Poster Session I (Exhibition Hall / Wednesday, 26 August, 13:45~15:15)

[26P-1] Q-Switching of Yb:KLu(WO_4)$_2$ Lasers with Graphene Saturable Absorbers

J. M. Serres[1], P. Loiko, X. Mateos[1], K. Yumashev[2], V. Petrov, U. Griebner, M. Aguiló[1], and F. Díaz[1]

[1]Universitat Rovira I Virgili, Spain, [2]Belarusian National Technical University, Belarus, [3]Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy, Germany

A diode-pumped Q-switched Yb:KLu(WO_4)$_2$ mini-laser generated a maximum average output power of 170 mW at 1030 nm. The shortest pulse duration was 165 ns at a pulse repetition rate of 350 kHz.

[26P-2] Halide Gas-Phase-Doping Technique to Fabricate Large-Mode-Area Laser Fiber

Kun Peng[1,2], Yuying Wang[1], Li Ni[1], Zhen Wang[1,2], Cong Gao[1], Huan Zhan[2], Jianjun Wang[1], Feng Jing[1], and Aoxiang Lin[1]

[1]China Academy of Engineering Physics, China, [2]Chinese Academy of Sciences, China

By using rare-earth-halide gas-phase-doping technique, we fabricated Yb-doped large-mode-area fiber preform. Yb concentration is of ~9500ppmw in core area and 951W@1064nm laser output was obtained with a slope efficiency of 83.3%.

[26P-3] Diode-Pumped Kerr-Lens Mode-Locked Femtosecond Yb:YAG Ceramic Laser

Ziye Gao[1], Jiangfeng Zhu[1], Junli Wang[1], and Zhiyi Wei[2]

[1]Xidian University, China, [2]Chinese Academy of Sciences, China

We experimentally demonstrated a diode-pumped pure Kerr-lens mode-locked femtosecond laser based on a Yb:YAG ceramic. Pulses with 97 fs pulse width, 2.8 nJ pulse energy and 320 mW average power were obtained.

[26P-4] Diode-Pumped Mode-Locked Picosecond Nd,Y-Codoped:SrF_2 Laser

Václav Kubeček[1], Michal Jelínek[1], Miroslav Čech[1], David Vyhlídal[1], Liangbi Su[2], Dapeng Jiang[2], Fengkai Ma[2], Qian Zhang[2], Yuexin Cao[2], and Jun Xu[2]

[1]Czech Technical University in Prague, Czech Republic, [2]Chines Academy of Sciences, China

Passively-mode-locked operation of Nd,Y:SrF_2 laser pumped by low-power-laser-diode at 796 nm is reported. The continuous pulse train with total output power of 100 mW and pulse duration of 1.5 ps at 136 MHz was generated.

[26P-5] Numerical Study on Spectral Coherence of Noise-Like Pulses in a Fiber Ring Cavity Configuration

Youngchul Kwon, Seungjong Lee, Kyoungyoon Park, Dongyeul Lee, Luis Alonso Vazquez-Zuniga, and Yoonchan Jeong

Seoul National University, Korea

We numerically investigate the noise-like pulse (NLP) operation in a simply modelled fiber ring cavity. Under the different cavity conditions, we verify how the spectral coherence of the NLP is altered.

[26P-6] Wavelength-Selectable Visible Operation in a Miniature Crystalline Ramanlaser

Xiaoli Li

Beijing University of Technology, China

We demonstrate a miniature crystalline Raman laser operating at three discretely-tunable wavelengths in the green-yellow. Over 200 mW output powers were obtained for each wavelength with 3.8 W pumping. The threshold is below 0.4 W.

[26P-7] Investigation of Thermooptical Effects in a High-Brightness Yb:KGW Laser

J. Yang[1], G. H. Kim[1], B. Lee[1], E. G. Sall[1], S. A. Chizhov[1], V. E. Yashin[2], and U. Kang[1]

[1]KERI, Korea, [2]S. I. Vavilov State Optical Institute, Russia

The thermo-optical effects in the diode-end-pumped lasers with Yb:KGW anisotropic crystals is experimentally investigated. Strong dependence of optical power and aberrations of the lenses on orientation of laser crystals concerning a direction of laser radiation propagation and a polarization direction is confirmed. By optimizing the crystal configuration we obtained a high-power output laser beams with the high spatial quality M2 close to unit in Q-switched mode and at regenerative amplification of chirped pulses.

[26P-8] Tm,Ho:KLu(WO_4)$_2$ Microchip Laser Q-Switched by a Cr^{2+}:ZnS Saturable Absorber

P. Loiko[1], J. M. Serres[2], X. Mateos[2], K. Yumashev[1], V. Petrov[3], U. Griebner[3], M. Aguiló[2], and F. Diaz[2]

[1]Belarusian National Technical University, Belarus, [2]Universitat Rovira i Virgili, Spain, [3]Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy, Germany

A diode-pumped Tm,Ho:KLu(WO_4)$_2$ microchip laser Q-switched by a Cr^{2+}:ZnS saturable absorber generated average output power of 131 mW at 2061 nm. The shortest pulses had duration of 9 ns and energy of 10 µJ.

[26P-9] A Design of Symmetrically Phase-Shifted FBG Structures with Improved Transmission Characteristics for Dual-Wavelength Fiber Lasers

Xu Ou and Han Yishi

Guangdong University of Technology, China

An improved approach is presented for a two symmetrically phase shifted structure based on FBGs. A step-apodized profile is designed to raise the transmission of peaks, which can help lasing building in dual-wavelength fiber lasers.

[26P-10] The Feasibility of Multi-Wavelength Lasers Fabricated Using Femtosecond Laser Pulses

Yuwen Duan, Xi Chen, and Ru Zhang

Beijing University of Posts and Telecommunications, China

We discuss the feasibility of multi-wavelength lasers fabricated using femtosecond laser pulses. A stable and narrow linewidth (<10 pm) dual-wavelength waveguide laser with the spacing between two lasing wavelength of ~ 140 pm is reported.

[26P-11] Revisiting Low Frequency Fluctuations in High Power Multi-Mode Laser Diodes Subject to Filtered Optical Feedback

Fadwa Baladi[1], Min Won Lee[1], Jean-René Burie[2], Mauro A. Bettiati[2], Azzedine Boudrioua[1], and Alexis P. A. Fischer[1]

[1]Université Paris 13, France, [2]3S Photonics Technologies, France

A highly detailed and extended map of low frequency fluctuations is established for a high power multi-mode 980nm laser diode subject to filtered optical feedback from a fibre Bragg grating. The low frequency fluctuations limits and substructures exhibit substantial differences with previous works.

[26P-12] Double Cladding Dispersion Compensating Photonic Crystal Fiber with High and Birefirngence

Yong Soo Lee[1], Chung Ghiu Lee[2], and Soeun Kim[1]

[1]GIST, Korea, [2]Chosun University, Korea

We proposed double cladding photonic crystal fibers based on dual lattice structure which has high and flattened birefringence. Using double cladding structure of square lattice, high flat birefringence and negative flat dispersion can be achieved atthe same time over wide wavelength region including S, C and L bands.

[26P-13] Mode Analysis of Tunable Single Longitudinal Mode Tm-Doped Fiber Ring Laser

Jae-Keun Yoo[1,2], Sun Do Lim[1,2], and Seung Kwan Kim[1]

[1]KRISS, Korea, [2]Korea University of Science and Technology, Korea

Longitudinal modes of a tunable Tm-doped fiber ring laser with/without an unpumped Tm-doped fiber as a saturable absorption grating are analyzed using an all-fiber scanning ring resonator. Temporal characteristics of the laser are also discussed.

[26P-14] Efficient Sum-Frequency Generation of a Yb Fiber Laser and an Er, Yb Fiber Laser Using an External Resonant Cavity

J. H. Lee and J. W. Kim

Hanyang University, Korea

We report efficient sum-frequency generation of a Yb fiber laser at 1064 nm and an Er, Yb fiber laser at 1550 nm by employing a bow-tie resonant cavity system.

