OAA

Optical Amplifiers and Their Applications

Topical Meeting and Tabletop Exhibit

July 6-9, 2003
Hilton Otaru
Otaru, Japan

Cooperating Societies:
Sponsored by: Optical Society of America
Technical Co-sponsors: IEEE/Lasers and Electro-Optics Society & IEICE Electronics Society

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About OAA

July 6-9, 2003

This topical meeting will provide an international forum for the most recent and advanced issues concerning optical amplifiers, including principles of operation, practical realization, design, photonic integration, and the optical systems and networks they enable. All aspects of optical amplifier implementation from research to manufacturing will be discussed.

Meeting Topics

Fiber and Active Waveguides
Planar waveguide amplifiers and sources, rare-earth doped fibers, Raman amplifiers, new fiber amplifiers and sources, nonlinear fiberoptic devices, materials and structures, design and fabrication, amplifier modeling and characterization, noise and linearity, active fiber-based integration.

Semiconductor Devices and Functional Circuits
Semiconductor amplifiers, semiconductor pump lasers, wavelength converters, optical switches and processing elements, semiconductor photonic integrated circuits, planar elements and subsystems, sensors, noise dynamics novel (e.g., low dimensional) material systems.

Networks and Systems
Multi-wavelength network applications, switched optical network applications, video and analog transport, subscriber-access networks, upgrade of existing systems, terrestrial and undersea transmission, soliton transmission, system-related analysis, nonlinear effects, field demonstrations/deployment experience.

Speakers

Plenary Speakers

EDFA; Serendipity of Optical Communications
Kazuo Hagimoto, NTT, Japan

Having it Both Ways: Linear and Nonlinear Applications for SOAs
Jay Wiesenfeld, Celion Networks, USA

Invited Speakers

The invited speakers for the main program include:

Recent Advances in 40 Gb/s Long Haul Transmission Technologies
S. Bigo, Alcatel, France

Linear and Nonlinear Characteristics of Long-Wavelength Quantum Dash SOAs
G. Eisenstein, Technion, Israel

Ultra Wide-Band Amplifiers for Transoceanic Length Transmission
Dmitri Foursa, Tyco Telecommunications, USA

Highly Nonlinear Fibers and Their Application to Discrete Raman Amplifiers
Motoki Kakui, Sumitomo Electric Ind. Ltd., Japan

Modulation Formats For High Speed Transmission
Y. Miyamoto, NTT, Japan

Optical Amplifier Transient Suppression Requirements for Dynamic DWDM Networks
R. Monnard, Onetta, USA

Polarization Insensitive SOAs with High Saturation Power
K. Morito, Fujitsu Laboratories Ltd., Japan

Recent Progress in Optical Parametric Amplifiers
Stojan Radic, Bell Labs., Lucent Tech., USA

Integrated Devices Employing SOAs
M. K. Smit, TU Eindhoven, The Netherlands

40 Gb/s-Based WDM Transmission Technologies for Transoceanic Distance Transmission
H. Sugahara, NEC Corporation, Japan

Ultrafast Optical Signal Processing Based on Quantum Dot SOAs: Theory and

Experiment
M. Sugawara, Fujitsu Laboratories Ltd., Japan

Recent Progress on 14xxnm Pump Lasers
Naoki Tsukiji and Junji Yoshida, The Furukawa Electric Co., Japan

Cladding Pumping Technology for Next Generation Fiber Amplifiers and Lasers
Kalle Yla-Jarkko, Southampton Photonics Inc., UK

Short Courses

Short courses are a wonderful way to enhance your knowledge of the optical field. OAA routinely picks experts in their fields to provide you with an in-depth look at intriguing topics. The courses are designed to increase your knowledge of a specific subject while learning from experienced teachers. An added benefit of the courses is the availability of continuing education credits (CEUs).

CEUs are awarded to each participant that successfully completes the short course. The CEU is a nationally recognized unit of measure for continuing education and training programs that meet established criteria. To earn CEUs, a participant must complete the CEU credit form and course evaluation and return it to the course instructor at the end of the course. CEUs will be calculated and certificates will be mailed to participants.

- Tuition for the short course is a separate fee. Advance registration is recommended as the number of seats in the course is limited.
- Short courses sell out quickly! There will be no wait list for the short course.
- Short course materials are not available for purchase.

Optical Amplifier Dynamics and Control for Dynamic WDM Optical Networks
Sunday, July 6, 2003; 9:00 a.m. - 12:00 p.m.
Yan Sun, Onetta, Inc.

Course Description

Optical amplifiers are being widely used in optical communication networks. As optical communication transitioned from single channel, point-to-point systems to WDM, ring and mesh optical networks, it is important to understand the dynamics of optical amplifiers and its impact on optical networks. The channel loading can vary in practice due to fault, reconfiguration and protection switching. In such cases, the optical amplifiers without control will move away from the operation point and the system may not function properly. In this course, the dynamics of single amplifiers will be presented first, followed by the dynamic behavior for a chain of amplifiers in WDM systems, the so-called fast power transients. Both theoretical and experimental results will be discussed for the large signal case and small signal case. As a result, the requirements on amplifier design will be outlined. Several amplifier control schemes, including pump control, link-control and laser control will be compared. The impact on optical systems and networks will be discussed. After a detailed study on the commonly used EDFA, the dynamics of several other types of optical amplifiers will be briefly addressed.

Publications

Advance Program

In early April 2003, the Advance Program will be available online only. A broadcast email will be sent to all previous registrants and authors notifying them of the availability of the online program.

Technical Digests

The OAA Technical Digest will be comprised of the camera-ready summaries of papers being presented during the meeting. At the meeting, each registrant will receive a copy of one Technical Digest. Extra copies can be purchased at the meeting for a special price of $60 USD.

Proceedings

OSA is pleased to announce another volume in our book series, Trends in Optics and Photonics (TOPS). For the 2003 OAA Topical Meeting, a proceedings volume will be completed featuring expanded Technical Digest and Postdeadline Papers.

TOPS offers specialists, students, and practioners a convenient and reliable source for information on the newest and most promising research and advances in many optical technologies. Each registrant will receive an OAA '03 TOPS volume upon publication as part of the full registration fee.

2002 Exhibitor List

3M Company
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Aegis Semiconductor, Inc.
Agilent Technologies
Axcel Photonics, Inc.
B & W TEK, Inc.
CiDRA Corporation
CISILIAS A/S
CorActive High-Tech Inc.
Fibercore Limited
Fitel Technologies, Inc.
Gemfire Corporation
IntelCore Technologies, Inc.
ITF Optical Technologies
JDS Uniphase
KEOPSYS, Inc.
Laser Focus World
Lightwave Electronics
Molecular OptoElectronics Corporation
Nufern
OFS Specialty Photonics
Optiwave Corporation
Photonics Spectra
PowerNetix, Inc.
RSoft Design Group
StockerYale, Inc.
TeraXion, Inc.
Thorlab
VPIsystems, Inc.

Agenda of Sessions

Sunday July 6, 2003

Time	Event
Noon - 7:00pm	Registration Open, Ballroom Foyer
1:00pm - 4:00pm	Short Course: Optical Amplifier Dynamics and Control for Dynamic WDM Optical Networks, Ryusai Room

Monday July 7, 2003

Time	Event
7:30am - 5:00pm	Registration Open & Speaker Check-in, Ballroom Foyer
8:30am - 10:15am	PL Opening Remarks & Plenary Presentation, Jurin Room
10:15am - 10:45am	Coffee Break, Ginga Room
10:15am - 4:00pm	Exhibit, Ginga Room
10:45am - Noon	MA Alternative Modulation Format, Jurin Room
Noon - 1:15pm	Lunch Break
1:15pm - 3:00pm	MB SOAs and Integrated Devices, Jurin Room
3:00pm - 3:30pm	Coffee Break, Ginga Room
3:30pm - 4:45pm	MC Raman Amplification, Jurin Room
5:00pm - 7:00pm	MD Poster Session, Ryusai Room
7:00pm - 8:30pm	Conference Reception, Ryusai Room

Tuesday July 8, 2003

Time	Event
7:30am - 5:00pm	Registration Open & Speaker Check-in, Ballroom Foyer
8:30am - 10:00am	TuA Amplifier Designs for System Applications, Jurin Room
10:00am - 10:30am	Coffee Break, Ginga Room
10:00am - 4:00pm	Exhibit, Ginga Room
10:30am - Noon	TuB Pump Lasers and Transmitters, Jurin Room
Noon - 1:30pm	Lunch Break
1:30pm - 2:45pm	TuC Cladding Pump and High Power Technologies, Jurin Room
2:45am - 3:15pm	Coffee Break, Ginga Room
3:15pm - 4:45pm	TuD Erbium-Doped Fiber Amplifiers, Jurin Room
7:00pm - 10:00pm	Rump Session, Jurin Room

