based on THz Comb

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We demonstrated a frequency measurement of CW-THz wave referring to THz frequency comb. Effectiveness of the proposed method is demonstrated by measurement of sub-THz test sources. The achieved precision of frequency measurement was 2.0×10^{-11}.

WPC-13
Highly Frequency-Stabilized Millimeter-Wave Signal Generation Using Optical Phase-Locked Loop and Flat Optical Frequency Comb

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We demonstrated millimeter-wave signal generation using optical phase-locked loop and flat optical frequency comb generation using a Mach-Zehnder modulator. The generated optical multi-tone signal has high frequency stability and optical signal-to-noise ratio.

WPC-14
Cherenkov Phase-Matched Terahertz Wave Generation Using Ridge-type Waveguide

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We present efficient terahertz wave generation from ridge-type waveguide propagation using Cherenkov-type radiation with non-linear optical crystal.

WPC-15
Terahertz-wave Parametric Generation and Detection System Covering the Range From 1 to 3 THz

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We report on a terahertz-wave generation and detection system based on nonlinear parametric conversion. Tunable terahertz-waves are generated by an injection-seeded terahertz-wave parametric generator, and then, detected by frequency up-conversion in a nonlinear MgO:$LiNbO_3$ crystal.

WPC-16
Generation of Efficient Terahertz Waves Using As-Grown DASC Single Crystals

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The sparingly soluble nature of DASC material in methanol solvent facilitated the growth of single crystals with varying thicknesses. The Terahertz (THz) frequencies generated exhibited efficiency dependence on the thickness of the as-grown DASC crystals.

WPC-17
High Average Power and Broadband THz Wave Generation Scheme Via Optical Rectification in 4-dimethylamino-N-methyl-4-stilbazolium tosylate Crystal

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We obtained average THz power of 18μW using DAST crystal via optical rectification of femtosecond pulses. This power is more than two orders higher than the average THz power obtained from the typical photoconductive antenna.

WPC-18
Bulk Crystals of Stilbazolium Derivative DAST and DASC for Terahertz-Wave Generation

M. Yoshimura [1], R. Sakae [1], Y. Takahashi [1], T. Matsukawa [1], R. Kaneko [2], I. Kawayama [2], M. Tonouchi [2], Y. Izutani [3], K. Kitagishi [3], S. Okada [4], and Y. Mori [1]
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Stilbazolium derivatives DAST and DASC are organic ionic nonlinear optical materials to efficiently generate terahertz waves. We succeeded in obtaining bulk crystals by using an acetonitrile-added methanol solvent and investigated the properties of THz-wave generation.

WPC-19
New Experimental Results on the Quasi Phase-Matching Properties for MgO Doped LiNbO3

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The quasi phase-matched SHG, SFG, and OPO wavelengths in the 0.39~4.95 micron were measured at 20ºC in the 5mol% MgO:$LiNbO_3$ crystals and the high-accuracy extraordinary Sellmeier equation is presented.

WPC-20
Generation of Wide Range and Stable THz Waves Using a Laser Chaos and a High Bias Voltage

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Generation of a wide-range and stable THz waves from a photoconductive antenna excited by a multimode semiconductor chaotic oscillation laser with an optical delayed feedback using an external mirror is investigated.

WPC-21
A Low Cost Dielectric Waveguide Platform for Sub-mm/THz Applications

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A new dielectric waveguide platform technology for sub-mm/THz applications is proposed. The feasibility to produce low-cost and low-loss dielectric waveguides by the proposed platform is investigated and demonstrated.

WPC-22
Terahertz Fiber Using Polymer Tube Bundle

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A new terahertz fiber using a polymer tube bundle is proposed and analyzed. The transmission loss reduces as the tube thickness and the refractive index difference decrease.

WPC-23
Fabrication and Terahertz Response of "split-tube" Arrays

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We designed and fabricated split-tube arrays using a maskless exposure system which was converted from a commercial projector. We found that the structures have magnetic response in terahertz region which are affected by mutual inductance.

WPC-24
Theoretical and Experimental Development of a Broadband Sub-millimeter Wave Rectangular-Metallic to Dielectric Rod-Waveguide Adaptor

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A plastic power adaptor operating in the sub- millimeter range have been designed and fabricated by injection-molding. Both numerical simulations and experimental results demonstrate broadband and low-loss energy transfer between metallic and dielectric waveguides.

WPD-1
Withdrawn

WPD-2
High Peak Power Laser for Range Detection and Object Recognition of 3D Image Scanning
Jeong-Ho Kim, Ju-Young Lim, Jung-Woon Lim, SWook Hann, Jong-Sup Kim, Yune-Hyoun Kim, Young-Eun Lim

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High output, broad area 1,550 nm InGaAsP/InP MQW lasers were fabricated using MOCVD equipment. The fabricated LDs have 10W high peak powers under 340V injection voltage and 30KHz pulse operation.

WPD-3
0.13mJ All-fiberized Tm-doped Fiber Laser at Low Repetition Rate
Y. D. Zhu, P. Zhou, H. B. Lv, H. Xiao, and S. F. Guo

College of Opto-electronic Science and Engineering, National Univ. of Defense Technology, Changsha, China

We report on an all-fiberized, gain-switched Tm-doped fiber laser source in master oscillator-power amplifier configuration. The central wavelength is 1.922μm, 0.13mJ per pulse energy could be realized at a 15kHz repetition rate.