Poster Session I (Exhibition Hall / Wednesday, 26 August, 13:45~15:15)

[26P-15] Sub-10 ps, 700 kW Peak-Power Pulses from a Nonlinearly Compressed All-Fiber MOPA System

Ryutaro Yamashita[1], Kazuo Maeda[1], Goro Watanabe[1], Kazuyoku Tei[1], Shigeru Yamaguchi[1], Jun Enokidani[2], and Shin Sumida[2]

[1]Tokai University, Japan, [2]OPT-i Co., Ltd., Japan

We demonstrate sub-10-ps pulse generation by nonlinear compression of pulses from an all-fiber-MOPA. The architecture supports wide range in pulse width, 8 ps to 2 ns. The shortest pulse has 700 kW peak power and <0.15 nm line width.

[26P-16] High Power Monolithic Linearly Polarized Narrow Linewidth Single Mode Fiber Laser at 1064 nm

Wei Shi[1,4], Qiang Fang[2,3,4], Jingli Fan[1,2], Ting Qu[2,3], and Xiangjie Meng[2,3]

[1]Tianjin University, China, [2]Shangdong HFB Photonics Co., Ltd., China, [3]Tianjin Optera Laser Technology Co., Ltd., China, [4]Tianjin Institute of Modern Laser & Optics Technology, China

We report a high power, narrow linewidth, linearly polarized, MOPA based fiber laser at 1064.46 nm with 520W average power, 30 GHz linewidth, 18 dB polarization extinction ratio, 88.7% slope efficiency, and diffraction-limited beam quality.

[26P-17] 85-W 2015-nm Single-Frequency Thulium-Doped All-Fiber Laser Amplifier

Kyung-Hyun Lee[1,2], Yonghee Kim[3], Yong-Ho Cha[3], Gwon Lim[3], Hyunmin Park[3], Hyuck Cho[2], and Do-Young Jeong[3]

[1]Duchembio Institute, Korea, [2]Chungnam National University, Korea, [3]KAERI, Korea

We report on the development of 2015-nm single-frequency Thulium-doped fiber amplifiers. The average output power is 85 W, and the slope efficiency is 54%. The laser linewidth is 20 MHz.

[26P-18] Stable and Amplitude-Equalized Rational Harmonic Mode-Locked Short-Cavity Fiber Laser Using a Bismuth-Oxide-Based Highly Nonlinear Erbium-Doped Fiber

Yutaka Fukuchi and Akihiro Enda

Tokyo University of Science, Japan

We demonstrate a rational harmonic mode-locked fiber laser employing a 151-cm-long bismuth-oxide-based highly nonlinear erbium-doped fiber. The cavity length is as short as 6 m. Stable and amplitude-equalized short pulses up to 40GHz are obtained.

[26P-19] Flat Optical Frequency Comb Generation from an Actively Mode-Locked Short-Cavity Fiber Laser Using a Bismuth-Based Highly Nonlinear Erbium-Doped Fiber

Yutaka Fukuchi, Kouji Hirata, and Joji Maeda

Tokyo University of Science, Japan

We generate frequency comb from a 10-GHz actively mode-locked laser using a bismuth-based highly nonlinear erbium-doped fiber and an optical filter with a rectangular filter profile. Flat 20 comb lines within 3-dB variation are obtained.

[26P-20] Fluorescence Resonance Energy Transfer (FRET) in Random Dye Lasers

Wan Zakiah Wan Ismail[1,2,3], Ewa M. Goldys[1] and Judith M. Dawes[1,2]

[1]Macquarie University, Australia, [2]ARC Centre of Excellence for Ultrahigh Bandwidth Devices for Optical Systems, [3]Islamic Science University of Malaysia, Malaysia

We demonstrate the effect of fluorescence resonance energy transfer on the emission spectra and threshold of Rhodamine 6G / methylene blue / titania random lasers. Rhodamine 6G enhances the laser emission of methylene blue at ~700 nm.

[26P-21] Impact of Cascading on the Efficiency of External Cavity CW Raman Laser

Soumya Sarang, Robert J. Williams, Ondrej Kitzler, Aaron McKay, Hadiya Jasbeer, and Richard P. Mildren

Macquarie University, Australia

Factors affecting the output efficiency of an external cavity quasi-cw KYW Raman laser were investigated. We show that a major limit to efficiency, in addition to thermal effects, results from a cascading effect involving a secondary Raman mode of KYW at 87 cm^{-1}.

[26P-22] Temperature Rise Measurement from Lasing Spectrum in a Diode Pumped Yb:YAG Crystal

Won-Kyo Jung[1], Changhwan Lim[2], and Hee-Jong Moon[1]

[1]Sejong University, Korea, [2]KAERI, Korea

A temperature measurement scheme using spectral shift was applied to a diode end-pumped Yb:YAG laser with ~ 4 W pumping level. The temperature rise was ~ 90 °C at the input power of 3.3 W.

[26P-23] Study of Femtosecond Laser Pulse Induced Thermal Lensing Effect in CS_2

Yi-Ci Li, Yu-Ting Kuo, Po-Yuan Huang, and Tai-Huei Wei

National Chung Cheng University, Taiwan

We experimentally verified fs laser pulse induced thermal lensing effect in CS_2 with the Z-scan technique and explain this effect as a result of relaxation of stimulated Raman scattering excited libration.

[26P-24] Generation of Cubic-Quintic Nonlinear Strodinger Equation Dark Pulse

Zian Cheak Tiu[1,2], Harith Ahmad[2], and Sulaiman Wadi Harun[2]

[1]KDU University College, Malaysia, [2]University of Malaya, Malaysia

CQNLSE dark pulse is demonstrated in EDFL with NPR technique. Pulse repetition rate, pulse width, and highest pulse energy of the CQNLSE dark pulse are obtained at 1.52 MHz, 219 ns, and 0.59 nJ, respectively.

[26P-25] Transient Kerr Effect and Its Influence in a Nonlinear Photonic Crystal Nanocavity

Chao Li, Min Wang, Yong-Lu Hu, Dao-Liu Liu, and Jun-Fang Wu

South China University of Technology, China

We present an analytical model to investigate the dynamic features of the transient Kerr effect in a nonlinear photonic crystal microcavity, and the theoretical predictions agree perfectly with the proposed experimental results.

[26P-26] Numerical Analyses of All-Optical Retiming Switches Using Quasi-Phase Matched Lithium Niobate Waveguide Devices: Output Deterioration by Domain Length Error

Yutaka Fukuchi and Masaru Yamamoto

Tokyo University of Science, Japan

We analyze characteristics of all-optical retiming switches employing the cascaded second-order nonlinear effect in quasi-phase matched lithium niobate waveguides. The domain length error decreases the switching efficiency and causes significant deterioration of the output signal.

[26P-27] Various Soliton Molecules in Large Anomalous Dispersion Fiber Laser

Xiaoxiang Han and Xueming Liu

Chinese Academy of Sciences, China

Soliton molecules (SMs) induced by the spectral filtering with the phase difference of 0, π, π/2 and multiple separations are observed. It is found that the equilibrium distances of SMs are multiple and discrete.

[26P-28] Strong Modulation Instability and Ultra-short Pulse Train Generation in Silicon-organic Hybrid Slot Waveguide

Xianting Zhang[1], Jinhui Yuan[1,2], Zhe Kang[1], Xinzhu Sang[1], Feng Li[2], Chongxiu Yu[1], and P. K. Alexander Wai[2]

[1]Beijing University of Posts and Telecommunications, China, [2]The Hong Kong Polytechnic University, Hong Kong

We investigate the strong modulation instability at telecommunication band in a silicon-organic hybrid slot waveguide. The pulse train is obtained via pump pulses with pulse width of 10 ps and peak power of 250 mW.

Poster Session I (Exhibition Hall / Wednesday, 26 August, 13:45~15:15)

[26P-29] Bidirectional Soliton Spectral Tunneling Effects in the Regime of Optical Event Horizon

Jie Gu[1], Hairun Guo[2], Shaofei Wang[1], Xuekun Bai[1], Jun Yuan[1], and Xianglong Zeng[1]

[1]Shanghai University, China, [2]Technical University of Denmark, Denmark

We study the cross-phase-modulation-induced soliton spectral shifting in the regime of the optical event horizon. The perturbed soliton to either red-shifting or blue-shifting is controllable, which could evoke bidirectional soliton spectral tunneling effects.

[26P-30] Defect Solitons in Two-dimensional Gaussian Potential

Yang Zheng, Huijie Zhang, and Youwen Liu

Nanjing University of Aeronautics and Astronautics, China

We report on the existence and stability of defect solitons in 2D optical Gaussian potentials. The power of the defect solitons is a monotonic decreasing function of the propagation constant, and the existence domain expands when the defect gets deep. Fundamental solitons are stable in the entire existence domain regardless of the depth of the defect. Dipole solitons exhibit instability in most of the power region and the instability window expands with the depth of the defect.