Wednesday July 9, 2003

Time	Event
7:30am - 5:00pm	Registration Open & Speaker Check-in, Ballroom Foyer
8:30am - 10:00am	WA High Capacity Transmission Systems, Jurin Room

10:00am - 10:30am	Coffee Break, Ginga Room
10:00am - 4:00pm	Exhibit, Ginga Room
10:30am - Noon	WB New Materials and Ultrafast Dynamics, Jurin Room
Noon - 1:15pm	Lunch Break
1:15pm - 2:30pm	WC Glass Material, Jurin Room
2:30pm - 3:00pm	Coffee Break, Ginga Room
3:00pm - 4:30pm	WD Parametric Amplification and Four Wave Mixing, Jurin Room
4:45pm - 6:45pm	WE Postdeadline Session, Jurin Room

■ Sunday
■ July 6, 2003

Location: Ballroom Foyer
7:30am – 5:00pm
Registration

Location: Ballroom Foyer
3:00pm
Postdeadline Paper Deadline

■ Monday
■ July 7, 2003

Location: Ballroom Foyer
7:30am – 5:00pm
Registration

Location: Jurin Room
8:30am – 10:15am
Opening Remarks and Plenary Presentations

8:30am
Opening Remarks

8:45am
EDFA: Serendipity of optical communications, *Kazuo Hagimoto, NTT Basic Research Labs., Yokosuka, Japan.*
EDFAs have opened new era of optical network, which is free from the limitations of power budgets in the optical network systems. These empowered optical networks got huge transmission capability, but still have remaining subjects. This talk presents cooperation of photonics and electronics bridged by optical amplifiers toward intelligent photonic networks.

9:30am
Having it both ways: Linear and nonlinear applications for SOAs, *Jay M. Wiesenfeld, Celion Networks, Tinton Falls, NJ, USA.*
Semiconductor optical amplifiers (SOAs) have many potential practical advantages, including size and integrability with other optic or electronic functions. Because the gain recovery time is in the range of 100's of picoseconds, i.e. the bit period for multi-gigabit/s systems, the application of SOAs for linear amplification has been limited. Use of this gain recovery nonlinearity, however, has enabled SOAs to perform as optically-controlled optical gates in all-optical signal processing applications. Continued device progress has now enabled SOA application to linear amplification, as well. In this talk, I will assess issues and progress for SOAs and their future applications.

Location: Ginga Room
10:15am – 10:45am
Coffee Break

Location: Jurin Room
10:45am – 12:00pm
MA ■ Alternative Modulation Format
Atul Srivastava, Onetta, Piscataway, NJ, USA, Presider.

MA1 10:45am ►INVITED
Bandwidth-efficient RZ format for DWDM transmission using orthogonal duobinary mode splitting, *Yutaka Miyamoto, NTT Network Innovation Labs., Yokosuka, Kanagawa, Japan; Akira Hirano, NTT Network Innovation Labs., Yokosuka, Kanagawa, Japan; Shoichiro Kuwahara, NTT Network Innovation Labs., Yokosuka, Kanagawa, Japan.*
This paper describes wideband "orthogonal duobinary mode splitting", which realizes simple modulation and demodulation of novel bandwidth-efficient RZ format, duobinary CS-RZ and CS-RZ DPSK, at channel rates over 40 Gbit/s.

MA2 11:15am
Tolerance of RZ-DPSK signal to pattern effects in Raman amplifier with forward pumping, *Takeshi Hoshida, Fujitsu Labs. Ltd., Kawasaki, Japan; Seemant Choudhary, Fujitsu Network Com., Inc., Richardson, TX, USA; Olga Vassilieva, Fujitsu Labs. of America, Inc., Richardson, TX, USA; Hideo Kuwahara, Fujitsu Labs. of America, Inc., Richardson, TX, USA.*
Waveform distortion in forward-pumped Raman amplifiers with dynamic pump depletion is numerically studied. The RZ-DPSK format, which shows 17 dB higher tolerance than the NRZ format to the forward Raman gain, provides significant flexibility in system design.

MA3 11:30am
Gordon-Mollenauer effect in DPSK transmission over transoceanic distances employing Raman/EDFA repeaters, *Takashi Mizuochi, Mitsubishi Elec. Corp., Kamakura, Japan; Kazuyuki Ishida, Mitsubishi Elec. Corp., Kamakura, Japan; Kaoru Kinjo, Mitsubishi Elec. Corp., Kamakura, Japan; Katsuhiro Shimizu, Mitsubishi Elec. Corp., Kamakura, Japan; Kuniaki Motoshima, Mitsubishi Elec. Corp., Kamakura, Japan.*
10 Gb/s x 100-wavelength transmission experiment and theoretical analysis show that the transmission performance of DPSK is degraded mainly by the Gordon-Mollenauer effect. A Raman/EDFA hybrid repeatered transmission line acts well to reduce that effect.

MA4 11:45am
Pattern-dependent bit error characteristics induced by asymmetrically filtering of CS-RZ signal, *Akira Agata, KDDI R&D Labs. Inc., Saitama, Japan; Takehiro Tsuritani, KDDI R&D Labs. Inc., Saitama, Japan; Itsuro Morita, KDDI R&D Labs. Inc., Saitama, Japan; Noboru Edagawa, KDDI R&D Labs. Inc., Saitama, Japan.*
We have experimentally and numerically studied the pattern dependency in bit error characteristics of asymmetrically filtered CS-RZ signals. We have found that the bit error intensively occurs just after the end of a long sequence of 1s or 0s for strong asymmetrical filtering.

12:00pm – 1:15pm
Lunch Break

Location: Jurin Room
1:15pm – 3:00pm
MB ■ SOAs and Integrated Devices
Jesper Moerk, Tech. Univ. of Denmark, Kgs. Lyngby, Denmark, Presider.

MB1 1:15pm ►INVITED
Integrated devices employing SOAs, *M.K. Smit, TU Eindhoven, Eindhoven, Netherlands.*
Semiconductor Optical Amplifiers are becoming increasingly important in Integrated Photonic Circuits, both for providing gain and for use as non-linear element in signal processing operations. A number of advanced applications will be discussed.

MB2 1:45pm
Dynamic behaviour of a novel 2R regenerator based on an asymmetric SOA-based Michelson interferometer containing a 1X1 MMISOA, *Jan De Merlier, Ghent Univ. IMEC, Ghent, Belgium; Geert Morthier, Ghent Univ. IMEC, Ghent, Belgium; Roel Baets, Ghent Univ. IMEC, Ghent, Belgium.*
All-optical 2R regeneration has been demonstrated at 2.5 Gb/s on a novel integrated SOA-based 2R regenerator. Simultaneous improvement of the extinction ratio and receiver sensitivity has been demonstrated for signals subject to different degrading mechanisms.

MB3 2:00pm
Input power dynamic range of all-optical 3R regenerator at 40 Gbit/s with double-stage SOA-based polarization discriminated switch, *Ryo Inohara, KDDI R&D Labs. Inc., Saitama, Japan; M. Tsurusawa, KDDI R&D Labs. Inc., Saitama, Japan; K. Nishimura, KDDI R&D Labs. Inc., Saitama, Japan; M. Usami, KDDI R&D Labs. Inc., Saitama, Japan.*
Input power dynamic range (IPDR) of an optical 3R regenerator with double-stage SOA-based polarization discriminated switch was experimentally investigated at 40 Gbit/s. The relation between IPDR characteristic and pattern effect was discussed.

MB4 2:15pm ►INVITED
Polarization-insensitive SOA with high saturation power, *Ken Morito, Fujitsu Labs. Ltd., Atsugi, Japan.*
SOA structure for coping with both high saturation power and low polarization sensitivity is presented. The thin tensile-strained bulk SOA that we developed exhibited a high fiber-coupled saturation power of +17 dBm and a low polarization sensitivity of 0.2 dB.

MB5 2:45pm
Long-term stability of a semiconductor optical amplifier, *Hiroyuki Kamioka, NTT Photonics Labs., Atsugi-shi, Kanagawa, Japan; Katsuaki Magari, NTT Photonics Labs., Atsugi-shi, Kanagawa, Japan; Toshio Ito, NTT Photonics Labs., Atsugi-shi, Kanagawa, Japan; Yuichi Tohmori, NTT Photonics Labs., Atsugi-shi, Kanagawa, Japan.*
A good correlation between the change in saturation output power and the change in gain was observed. Lifetime is estimated to be over 10^5 hours at 25 degrees centigrade and 100 mA based on a criterion of 1 dB decrease in gain.

Location: Ginga Room
3:00pm – 3:30pm
Coffee Break

Location: Jurin Room
3:30pm – 4:45pm
MC ■ Raman Amplification
Michael Vasilyev, U.S. Photonics, Belle Mead, NJ, USA, Presider.

MC1 3:30pm ►INVITED
Highly nonlinear fibers and their application to discrete Raman amplifiers, *Motoki Kakui, Sumitomo Elec. Ind., Ltd., Yokohama, Japan.*
As a flexible gain element, that is capable of operating at arbitrary wavelengths, discrete Raman amplifiers employing highly nonlinear fiber (HNLF) are examined in terms of pumping efficiency, noise characteristics, impact on signal quality, and dispersion characteristics.