WPD-4
Fiber Fuse Effect in High-Power Double-Clad Fiber Laser
Hanwei Zhang, Pu Zhou, Xiaolin Wang, Hu Xiao and Xiaojun Xu

College of Opto-electronic Science and Engineering, National Univ. of Defense Technology, Changsha, China

We report the study of fiber fuse effect in large mode area double-clad fiber.The fiber fuse pictures and a model of describing the propagation of the effect in double-clad fiber are presented in this paper.

WPD-5
Smith-Purcell Radiation From Laser-plasma-generated Electrons
Z. Jin[1], Z. L. Chen[3], H.B. Zhuo[3,5], A. Kon[3], M. Nakatsutsumi[3], H. B. Wang[2], B. H. Zhang[2], Y. Q. Gu[2], Y. C. Wu[2], B. Zhu[2], M. Y. Yu[6,7], Z. M. Sheng[8,9], and R. Kodama[1,3,4]

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Near-infrared radiation is experimentally observed by coupling a grating to the electron beams generated in the laser-solid target interaction. Such kinds of radiation hold a promise for a tunable compact "table-top" powerful Tera-Hertz source.

WPD-6
Generation of Laser-Induced Fast Neutrons and Application for Activation Analysis
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A laser-induced repetitively operated fast neutron source was developed by using a deuterated polystyrene film target and a femtosecond laser and was applied for laser activation analyses of indium and gold samples.

WPE-1
Ablation Process of PMMA Induced by Irradiation with Laser Plasma EUV Light
Nobuhiko Sugiura[1], Shuichi Torii[1], Tetsuya Makimura[1], Yoshiyuki Ichinosawa[2], Kouta Okazaki[3], Daisuke Nakamura[3], Akihiko Takahashi[4], Tatsuo Okada[3], Hiroyuki Niino[5], Kouichi Murakami[1]

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We have investigated ablation process of PMMA induced by irradiation with laser plasma EUV light. Appling the technique, micro-structured mold can be fabricated by transferring structures of the master PMMA plate.

WPE-2
Micromachining of Polydimethylsiloxane using EUV light
Shintaro Fukami[1], Shuichi Torii, Tetsuya Makimura, Kota Okazaki[2], Daisuke Nakamura, Akihiko Takahashi[3], Tatsuo Okada, Hiroyuki Niino[4], Koichi Murakami[1]

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We studied the method to fabricate microstructures in PDMS sheet using laser-generated EUV light. In the high power density EUV light irradiation region, PDMS can be machined without chemical modification.

WPE-3
Calculational Studies on Controllability of Nanosphere Propulsion by Using Femtosecond Laser-Excited Enhanced Near Field
T. Shinohara, K. Hirano, G. Obara, and M. Terakawa

Keio Univ, Kanagawa, Japan

In this study, we propose a thrust/propulsion of nanospheres by using near field excited by femtosecond laser to control the sphere velocity and propelled angle.

WPE-4
Evolution of Nanostructures on Metal Surfaces Irradiated by Low-Fluence Multiple Femtosecond Laser Pulses
Masahiro Shimizu, Masaki Hashida, Yasuhiro Miyasaka, Shigeki Tokita, and Shuji Sakabe

Inst. for Chemical Research, Kyoto Univ., Kyoto, Japan

Aggregation of nanometer-size cracks oriented perpendicular to incident laser polarization is formed on tungsten and molybdenum by low-fluence femtosecond laser pulses. Local field enhancement around a nanometer-size hole will be an origin of the crack.

WPE-5
Effect of Superimposed Multiple Shots of Femtosecond Laser Pulses on Periodic Surface Nanoablation
G. Miyaji and K. Miyazaki

Inst. of Advanced Energy, Kyoto Univ., Kyoto, Japan

Pump-probe reflectivity measurements have shown that the multiple shots of low-fluence femtosecond laser pulses on silicon accumulate non-thermal bonding structure change to decrease ablation threshold and subsequently excite surface plasmon polaritons for periodic nanoscale ablation.

WPE-6
Three-Dimensional Micro Modification and Selective Etching of Crystalline Silicon Using 1.56-μm Subpicosecond Laser Pulses
Shigeki Matsuo, Keiji Oda, Yoshiki Naoi

The Univ. of Tokushima, Tokushima, Japan

Three dimensional micro removal processing was attempted to crystalline silicon substrate using a 1.56-μm subpicosecond laser. Selective removal was observed on both top and rear surfaces when nitric hydrofluoric acid was used as etchant.

WPE-7
Withdrawn

WPE-8
Shape Control of Element Distribution inside a Glass by Simultaneous Irradiation with Femtosecond Laser Pulses at Multiple Spots
Torataro Kurita[1], Masaaki Sakakura[2], Masahiro Shimizu[3], Kouhei Yoshimura[1], Yasuhiko Shimotsuma[1], Naoaki Fukuda[2], and Kiyotaka Miura[1]

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Control of a shape of local element distribution inside a glass, especially to induce sharp-edged structure was achieved by simultaneous irradiation of femtosecond laser pulses with high repetition rate and low repetition rate.

WPE-9
Development of Femtosecond Laser Processed FBG Sensors for High Temperature Piping System
A. Nishimura[1], Y. Shimada[1] and H. Suzuki[2]

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Fiber Bragg grating was made by ultrashort laser processing. Carbon silicate fabric was used to reinforce the FBG sensor. The FBG sensors were prepared for the structural health monitoring of high temperature complex piping system.

WPE-10
Control of microstructures by two interfered femtosecond laser pluses using biprism
O. Konda[1], T. Sato[1], F. Itoigawa[1], S. Ono[1], M. Ota[2]

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Periodic microgrooves on Si wafer induced by interfered femtosecond laser pluses using biprism are reported. Shape of microstructures is controlled by laser fluence, scanning numbers, and base angle of biprism. Tribological property changes by microgrooves.