[26P-31] Active Control of Nano Plasmonic Field Using a Few Cycle Laser Pulse

Sungho Choi, Ziaul Hoque, Seungchul Kim, and Dong-Eon Kim

POSTECH, Korea

In this study, we show that localized ultrafast plasmonic field of nano structure can be spectrally or spatially manipulated under excitation of few cycle pulse. By controlling geometrical parameters of nanostructure, plasmonic response can be actively tailored.

[26P-32] Refinement of Dispersion Relations in the VUV from Spectral Fringes in Non-Phase-Matched Second Harmonic Generation

Peter Trabs[1], Frank Noack[1], Aleksandr Aleksandrovsky[2], Alexandre Zaitsev[2], Nikita Radionov[2], and Valentin Petrov[1]

[1]Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy, Germany, [2]Russia and Siberian Federal University, Russia

Spectral fringes in the second harmonic of fs pulses under strong phase- and group-velocity mismatch are used to evaluate the refractive index of SrB4O7 down to 160 nm, essential for random quasi-phase-matching in the VUV.

[26P-33] CEP-stabilized Infrared Optical Parametric Amplifier with High Efficiency

Xiaotao Geng[1], Weijun Ling[1,2], Shuyan Guo[3], Zhiyi Wei[3], Ferenc Krausz[4,5], and DongEon Kim[1]

[1]POSTECH, Korea, [2]Tianshui Normal University, China, [3]Chinese Academy of Sciences, China, [4]Max-Planck-Institut for Quantum Optics, Germany, [5]Ludwig-Maximilians-Universit, Germany

A high efficiency, tunable, carrier-envelope-phase (CEP) stabilized optical parametric amplifier (OPA) is demonstrated with single crystal. We achieved a pump-tosignal conversion efficiency of 34% which is the highest conversion efficiency reported in broadband OPAusing two stages.

[26P-34] CEP-stable, Sub-6 fs, 300-kHz OPCPA System with an Average Power of more than 15 W

Yeon Lee[1], Stephan Prinz[2,3], Matthias Haefner[2], Catherine Yuriko Teisset[2], Robert Bessing[2], Knut Michel[2], Xiao Tao Geng[1], Seungchul Kim[1], Dong Eon Kim[1], Thomas Metzger[2,4], and Marcel Schultze[2]

[1]POSTECH, KOREA, [2]TRUMPF Scientific Lasers GmbH + Co. KG, German, [3]Technische Universität München, German, [4]Max-Planck-Institut für Quantenoptik, German

We report on a CEP-stable OPCPA system reaching multi-GW peak power at 300 kHz repetition rate. It delivers over 50 uJ of pulse energy and pulse duration below 6 fs. Power fluctuations < 1.5% was achieved including a pump-seed-synchronization.

[26P-35] Laser-driven Fast Electron Beam from the Solid Target for Ultrafast Electron Diffraction

Ye Tian and Jiansheng Liu

Shanghai Institute of Optics and Fine Mechanics, China

We have obtained stable collimated quasimonoenergetic electrons near the target specular direction. The fast electron pulse is prominent for the laser-driven fast electron diffraction source.

[26P-36] Ultrafast Interaction between Water-soluble Corrole and DNA

Hui Wang[1], Li-Li Wang[1], Lei Zhang[1], Hai-Yang Liu[2], and Liang-Nian Ji[1]

[1]Sun Yat-Sen University, China, [2]South China University of Technology, China

The interaction of the water-soluble Ga(III) corrole with calf thymus DNA via an outside binding mode has been studied by femtosecond transient absorption spectroscopy. The forward (kf > 6.41´1012 s-1) and back (kb ~ 2.35´1012 s-1) electron transfer processes have been observed.

[26P-37] Ultrafast Broadband Third-order Optical Nonlinearity of Silk Biopolymer

Byung Jic Lee, Hyunsoo Kwon, Fabrian Rotermund, and Sunghwan Kim

Ajou University, Korea

We report on ultrafast broadband third-order nonlinearity of silk, a newly and high-technologically reinvented biopolymer in optics and electronics. Z-scan and optical Kerr-gate measurements at various wavelengths were used to investigate third order susceptibilities of silk films.

[26P-38] Ultrafast Optical Modulation of Magnetization Orientation in TbFeCo/GdFeCo Coupled Bilayer

Zhifeng Chen, Xiaohui Fang, Bingzhi Zhang, Wenan Li, and Jun Peng

Guangzhou University, China

We study the optical modulation effect of magnetization orientation in TbFeCo/GdFeCo bilayer using pump-probe polar Kerr spectroscopy. The magnetization rotation is triggered by fs pulse, driven by exchange interaction, and occurs within ~300 ps.

[26P-39] Broadband Red Green Blue Light Source for Speckle Noise Reduction

Seong-Jin Son, Ju Won Choi, Do-Kyeong Ko, and Nan Ei Yu

GIST, Korea

We design the apodized aperiodic poled lithium niobate crystals that generated broadband red, green, blue light based on second harmonic generation for laser projection display. The spectral and temporal bandwidth are about 10nm. The broadband lightsources exhibited speckle noise free.

[26P-40] Insulator-to-semimetal Transition of Calcium Fluoride Induced by Optical Field

Ojoon Kwon and Dong Eon Kim

POSTECH, Korea

We studied response of calcium fluoride single crystal against intense optical field. It undergoes transition into semimetal, ensured by detecting optical-field-induced current. The transient conductivity jumps by 16 orders of magnitude within sub-femtosecond time scale.

[26P-41] Large Diameter Ceramic TGG Faraday Rotator for High-average-power Laser Systems

Hidetsugu Yoshida, Koji Tsubakimoto, Hisanori Fujita, and Noriaki Miyanaga

Oasaka university, Japan

A large diameter Faraday isolator for few kW laser systems was demonstrated using a TGG Faraday rotator compensated for thermal induced depolarization.

[26P-42] 300-W Spectral Beam Combination of Narrow-linewidth Pulsed Rod-type Fiber Lasers

Yong-Ho Cha, Gwon Lim, Yong-Hee Kim, Jae Sung Shin, and Do-Young Jeong

KAERI, Korea

We have demonstrated spectral beam combination of three narrow-linewidth pulsed rod-type fiber lasers with different wavelengths by using a multi-layer dielectric grating. The combined laser power is 300 W with a good beam quality.

Poster Session I (Exhibition Hall / Wednesday, 26 August, 13:45~15:15)

[26P-43] Computational Simulation Methodology for the Beam Quality of a High Power Zigzag Slab Laser

Jae Sung Shin[1], Yong Ho Cha[1], Byung Heon Cha[1], Hyeon Cheor Lee[2], and Hyun Tae Kim[2]
[1]KAERI, Korea, [2]Doosan DST, Korea

A computational simulation methodology for the beam quality of a high power zigzag slab laser has been developed. This methodology can predict the beam quality for the various optical arrangements and optimize the design effectively.

[26P-44] Generation of 30 mW CW Ultraviolet by a Two-path Geometry for Cascaded $\chi^{(2)}$ Processes with Periodically Poled Lithium Niobate Crystals

Yin-Kuang Yang[1], Chia-Lun Tsai[1], Jui-Yu Lai[1,2], Chen-Shao Hsu[2], Yen-Yin Lin[1], Chiang-Chung Fu[1], and Shang-Da Yang[1]
[1]National Tsing Hua University, Taiwan, [2]Hsinchu Science Park, Taiwan

30 mW continuous wave ultraviolet radiation is generated via a two-path geometry for cascaded frequency doubling and sum-frequency generation (SFG) at 18.9 W pump, where SFG is enabled by a third-order periodically poled $MgO:LiNbO_3$.

[26P-45] Investigation of Contamination Induced by Various Processes on Fused Silica Optics

Liu Hongjie, Huang Jin, Jiang Xiaodong and Zheng Wanguo
China Academy of Engineering Physics, China

We investigated contamination on fused silica optics with various processes by TOF-SIMS. The kinds and quantities of metal-impurities and their distribution as a function of depth from the surface are obtained.