MC2 4:00pm
20dB intra-cavity net gain with Raman fiber oscillator, *Scott S. Yam, Stanford Univ./ Sprint ATL, Stanford, CA, USA; Michel E. Marhic, Stanford Univ., Stanford, CA, USA; Youichi Akasaka, Sprint ATL, Burlingame, CA, USA; Katzushiro Shimizu, Stanford Univ., Stanford, CA, USA; Nobuhiko Kikuchi, Stanford Univ., Stanford, CA, USA; Leonid Kazovsky, Stanford Univ., Stanford, CA, USA.*
Raman fiber oscillator used for intracavity amplification is demonstrated to have lower double Rayleigh scattering, transient spikes, cross phase modulation, and higher saturation input threshold compared with conventional discrete Raman amplifier at similar operating conditions and pump power.

MC3 4:15pm
A linearized method for unique determination of the input pump powers in designing and controlling WDM-pumped Raman amplifiers, *Koji Fujimura, Furukawa Elec. Co., Ltd., Ichihara, Chiba, Japan; Misao Sakano, Furukawa Elec. Co., Ltd., Ichihara, Chiba, Japan; Takeshi Nakajima, Furukawa Elec. Co., Ltd., Ichihara, Chiba, Japan; Shu Namiki, Furukawa Elec. Co., Ltd., Ichihara, Chiba, Japan.*
We successfully developed a linearized method for predicting the multi-wavelength interactions through stimulated Raman scattering, and solved the inverse problem to uniquely determine the optimum input pump power allocation from a given target gain spectrum.

MC4 4:30pm
Numerical and experimental study of the influence of chromatic dispersion on cascaded Raman generation in optical fibers, *Frédérique Vanholsbeeck, Univ. Libre de Bruxelles, Brussels, Belgium; Stéphane Coen, Univ. Libre de Bruxelles, Brussels, Belgium; Catherine Martinelli, Alcatel Res. & Innovation, Marcoussis, France; Philippe Emplit, Univ. Libre de Bruxelles, Brussels, Belgium; Thibaut Sylvestre, Lab. d'Optique P. M. Duffieux, Besançon, France.*
Cascaded Raman generation in optical fibers, both in single pass and in laser configurations, is shown to be strongly affected by the chromatic dispersion profile of the fiber. Some applications of this phenomenon are discussed.

Location: Ryusai Room

5:00pm – 7:00pm
MD ■ Poster Session

MD01
Double pass erbium doped fiber amplifier with an embedded DCF module for L band DWDM applications, *Joao B. Rosolem, CPqD Fondation, Campinas-SP, Brazil; Miriam Regina X. de Barros, CPqD Fondation, Campinas-SP, Brazil; Antonio A. Juriollo, CPqD Fondation, Campinas-SP, Brazil; Julio Cesar R. Fernandes, CPqD Fondation, Campinas-SP, Brazil; Mariza R. Horiuchi, CPqD Fondation, Campinas-SP, Brazil.*
We present gain, noise figure and 10 Gbit/s BER characterization of an 8 channels L band DWDM system which uses a double pass erbium doped fiber amplifier incorporating a DCF module for chromatic dispersion compensation

MD02
Efficiency of highly nonlinear fiber in soliton converter for 40 Gbit/s 10,000 km fiber transmission, *Koji Igarashi, Furukawa Elec. Co., Ltd., Chiba, Japan; Shunichi Matsushita, Furukawa Elec. Co., Ltd., Chiba, Japan; Frederic Seguineau, Alcatel Res. & Innovation, Cedex, France; Delphine Rouvillain, Alcatel Res. & Innovation, Cedex, France; Patrick Brindel, Alcatel Res. & Innovation,Cedex, France; Bruno Lavigne, Alcatel Res. & Innovation,Cedex, France; Olivier Leclerc, Alcatel Res. & Innovation,Cedex, France; Ryuichi Sugizaki, Furukawa Elec. Co., Ltd., Chiba, Japan; Hideaki Tobioka, Furukawa Elec. Co., Ltd., Chiba, Japan; Osamu Aso, Furukawa Elec. Co., Ltd., Chiba, Japan; Shu Namiki, Furukawa Elec. Co., Ltd., Chiba, Japan.*
We show that highly nonlinear fiber is essential to reduce the input power, length, loss, and noise of a soliton converter, and that it actually halves the input power and length compared with a conventional DSF in 40 Gbit/s 10,000 km transmission.

MD03
Optical transients in cascaded EDFA's: Effects on transmission system performance, *Paul Lundquist, Ciena Corp., San Jose, CA, USA; Marc Levesque, Ciena Corp., San Jose, CA, USA; Janelle Morrier, Ciena Corp., San Jose, CA, USA; Denis Zaccarin, Ciena Corp., San Jose, CA, USA.*
The performance of dynamic DWDM transmission systems is often limited by the sensitivity of constituent EDFA's to optical power transients. The effects of transients in EDFA cascades are described and resulting system penalties are quantified.

MD04
Field trial of 40 Gbit/s 64 WDM (2.56 Tbit/s) signal transmission over 351 km (4 x 87.8 km) installed SSMF, *Masahiro Daikoku, KDDI R&D Labs. Inc., Saitama, Japan; T. Otani, KDDI R&D Labs. Inc., Saitama, Japan; N. Yoshikane, KDDI R&D Labs. Inc., Saitama, Japan; I. Morita, KDDI R&D Labs. Inc., Saitama, Japan; K. Nishijima, KDDI Corp., Saitama, Japan; H. Tanaka, KDDI R&D Labs. Inc., Saitama, Japan; M. Suzuki, KDDI R&D Labs. Inc., Saitama, Japan.*
Field trial of 40 Gbit/s 64 WDM transmission was successfully demonstrated over 351 km (4 x 87.8 km) installed standard single mode fibers without utilizing an out-band FEC rate and distributed Raman amplifiers.

MD05
Suppression of intrachannel nonlinearities in 40 Gb/s WDM transmission systems, *Ivan M. Uzunov, Optiwave Corp., Ottawa, ON, Canada; Kiril Marinov, Optiwave Corp., Ottawa, ON, Canada; Marcio Freitas, Optiwave Corp., Ottawa, ON, Canada; Jackson Klein, Optiwave Corp., Ottawa, ON, Canada.*
We study the performance a of 40 Gb/s WDM system in pseudo-linear regime of transmission for different modulation formats. We show that the combination of modified duobinary modulation format and a symmetric dispersion map yields a substantial improvement of the system performance.

MD06
Statistical analysis on stimulated Raman scattering in fiber Raman amplifier systems, *Toshiaki Yamamoto, Kyoto Univ., Kyoto, Japan; Seiji Norimatsu, Kyoto Univ., Kyoto, Japan.*
Previous work on the statistical analysis of power impairments due to stimulated Raman scattering (SRS) was extended to fiber Raman amplifier systems and examples of SRS crosstalk in some typical dispersion-managed fiber links are shown.

MD07
Transparent wavelength conversion at up to 160Gb/s by using supercontinuum generation in a nonlinear fiber, *Fumio Futami, Fujitsu Labs. Ltd., Kawasaki, Japan; Ryou Okabe, Fujitsu Higashi-Nihon Digital Tech. Ltd., Sapporo, Japan; Yutaka Takita, Fujitsu Labs. Ltd., Kawasaki, Japan; Shigeki Watanabe, Fujitsu Labs. Ltd., Kawasaki, Japan.*
Wavelength conversion by spectral broadening in a normal dispersion fiber is experimentally demonstrated at 40, 80 and 160Gb/s, for the first time, and bit-rate free operation is confirmed. 2R-regenerating capability is also demonstrated at 160Gb/s.

MD08
Impact of pump failure on gain modulation dynamics in 80nm-band high power Raman amplifier, *Kaoru Imai, KDDI R&D Labs. Inc., Kamifukuoka-shi, Saitama, Japan; Itsuro Morita, KDDI R&D Labs. Inc., Kamifukuoka-shi, Saitama, Japan; Noboru Edagawa, KDDI R&D Labs. Inc., Kamifukuoka-shi, Saitama, Japan.*
We studied the impact of pump failure on gain modulation dynamics in 80nm-band high power Raman amplifier. We found that the modulation frequency should be higher than 10kHz to reduce the impact of pump failure.

MD09
Characterization of optical and electrical pulse modulation induced harmonic mode-locking fiber lasers, *Yung-Cheng Chang, Inst. of Electro-Opt. Eng., Natl. Chiao Tung Univ., Hsinchu, Taiwan Republic of China; Gong-Ru Lin, Inst. of Electro-Opt. Eng., Natl. Chiao Tung Univ., Hsinchu, Taiwan Republic of China.*
Optical and electrical pulse modulation induced actively harmonic mode-locking of Erbium-doped fiber ring lasers are demonstrated. Comparisons between these two configurations such as output stability, build-up dynamics, and frequency characteristics are reported as well.