WPE-11
Pattern Writing in a Liquid-Crystal-Monomer Mixture Using Two-Photon Polymerization
Chandroth P. Jisha[1], Kuei-Chu Hsu[2], YuanYao Lin[1], Ja-Hon Lin[3], Chien-Chung Jeng[4], and Ray-Kuang Lee[1]

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Through two-photon lithography directly written by femtosecond laser pulse, we report experimentally and numerically a series of photoinduced polymerization patterns in shapes from straight channel, serpentine curve, to periodic grating in in a liquid-crystal-monomer mixture.

WPE-12
Fabrication of Spherical-Shaped Submicron Particles of ZnO Using Laser-induced Melting of Submicron-sized Source Materials
Yuuma Higashi[1], Takeshi Tsuji[1], Masaharu Tsuji[1], Hideki Fujiwara[2], Yoshie Ishikawa[3], Naoto Koshizaki[4]

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Submicron-sized spherical ZnO particles were prepared using laser irradiation for submicron-sized source particles. It was revealed that the agglomeration of the source particles is a critical factor to determine the particle size.

WPE-13
Luminescence and Lifetime Properties of Nd^{3+}:LaF_3 Thin Films Grown by Pulsed Laser Deposition
Naoki Yoshida[1], Mirai Ieda[1], Shingo Ono[1], Kohei Yamanoi[2], Toshihiko Shimizu[2], Nobuhiko Sarukura[2], Yuui Yokota[3], Takayuki Yanagida[4], and Akira Yoshikawa[3]

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Nd^{3+}:LaF_3 thin films were grown by pulsed laser deposition. Photoluminescence spectra revealed a dominant peak at 173nm with a decay time of 8.2 ns, which is similar to the results obtained from bulk Nd^{3+}:LaF_3 crystal.

WPE-14
3D Microfabrication in YAG Crystals by Direct Laser Writing and Chemical Etching

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We report selective etching of mm-length direct laser written three-dimensional microstructures inside Nd:YAG crystals. The structures exhibit enhanced etching selectivity compared to unmodified YAG. Origin of this selectivity is investigated using Nd^{3+} micro-spectroscopy and micro-Raman.

WPE-15
LIBS Combined with Temporal and Spatial Measurements for Detecting a Salt Deposit on a GFRP Material

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Detection of a salt deposit on wind turbine blade was necessary to protect the blades from lightning damage in an offshore environment. LIBS technique was used to identify and rank the severity of salt deposit.

WPE-16
Optical Properties of Ce^{3+}:$LiCaAlF_6$ Thin Films Prepared by Pulsed Laser Deposition

Masahiro Yanagihara [1], Shingo Ono [1], Toshihiko Shimizu [2], Nobuhiko Sarukura [2], Yuui Yokota [3], Takayuki Yanagida [4], and Akira Yoshikawa [3]

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We have grown Ce^{3+}:$LiCaAlF_6$ thin films by pulsed laser deposition. Cathodoluminescence showed two emission peaks which correspond to crystal, and photoluminescence of thin films had shorter decay time than that of crystal.

WPE-17
A Compact Dual-wavelength Optical Head for Photo-lithography

Yuan-Chin Lee [1,2], Shiuh Chao [2], Chun-Chieh Huang [1], Shuen-Chen Chen [1] and Chung-Ta Cheng [1]

[1] Electronics and Optoelectronics Research Laboratories, Industrial Technology Research Inst., Taiwan, [2] Inst. of Photonics Technologies, National Tsing Hua Univ., Taiwan

A dual-wavelength optical head with an NA0.85 objective lens for lithography was developed. Both 405nm and 650nm are integrated in this optical head. It can be used to expose both organic and in-organic photo-resists.

WPF-1
Simple Method for Measuring Timing-Jitter in a Gain-Switched DFB Laser Using Delayed Optical Feedback

K. Wada, Y. Hono, T. Hashii, Y. Yamagami, T. Matsuyama, and H. Horinaka

Dept. of Physics and Electronics, Osaka Prefecture Univ., Osaka, Japan

A simple method for measuring timing-jitter in a gain-switched distributed-feedback laser using delayed optical feedback was proposed. Using this, the timing-jitter in a gain-switched pulse-train was estimated to be 26 ps without using high-speed equipment.

WPF-2
Optical Heterodyne Spectroscopy of Acetylene Saturated Absorption in a Hollow-core Photonic Crystal Fiber

J. J. Liu, J. L. Chang, C. C. Chou, and T. Lin

Dept. of Photonics, Feng Chia Univ., Taichung, Taiwan, ROC

We demonstrated an optical heterodyne scheme based on single acousto-optic frequency shifter, to observe saturated absorption of acetylene $\nu_1+\nu_2$ band P(7) line.

WPF-3
Frequency Measurement of the 6S-8S Two-Photon Transition in Cesium

Tomoyuki Uehara, Kazuhiko Sugiyama, and Masao Kitano

Graduate School of Electronic Science and Engineering, Kyoto Univ., Kyoto, Japan

We determined the unperturbed frequencies of the 6S-8S two-photon transitions in cesium by evaluation of systematic frequency shifts of the lasers stabilized to the transition, together with frequency measurement with an octave-spanning optical frequency comb.

WPF-4
Near-Infrared Achromatic Frequency Shifter

Hsiao-Ping Chiang, and Sheng-Hua Lu

Dept. of Photonics, Feng Chia Univ., Taiwan, R.O.C.

A near-infrared achromatic frequency shifter, based on Fourier domain delay line, is presented. Both 855-nm and 633-nm lights passing simultaneously through the proposed device experience the same frequency shift of 2 kHz.

