Printed with permission of The Institute of Pure and Applied Physics (IPAP)
JAPANESE JOURNAL OF APPLIED PHYSICS [Part2]

Abstracts of Express Letters

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L307-L310
Part 2, No. 14, 25 April 2007

Influence of High Temperature in the Growth of Low Dislocation Content AlN Bridge Layers on Patterned 6H-SiC Substrates by Metalorganic Vapor Phase Epitaxy

Krishnan Balakrishnan, Akira Bandoh[1], Motoaki Iwaya, Satoshi Kamiyama, Hiroshi Amano, and Isamu Akasaki

(Received March 3, 2007; accepted March 11, 2007; published online March 30, 2007)

A novel high temperature metalorganic vapor phase epitaxy (MOVPE) growth of AlN bridge layer is reported. Positive influence of high temperature on the growth rate and reduction of dislocation content in the AlN bridge layer has been observed. Transmission electron microscopy, X-ray diffraction, and atomic force microscopy analyses confirmed that the layer had high structural quality and smooth morphology.
[DOI : 10.1143/JJAP.46.L307]

Keywords: high temperature metal organic vapor phase epitaxy, aluminum nitride, bridge layer growth, transmission electron microscopy

21st Century Center-of-Excellence (COE) Nano-Factory, Meijo University, 1-501 Shiogamaguchi, Tempaku-ku, Nagoya 468-8502, Japan
1 Corporate R&D Center, Showa-Denko K.K., 1-1-1 Ohodai, Midori-ku, Chiba 267-0056, Japan

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L311-L313
Part 2, No. 14, 25 April 2007

Lead-Free Piezoelectric (K,Na)NbO_3 Thin Films Derived from Metal Alkoxide Precursors

Yoshifumi Nakashima, Wataru Sakamoto, Hiroshi Maiwa[1], Tetsuo Shimura, and Toshinobu Yogo

(Received February 9, 2007; accepted March 8, 2007; published online March 30, 2007)

Lead-free piezoelectric $K_{0.5}Na_{0.5}NbO_3$ thin films for microelectromechanical systems were fabricated via chemical solution process using metal alkoxide. Perovskite $K_{0.5}Na_{0.5}NbO_3$ (KNN) single-phase thin films with good leakage current properties were successfully prepared by optimizing the $K_xNa_xNbO_3$ ($x \geqq 0.5$) composition of the precursor solution. The KNN thin films prepared from the solution with $K_{0.55}Na_{0.55}NbO_3$ composition showed typical ferroelectric *P–E* hysteresis and field-induced strain loops. The $2P_r$ and $2E_c$ values of the $K_{0.55}Na_{0.55}NbO_3$ films were 14 μC/cm^2 and 140 kV/cm, respectively. From the slope of the field-induced butterfly loop, the effective d_{33} was found to be 46 pm/V.
[DOI : 10.1143/JJAP.46.L311]

Keywords: $K_{0.5}Na_{0.5}NbO_3$, thin film, chemical solution deposition, ferroelectric property, piezoelectric property

Division of Nanomaterials Science, EcoTopia Science Institute, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan
1 Department of Materials Science and Engineering, Shonan Institute of Technology, 1-1-25 Tsujido-Nishikaigan, Fujisawa, Kanagawa 251-8511, Japan

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L314-L316
Part 2, No. 14, 25 April 2007

Development of a Taste Sensor Based on a Carbon Nanotube-Polymer Composite Material

Takamichi Hirata, Keisuke Takagi, and Masahiro Akiya

(Received February 26, 2007; accepted March 15, 2007; published online March 30, 2007)

A taste sensor consisting of a back-gate type field effect transistor (FET) chip based on carbon nanotube compound materials [poly(ethylene glycol) (PEG)-grafted single-walled carbon nanotubes (PEG-SWNTs)] was developed. The results of impedance measurements for five tastes (sourness, saltiness, bitterness, sweetness, and umami), are shown much difference for specific tastes which are difficult to identify by using Langmuir–Blodgett (LB) film. Moreover, the sensor is able to distinguish most of the experimental taste materials with a short response time (~60 s).
[DOI : 10.1143/JJAP.46.L314]

Keywords: taste sensor, PEG-grafted SWNTs

Department of Electronics and Communication, Musashi Institute of Technology, Tokyo 158-8557, Japan

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L339-L341
Part 2, No. 15, 25 April 2007

Photoluminescence Imaging of Multicrystalline Si Wafers during HF Etching

Hiroki Sugimoto* and Michio Tajima

(Received February 14, 2007; accepted March 20, 2007; published online April 6, 2007)