MD10
Asymmetric-cladding 1480-nm pump laser with CW fiber output power of 1W, *Yasuaki Nagashima, Anritsu Corp., Atsugi-shi, Kanagawa, Japan; Shinichi Onuki, Anritsu Corp., Atsugi-shi, Kanagawa, Japan; Yoshiharu Shimose, Anritsu Corp., Atsugi-shi, Kanagawa, Japan; Atsushi Yamada, Anritsu Corp., Atsugi-shi, Kanagawa, Japan; Tomoyuki Kikugawa, Anritsu Corp., Atsugi-shi, Kanagawa, Japan.*
We have proposed high slope efficiency 1480-nm pump laser with asymmetric waveguide structure employing n-InGaAsP cladding layer. We have achieved excellent fiber coupling efficiency of 92 % and fiber output power of 1W at 4A.

MD11
All-optical 3R-signal regeneration at 80 Gbit/s using high-speed electro-absorption modulator, *Hitoshi Murai, Oki Elec. Ind. Co., Ltd., Tokyo, Japan; Masatoshi Kagawa, Oki Elec. Ind. Co., Ltd., Tokyo, Japan; Hiromi Tsuji, Oki Elec. Ind. Co., Ltd., Tokyo, Japan; Kozo Fujii, Oki Elec. Ind. Co., Ltd., Tokyo, Japan.*
An all-optical 3R-signal regeneration using cross-absorption modulation in EAM was investigated and the error free signal regeneration at the bit rate of 80 Gbit/s was achieved with a proper operating condition.

MD12
Degradation of the mode suppression in single mode laser diodes due to integrated optical amplifiers, *Bart Moeyersoon, Dept.of Info. Tech., Ghent Univ.-IMEC, Ghent, Belgium; Mingshan Zhao, Dept. of Info. Tech., Ghent Univ.-IMEC, Ghent, Belgium; Geert Morthier, Dept. of Info. Tech., Ghent Univ.-IMEC, Ghent, Belgium.*
We show that the side mode suppression in single mode laser diodes, such as DFB or DBR laser diodes, can be reduced with 10 dB or more if an optical amplifier is integrated with the laser diode.

MD13
A gain clamped semiconductor optical amplifier combined with a distributed Raman fiber amplifier: A good candidate as an inline amplifier for WDM networks, *Han Hyub Lee, Chungnam Natl. Univ., Daejeon, Rep. of Korea; Donghan Lee, Chungnam Natl. Univ., Daejeon, Rep. of Korea; JinSoo Han, Elec. and Telecomm. Res. Inst., Daejeon, Rep. of Korea; Hee Sang Chung, Elec. and Telecomm. Res. Inst., Daejeon, Rep. of Korea; Moo Jung Chu, Elec. and Telecomm. Res. Inst., Daejeon, Rep. of Korea.*
A gain-clamped-SOA is used as an inline amplifier in combination with a distributed Raman-fiber-amplifier. The amplifier has 20dB-gain and a noise figure below 2.7dB. The OSNRs after five spans of 80km are better than an equivalent EDFA. The amplifier shows negligible transients under dynamic add-drops.

MD14
Time stability of 500mW 980nm pump laser module with polarization-maintaining fiber, *Takeshi Koiso, MC-FITEL, Inc., Sodegaura, Japan; Atsushi Okubo, MC-FITEL, Inc., Sodegaura, Japan; Tsuyoshi Fujimoto, MC-FITEL, Inc., Sodegaura, Japan; Yoshikazu Ikegami, MC-FITEL, Inc., Sodegaura, Japan; Naoki Hayamizu, Furukawa Elec. Co., Ltd, Ichihara, Japan; Takashi Koseki, Furukawa Elec. Co., Ltd., Ichihara, Japan; Kevin Nishikata, Furukawa Elec. Co., Ltd., Ichihara, Japan.*
We achieved excellent time stability at high power, 0.1% at 500mW, and a low variation of back facet monitor current, 1.6%, in 980nm pump laser modules. The laser structure was optimized by measuring relative intensity noise to control coherence-collapse phenomenon.

MD15
10 Gb/s all-optical AND gate by using semiconductor optical amplifiers, *Jae H. Kim, KIST, Seoul, Rep. of Korea; Byung C. Kim, KIST, Seoul, Rep.of Korea; Young T. Byun, KIST, Seoul, Rep.of Korea; Young M. Jhon, KIST, Seoul, Rep. of Korea; Min C. Park, KIST, Seoul, Rep. of Korea; Seok Lee, KIST, Seoul, Rep. of Korea; Deok H. Woo, KIST, Seoul, Rep. of Korea; Sun H. Kim, KIST, Seoul, Rep. of Korea; Young W. Choi, Chung Ang Univ., Seoul, Rep. of Korea; Tae H. Yoon, Pusan Natl. Univ., Pusan, Rep. of Korea.*
By using gain saturation of semiconductor optical amplifiers (SOAs), an all-optical AND gate has been successfully demonstrated. Firstly, inversion of signal B is obtained using the first SOA with signal B and clock injection. Then, the all-optical AND gate is achieved using the second SOA.

MD16
Experimental demonstration of wideband spectral inversion in polarisation-insensitive semiconductor optical amplifiers, *Yanhua Hong, Univ. of Wales, School of Informatics, Bangor, United Kingdom; Paul S. Spencer, Univ. of Wales, School of Informatics, Bangor, United Kingdom; K. Alan Shore, Univ. of Wales, School of Informatics, Bangor, United Kingdom.*
Wideband spectral inversion in semiconductor optical amplifiers has been investigated experimentally. Polarisation independence was obtained when the wavelength detuning is larger than 0.6 nm. Near flat conversion efficiency was achieved over about 60 nm.

MD17
Picosecond electro-optic switching time based on pre-pulse induced chirp filtering in semiconductor optical amplifiers, *Cristiano M. Gallep, DMO-FEEC-Unicamp, Campinas-SP, Brazil; Aldário C. Bordonalli, DMO-FEEC-Unicamp, Campinas- SP, Brazil; Evandro Conforti, DMO-FEEC-Unicamp, Campinas-SP, Brazil.*
Optical filtering of current induced chirp is proposed to obtain faster electro-optic SOA-based switches. A 5.4ps switching time was theoretically obtained for pre-pulsed-step current injection with filtering by a frequency-discriminator filter after the active device.

MD18
Single to multi-wavelength conversion using FP-LD with linear optical amplifier, *Jeung-Mo Kang, Yonsei Univ., Seoul, Rep. of Korea; Yong-Ook Kim, Yonsei Univ., Seoul, Rep. of Korea; Sang-Kook Han, Yonsei Univ., Seoul, Rep. of Korea.*
We propose and demonstrate a single to multi-wavelength converter using FP-LD with linear optical amplifier (LOA) which based on cross-gain modulation can convert an input signal to many wavelengths simultaneously for reconfigurable wavelength conversion in OXC and broadcasting in WDM systems.

MD19
1550nm band selective photodetector with the noise carrier extinction layer, *Masanobu Kato, Kyoto Semiconductor Corp., Eniwa-shi, Hokkaido, Japan; T. Ito, Kyoto Semiconductor Corp., Eniwa-shi, Japan; Y. Nishimura, Kyoto Semiconductor Corp., Eniwa-shi, Japan; H. Tomozawa, Kyoto Semiconductor Corp., Eniwa-shi, Japan; N. Yokogawa, Kyoto Semiconductor Corp., Eniwa-shi, Japan; K. Nishida, Kyoto Semiconductor Corp., Eniwa-shi, Japan.*
Photodetector with Noise Carrier Extinction (NCE) layer has been developed for bi-directional optical networks. NCE PD eliminates the 1310nm light and selects the 1550nm signal, and provides the isolation ratio of about -17dB over 50MHz.

MD20
Extremely broadband InGaAsP/InP superluminescent diode/semiconductor optical amplifiers with emission spectrum covering from 1250 nm to 1650 nm, *Ching-Fuh Lin, Natl. Taiwan Univ., Taipei, Taiwan Rep. of China; Chia-Wei Tsai, Natl. Taiwan Univ., Taipei, Taiwan Rep. of China; Yi-Shin Su, Natl. Taiwan Univ., Taipei, Taiwan Rep. of China; Gagik Sh. Shmavonyan, Natl. Taiwan Univ., Taipei, Taiwan Rep. of China.*
Using five 60A InGaAsP quantum wells and two 150A InGaAs quantum wells for superluminescent diodes, we obtain a very broad emission spectrum. The spectral width is nearly 400nm, covering the range from 1250nm to 1650nm.