WPF-5
Improved Nematic Liquid-Crystal Phase Shifter

Wei-Chang Liu and Sheng-Hua Lu

Dept. of Photonics, Feng Chia Univ., Taichung, Taiwan, R.O.C.

A nematic liquid-crystal phase shifter, based on the QHQ configuration, is activated by an improved method. Thus the inserted liquid-crystal cells with large thickness tolerances are allowed without sacrificing accuracy.

WPF-6
Laser Induced Breakdown Spectroscopy to Detect Copper Contamination in Transformer Insulation

Aparna N [1], Wazeem M. A. [1], Nilesh J. Vasa [1], R. Sarathi [2], Sundara Rajan J. [3]

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Laser Induced Breakdown Spectroscopy combined with a laser-ablation based depth profiling technique is demonstrated for the detection of copper contamination in transformer insulation. An increase in copper diffusion was found with ageing.

WPF-7
Remote Detection of Cerium Using Laser-Induced Breakdown Spectroscopy

Daewoong Choi [1], Yongdeuk Gong [1], Heesigi Kim [1], Bongsuk Gwak [1], Yonghoon Lee [1], Bo-Young Han [2], Heesung Shin [2]

[1] Dept. of Chemistry, Mokpo National Univ., Jeonnam, Republic of Korea, [2] Korea Atomic Energy Research Inst., Daejeon, Republic of Korea

We developed a stand-off laser-induced breakdown system for the remote detection of nuclear materials. Ce, a Pu surrogate, in pellets with KCl matrix was detected by this system in open path and through shielding windows.

WPF-9
Stimulated Brillouin Scattering in Multi-mode Optical Fibers: Toward Plastic-fiber-based BOTDA

N. Hayashi, Y. Mizuno, and K. Nakamura

Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Yokohama, Japan

By observing stimulated Brillouin scattering (SBS) in a silica graded-index multimode optical fiber with pump-probe technique, we show that the difficulty in inducing SBS in plastic optical fibers lies in their material problems.

WPF-10
Measurement of Carbon Dioxide Concentration by Fiber Loop Ring Down Spectroscopy for Telemetering

Hiroshi Noriyasu, Yuki Fukushima, Takumi Yonekura, and Hiromasa Shimizu

Dept. of Electrical and Electronic Engineering, Tokyo Univ. of Agriculture and Technology, Tokyo, Japan

We report the measurement of carbon dioxide concentration by using fiber loop ring-down spectroscopy. By increasing the propagation distance to 350 m, we measured the CO_2 concentration with resolution of 0.1 %.

WPF-11
Fiber Evanescent Wave Spectroscopy of Acetylene Molecules with the Optical Microfiber Taper

K. J. Huang, T. Lin, C. C. Chou, and C. W. Wu

Dept. of Photonics, Feng Chia Univ., Taichung, Taiwan, ROC

We demonstrated the evanescent wave of an optical microfiber taper of μm level with the high sensitivity spectroscopic methods such as the difference spectroscopy and the optical heterodyne spectroscopy to observe the acetylene absorption transition.

WPF-12
Potential Applicability of Brillouin Scattering in Partially Chlorinated Plastic Optical Fibers to High-Precision Temperature Sensing

K. Minakawa, N. Hayashi, Y. Mizuno, and K. Nakamura

Precision and Intelligence Laboratory, Tokyo Inst. of Technology, Yokohama, Japan

We estimate the Brillouin frequency shift and its temperature dependence in partially-chlorinated plastic optical fibers based on ultrasonic pulse-echo technique, and show that they are potentially applicable to high-precision temperature sensing with high thermal stability.

WPF-13
2D Directional Surface Strain Mapping Through Distributed Optical Fiber Sensors

Jin Huang [1], Samuele Lilliu [1], Ammar Alqahtani [1], Júlio Martins [2], João Petiz [2] and Marcus S. Dahlem [1]

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A low-cost Rayleigh backscattering sensing configuration is used to obtain high-resolution and real-time 2D maps of the directional surface strain on a fiberglass board. This approach has potential applications in 2D/3D structural health monitoring.

WPF-14
DSB-SC Phase Demodulation -Application for Vibration Measurement

Hui-Kang Teng, Kuo-Chen Lang

Dept. of Digital Living Innovation, and Dept. of Computer and Communication Engineering Nan-Kai Univ. of Technology, Taiwan, ROC

A heterodyne interferometry with DSB-SC performance is presented to measure small vibration signal. The vibration induced phase is demodulated by self-mixing without a local oscillator, which is commonly employed to down-convert the high frequency signal.

WPF-15
Multi-frequency Light Source Using Spatial Light Modulator for Profilometry

Samuel Choi [1], Shunsuke Takatsuka [1], Osami Sasaki [1] and Takamasa Suzuki [2]

[1] Dept. of Electrical and Electronic Engineering, Niigata Univ., Niigata, Japan, [2] Graduate School of Engineering, Niigata Univ., Niigata, Japan

A multi-frequency light source with a spatial light modulator that generated a broadband spectrum with variable interval and center frequency was demonstrated. It can carry out the arbitrary multi-frequency scan for interferometric profile measurement.

WPF-16
Wavelength-scanning Surface Plasmon Microscopy for Detection of a Bubble Layer

Koyo Watanabe [1,2] and Koji Matsuura [2]

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We proposed wavelength-scanning surface plasmon microscopy for the application of micro/nanobubble detection. We demonstrated that the bubble layer's position localized at a substrate's surface could theoretically be identified in a vertical direction.