[26P-46] Single Shot Third-order Cross-correlator for Ultra-high Intensity Laser

A. Kon, M. Nishiuchi, H. Kiriyama, K. Ogura, H. Sakaki, Y. Fukuda, M. Kando and K. Kondo
Japan Atomic Energy Agency, Japan

We have developed a multi-channel cross-correlator (MCCC) for single-shot measurement of temporal contrast of Peta-watt class laser pulse. We report experimental results with the MCCC system.

[26P-47] Generation of High Power High Quality Beam for Supersonic Laser Plasmatron

Victor Shulyatyev and Anatoly Orishich
Khristianovich Institute of Theoretical and Applied Mechanics, Russia

The results of development of the optical system for the repetition rate laser plasmaton are presented. A self filtering resonator is applied to form the high-quality beam at the high power short pulse Q-switching CO_2 laser. The system permits formingthe quasi-stable plasmoid in the supersonic air flow.

[26P-48] Development of 1 J, 100 Hz Yb:YAG Laser Amplifier System for OPCPA Pumping

Shigeki Tokita[1], Martin Divoky[2], SungIn Hwang[1], Koichi Iyama[3], Toshiyuki Kawashima[3], Hajime Nishioka[4], and Junji Kawanaka[1]
[1]Osaka University, Japan, [2]Institute of Physics, Czech Republic, [3]Hamamatsu Photonics K.K., Japan, [4]The University of Electro-Communications, Japan

We report on our progress in the development of a 1 J class Yb:YAG laser system with a repetition rate of 100 Hz for OPCPA pumping. We have demonstrated amplification of 10 ns pulses to 1 J at 100 Hz by using a multi-TRAM.

[26P-49] Pulse Stretching in a Narrow-band Yb:YAG Regenerative Amplifier using Transmission Gratings

Shigeki Tokita[1], SungIn Hwang[1], Toshiyuki Kawashima[3], Hajime Nishioka[2], and Junji Kawanaka[1]
[1]Osaka University, Japan, [2]Hamamatsu Photonics K. K., Japan, [3]The University of Electro-Communication Tokyo Japan, Japan

We report on our progress in the development of a highpulse-energy Yb:YAG laser system for OPCPA pumping. We have demonstrated generation of 160-ps chirped-pulses with a spectral bandwidth of 0.12 nm and a pulse energy of a few mJ by using a Yb:YAG regenerative amplifier inserting a transmission grating pair.

[26P-50] Fano Resonant Chiral Electromagnetic Fields by Metasurfaces

Seo Joo Lee, Seok Jae Yoo, Suyeon Lee, and Q-han Park
Korea University, Korea

We demonstrate for the first time that chiral electromagnetic fields display Fano resonance using nanohole metasurfaces. We show the nano-hole structure can be utilized as biosensors to detect chiral molecules.

[26P-51] Double Fano Resonances in a Composite Metamaterial Possessing Tripod Plasmonic Resonances

Yeon Ui Lee and Jeong Weon Wu
Ewha Womans University, Korea

Double Fano resonances are observed in a planar composite metamaterial possessing tripod plasmonic resonances, where a common subradiant driven oscillator is coupled with two superradiant oscillators. As a classical analogue of four-level tripod atomic system, the extinction spectrum of the composite metamaterial exhibits a coherent effect based on double Fano resonances. It is shown that a transfer of the absorbed power between two orthogonal superradiant oscillators is mediated by a common subradiant oscillator.

[26P-52] Active Control of On-chip Plasmonic Nanocavities by Two-plasmonic Absorption

Zhen Chai, Xiaoyong Hu, Hong Yang, and Qihuang Gong
Peking University, China

The tunable on-chip plasmonic coupled nanocavities are realized by two-plasmonic absorption of (SU-8)-co-(gold nanoparticles) composite film. Strong near resonance nonlinear absorption and localized field plasmonic can realize microwatts order pump tunability.

[26P-53] Low Propagation Loss in an Asymmetric Plasmonic Crystal Waveguide

Motoki Itou[1], Masashi Fukuhara[1,2], Masashi Ota[1], Asahi Sumimura[1], Yuya Ishii[1], and Mitsuo Fukuda[1]
[1]Toyohashi University of Technology, Japan, [2]Japan Society for the Promotion of Science, Japan

We present a promising design for low-loss asymmetric plasmonic crystal waveguides. The plasmonic crystal consists of Au cylinders, and the waveguide is introduced by eliminating a single line of cylinders on Au metal.

[26P-54] Designing Whispering Gallery Modes via Transformation Optics

Yushin Kim[1], Soo-Young Lee[2], Jung-Wan Ryu[2], Inbo Kim[2], Jae-Hyung Han[2], Heung-Sik Tae[2], Muhan Choi[2], and Bumki Min[1]
[1]KAIST, Korea, [2]Kyungpook National University, Korea

Transformation optics suggest a novel way to control the propagation of light. By applying it to resonant optical cavity, we restore the whispering gallery mode in an optical cavity of deformed boundary.

[26P-55] Giant Electric Field Enhancement in a Multilayered Dipole Nano-antenna

Evgeny Mironov[1,2], Abdul Khaleque[1], Liming Liu[1], and Haroldo Hattori[1]
[1]UNSW Australia, Australia, [2]Australian National University, Australia

We investigate the electric field enhancement in multilayered dipole nano-antenna and show that the combination of Au/SiO2 layers taken at a 50% filling factor can produce extremely high field enhancements in the order of 17.9.

[26P-56] All-semiconductor Optical Microcircuit Board

Li Min and Lirong Huang
Huazhong University of Science and Technology, China

A low-loss all-semiconductor metamaterial-based optical circuit board with optical inductors, capacitors, insulators and conductors at the microscale is proposed, which can always hold band-stop filtering function for various polarized waves.

Poster Session I (Exhibition Hall / Wednesday, 26 August, 13:45~15:15)

[26P-57] Graphene Plasmonic Metamaterials to Manipulate Infrared Light

Chao Zeng, Xueming Liu, and Jing Guo

Xi'an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences, China

Two and three dimensional graphene plasmonic metamaterials are proposed and investigated to manipulate infrared light. The gradient-index lenses are implemented to focus, collimate, and guide the surface plasmon waves. High-contrast electro-optic modulator is also conceived.

[26P-58] Resolving the Optical Modulation Mechanism of Graphene-hybridized Plasmonic Metamaterials

Lei Zhu, Zhonghui Nie, Yongbing Xu, and Frank Wang

Nanjing University, China

Optical modulation characterisitics of graphene hybridized plasmonic metamaterials is investigated. It is revealed that resonance peak transmission can be effectively tuned by the applied gate voltage, suggesting an electroabsorption modulation (EAM) mechanism.

[26P-59] Optimization of Lorentz Model Parameters for Crystalline As_2S_3, SiC and Modified Lorentz Model Parameters for Nanocrystalline SiO

Mehedi Islam, Md. Nazmul Islam, Monzurul Islam, Md. Ghulam Saber, and Rakibul Hasan Sagor

Islamic University of Technology, Bangladesh

We have presented the optimized Lorentz model parameters for crystalline arsenic sulfide (As_2S_3), silicon carbide (SiC) and modified Lorentz model parameters for nanocrystalline silicon monoxide (SiO) obtained using a large scale non-linear algorithm. The complex relative permittivity calculated using the optimized parameters agree well with the experimental values over broad frequency bands. The associated RMS deviations are 0.254, 0.003, 0.010 and 0.009 respectively.

[26P-60] Metamaterial-based Light Diffuser with Deep-subwavelength Thickness

Jong Uk Kim and Jonghwa Shin

KAIST, Korea

Metamaterial based angular light diffuser with deep subwavelength thickness is proposed. It consists of metallic strips with randomized width and separations. We numerically demonstrate that metamaterial diffuser exhibits light diffusion angles comparable to conventional, thick diffusers.

[26P-61] Magnetic Response Based on Deep Subwavelength Nonmagnetic Metallic Structures

Minsung Heo and Jonghwa Shin

KAIST, Korea

We proposed the nonmagnetic metallic coil-plate array to manipulate the magnetic resonance caused by an inductor capacitor circuit resonance in microwave range. The effect of geometrical parameters on the magnetic response is studied.