MD21
Precise characterization of Er^{3+} ions in fibers with different Al_2O_3 content, *Shunsuke Ono, Kyoto Univ., Kyoto, Japan; Setsuhisa Tanabe, Kyoto Univ., Kyoto, Japan.*
Precise characterization of Er^{3+} ions in fibers with different Al_2O_3 content was performed using the Judd-Ofelt analysis.The improvement of quantum efficiency and the Ω_6 parameter with the increase of Al_2O_3 content was shown.

MD22
Investigation and modeling of green emission in erbium doped fiber amplifier, *Orietta Quargnolo, Marconi Comm., Genova, Italy; Stefano Taccheo, INFM-Politecnico di Milano and IFN-CNR, Milano, Italy.*
We investigate both experimentally and theoretically, by means of a simple model, green emission from erbium-doped optical amplifiers as a function of operating condition. Experimental results are in agreement with theoretical prediction.

MD23
Picosecond pulse amplification over a bandwidth of 80 nm in a 23 cm length of Bi_2O_3-based Erbium-doped fiber, *Juliet T. Gopinath, MIT, Cambridge, MA, USA; Hideyuki Sotobayashi, MIT, Cambridge, MA, USA; Erich P. Ippen, MIT, Cambridge, MA, USA.*
One-picosecond pulses are amplified without distortion in a 22.7-cm Bi_2O_3-based EDFA. Gains of 12 dB and higher are demonstrated over a bandwidth of 80 nm (1520 - 1600 nm).

MD24
Low nonlinear Bi_2O_3-based EDF for L-band amplification, *Seiki Ohara, Asahi Glass Co., Ltd., Yokohama, Japan; Tatsuo Nagashima, Asahi Glass Co., Ltd., Yokohama, Japan; Katsuhiro Ochiai, Asahi Glass Co., Ltd., Yokohama, Japan; Naoki Sugimoto, Asahi Glass Co., Ltd., Yokohama, Japan.*
We demonstrated very low FWM cross-talk, with a ratio of idler to signal of less than -47 dB and more than 20 dBm output signal power from 1560 to 1610 nm using high Erbium concentration and very short length Bi_2O_3-based EDF.

MD25
Effect of auxiliary L-band laser on the upconversion mechanism of Tm-doped fiber in dual-wavelength pumping scheme,
Takeshi Tamaoka, Kyoto Univ., Kyoto, Japan; Setsuhisa Tanabe, Kyoto Univ., Kyoto, Japan.
Effect of auxiliary L-band laser on the upconversion pumping mechanism of Tm-doped fiber was investigated based on spectroscopy for dual-wavelength pumping scheme using a main pump (1.05μm) and an auxiliary pump (1.56-1.62μm).

MD26
Dispersion managed U-band discrete fiber Raman amplifiers for 43Gb/s WDM transmission, *Tetsufumi Tsuzaki, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Shinobu Tamaoki, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Motoki Kakui, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Masaaki Hirano, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Masayuki Shigematsu, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Morio Wada, Yokogawa Elec. Corp., Musashino, Japan; Toshimasa Umezawa, Yokogawa Elec. Corp., Musashino, Japan; Takahiro Kudou, Yokogawa Elec. Corp., Musashino, Japan; Takashi Mogi, Yokogawa Elec. Corp., Musashino, Japan; Shinji Iio, Yokogawa Elec. Corp., Musashino, Japan; Shinji Kobayashi, Yokogawa Elec. Corp., Musashino, Japan; Tsuyoshi Yakihara, Yokogawa Elec. Corp., Musashino, Japan; Akira Miura, Yokogawa Elec. Corp., Musashino, Japan.*
We evaluated the eye-patterns of 43Gb/s WDM signals, which were amplified by dispersion managed U-band discrete fiber Raman amplifiers employing highly nonlinear fiber. No degradation of the eye-patterns was observed by adjusting the dispersion.

MD27
Dispersion neutral discrete Raman amplifier,
Peter B. Gaarde, OFS Fitel Denmark, Brøndby, Denmark; Yujun Qian, OFS Fitel Denmark, Brøndby, Denmark; Bera Palsdottir, OFS Fitel Denmark, Brøndby, Denmark.
We have developed a Raman gain efficient fiber with positive dispersion. In combination with a negative dispersion fiber we have built Raman amplifiers with zero total dispersion and present results on gain, noise figure and MPI.

MD28
Optimal design for fiber Raman amplifier using hybrid genetic algorithm, *Xueming Liu, School of Elec. Eng., Seoul, Rep. of Korea; Byoungho Lee, School of Elec. Eng., Seoul, Rep. of Korea.*
We employ a hybrid genetic algorithm to solve multimodal optimizations in distributed-multi-pump Raman amplifier. Optimal results show bandwidth of >100nm can be designed with five pumps under required parameters. Four different schemes can be realized.

MD29
Gain limitation due to pump stimulated Brillouin scattering in various fibers,
Yujun Qian, OFS Denmark, Brøndby, Denmark; Yoshihiro Emori, OFS, Holmdel, NJ, USA; Lynn Nelson, OFS, Holmdel, NJ, USA; Bera Palsdottir, OFS Denmark, Brøndby, Denmark; Shu Namiki, Fitel Photonics Lab., Ichihara, Chiba, Japan.
We investigate Raman amplification limited by pump stimulated Brillouin scattering for various fibers and low noise pump lasers. The obtainable Raman on-off gain depends on the fiber type and the largest difference is 60% in dB scale.

Location: Ryusai Room
7:00pm – 8:30pm
Conference Reception

■ Tuesday
■ July 8, 2003

Location: Ballroom Foyer
7:30am – 5:00pm
Registration

Location: Jurin Room
8:30am – 10:00am
TuA ■ Amplifier Designs for System Applications
Kiyoshi Fukuchi, NEC Corp., Kawasaki, Kanagawa, Japan, Presider.

TuA1 8:30am ►INVITED
Optical amplifier transient suppression requirements for dynamic DWDM networks, *Rene Monnard, Onetta, Inc., San Jose, CA, USA; Atul Srivastava, Onetta, Inc., San Jose, CA, USA.*
Scenarios inducing channel load changes and their time scale are presented. Fast transient-control EDFAs are needed to adapt to those quick changes. A new approach to measure the system impact of channel transient is proposed.

TuA2 9:00am
A novel Raman-gain control method by detecting the Rayleigh backscattering of pump lights, *Hiroji Masuda, NTT Network Innovation Labs., Yokosuka, Japan; Yutaka Miyamoto, NTT Network Innovation Labs., Yokosuka, Japan; Masahito Tomizawa, NTT Network Innovation Labs., Yokosuka, Japan.*
We report a novel Raman-gain control method with a simple setup in distributed Raman amplification systems. The method keeps Raman gain completely constant regardless of the variations in connector- and fusion-splicing losses by detecting the Rayleigh backscattering of multi-wavelength pump lights.

TuA3 9:15am
Optimal path-averaged power and gain ratio of Raman/EDFA hybrid amplification for in-line amplifier transmission systems, *Takashi Kotanigawa, NTT Corp., Yokosuka, Japan; Toshiya Matsuda, NTT Corp., Yokosuka, Japan; Tomoyoshi Kataoka, NTT Corp., Yokosuka, Japan.*
Raman/EDFA hybrid amplifier systems are optimized in path-averaged power and the gain ratio; we consider the optical signal-to-noise ratio, waveform distortion, and double Rayleigh scattering. 40Gb/s transmission experiments verify the success of our optimization approach.

TuA4 9:30am
Analysis of WDM signal bandwidth upgradeability in wide-band DRA-based system,
Masahiro Yuki, Fujitsu Labs. Ltd., Kawasaki, Japan; Toshiki Tanaka, Fujitsu Labs. Ltd., Kawasaki, Japan; Kenichi Torii, Fujitsu Labs. Ltd., Kawasaki, Japan; Toru Katagiri, Fujitsu Labs. Ltd., Kawasaki, Japan; Takao Naito, Fujitsu Labs. Ltd., Kawasaki, Japan.
We theoretically and experimentally analyzed the upgradability of a WDM signal bandwidth in a wide-band DRA with consideration of the wavelength-dependent A_{eff}. The gain differences were 3 dB or less when the bandwidth was upgraded from 36 to 200 nm.

TuA5 9:45am
Transmission characteristics of highly-nonlinear-fiber-based Raman amplifier for CWDM systems, *Toshiyuki Miyamoto, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Masato Tanaka, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Junko Kobayashi, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Tetsufumi Tsuzaki, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Toshiaki Okuno, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Motoki Kakui, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Masayuki Shigematsu, Sumitomo Elec. Ind., Ltd., Yokohama, Japan.*
We have developed a discrete fiber Raman amplifier (FRA) utilizing highly nonlinear fiber for 4-channel CWDM systems. By using FRA, we have successfully achieved the transmissino over single mode fiber with the length of 150km.

Location: Ginga Room
10:00am – 10:30am
Coffee Break

Location: Jurin Room
10:30am – 12:00pm
TuB ■ Pump Lasers and Transmitters
David A. Loeber, Corning Photonic Tech., Inc., Bedford, MA, USA, Presider.