WPF-17
Non-mechanical Scanning Laser Doppler Velocimeter with Directional Discrimination Using Single Transmission Path

Takahiro Hata and Koichi Maru
Dept. of Reliability-based Information Systems Engineering, Graduate School of Engineering, Kagawa Univ., Kagawa, Japan

A non-mechanical axial scanning laser Doppler velocimeter (LDV) with directional discrimination using a single transmission path is proposed. The axial scan and directional discrimination has been demonstrated experimentally using a sensor probe setup.

WPF-18
Wafer Metrology Based on Combined Optical Interferometry

Young Gwang Kim, Yong Bum Seo, and Ki-Nam Joo
Dept. of Photonic Engineering, Chosun Univ., Gwangju, Republic of Korea

In this presentation, we report a simple combined interferometer with low coherence scanning interferometry and spectrally-resolved interferometry using NIR SLD to measure both side surface and thickness profiles of a Si wafer at once.

WPF-19
Shape Variation of Brillouin Gain Spectrum Caused by Sinusoidal-like Strain Distribution

Yoshiki Hayase and Hiroshi Naruse
Mie Univ., Mie Prefecture, Japan

Shape variation characteristics of the Brillouin gain spectrum caused by sinusoidal-like strain distribution, which is a typical non-uniform strain distribution produced in a ring structure, are clarified through numerical calculation and experiments.

WPF-20
Optical Fiber Sensor for Refractive Index Measurement Based on Localized Surface Plasmon Resonance

Seong Jun Park [1], Chee Leong Ta [1], Hee Gyu Baek [2], Young Ho Kim [1], Joo Beom Eom [3], Yong Tak Lee [1], and Byeong Ha Lee [1,2]
[1] School of Information and Communications, GIST, Gwangju, South Korea, [2] Dept. of Medical System Engineering, GIST, Gwangju, South Korea, [3] Korea Photonics Technology Inst., Gwangju, South Korea

Fiber-optic based localized surface plasmon sensor has been developed for the measurements of refractive index (RI). The RI sensitivity of 506 nm/RI unit was achieved.

WPF-22
Development of Dual Laser Triangulation Measurement Device Applied on Petal Thickness Inspection

Kuang-Chyi Lee [1], Jiun-Shiang Yang [1], Hsin Her Yu [2]
[1] Graduate Institue of Automatic Engineering, [2] Dept. of Biotechnology, National Formosa Univ., Yunlin, Taiwan

A device for measuring petal thickness was developed with linear CCD sensors by Scheimpflug principle. The range of petal thickness measured is 4mm and the resolution is about 2μm for this device.

WPF-23
10-meter Remote Measurements by Use of a 3-D Telescope

Ming-Hung Chiu and Yan-Sin Chen
Dept. of Electro-Optical Engineering, National Formosa Univ., Yunlin, Taiwan

We presented a 10-m remote measurement method based on the algorithm of reflectivity-height transformation by use of a commercial telescope and a parallelogram prism for thickness, deformation, and profile measurements.

WPF-24
Minimization of Spectral Phase Errors in Spectrally Resolved Interferometry

A. Joonho You [1], B. Ki-Nam Joo [2]
[1] INTEKPLIS Co., Daejeon, Republic of Korea, [2] Dept. of Photonic Engineering, Chosun Univ., Gwangju, Republic of Korea

We introduce and verify an iterative least squared phase shifting method, inherently insensitive to any types of phase shifting errors, to calculate the spectral phase in PS-SRI.

WPF-25
Spatial and Temporal Dynamics of Thermal and Carrier Diffusions in Clathrate Compounds

T. Watanabe [1], T. Moriyasu [1], H. Okamura [1], K. Suekuni [2], T. Onimaru [2], T. Takabatake [2], and T. Kohmoto [1]
[1] Graduate School of Science, Kobe Univ., Kobe, Japan, [2] Graduate School of Advanced Sciences of Matter, Hiroshima Univ., Higashi-Hiroshima, Japan

The direct observation of the spatial and temporal dynamics of lattice and carrier diffusions in clathrate compounds are demonstrated by a pump-probe experiment. The effect of the rattling motion on the thermal diffusion is discussed.

WPF-26
Non-destructive and Non-contact Thickness Measurement for Optically Opaque Samples by Optical Fiber Heterodyne Interferometry System

Jonghyun Eom [1], Seong Jun Park [2], Young Ho Kim [2], Byeong Ha Lee [1,2]
[1] Dept. of Medical System Engineering Gwangju Inst. of Science and Technology, Gwangju, Republic of Korea, [2] School of information and communications, Gwangju Inst. of Science and Technology, Gwangju, Republic of Korea

We demonstrate a scheme of non-destructive and non-contact thickness measurement. By monitoring the laser-induced acoustic pressure wave with a compact optical fiber heterodyne interferometer, we could measure the thickness of an opaque or metallic sample.

WPF-27
Assessment of Reconstruction Method of Absorber in Scattering Medium Using Intensity Ratio

Toshihiko Yamaoki, Kouichi Nitta, Osamu Matoba
Kobe Univ., Kobe, Japan

For the reconstruction of absorber embedded in a homogeneous scattering medium, a backprojection method using intensity ratio is evaluated numerically. The proposed method uses the intensity ratio between an object medium and a reference medium.

WPF-28
Deep Walls Microscaffold Characterization Using Digital Holographic Microscopy

M. Mihailescu [1], I. A. Paun [1,2], R. C. Popescu [1], A. Matei [2], A. Acasandrei [3], M. Dinescu [2], E. I. Scarlat [1]
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We fabricated polymeric microscaffolds with deep walls for biomedical applications. To characterize its microrelief, we used digital holographic microscopy. The phase information recorded in holograms provides the depth and the refractive index of the walls.