[26P-62] Bowtie-shaped Hole Array for Fiber-optic Refractive Index Sensing in Telecom-wavelengths

Hang-Eun Joe[1], Farid Ahmed[2], Martin B.G. Jun[2], and Byung-Kwon Min[1]

[1]Yonsei University, Korea, [2]University of Victoria, Canada

Array of bowtie-shaped holes is proposed to develop a fiber-optic refractive index sensor. Reflection spectra in telecom-wavelength range around 1.3 μm and 1.55 μm obtained by FDTD simulations are analyzed to design and evaluate its performance.

[26P-63] Surface-Plasmon Sensor in Photonic Crystal Fiber

Jung-Sheng Chiang, Yong-Hang Wu, Syuan-Yu Jhang, and Nai-Hsiang Sun

I-Shou University, Taiwan

We analyze the surface-plasmon sensor of photonic crystal fiber by the finite element method. The photonic crystal fiber sensor with the thin-film of copper corresponds to the resonance wavelength 750 nm.

[26P-64] Three-Dimensional Plasmonic Ruler Based on Silver Metal Blocks

Tae-Woo Lee, Da Eun Lee, Yung Jin Lee, and Soon-Hong Kwon

Chung-Ang University, Korea

We introduce a three-dimensional plasmonic ruler based on silver metal double nano-blocks. Two resonant modes show different wavelength dependences on x- or y-directional shift of blocks, which enables the measurement of spatial position with nanometer resolutions.

[26P-65] Energy Harvesting with Black Si/plasmonics Composite Material

Ryosuke Komatsu[1], Armandas Balcytis[2,3], Gediminas Seniutinas[2,3], Yoshiaki Nishijima[1], and Saulius Juodkazis[2,3]

[1]Yokohama National University, Japan, [2]Swinburne University of Technology, Australia, [3]The Australian National Fabrication Facility ANFF, Australia

The photo-thermo electrical conversion system using black silicon and gold nanoparticles have been suggested for energy harvesting. Efficient light absorption with black silicon and plasmonic photo-thermal energy conversion was successfully improving the energy conversion efficiency of light. Totally ~50% of improvements has been achieved with optimization of Au nanoparticles diameters and density.

[26P-66] Heterogeneous Three-Dimensional Assembly of Metamaterials and Metadevices by Modular Transfer Printing

Seungwoo Lee[1], Byungsoo Kang[1], Hohyun Keum[2], Alaa Alokaily[2], Hyun-Sung Park[1], Numair Ahmed[2], John A. Rogers[2], Placid M. Ferreira[2], Seok Kim[2], and Bumki Min[1]

[1]KAIST, Korea, [2]University of Illinois, Urbana Champaign, USA

A metamaterial transfer printing method done by adhesion switching of viscoelastic stamp is presented. 3-D stack of heterogeneous material can be built at a desired position regardless of target substrate even on cheese.

[26P-67] Three-dimensional Sub-5-nm-gap Plasmon Antenna Printed on the Apex of Optical Fiber

Seung Ju Yoon, Hongchul Sim, Myung-Ki Kim, and Yong Hee Lee

KAIST, Korea

We demonstrate fiber-integrated three-dimensional sub-5-nm-gap plasmon antennas by employing proximal milling and micro-transfer printing techniques. The photons are extremely confined in a volume of $10^{-7}\ \lambda^3$ and efficiently couple to a single-mode optical fiber.

[26P-68] Whispering Gallery Mode Biosensor Detection Using Nanopost Structures

Seunghun Lee and Kyujung Kim

Pusan National University, Korea

High-quality (Q) factor whispering gallery mode biosensor which detects wavelength shift induced by biomolecules can be amplified by introduction of nanostructures. We demonstrate molecule detection by localized WGM field on nanopost structures.

[26P-69] Simulation of Improved Sensitivity of Whispering Gallery Modes Sensor by Nanostructure Chip

Taeyoung Kang and Kyujung Kim

Pusan National University, Korea

We simulated Whispering Gallery Mode (WGM) sensor that is highly sensitive enough to detect unlabeled single molecule and method of improving sensitivity using nano structure chip.

[26P-70] Effect of DC Power on Alternative Plasmonic Materials Fabrication with Room Temperature High-power Impulse Magnetron Sputtering

Zih-Ying Yang[1], Yi-Hsun Chen[1], Bo-Huei Liao[2], and Kuo-Ping Chen[1]

[1]National Chiao Tung University, Taiwan, [2]National Applied Research Laboratories, Taiwan

TiN thin films were prepared using magnetron sputtering. When the power increases from 80W to 300W, the conductivity rises to 16.8 times, and the plasma frequency is blue-shifted from 515 nm to 460 nm.

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[26P-71] Polarization Independent Terahertz Metamaterial Filters Based on Combinatory Array of Crosses and Mesh Network

Dongju Kim, Muhammad Tayyab Nouman, Soyeon Kim, Kyejeong Lee, and Jae-hyung Jang
GIST, Korea

Design of a polarization independent bandpass filter based on cross and two dimensional wire lattice metamaterial is presented. Introducing wires among the dipoles transforms its bandstop characteristics to bandpass characteristics. By applying aboveprinciple to cross shaped metamaterials a polarization independent bandpass characteristic is demonstrated.

[26P-72] Plasmonic Vortex Lens with Distributed Nanoslits for Arbitrary Tuning of Vortex Size

Gun-Yeal Lee, Seung-Yeol Lee, and Byoungho Lee
Seoul National University, Korea

A tunable plasmonic vortex lens (PVL) that can adjust the size of vortex by changing optical polarization is proposed. The tunable PVL provides a novel degree of freedom in managing surface plasmon polariton fields.

[26P-73] Tunable Polarizer Based on Graphene Nanoantennas at Terahertz Wave Band

Yi Cheng Tang, Zhi Hong Zhu, Jian Fa Zhang, Chu Cai Guo, Ken Liu, Xiao Dong Yuan, and Shi Qiao Qin
National University of Defense Technology, China

We theoretically and numerically demonstrate that a transmission-type electrically tunable polarizer can be realized using graphene nanoantennas supported on a dielectric film with a graphene sheet behind. The polarization mechanism originates from the antenna plasmon resonance of graphene stripes. The results of fullwave numerical simulations reveal that transmittance of 0.70 for one polarization and 0.0073 for another polarization can be obtained at normal incidence. The transmission-type electrically tunable polarizer provides and facilitates kinds of applications, including filtering, detecting, and imaging.

[26P-74] Enhanced Optical Torque on Planar Metal-insulator-metal Cavity Structured Gammadion

Sun-Je Kim, Kyookeun Lee, Yohan Lee, Hyeonsoo Park, and Byoungho Lee
Seoul National University, Korea

Novel planar metal-insulator-metal cavity structured gammadion is suggested. It is shown that the proposed gammadion can exhibit 8 times higher optical torque under spin-less normally incident light compared to the previous work.

[26P-75] Complex Modulation by One-Port Absorbing Structure in Plasmonic MIM Waveguide

Hyeonsoo Park, Seong-Yeol Lee, and Byoungho Lee
Seoul National University, Korea

We present a sub-micron sized complex modulator. It consists of a magnetic dipole resonant absorbing structure and Fabry-Perot resonator. Additional wave retardation in the resonator gives full modulation of reflected light.

[26P-76] Electrically Tunable Polarizer Based on Pattern-free Graphene

C. Ye, Z. Zhu, W. Xu, X. Yuan, and S. Qin
National University of Defense Technology, China

We theoretically demonstrate that an electrically tunable polarizer can be obtained using a pattern-free graphene monolayer supported on a periodical dielectric array.

[26P-77] Dielectric Environment Affects Photoinduced Voltage in Nanoporous Gold Thin Film

Marjan Akbari and Teruya Ishihara
Tohoku University, Japan

We report an experimental study of photoinduced voltage in nanoporous gold film with/without dielectric infiltration under the radiation of obliquely incident nanosecond laser light in visible frequencies.

[26P-78] Waveguiding of Spoof Surface Plasmon Polaritons

Seong-Han Kim[1], Sang Soon Oh[2], Kap-Joong Kim[3], and Chul-Sik Kee[1]
[1]GIST, Korea, [2]Imperial College London, UK, [3]ETRI, Korea

We numerically and experimentally demonstrate subwavelength scale waveguiding of spoof surface plasmon polaritons at a line defect in a two-dimensional groove metal array that exhibits a band gap region.