TuB1 10:30am ►INVITED
Recent progress on 14xx nm pump lasers, *Naoki Tsukiji, Furukawa Elec. Co., Ltd., Yokohama, Japan; Junji Yoshida, Furukawa Elec. Co., Ltd., Yokohama, Japan.*
Advanced 14xx-nm-pump-lasers were demonstrated for next generation optical fiber amplifiers. Inner-Grating-Multi-mode-laser (IGM-laser) with ultra low noise and reduced Stimulated-Brillouin-Scattering, and Hybrid-pump with ultra high power and low-DOP (degree of polarization) were described.

TuB2 11:00am
Cooler-less and heat-sink-free 980nm pump laser diode module wavelength-stabilized from -40 to 100 °C, *Yuichiro Irie, Furukawa Elec. Co., Ltd, Ichihara, Japan; Takashi Koseki, Furukawa Elec. Co., Ltd, Ichihara, Japan; Masayuki Minamino, Furukawa Elec. Co., Ltd, Ichihara, Japan; Jun Miyokawa, Furukawa Elec. Co., Ltd, Ichihara, Japan; Kevin Nishikata, Furukawa Electric Co., Ltd, Ichihara, Japan; Takeshi Koiso, MC-Fitel, Inc., Sodegaura, Japan; Yuji Yamagata, MC-Fitel, Inc., Sodegaura, Japan; Yoshikazu Ikegami, MC-Fitel, Inc., Sodegaura, Japan.*
Cooler-less 200mW kink free 980nm LD module was developed. Center wavelength was locked and unnecessary modes were suppressed from -40 to 100 deg. C. under low heat dissipation condition using IC socket without a heat sink.

TuB3 11:15am
GaAsSb quantum well for 980nm laser diode, *Hirotatsu Ishii, Furukawa Elec. Co., Ltd., Yokohama, Japan; Mikihiro Yokozeki, Furukawa Elec. Co., Ltd., Yokohama, Japan; Masayuki Iwami, Furukawa Elec. Co. Ltd., Yokohama, Japan; Akihiko Kasukawa, Furukawa Elec. Co. Ltd., Yokohama, Japan.*
We propose the novel material, GaAsSb, as the active layer for highly reliable operations of 980nm LDs. The GaAsSb-QW LDs show higher COD level and longer lifetime in a preliminary APC test than InGaAs-QW LDs.

TuB4 11:30am
Low power cosumption 980nm broad-area laser module, *Naoki Hayamizu, Furukawa Elec. Co., Ltd, Ichihara, Japan; Jun Miyokawa, Furukawa Elec. Co., Ltd, Ichihara, Japan; Hideaki Murata, Furukawa Elec. Co., Ltd, Ichihara, Japan; Kevin Nishikata, Furukawa Elec. Co., Ltd, Ichihara, Japan; Yasuo Oeda, MC-Fitel, Inc., Sodegaura, Japan; Tsuyoshi Fujimoto, MC-Fitel, Inc., Sodegaura, Japan; Yoshikazu Ikegami, MC-Fitel, Inc., Sodegaura, Japan.*
Multi-mode 980nm broad-area laser diode module with the standard 14-pin butterfly package attained maximum output power of 4.2W at 10deg. C. and total power consumption of 10.4W at 70deg. C. at 1.5W output.

TuB5 11:45am
A wavelength-tunable optical transmitter using semiconductor optical amplifiers and an optical tunable filter for metro/access DWDM applications, *Jun-ichi Kani, NTT Network Innovation Labs., Yokosuka, Japan; Mitsuhiro Teshima, NTT Network Innovation Labs., Yokosuka, Japan; Katsumi Iwatsuki, NTT Network Innovation Labs., Yokosuka, Japan.*
This paper demonstrates a widely tunable and precisely controllable optical transmitter that comprises semiconductor optical amplifiers and an optical tunable filter for advanced metro/access DWDM systems/networks.

12:00pm – 1:30pm
Lunch Break

Location: Jurin Room
1:30pm – 2:45pm
TuC ■ Cladding Pump and High Power Technologies
Clifford E. Headley, III, OFS, Somerset, NJ, USA, Presider.

TuC1 1:30pm ►INVITED
Cladding pumping technology for next generation fiber amplifiers and lasers, *Kalle Yla-Jarkko, Southampton Photonics Inc., Southampton, United Kingdom; Shaif-ul Alam, Southampton Photonics Inc., Southampton, United Kingdom; Paul W. Turner, Southampton Photonics Inc., Southampton, United Kingdom; John Moore, Southampton Photonics Inc., Southampton, United Kingdom; Johan Nilsson, Optoelectronics Res. Ctr., Univ. of Southampton, Southampton, United Kingdom; Romeo Selvas, Optoelectronics Res. Ctr., Univ. of Southampton, Southampton, United Kingdom; Daniel B. Soh, Optoelectronics Res. Ctr., Univ. of Southampton, Southampton, United Kingdom; Christophe Codemard, Optoelectronics Res. Ctr., Univ. of Southampton, Southampton, United Kingdom; Jianto K. Sahu, Optoelectronics Res. Ctr., Univ. of Southampton, Southampton, United Kingdom.*
We discuss recent advances in cladding-pumped fiber technology considering various applications of GTWave fiber amplifiers and 977 nm ytterbium-doped fiber devices based on jacketed-air clad fibers.

TuC2 2:00pm
Cladding-pumped L-band phosphosilicate erbium-ytterbium co-doped fiber amplifier, *Christophe A. Codemard, Optoelectronics Res. Ctr., Southampton, United Kingdom; Daniel B. Soh, Optoelectronics Res. Ctr., Southampton, United Kingdom; Kalle Yla-Jarkko, Southampton Photonics, Southampton, United Kingdom; Jayanta K. Sahu, Optoelectronics Res. Ctr., Southampton, United Kingdom; Johan Nilsson, Optoelectronics Res. Ctr., Southampton, United Kingdom; Mathieu Laroche, Optoelectronics Res. Ctr., Southampton, United Kingdom.*
We report a cladding-pumped broadband L-band amplifier based on a phosphosilicate erbium ytterbium doped fiber. A gain of more than 20 dB has been achieved from 1553 to 1620 nm in a 5 m long fiber in a double-pass amplifier configuration.

TuC3 2:15pm
Multimode-pumped monolithic amplifier arrays based in erbium-doped phosphate glass, *Arturo Chavez-Pirson, NP Photonics, Tucson, AZ, USA; Wenyan Tian, NP Photonics, Tucson, AZ, USA; Dan Nguyen, NP Photonics, Tucson, AZ, USA; Tao Luo, NP Photonics, Tucson, AZ, USA; Sandrine Hocde, NP Photonics, Tucson, AZ, USA; Zhidong Yao, NP Photonics, Tucson, AZ, USA; Shibin Jiang, NP Photonics, Tucson, AZ, USA; Nasser Peyghambarian, Univ. of Arizona, Tucson, AZ, USA.*
We demonstrate the first monolithic optical amplifier array based on high gain per unit length erbium-doped phosphate glass. The 7-cm long chip, pumped by one multimode diode laser, delivers 28 dB gain at each of three-ports.

TuC4 2:30pm
Study of high-power endurance characteristics in optical fiber link, *Naoya Nishimura, Fitel Photonics Lab., Furukawa Elec. Co., Ltd., Ichihara, Japan; Koji Seo, Fitel Photonics Lab., Furukawa Elec. Co., Ltd., Ichihara, Japan; Masato Shiino, Fitel Photonics Lab., Furukawa Elec. Co., Ltd., Ichihara, Japan; Renichi Yuguchi, Fitel Photonics Lab., Furukawa Elec. Co., Ltd., Ichihara, Japan.*
We investigated the high power problems in optical fiber link. We experimentally show the correlation between the threshold power of a fiber fuse and mode field diameter of the fiber. And we also show the differences of high power durability in various fiber coatings.

Location: Ginga Room
2:45pm – 3:15pm
Coffee Break

Location: Jurin Room
3:15pm – 4:45pm
TuD ■ Erbium-Doped Fiber Amplifiers
Shinji Yamashita, Univ. of Tokyo, Tokyo, Japan, Presider.

TuD1 3:15pm ►INVITED
Ultra wide-band amplifiers for transoceanic length transmission, *Dmitri Foursa, Tyco Telecomm., Eatontown, NJ, USA; J. X. Cai, Tyco Telecomm., Eatontown, NJ, USA; C. R. Davidson, Tyco Telecomm., Eatontown, NJ, USA; Y. Cai, Tyco Telecomm., Eatontown, NJ, USA; A. N. Pilipetskii, Tyco Telecomm., Eatontown, NJ, USA; M. Nissov, Tyco Telecomm., Eatontown, NJ, USA.*
Ultra wide-band amplifiers for long-haul systems are discussed. Broadband transmission experiments utilizing hybrid Raman-EDFAs are presented together with a cost-effective experimental technique for high capacity transmissions.