WPF-29
Experimental Evaluation of Depth of Focus by MTF in Digital Holographic Microscopy

Kazuhiro Tsuchiya [1], Kouichi Nitta [1], Osamu Matoba [1], and Yasuhiro Awatsuji [2]
[1] Kobe Univ., Kobe, Japan, [2] Kyoto Inst. of Technology, Kyoto, Japan

Depth of focus (DOF) in the object field is evaluated experimentally by using modulation transfer function in digital holographic microscopy. DOF in 20× objective lens system is 2 mm when the period is 228 lines-per-mm.

WPF-30
Influence of Spatial Coherence Degree in Fluorescence Digital Holography

Kazuhiro Tsuchiya [1], Yoshiki Tone [1], Kouichi Nitta [1], Osamu Matoba [1], and Yasuhiro Awatsuji [2]
[1] Kobe Univ., Kobe, Japan, [2] Kyoto Inst. of Technology, Kyoto, Japan

In fluorescence digital holography, the influence of spatial coherence degree and size of quasi-point light source on the reconstruction quality is evaluated numerically. Reconstructed contrast is improved by small size of light source.

WPF-31
Uncertainty Budget of PD's Frequency Response Measurement Using Heterodyne Technique

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Uncertainty budget is evaluated on a frequency response measurement system of PDs that is based of heterodyne technique. The evaluated extended uncertainty is ±0.342 dB at 10 GHz.

WPF-32
PD Frequency Response Measurement Technique Using MZM with Two-tone Lightwave Power Control

T. Tangmala [1], U. Mankong [1], K. Inagaki [2], and T. Kawanishi [2]
[1] Dept. of Electrical Engineering, Faculty of Engineering, Chiang Mai Univ., Chiang Mai, Thailand, [2] Photonic Network Research Inst., National Inst. of Information and Communications Technology (NICT), Tokyo, Japan

We use EDFA to control the two-tone stimulus signal generated by MZM for our recently proposed PD response measurement technique. The two-tone power is kept constant across all frequencies, the response results show better repeatability.

WPF-33
Development of an Inspection Probing System Using Laser Monitoring for Aging Power Plants

F. Ito, A. Nishimura, and K. Tomiyoshi
Japan Atomic Energy Agency Quantum Beam Science Directorate, Kansai Photon Science Inst., Kyoto, Japan

A function such as observation of target object by wide-angle image, and the technique such as the elemental analysis by spectroscope and laser are built in the very compact device.

WPF-34
Withdrawn

WPF-35
Space Radiation Effects on a Semiconductor Saturable Absorber

Yoon-Soo Jang [1], Seung-man Kim [1], Joohyung Lee [2], Keunwoo Lee [1], Seongheum Han [1], Young-Jin Kim [1] and Seung-Woo Kim [1]
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The gamma-ray induced behavior of a saturable absorber was tested by pump-probe experiment, which reveals that the modulation depth and saturation fluence vary from 6-to-3 % and 40-to-105 μJ/cm^2, after gamma-ray exposure of ~120 krad.

WPF-36
Real-time Monitoring and Control System for Femtosecond Pulse Lasers

Heesuk Jang [1], Keunwoo Lee [2], Seongheum Han [1], Joohyung Lee [2], Young-Jin Kim [1], and Seung-Woo Kim [1]
[1] Ultrafast Optics for Ultraprecision Group, Dept. of Mechanical Engineering, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, South Korea, [2] Korea Research Institute of Standard and Science (KRISS), Daejeon, South Korea

Real-time monitoring and control (RMC) of the operational state of a femtosecond laser is demonstrated at a compact all-fiber-based RMC system which automatically supervises multiple key pulse parameters in both the temporal and frequency domain.

WPG-1
Magneto-optical double resonance of a single NV center in diamond for photon-spin state transfer

Naeko Niikura, Hideo Kosaka, Naofumi Abe, Yasuyoshi Mitsumori, Keiichi Edamatsu
Research Inst. of Electrical Communication, Tohoku Univ., Sendai, Japan

We demonstrate magneto-optical double resonance of a single NV center in diamond for quantum media conversion between a photon and an electron or a nuclear spin via resonant photo-absorption.

WPG-2
Optical WGMs THz Tuning and Mechanical Modes in a PDMS Double-Stem Resonator

Ramgopal Madugani [1,2], Yong Yang [1], Jonathan M Ward [1], and Síle Nic Chormaic [1,2]
[1] Light-Matter Interactions Unit, OIST Graduate Univ., Okinawa, Japan, [2] Physics Dept., Univ. College Cork, Cork, Ireland

2 THz tuning of optical WGMs is observed in a stretchable PDMS microresonator, demonstrating sensitivities as high as 0.13 nm/μN. The structure also provides the possibility of observing mechanical modes with frequencies in kHz range.

WPG-3
High-resolution Quantum Optical Coherence Tomography by Broadband Parametric Fluorescence

Masayuki Okano [1,2], Ryo Okamoto [1,2], Akira Tanaka [1,2], Shutaro Ishida [3], Norihiko Nishizawa [3], and Shigeki Takeuchi [1,2]
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Quantum optical coherence tomography (QOCT) can achieve high-resolution imaging with dispersion tolerance by virtue of quantum entanglement. We demonstrate advantages of high-resolution QOCT by comparison with classical optical coherence tomography.

WPG-4
Adaptive Quantum State Estimation of Mixed States Using Photons

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Adaptive quantum state estimation of mixed state inputs is experimentally demonstrated. The theoretically predicted different behavior of the convergence of the estimated value between the pure and mixed state is confirmed.