[26P-79] Single Line Waveguide inside Ho^{3+}-doped Chalcogenide Glass Inscribed by Femtosecond Laser

Junli Wang[1], Borong He[1], Jiangfeng Zhu[1], Zhiyi Wei[1,2], and Shixun Dai[3]
[1]Xidian University, China, [2]Chinese Academy of Sciences, China, [3]Ningbo University, China

We inscribed a single mode waveguide with the minimum propagation loss of 1.58 dB/cm at 1030nm inside the Ho^{3+}-doped chalcogenide glass by femtosecond laser. The inscribing parameters are 0.4 μJ pulse energy and 90 μm/s translation speed.

[26P-80] Ablation Detph Control on ITO Using Beam Shaped Femtosecond Laser

Hoon-Young Kim[1,2] and Sung-Hak Cho[1,2]
[1]KIMM, Korea, [2]Korea University of Science and Technology, Korea

We report on the ablation depth control with a resolution of 40 nm on indium tin oxide (ITO) thin film using a square beam shaped femtosecond (190 fs) laser (λ p = 1030 nm). A slit is used to make the square, flat top beam shaped from the Gaussian spatial profile of the femtosecond laser. An ablation depth of 40 nm is obtained using the single pulse irradiation at a peak intensity of 2.8 TW/cm^2. The morphologies of the ablated area are characterized using an optical microscope, atomic force microscope (AFM), and energy dispersive X-ray spectroscopy (EDS). Ablations with square and rectangular types with various sizes are demonstrated on ITO thin film using slits with varying x-y axes. The stereo structure of the ablation with the depth resolution of approximately 40 nm is also fabricated successfully using the irradiation of single pulses with different shaped sizes of femtosecond laser.

[26P-81] Analysis of Laser Induced Oxidation Processes with Different Laser Powers

Feng Xia[1], Xinzheng Zhang[1], Meng Wang[1,2], Sanming Yi[1], Qian Liu[2], and Jingjun Xu[1]
[1]Nankai University, China, [2]National Center for Nanoscience and Technology, China

Metal-transparent-metallic-oxide (MTMO) grayscale photomasks fabricated by laser-induced oxidization are studied based on three stages oxidation theories and absorbed laser power density distribution. The calculated fabrication diameter is consistent with the experimental fabrication size.

[26P-82] Ultrashort Laser Ablation for Hydrophilic Surface

Munju Bae[1], Jiyeon Park[1], BinhX. Cao[1], Hyonkee Sohn[1], Cheon-Seog Rim[2], and Jiwhan Noh[1]
[1]KIMM, Korea, [2]Hannam University, Korea

The hydrophilic property of the surface with the microsize spikes was tested. Water drops were placed on the micro-spikes to measure the contact angle, which was 10° while that of the surface without micro spikes was 80°. This shows that a surface can be processed to be hydrophilic with laser ablation.

[26P-83] Maximization of the Ablation Rate of Metal, Semiconductor and Dielectric with a MHz Repetition Rate Ultrafast Laser

Mirae Lim, Yonghyeon Kim, Hyonkee Sohn, Dongsig Shin, and Jiyeon Choi
KIMM, Korea

Maximization of the ablation rate of various materials was investigated by optimization of ultrafast laser parameters. The optimized parameters were used to engrave metal roles for micron-sized pattern transfer of conductive ink to flexible substrates.

[26P-84] Nd:YLF Waveguide Laser Fabricated by Second-Harmonic Femtosecond Laser Pulses

Takuya Sato, Yusuke Yamanaka, Kenichi Hirosawa, and Fumihiko Kannari
Keio University, Japan

Channel waveguides are fabricated in a Nd:YLF crystal with 400-nm femtosecond laser pulses, and the laser oscillation at 1047 nm pumped by an 800-nm laser is demonstrated.

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[26P-85] Fabrication of Micro Lens Shape Array Using Picosecond Laser

Jiyeon Park, Munju Bae, BinhX. Cao, Hyonkee Sohn, and Jiwhan Noh

KIMM, Korea

In this paper, we fabricated a convex-lens-shaped microstructure with a diameter of 50 um on a metallic mold substrate using a laser ablation process. The fabricated convexlens-shaped microstructure on the metallic substrate can be used as the mold for the micro lens or superhydrophobic/hydrophilic surface.

[26P-86] 1-μm Periodical Grating Structure on Stainless Steel Designed by High-power Nanosecond Pulsed Fiber Lasers

Shaoxiang Chen, Seongwoo Yoo, Perry Ping Shum, Xiaohui Li, Meng Liu, Yukun Ma, and Qi Jie Wang

Nanyang Technological University, Singapore

Nanosecond-pulsed, Yb-doped fibre laser has been used to create laser induced periodic surface structure on the surface of stainless steel. Grating periodic structure for visible light with distance of 1 μm is demonstrated and explained.

[26P-87] Holographic Optical Element for Solar Concentrators Using Photopolymer

Jeong Hyeon Lee, Jong-Chan Kim, Jae Wook Jeong, and Nam Kim

Chungbuk National University, Korea

In this study, the holographic optical element for solar concentrators using photopolymer was proposed. For this, we fabricated the holographic solar condensing lens which has maximum efficiency. To add sun tracking function, we performed the angular multiplexing.

[26P-88] Pulsed Laser Sintering for Fabricating Indium Tin Oxide Thin Films

Jeonghong Ha and Dongsik Kim

POSTECH, Korea

A direct excimer laser sintering process and a novel laser-induced plasma sintering process were developed for fabricating Indium Tin Oxide (ITO) thin films from wetcoated ITO nanoparticles.

[26P-89] Laser-induced Spray Jet Cleaning for Nanoscale Contaminant Removal Using Water-isopropyl Alcohol Mixtures

Changho Seo and Dongsik Kim

POSTECH, Korea

In this work, we demonstrate a novel laser-induced spray jet cleaning process using non-water cleaning agents including isopropyl alcohol. The process could remove <30 nm PSL particles from silicon surfaces without watermark generation.

[26P-90] Laser Fabrication of Micro-lens Array on Fused Silica

Ik-Bu Sohn[1,2], Hun-Kook Choi[1,2], Young-Jun Jeong[1], Young-Chul Noh[1], Jae-Hee Sung[1], Seong-Ku Lee[1], Tae-Moon Jeong[1], and Jin-Tae Kim[2]

[1]GIST, Korea, [2]Chosun University, Korea

We fabricated micro-lens array on fused silica glass using femtosecond and CO_2 laser. We micro-machined periodic micro-grooves on the glass surface with femtosecond laser, and polished the patterned surface with CO_2 laser. We confirmed that curvature was formed on the surface by heat from the CO_2 laser beam as the surface roughness was removed. Depending on the fabricated pattern size, we could fabricate micro-lens array with controlling sizes. Using such this laser fabrication technique, we have demonstrated micro-lens array with various dimension.

[26P-91] Bessel Beam Scanning without Mechanical Scanner

Maria Eloisa Ventura, Paul Leonard Atchong Hilario, Giovanni Tapang, and Caesar Saloma

University of the Philippines, Philippines

We demonstrate motionless Bessel beam scanning with a spatial light modulator (SLM). The scanning control was emulated in the SLM by adding a grating phase or chirp phase to translate the beam transversely or axially.

[26P-92] A Single Chip White Light In GaN/GaN Quantum Well Microfacets Using Selective Area Epitaxy

Guofeng Yang[1], Zhenlong Wu[2], and Peng Chen[2]

[1]Jiangnan University, China, [2]Nanjing University, China

A monolithic color synthesis method based on InGaN/GaN multiple quantum wells (QWs) grown on GaN microstripes formed by selective area epitaxy on SiO2 mask patterns is demonstrated. The stripe microfacet structure is composed of (0001) and {11-22} planes, attributing to surface polarity and surface energy. InGaN/GaN QWs on different microfacets contain spatially inhomogeneous composition are due to the diffusion of adatoms among the facets. The unique property allows microfacet QWs emits blue light from the {11-22} plane and yellow light from the top (0001) plane, of which the luminescence reveals white due to the dual color mixing.

[26P-93] Power-loss Mechanisms in Surface Passivated AlGaN/AlN/GaN Heterojunctions

Engin Tiras[1], Gokhan Atmaca[2], Sefer Bora Lisesivdin[2], Sukru Ardali[1], T. Malin[3], V. Mansurov[3], and K. Zhuravlev[3]

[1]Anadolu University, Turkey, [2]Gazi University, Turkey, [3]Siberian Branch of Russian Academy of Sciences, Russia

The surface passivation effect on the power-loss mechanisms in AlGaN/AlN/GaN heterostructures was investigated. The electron temperatures of hot electrons was obtained from the temperature and the applied electric field dependencies of the Hall mobility.