TuD2 3:45pm
Experimental observation of the complex shape of spectral holes in Erbium-doped silica fiber, *Dmitri G. Foursa, Tyco Telecomm., Eatontown, NJ, USA; Alexei N. Pilipetskii, Tyco Telecomm., Eatontown, NJ, USA; Dmitri Kovsh, Tyco Telecomm., Eatontown, NJ, USA; Morten Nissov, Tyco Telecomm., Eatontown, NJ, USA; Stuart M. Abbott, Tyco Telecomm., Eatontown, NJ, USA.*
Spectral hole burning in Erbium-doped silica fiber was experimentally studied in a 100+ nm bandwidth. It was observed that the spectral holes overlap even for widely spaced saturating tones (>40 nm); thus, the conventional two-tone subtractive measurement technique cannot be used to separate the holes.

TuD3 4:00pm
Characterization and new numerical model of spectral hole burning in broadband erbium-doped fiber amplifier, *Masato Nishihara, Fujitsu Labs., Ltd., Kawasaki, Japan; Yasushi Sugaya, Fujitsu Labs., Ltd., Kawasaki, Japan; Etsuko Ishikawa, Fujitsu Labs., Ltd., Kawasaki, Japan.*
We propose a new numerical model considering the two types of spectral hole burning (SHB), which were observed in the same gain spectrum of broadband EDFA.

TuD4 4:15pm
Gain inhomogeneity in L-band phosphosilicate-based Erbium-Doped Fiber Amplifiers (EDFA), *Li Qian, Dept. of Elec. and Computer Eng., Toronto, ON, Canada; Davide Fortusini, Corning Inc., Corning, NY, USA; Seldon Benjamin, Corning Inc., Corning, NY, USA.*
We report large pump–mediated inhomogeneity in an L-band phosphosilicate-based EDFA, pumped in the 1480 nm absorption band. We have investigated inhomogeneous effects as a function of average inversion level, input signal power, and pumping configuration.

TuD5 4:30pm
A temperature-insensitive erbium-doped fiber amplifier, *Haruo Nakaji, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Toshikazu Shibata, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Masaki Ohmura, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Akira Inoue, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Masayuki Shigematsu, Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Yoji Ishizawa, Sumiden High Precision Co., Ltd., Chigasaki-shi, Japan.*
We have developed a temperature-insensitive erbium-doped fiber amplifier. By optimizing both the pump wavelength in 980-nm band and the temperature-sensitive gain flattening filter, gain variation between 0 and 65 ^{o}C was successfully suppressed to be 0.18 dBpp over 37 nm bandwidth.

Location: Jurin Room

7:00pm – 10:00pm
Rump Session

Topics to be discussed:

- Which pump will dominate the future – 980, 1480, or fiber lasers?
- Low cost regeneration vs. amplifiers in metro networks.
- Can high-spectral efficiency systems be valuable?

■ Wednesday
■ July 9, 2003

Location: Ballroom Foyer
7:30am – 5:00pm
Registration

Location: Jurin Room
8:30am – 10:00am
WA ■ High Capacity Transmission Systems
Stojan Radic, Bell Labs., Holmdel, NJ, USA, Presider.

WA1 8:30am ►INVITED
40 Gb/s-based WDM transmission technologies for transoceanic distance transmission, *Hiroto Sugahara, NEC Corp., Kawasaki-shi, Japan.*
This paper summarizes some recent technologies developed for 40Gb/s-based WDM transoceanic distance transmissions, focusing on suppressing nonlinear degradation. We have experimentally confirmed their effectiveness for extending the transmission distance up to 9,000km in 40Gb/s-based WDM systems.

WA2 9:00am
25 GHz-spaced 10 Gbps x 160 channels, 3000 km E-LEAF transmission experiment by using dispersion management to mitigate XPM-induced waveform distortion,
Akira Miura, Fujitsu Labs. Ltd., Kawasaki, Japan; Toshiki Tanaka, Fujitsu Labs. Ltd., Kawasaki, Japan; Toru Katagiri, Fujitsu Labs. Ltd., Kawasaki, Japan; Masahiro Yuki, Fujitsu Labs. Ltd., Kawasaki, Japan; Takao Naito, Fujitsu Labs. Ltd., Kawasaki, Japan.
We quantitatively analyzed dispersion management to mitigate XPM-induced waveform distortion in a 25-GHz-spaced, 10-Gbps-based dense WDM transmission system using E-LEAF in L-band. Using a well-managed dispersion map, we achieved 1.6-Tbps, 100-km x 30-span transmission.

WA3 9:15am ►INVITED
Design of Nx40Gbit/s multi-terabit/s transmission systems assisted by simple analytical tools, *Sébastien Bigo, Alcatel Res. and Innovation, Marcoussis, France.*
We provide two analytical rules to optimally manage dispersion in Nx40Gbit/s systems, and thus contain nonlinearities. These rules proved helpful for extending the distance of a recent 5Tbit/s experiment from 1200 km to 1500 km.

WA4 9:45am
Jitter tolerance analysis on optical 3R regenerator, *Michiaki Hayashi, KDDI R&D Labs. Inc., Saitama, Japan; Tomohiro Otani, KDDI R&D Labs. Inc., Saitama, Japan; Hideaki Tanaka, KDDI R&D Labs. Inc., Saitama, Japan; Masatoshi Suzuki, KDDI R&D Labs. Inc., Saitama, Japan.*
Jitter tolerance of the 40 Gbit/s optical 3R regenerator was analyzed for wide range frequency according to ITU-T specification, for the first time. The tradeoff relation between jitter suppression and jitter tolerance was experimentally confirmed.

Location: Ginga Room
10:00am – 10:30am
Coffee Break

Location: Jurin Room
10:30am – 12:00pm
WB ■ New Materials and Ultrafast Dynamics
Hitoshi Kawaguchi, Yamagata Univ., Yonezawa, Japan, Presider.

WB1 10:30am ►INVITED
Ultrafast optical signal processing based on quantum-dot semiconductor optical amplifiers: Theory and experiment, *Mitsuru Sugawara, Nanoelec. Collaborative Res. Ctr., Inst.of Ind. Science, Univ. of Tokyo, Tokyo, Japan; Yasuhiko Arakawa, Nanoelec. Collaborative Res. Ctr., Inst. of Ind. Science, Univ. of Tokyo, Tokyo, Japan; Hiroji Ebe, Nanoelec. Collaborative Res. Ctr., Inst. of Ind. Science, Univ. of Tokyo, Tokyo, Japan; Nobuhiko Hatori, Nanoelec. Collaborative Res. Ctr., Inst. of Ind. Science, Univ. of Tokyo, Tokyo, Japan; Tomoyuki Akiyama, Fujitsu Labs. Ltd. and Fujitsu Ltd., Atsugi, Japan; Kohji Otsubo, Fujitsu Labs. Ltd. and Fujitsu Ltd., Atsugi, Japan; Yoshiaki Nakata, Fujitsu Labs. Ltd. and Fujitsu Ltd., Atsugi, Japan.*
This paper provides current status and prospects of quantum-dot semiconductor optical amplifiers, based on our pioneering work covering the proposal of their promising features, the quantum-dot optical device theory, experimental demonstrations, and the design and assembly of all-optical switching modules.

WB2 11:00am
Ultrafast cross-gain saturation dynamics measurements of SOAs using two-color pump-probe technique with supercontinuum optical pulses, *Takeo Katayama, Yamagata Univ., Yonezawa, Japan; Hitoshi Kawaguchi, Yamagata Univ., Yonezawa, Japan.*
We have measured the gain dynamics of wide gain-bandwidth SOAs using the two-color pump-probe technique with a few hundred-femtosecond optical pulses. The optical pulses were created from compressed supercontinuum optical pulses by optical filtering.

WB3 11:15am
1.3 µm travelling-wave GaInNAs semiconductor optical amplifier, *Jun-ichi Hashimoto, OITDA, Optoelectronics R&D Labs., Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Kenji Koyama, OITDA, Optoelectronics R&D Labs., Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Tsukuru Katsuyama, OITDA, Optoelectronics R&D Labs., Sumitomo Elec. Ind., Ltd.,Yokohama, Japan; Yasuhiro Iguchi, OITDA, Optoelectronics R&D Labs., Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Takashi Yamada, OITDA, Optoelectronics R&D Labs., Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Shigenori Takagishi, Optoelectronics R&D Labs., Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Masashi Ito, Optoelectonics R&D Labs. Sumitomo Elec. Ind., Ltd., Yokohama, Japan; Akira Ishida, OITDA, Cooperate R&D Sumitomo Elec. Ind., Ltd., Yokohama, Japan.*
Travelling-wave GaInNAs-SOA was realized for the first time. The peak chip gain of 14dB and 3-dB gain bandwidth of 49 nm were obtained. The Gain dependence of the GaInNAs-SOA on temperature was much smaller than that of the conventional InP-based-SOA.