WPG-5
Broadband Frequency Correlated Photon Pairs Using a Chirped-QPM Device

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We report the observation of the broadest frequency correlation of two-photon states to date via parametric down conversion using chirped QPM device. The two-photon correlation in time domain can be compressed to 3.3 cycles.

WPG-6
Sum-Frequency-Photon Generation From an Entangled Photon Pair

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We report sum-frequency-photon generation from an entangled photon pair, which is an important step toward the realization of photon pairs with ultra-short (monocycle) temporal correlation.

WPG-7
Release-recaptu Experiment o Cold ^{85}Rb Atoms with an Optical Nanofiber Probe

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An optical nanofiber (ONF) has been used to measure the temperature of cold ^{85}Rb atoms in a magneto-optical trap by the release-and-recapture method. Integration of the ONF with cold atoms is useful for quantum technologies.

WPG-8
Manipulation of Self-arranged Dielectric Particles Using Optical Nanofibers

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Propulsion properties of single and chains of particles with well-separated distance between particles in the evanescent field surrounding a nanofiber were studied. Interference of counter-propagating beams is demonstrated, useful for directional propulsion and positional control.

WPG-9
WDM Polarization-Entanglement by Cascaded Optical Nonlinearities in a PPLN Waveguide

Shin Arahira and Hitoshi Murai
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We report generation of wavelength-multiplexed polarization-entangled photon-pairs by cascaded optical nonlinearities (sum-frequency-generation and parametric down conversion) in a periodically-poled LiNbO3 waveguide device. The visibilities higher than 98% were achieved for all the evaluated wavelength channels.

WPG-10
Radially and Azimuthally Polarized Non Paraxial Bessel Beams

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We present a method for the realization of cylindrically polarized non-paraxial beams by constructing exact vector solutions of Maxwell's equations from scalar Bessel beams and combining them together by analogy with the paraxial case.

WPG-11
Sub-Rayleigh Imaging with Incoherent Light

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We demonstrate sub-Rayleigh limit imaging of an object via speckle illumination. Imaging beyond the Rayleigh limit is achieved by illuminating the object with pseudothermal light. An object image is reconstructed from the second-order correlation measurement.

WPG-12
Modulation Transfer Spectroscopy for D_2 Transition Line of Rubidium

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When a frequency-modulated pump beam overlaps with a probe beam, new modulated probe beams are generated via nonlinear interaction with atoms. We observed this phenomenon for D_2 line of ^{87}Rb and compared with calculated results.

WPG-13
Self-Rotation of Elliptically Polarized Light in Doppler-Broadened Rubidium

Eun Hyun Cha, Jung Min Park, and Heung-Ryoul Noh
Chonnam National Univ., Gwangju, Korea

We present an experimental and theoretical study of the self-rotation of elliptically polarized light in Doppler- broadened rubidium in upper hyperfine transition of ^{85}Rb and ^{87}Rb. The experimental results were compared with the calculated results.

WPG-14
Combination Method of Atom Trap and Time-of-Flight Mass Spectrometer for Ca Isotope Analysis

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The combination method of the atom trap and the time-of-flight mass spectrometer is demonstrated using calcium atom. The design of the acceleration unit is introduced and the isotope selective characteristics of the systems are discussed.

WPG-15
Quantum Communication Utilizing Cavity-based Quantum Devices

Kae Nemoto [1], A. Stephens [1], S. Devitt [1], M. Everitt [1], J. Schmiedmayer [2], M. Trupke [2], S. Saito [3], Y. Matsuzaki [3], A. SaiToh [1], K. Harrison [1], W. J. Munro [3]
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Photons play a central role in performing communication tasks. For long distance, photons will be lost requiring correction. We present several quantum repeater schemes, their implementation and compare the advantages and disadvantages of each.

WPG-16
Flexible Nonlinearity in an Antenna-coupled Double Quantum Dot

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We theoretically investigate nonlinear excitations in a double quantum dot (DQD). It is found that a flexible and strong nonlinearity of the excitations in the coupled system caused by quantum interferences.

WPG-17
Compact Experimental Apparatus for Producing High Repetition Rate ^{87}Rb Bose Einstein Condensation on Atom Chip

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We construct a compact experimental apparatus for producing a high repetition rate ultra cold ^{87}Rb based on an external atom chip. In this system, we successfully produce Bose-Einstein condensation(BEC) with about 5 sec repetition period.

WPG-18
Observation of Interferometric Structure in Fluorescence From Thiophene/Phenylene Co-Oligomer Crystal

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We report on interferometric structures in fluorescence from a thin slab crystal of 5,5´-bis(4´-methoxybiphenyl-4-yl)-2,2´-bithiophene. These structures observed in the relative delay time with 10 ps between double pulses were discussed in terms of coherent dynamics.

WPG-19
Development of a Surface Electrode Trap for Two-Dimensional Ion Lattice

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We report a surface electrode trap which enables two-dimensional ion lattice. Calcium ion lattice has been observed by adjusting the trapping potential. Such trap could be applied for quantum simulation of coupled spin systems.

WPG-20
Highly Efficient Light Collecting Devices Utilizing a Nanofiber Tip

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We have performed numerical simulations of light collecting devices utilizing a silica nanofiber tip. Up to 39% of light from a point dipole source can be coupled to the fundamental guided mode of the nanofiber.

WPG-21
Optical Control of Microcavity by Mechanical Nonlinearity Under Environmental Fluctuations

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Nonlinear dynamics of an optical microcavity-based oscillator are studied under the self-consistent radiation pressure and environmental fluctuations. Vibration amplitude is significantly suppressed with the negative optical rigidity and effective suppression arising from higher mechanical modes.