[26P-94] Effect of Nanometer Sized Ni-dot/Ag/Pt Metal on White Light Emitting Diodes

Myoung Gyun Suh[1] and Kyu Sang Kim[2]

[1]California Institute of Technology, USA, [2]Sangji University, Korea

Ni-dot/Ag/Pt metal coating films were incorporated in InGaN blue light emitting diodes as p-type reflection metal to enhance the extraction efficiency of blue light. For the reflectivity change from 84% to 93.7%, the optical output power of blue light before phosphor coating and the luminous flux white light after phosphor deposition have improved by 49.3% and 58.2% at the current of 350 mA, respectively.

[26P-95] Consideration of Number of via Holes for High Efficiency GaN Based VI-LED Design

Gil Jun Lee[1], Yu-Jung Cha[1], Seung-Kyu Oh[1], Hyung-Jo Park[2], Tak Jeong[2], and Joon Seop Kwak[1]

[1]Sunchon National University, Korea, [2]Korea Photonics Technology Institute, Korea

This study examined the electrical and optical characteristics of GaN–based vertical-injection lightemitting diodes (VI-LEDs) with various numbers of via holes.

[26P-96] Modification of Spontaneous Emission Rate in GaN-based Nanorod LED Structures Investigated by FDTD Simulations

Guen-Hwan Ryu and Han-Youl Ryu

Inha University, Korea

The characteristics of modifications in spontaneous emission (SE) from GaN-based nanorod light-emitting diode structures are numerically investigated using finite-difference time-domain methods. It is found that the SE rate can be enhanced by >6 timesin optimized structures.

[26P-97] Analysis of the Characteristics with Increasing the Number of QWs for Near-Ultraviolet LEDs

Hyo-Shik Choi and Jong-In Shim

Hanyang University, Korea

This paper reports the analysis of the near-ultraviolet light-emitting-diodes (NUV LEDs) characteristics with increasing the number of QWs from 5 to 7 by same growth process. By means of optical, electrical characterization and carrier rate equationanalysis, we show that the NUV LEDs performances were improved with increasing the number of QWs by decreasing the non-radiative recombination rate.

[26P-98] Localized Surface Plasmon Resonance from Pt-based Split Ring Structures

Kyung Rock Son, Byeong Ryong Lee, Tae Hoon Park, Kyeong Heon Kim, and Tae Geun Kim

Korea University, Korea

We fabricated split ring (SR) nanostructures to enhance the interaction with resonant photons caused by an excitation of localized surface plasmon resonance (LSPR) in the deep-ultraviolet region. Also, the effect of SR diameter size and split gap angle on the coherent plasmon coupling was investigated in 2D arrays of Pt based SR. The absorption resonance of the fabricated Pt-based SR depends on its diameter, and shifts toward shorter wavelength for the SR with larger diameter.

Poster Session I (Exhibition Hall / Wednesday, 26 August, 13:45~15:15)

[26P-99] Various Metal-doped ITO as Transparent conductive Electrode for Near-ultraviolet Light Emitting Diodes

Min Ju Kim, Ju Hyun Park, Dong Su Jeon, Tae-Ho Lee, and Tae Geun Kim

Korea University, Korea

We fabricated under various metal doped indium tin oxide (ITO) transparent conductive electrodes (TCE) for use in near-ultraviolet (NUV) light emitting diodes (LEDs). The role of metal is to improve the transmittance especially in NUV region and current spreading of ITO. The ITO/metal (Ti, Ga, Ge, Al) TCEs (annealed at 550°C, 1 min) exhibit 90.5 ~ 94.7% transmittance at 385 nm on the quartz substrate and the sheet resistance is ranged from 23.2 to 73.5 Ω/□ on the NUV LED wafer.

[26P-100] Low-Frequency Noise Characteristics of InGaN-Based Light-Emitting Diodes

Chan-Hyoung Oh, Dong-Pyo Han, Dong-Soo Shin, and Jong-In Shim

Hanyang University, Korea

We investigate the low-frequency noise characteristics of InGaN-based light-emitting diodes with different forward leakage currents. It is found that the low-frequency noise characteristics are closely correlated with the forward leakage current.

[26P-101] U-shape Phenomenon in the Efficiency-versus-current Curves in AlGaN-based Deep-ultraviolet Light-emitting Diodes

Junhyuk Park[1], Guan-Bo Lin[2], Dong Yeong Kim[1], Jong Won Lee[1], Jaehee Cho[3], E. Fred Schubert[2], and Jong Kyu Kim[1]

[1]POSTECH, Korea, [2]Rensselaer Polytechnic Institute, USA, [3]Chonbuk National University, Korea

The efficiency of an AlGaN deep-ultraviolet light emitting diode with peak emission wavelength of 285 nm is investigated as a function of current over a wide range of temperatures (110K to 300K). We find that the efficiency-versus-current curve exhibits unique and distinct features over the entire temperature range including three points of inflection, a u-shape phenomenon which the efficiency increases again after the minimum, and higher low temperature efficiency than room-temperature efficiency at high-current density regime.

[26P-102] Influence of Aging on the Characteristics of Near-Ultraviolet LEDs

Hyo-Shik Choi, Jong-In Shim, and Won-Jin Choi

Hanyang University, Korea

We analyzed the influence of a current aging on 380 nm band near-ultraviolet light-emitting diodes with different current densities. Aging have been carried out on LEDs with current densities of 5, 35 and 50 A/cm^2 at room temperature for 1000 h. After stressed, both optical and electrical characteristics of LEDS are getting worse as increasing aging current density. We suggest that the possible degradation mechanism of characteristics is increase of the non-radiative (NR) recombination of LEDs due to generation of NR recombination centers in active regions after a current aging.

[26P-103] Investigations on Correlation between Photoluminescence Images of an LED Epi-wafer and Characteristics of LED Chips

Jongseok Kim[1], Hyung Tae Kim[1], Seungtaek Kim[1], Hoon Jeong[1], In-Sung Cho[2], Min Soo Noh[2], and Hyundon Jung[3]

[1]KITECH, Korea, [2]Soft-Epi, Korea, [3]Etamax Co., Korea

Photoluminescence (PL) imaging is employed in order to inspect InGaN/GaN LED epi-wafers. The image shows a map of integrated PL intensity over the wafer and dark spots with degraded luminescence properties. Dark spots with various sizes indicate areas with nonradiative defects showing that the nonradiative recombination coefficient increases with the size. The PL images are compared with data obtained from LED chips on the wafer after fabrication process. The characterization results for LED chips show that most of the chips fabricated on the dark spots have degraded properties. The result indicates that PL imaging of epi-wafers could be an inspection tool to predict properties of LED chips.

[26P-104] Shadow Excitation of Nanoneedles: Roguing Localization and Strain Effects from Photoluminescence

Hyeong-Yong Hwang[1], Hoonil Jeong[1], Hyun-Jun Baek[2], Gyu-Chul Yi[2], Hyoung-Chan Kim[3], and Young-Dahl Jho[1]

[1]GIST, Korea, [2]Seoul National University, Korea, [3]National Fusion Research Institute, Korea

In order to pinpoint the spatially resolved role of strain, localization, and quantum confinement (QC) in tapered nanoneedles (NNs), angle-resolved photoluminescence (PL) was adapted as a function of temperature.

[26P-105] Dopant-dependent Chemical Wet Etching Phenomena of Semipolar (11-22) GaN Film

Jiyeon Park and Sung-Nam Lee

Korea Polytechnic University, Korea

Wet etching properties of semipolar (11-22) GaN films are investigated by using the different dopants, such as Si and Mg. A trigonal prism cell structure with a (0001) c-plane and the next-nearest-neighbor {10-10} m-planes is formed by KOH wet etchant. Etching rate of semipolar (11- 22) Si-doped GaN film was faster than Mg-doped and undoped GaN. Regardless of dopants, the etching rate increased with etching depth.