WB4 11:30am ►INVITED
Linear and nonlinear characteristics of quantum dash SOAs, *Gadi Eisenstein, Technion, Haifa, Israel; Alberto Bilenca, Jr., Technion, Haifa, Israel; Robert Alizon, Technion, Haifa, Israel; Visorian Mikhelashvili, Technion, Haifa, Israel; Ruth Schwertberger, Univ. Wurzburg, Wurzburg, Germany; Dominic Gold, Univ. Wurzburg, Wurzburg, Germany; Johan P. Reithmaier, Univ. Wurzburg, Wurzburg, Germany; Alfred Forchel, Univ. Wurzburg, Wurzburg, Germany.*
This paper describes various properties of InP based quantum dash semiconductor optical amplifiers operating at 1550 nm. The unique properties of the imperfect inhomogeneous broadening of the gain spectrum will be highlighted.

12:00pm – 1:15pm
Lunch Break

Location: Jurin Room

1:15pm – 2:30pm

WC ■ Glass Material

Masashi Onishi, Sumitomo Elec. Ind., Ltd., Sakae-ku, Yokohama, Japan, Presider.

WC1 1:15pm

Transparent Cr^{4+}-doped gehlenite ($Ca_2Al_2SiO_7$) glass-ceramics for broadband amplifier, *Hiroshi Yamazaki, Graduate School of Human and Environmental Studies, Kyoto Univ., Kyoto, Japan; Setsuhisa Tanabe, Graduate School of Human and Environmental Studies, Kyoto Univ., Kyoto, Japan.*

A novel transparent Cr^{4+}-doped gehlenite ($Ca_2Al_2SiO_7$) glass-ceramics was developed. Cr^{4+} ions are selectively incorporated in gehlenite phase, showing a broad-band emission of 1.1~1.4 μm with higher intensity than in the corresponding as-quenched glass.

WC2 1:30pm

Novel Er^{3+}-doped glass-ceramics with extra-broad emission for S^+- and U-band amplifier, *Masayuki Nishi, Dept. of Material Chemistry, Graduate School of Eng., Kyoto Univ., Kyoto, Japan; Setsuhisa Tanabe, Faculty of Integrated Studies, Kyoto Univ., Kyoto, Japan; Koji Fujita, Dept. of Material Chemistry, Graduate School of Eng., Kyoto Univ., Kyoto, Japan; Kazuyuki Hirao, Dept. of Material Chemistry, Graduate School of Eng., Kyoto Univ., Kyoto, Japan.*

Er:YAG glass ceramics were developed in the CaO-Y_2O_3-Al_2O_3-SiO_2 system. The obtained glass ceramics showed much broader emission linewidth than the polycrystalline Er:YAG, whose infrared emission band extends to U-band with many separated sharp lines.

WC3 1:45pm

Spectroscopy of Er^{3+} doped antimony silicate glasses for broad-band amplifier, *Masafumi Onishi, Graduate School of Eng., Kyoto Univ., Kyoto, Japan; Setsuhisa Tanabe, Faculty of Integrated Studies, Kyoto Univ., Kyoto, Japan; Kazuyuki Hirao, Graduate School of Eng., Kyoto Univ., Kyoto, Japan.*

In Er^{3+}-doped antimony silicate glasses, no compositional dependence was observed for the Judd-Ofelt Ω_6 parameter and local phonon energy. These results suggest that the Er^{3+} ions are surrounded selectively by Sb_2O_3-rich phase.

WC4 2:00pm

1.6μm emission properties of Ho^{3+} in fluoride and chalcogenide glasses for U-band fiber-optic amplifiers, *Jong Heo, Pohang Univ. of Science and Tech., Pohang, Rep. of Korea; Tae Hoon Lee, Pohang Univ. of Science and Tech., Pohang, Rep. of Korea; Yong Gyu Choi, Elec. and Telecomm. Res. Inst., Daejon, Rep. of Korea; Bong Je Park, Elect. and Telecomm. Res. Inst., Daejon, Rep. of Korea; Kyong Hon Kim, Elec. and Telecomm. Res. Inst., Daejon, Rep. of Korea.*

Non-oxide glasses doped with Ho^{3+} were proposed for U-band amplification. Characteristic properties of the 1.6μm band emission from Ho^{3+} ion were investigated. Effect of Tb^{3+} co-doping on the population density and amplification properties were analyzed.

WC5 2:15pm

Nanoparticle doping process: Towards a better control of erbium incorporation in MCVD fibers for optical amplifiers, *Andre Le Sauze, Alcatel Res. and Innovation, Marcoussis, France; Christian Simonneau, Alcatel Res. and Innovation, Marcoussis, France; Alain Pastouret, Alcatel Res. and Innovation, Marcoussis, France; Daniel Gicquel, Alcatel Res. and Innovation, Marcoussis, France; Laurent Bigot, Lab. de Physico-Chimie des Matériaux Luminescents, Lyon, France; Samuel Choblet, Lab. de Physico-Chimie des Matériaux Luminescents, Lyon, France; Anne Marie Jurdyc, Lab. de Physico-Chimie des Matériaux Luminescents, Lyon, France; Bernard Jacquier, Lab. de Physico-Chimie des Matériaux Luminescents, Lyon, France; Dominique Bayart, Alcatel Res. and Innovation, Marcoussis, France; Laurent Gasca, Alcatel Res. and Innovation, Marcoussis, France.*

Germano-silica and alumino-silica Erbium Doped Fibers have been fabricated through a new Nanoparticles Doping process with MCVD technology. These fibers have been characterized in WDM amplification experiments in both C and L band.

Location: Ginga Room

2:30pm – 3:00pm

Coffee Break

Location: Jurin Room

3:00pm – 4:30pm
WD ■ Parametric Amplification and Four Wave Mixing

Morten Nissov, Tyco Telecomm., Eatontown, NJ, USA, Presider.

WD1 3:00pm ►INVITED
Recent progress in optical parametric amplifiers, *Stojan Radic, Bell Labs., Holmdel, NJ, USA; Colin J. McKinstrie, Bell Labs., Holmdel, NJ, USA.*
Advances in optical parametric amplification is reviewed. The properties of two-pump parametric amplifiers are discussed. Practical applications in wavelength conversion, all-optical signal regeneration and polarization invariant amplification are outlined. The limitations imposed by highly nonlinear fiber imperfections on two-pump amplifier design are analyzed.

WD2 3:30pm
Impact of the longitudinal variations of the chromatic dispersion on the gain of fiber parametric amplifiers, *Anne Legrand, Alcatel Res. and Innovation, Marcoussis, France; Christian Simonneau, Alcatel Res. and Innovation, Marcoussis, France; Dominique Bayart, Alcatel Res. and Innovation, Marcoussis, France; Arnaud Mussot, LOPMD, Besancon, France; Eric Lantz, LOPMD, Besancon, France; Thibaut Sylvestre, LOPMD, Besancon, France; Herve Maillotte, LOPMD, Besancon, France.*
We study experimentally the detrimental impact of longitudinal variations of chromatic dispersion on the gain of a broadband fiber optical parametric amplifier. Thanks to the optimization of the pump wavelength, a 3dB-gain bandwidth of 25nm is demonstrated using only 740mW pump power.

WD3 3:45pm
Optical fiber four-wave mixing using synchronous modulation with a single phase modulator, *Michinori Tani, Univ. of Tokyo, Tokyo, Japan; Shinji Yamashita, Univ. of Tokyo, Tokyo, Japan.*
Highly efficient Four-Wave Mixing (FWM) using synchronous modulation with a single phase modulator is proposed and successfully demonstrated. Wavelength conversion and chromatic dispersion compensation using the Mid-Span Spectral Inversion technique by FWM are also demonstrated successfully.

WD4 4:00pm
Raman gain enhancement through four-wave mixing in a microstructured photonic crystal fiber, *Frédérique Vanholsbeeck, Univ. Libre de Bruxelles, Brussels, Belgium; Philippe Emplit, Univ. Libre de Bruxelles, Brussels, Belgium; Stéphane Coen, Univ. Libre de Bruxelles, Brussels, Belgium.*
We demonstrate experimentally that four-wave mixing leads to a three-fold increase in the gain of Raman amplifiers based on photonic crystal fibers. Our work illustrates the influence of dispersion on the Raman gain.

WD5 4:15pm
Soliton self-frequency shift and compression of pulses at 10-GHz-repetition rate in a photonic crystal fiber, *Kazi S. Abedin, Ultrafast Photonic Network Group, Tokyo, Japan; Fumito Kubota, Ultrafast Photonic Network Group, Tokyo, Japan.*
Soliton self-frequency shift (SSFS) and simultaneous compression of mode-locked pulses at 10-GHz-repetition-rate are demonstrated in a photonic crystal fiber. We obtained sub-300 fs pulses up to 1.61micron from 1.4-ps pulses at 1.56 micron wavelength using 12-m-long highly nonlinear fiber.

Location: Jurin Room

4:45pm – 6:45pm
WE ■ Postdeadline Session