WPG-22
Improvement of Success Probability by Squeezed Light in Weak Value Amplification for Single-Photon-Level Nonlinearity

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We propose the use of a squeezed coherent light probe in weak value amplification of single photon nonlinearity. It improves the success probability more than tenfold without the degradation of the error probability.

WPG-23
Withdrawn

WPJ-1
Ablation of Carious Dentin with a Nanosecond Pulsed Laser At a Wavelength of 5.85 Micrometer -Relationship Between Selectivity and Hardness-

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Relationship between ablation depth and hardness in human carious dentin with a nanosecond pulsed laser at a wavelength of 5.85 μm was investigated for the selective removal of dental caries in minimal intervention dentistry.

WPJ-2
Femtosecond Pumping of eGFP Transfected Human Embryonic Kidney Cells

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An investigation was made of femtosecond pumping of a cell laser using human embryonic kidney (HEK293) cells transfected with enhanced green fluorescent protein.

WPJ-3
Dependence of the Photobleaching of Fluorescent Proteins on the Repetition Rate of Femtosecond Light Pulses

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We investigate the photobleaching of fluorescent proteins as function of pulse interval, chirp, and pulse energy of femtosecond excitation lights and find out that the photobleaching occurs via one-photon excited-state absorption of the triplet state.

WPJ-4
2D Simultaneous Spatial and Temporal Focusing as a Fast-Scanning Two-Photon Excited Fluorescence Microscopy

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We propose a two-dimensional simultaneous spatial and temporal focusing (SSTF) microcopy employing a VIPA and a grating, which can improve both axial resolution and background noise compared to 1-D SSTF microscopy.

WPJ-5
Ultrafast Excitation of Quantum Dots with a Fibre Laser for Deep Tissue Imaging

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Fluorescence from three photon absorption was observed in CdSe quantum dots excited with ultrashort pulses from a telecom band Erbium fibre laser. Reduced scattering at longer wavelengths makes this approach interesting for deep tissue imaging.

WPJ-6
Withdrawn

WPJ-7
Real-Time Detection of Protein Kinase A Activity by A Si-Based ARROW-B SPR Biosensor

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The ARROW-B SPR biosensors were proposed to provide label-free and high sensitivity characteristics to detect biomolecular interaction. In this work, ARROW-B SPR biosensors were utilized for detection of protein kinase A activity.

WPJ-8
Characterization of Photoacoustic Signal of Plasmonic Gold Nanoparticles

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We performed a comprehensive photoacoustic measurement of various gold nanoparticles to design exogenous imaging agents for enhancing the contrast. The photoacoustic signal intensities were sensitive to the shape and size of the gold nanoparticles.

WPJ-9
Laser-Assisted Control of Protein Adsorption for Dynamically Arranging Viable Cells

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Polymers and proteins covering glass surface were ablated by femtosecond laser pulses under physiological aqueous condition. The prepared micropatterns of proteins were confirmed by fluorescence imaging and their cell adhesion characteristics was demonstrated.

WPJ-10
Cell Migration Guidance by Using Optical Micropatterns

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We used static and dynamic optical micropatterns to guide the migration of adherent cells. With 0.2 W/cm^2 intensity and a 2.8 um/h pattern speed, 70% of the tested cells were guided along an optical pattern.

WPJ-11
Optical Measurement on Membrane Roughness of Neuroblastoma Cells Treated with Amyloid-beta Peptide and Electric Fields

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We measured the membrane roughness of neuroblastoma cells by non-interferometric wide-field optical profilometry. We found that the peptide related to Alzheimer's disease, Amyloid-beta 42, reduces membrane roughness, but direct-current electrical fields recover this effect.

WPJ-12
Identification of Malignant Melanoma by Three-dimensional Single-cell Tomography

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Discriminating melanoma cells from keratinocytes and fibroblasts by ultrahigh-resolution optical coherence tomography was demonstrated. 20 features were acquired from volume images. 97% sensitivity and 94% specificity for melanoma cells were achieved by linear discriminant analysis.

WPJ-13
Simultaneous measurement of the mental-sweating dynamics of a few tens of sweat glands by OCT

Masato Ohmi, and Yuki Wada
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We demonstrate the dynamic OCT analysis of mental sweating of a few tens of eccrine sweat glands. The dynamic analysis of mental sweating for sound stimulus is performed by the time-sequential en-face OCT images.

WPJ-14

GPU Accelerated Correlation Mapping OCT for Real-Time Imaging of Microvasculature

Yuuki Watanabe, Hiroshi Numazawa, and Dai Kamiyama
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We developed GPU(Graphics Processing Unit) processing to display correlation mapping OCT images in real-time. A display rate of 91 frames per second for processed images (1024 FFT size × 512 lateral A-scans) was achieved.

WPJ-15

Reflectance Images using 5 mm Graded-Index Multimode Fiber

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The imaging condition and magnifications were measured using graded index multimode fiber with diameter of 140 μm and length of 5 mm. Reflectance images of weed surface were measured to show cell shapes.

WPJ-16

Estimation of Scattering Coefficient in CW Reflectance Measurement for Noninvasive Triglyceride Evaluation

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For noninvasive measurement of the triglyceride in the blood, a technique was developed to estimate the scattering coefficient of a turbid medium from the backscattered intensity at two different points on the human body surface.

WPJ-17

Effect of Probe Arrangement on Reconstruction of Optical Brain Function Imaging

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The effect of probe arrangements on optical brain function imaging is evaluated. The high-density probe arrangements, in which the distance between neighboring probe pairs is less than 10 mm can effectively improve the reconstructed image.