[26P-106] Study of the Ideality Factor of Blue Light-Emitting Diodes Using the Photovoltaic Characteristics

Jae-Hoon Ham[1], Chan-Hyoung Oh[1], Dong-Pyo Han[1], Hyunsung Kim[1], Jong-In Shim[1], Dong-Soo Shin[1], and Kyu-Sang Kim[2]

[1]Hanyang University, Korea, [2]Sangji University, Korea

We investigate the diode ideality factors obtained from the photovoltaic characteristics and compare them with the ones from the conventional current-voltage characteristics. By eliminating the series resistance in the bulk region, the ideality factors from the photovoltaic measurements can give more accurate information on the recombination processes and the defects in the active quantum wells.

[26P-107] Experimental Separation of Injection and Radiative Efficiencies in InGaN/GaN Light Emitting Diodes

Nan-Cho Oh[1], Tae-Soo Kim[1], Youngboo Moon[2], and Jung-Hoon Song[1]

[1]Kongju National University, Korea, [2]UJL Inc, Korea

The carrier injection efficiency (CIE) and the radiative efficiency (RE) are experimentally determined in order to clarify the origin of the efficiency droop in blue-emitting GaN light emitting diodes. The difference in the shape of RE curves and the external quantum efficiency (EQE) curves shows the CIE is a function of the injection current, while the RE curves show the droop behavior to a certain degree. The experimentally determined CIE is significantly lower than unity and decreases with the current density, indicating that imperfect carrier injection has strong effects on the efficiency droop. Through our analysis, we conclude that both an intrinsic component, such as Auger recombination, and current leakage component exist and make notable contributions to the total EQE droop. These two components can be quantitatively separated through our proposed method. In addition, the result above is also comparatively investigated with the result of time-resolved electroluminescence (TREL) spectroscopies. The obtained CIE and RE consistently explain the behavior of TREL at various current density levels.

[26P-108] Carrier Overflow in InGaN/GaN Light-Emitting Diodes Investigated by Temperature-Dependent Short-Circuit Current Characteristics

Dong-Kuk Youn, Gyeong Won Lee, Dong-Soo Shin, and Jong-In Shim

Hanyang University, Korea

The temperature dependence of the short-circuit current in the InGaN/GaN multiple-quantum-well light-emitting diode is investigated. From the experiments, we demonstrate that the carrier overflow to the p-GaN clad occurs more severely with decreasing temperature, resembling the behavior of the efficiency droop and the open-circuit voltage.

[26P-109] Quantitative Analysis of Carrier Escape Efficiency in GaN-Based Light-Emitting Diodes

Seung-Hyuk Lim, Young-Ho Ko, and Yong-Hoon Cho

KAIST, Korea

Internal quantum efficiency, non-radiative efficiency in the active region, and efficiency of carrier escape out of the active region in InGaN-based light-emitting diode are deduced by comparison between open- and short-circuit photoluminescence experiments.

[26P-110] Effect of the p-type GaN Thickness on the Near-Ultraviolet Light-emitting Diodes

Hyo-Shik Choi, Jong-In Shim, and Dong-Soo Shin

Hanyang University, Korea

We analyzed the influence of the p-type GaN layer thickness on the 380nm band near-ultraviolet light-emitting diodes. Both electrical and optical characteristics of the LEDs were getting worse p-type GaN layer thickness increases with growth time. We suggest that the possible degradation mechanisms of characteristics are due to the increase of the non-radiative (NR) recombination rate in the active region as a result of thermal damage during p-type GaN layer growth process.

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[26P-111] Strong Correlation Between Efficiency and Carrier Recombination Processes in Efficiency Droop of GaN Based Light-emitting Diodes

Yang Seok Yoo[1], Jong Ho Na[2], Sung Jin Son[2], and Yong Hoon Cho[1]
[1]KAIST, Korea, [2]LG Innotek, Korea

We present strong correlation between efficiency droop and carrier recombination rate variation in GaN based light-emitting diodes. And we analyze effect of radiative and nonradiative recombination processes under current injection without assuming any theoretical model.

[26P-112] Efficiency analysis of AlGaN deep UV-LEDs based on rate equation

Joosun Yun[1], Hideki Hirayama[1], and Jong-In Shim[2]
[1]RIKEN, Japan, [2]Hanyang University, Korea

Efficiencies of 280nm AlGaN Deep UV-LEDs are extracted based on carrier rate equation. The results point out that hole density in p-type cladding layer is one of the important factor for efficiency droop phenomena.

[26P-113] Design Principles of Ultra High Transmittance Dielectric/Metal/Dielectric Electrodes

Jin-Young Na, Han-Kyeol Lee, Yoon-Jong Moon, and Sun-Kyung Kim
Kyung Hee University, Korea

We designed a high-transmittance dielectric/Ag/ITO electrode for high-efficiency GaN-based light-emitting diodes by using the scattering matrix method. The optimized multilayer dielectric/Ag/ITO electrode yielded a transmittance of > 0.90 with an approximately 10-nm-thick Ag layer.

[26P-114] Optimization of AlN Substrate Geometry for AlGaN-based Deep-Ultraviolet Light-Emitting Diodes

Manabu Taniguchi[1,2], Guo-Dong Hao[1], Kousei Nakaya[1], and Shin-Ichiro Inoue[1,2]
[1]National Institute of Information and Communications Technology, Japan, [2]Kobe University, Japan

Light extraction efficiency (LEE) in deep-ultraviolet light emitting diodes with AlN substrate was investigated using Ray Tracing method. The results showed that LEE was dramatically improved by optimizing the sidewalls angle and AlN thickness.

[26P-115] Direct Mapping of Strain State in Nonpolar InGaN/GaN Multilayers Using Dark-field Inline Electron Holography

Ja Kyung Lee[1], Kyung Song[1], Christoph T. Koch[2], Woo Young Jung[1], Dmitry Tyutyunnikov[2], Jong Kyu Kim[1], Chan Gyung Park[1], Peter A. Van Aken[3], and Sang Ho Oh[1]
[1]POSTECH, Korea, [2]Ulm University, Germany, [3]Max-Planck Institute for Intelligente Systeme, Germany

Two-dimensional strain in a nonpolar InGaN/GaN quantum well was measured quantitatively using inline electron holography. A periodic undulation of the strain was observed to arise to compensate otherwise diverging potential associated with the in-plane polarization.

[26P-116] Injection-Locked Dual Fabry-Perot Laser Diodes for Interferometric Noise Suppression

Sang-Hwa Yoo, Myeonggyun Kye, Quoc-Hoai Tran, and Chang-Hee Lee
KAIST, Korea

We propose and demonstrate a reduction of mode partition noise of an F-P LD using a fiber-based Mach-Zehnder interferometer (MZI). Injection-locked dual F-P LDs suppress polarization dependence to reduce a noise power by 3-dB.

[26P-117] Global Performance Investigation of Composite Pulses in Atom Interferometry

Yukun Luo, Shuhua Yan, Jun Yang, Qingqing Hu, Aiai Jia, Chunhua Wei, and Guochao Wang
National University of Defense Technology, China

We theoretically analyzed the global performance of composite pulses on compensating off-resonance effects in atom interferometry. Results suggest emphasis be drawn on the necessity of a uniform phase response.

[26P-118] Optical and Optomechanical Design of Multiscale Gigapixel Camera System

Hyeong-Woo Joo, Hee-Joon Moon, Yeon-Chan Choi, Ho-Kwan Kang, and Cheon-Seog Rim
Hannam University, Korea

As reported in Nature journal, the super resolution gigapixel camera of Duke University was highlighted on June, 2012 from Wall Street Journal and mass media. According to the reports, Duke gigapixel camera system was developed with big grant for the purpose of military operation and surveillance under the supports of DARPA because of the needs of US military. And this gigapixel camera is expected to promote new big market in the area of national defense and vision technology in the near future. In this paper, optical structural study was first proceeded to make a sense of whole optical ray mechanism so that the lens system could be optimized effectively by utilizing the data from structural study. And we also studied optomechanical designfor building whole camera system.

[26P-119] A Bragg Diffraction-based Atomic Gravimeter

Qingqing Hu, Jun Yang, Shuhua Yan, Yukun Luo, Aiai Jia, Chunhua Wei, and Guochao Wang
National University of Defense Technology, China

We presented a Bragg diffraction-based atomic gravimeter, which is able to increase the gravity measurement sensitivity significantly compared with the common Raman atomic gravimeter. We also discussed its advantages and difficulties.