Rapid characterization of multicrystalline Si wafers was demonstrated by photoluminescence (PL) imaging with the wafers immersed in a HF solution. Highly spatially-resolved PL images were obtained within 1 s by the present technique. We found that the PL intensity from the HF-dipped wafers increased two orders of magnitude higher than that from wafers without the HF immersion. We examined the effects of the HF concentration on the surface property, and concluded that 5% HF etching was the most appropriate surface treatment. Temporal variations of PL intensity after the HF etching were also investigated. The intensity immediately decreased within 1 min after the etching, which indicated that no sooner had the wafer been taken from the HF solution than the surface defects dramatically increased. These findings showed clearly that PL imaging during HF etching is a powerful tool for characterizing the accurate bulk property.
[DOI : 10.1143/JJAP.46.L339]

Keywords: photoluminescence, PL, imaging, multicrystalline Si, solar cells, HF etching, surface treatment

Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan
* E-mail address: sugimoto@isas.jaxa.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L342-L344
Part 2, No. 15, 25 April 2007

Atomically Stepped Glass Surface Formed by Nanoimprint

Yasuyuki Akita, Takahiro Watanabe, Wakana Hara, Akifumi Matsuda, and Mamoru Yoshimoto
(Received March 13, 2007; accepted March 22, 2007; published online April 6, 2007)

We investigated atomic-scale surface modifications of silicate glass by nanoimprint using an atomically stepped sapphire (α-Al_2O_3 single crystal) plate as nanopattern mold. The sapphire mold had regularly arranged straight atomic steps, with uniform height and terrace width of about 0.2 and 80 nm, respectively. During pressing, vertical positions of the sapphire mold and glass plate significantly affected the morphology of the imprinted glass surface. The nanopattern was transferred to the glass surface when the mold was set on the glass plate, while the nanowave pattern was formed on the glass surface when the glass plate was set on the mold. [DOI : 10.1143/JJAP.46.L342]

Keywords: oxide glass nanoimprint, nanowave, imprint, oxide glass, sapphire

Department of Innovative and Engineered Materials, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology, 4259-R3-6 Nagatsuta-cho, Midori-ku, Yokohama 226-8503, Japan

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L345-L347
Part 2, No. 15, 25 April 2007

Color Control and White Emission of Organic Light-Emitting Device by External Light

Koichi Sakaguchi, Masayuki Chikamatsu, Yuji Yoshida, Reiko Azumi, and Kiyoshi Yase
(Received March 16, 2007; accepted March 23, 2007; published online April 6, 2007)

Color control and white emission of organic light-emitting device by external light irradiation was achieved by employing an opto-electronic gate out of titanyl phthalocyanine and two emission layers that emit complimentary color of each other. The recombination site in the device can be tuned by intensity of external light. Without laser irradiation, holes and electrons recombine mainly at the blue emission layer, thus only a blue emission is observed. On the other hand, electroluminescent peak around 560 nm increases by laser irradiation: the emission color is continuously and reversibly varied from blue to orange via white.
[DOI : 10.1143/JJAP.46.L345]

Keywords: organic light-emitting device, color control, color variable, titanyl phthalocyanine, white emission

Photonics Research Institute, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki 305-8565, Japan

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L389-L391
Part 2, No. 17, 25 May 2007

Preparation of a Freestanding AlN Substrate by Hydride Vapor Phase Epitaxy at 1230°C Using (111)Si as a Starting Substrate

Yoshinao Kumagai[1,*], Toru Nagashima[1,2], and Akinori Koukitu[1]
(Received March 31, 2007; accepted April 6, 2007; published online April 20, 2007)

A freestanding (0001)AlN substrate with a thickness of 112 µm was successfully prepared by hydride vapor phase epitaxy (HVPE) of AlN at 1230°C on a (111)Si starting substrate and subsequent removal of the Si substrate using a chemical etchant. The AlN substrate was transparent and displayed a smooth surface without cracks. Plan-view transmission electron microscopy (TEM) observations at the top surface of the AlN substrate revealed that an average dislocation density of $3 \times 10^9 cm^{-2}$ was achieved. The dislocations were found to run inclined from the direction of growth. The AlN substrate exhibited a near-band-edge emission at 209.4 nm in the room-temperature photoluminescence spectrum.
[DOI : 10.1143/JJAP.46.L389]

Keywords: AlN substrate, thick AlN layer, hydride vapor phase epitaxy, HVPE, (111)Si substrate, freestanding

1 Department of Applied Chemistry, Tokyo University of Agriculture and Technology, 2-24-16 Naka-cho, Koganei, Tokyo 184-8588, Japan
2 Research and Development Division, Tokuyama Corporation, Shibuya Konno Bldg., 3-3-1 Shibuya, Shibuya-ku, Tokyo 150-8383, Japan
* E-mail address: 4470kuma@cc.tuat.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L392-L395
Part 2, No. 17, 25 May 2007

Ion Beam Deposition Technique for Fabricating Luminescent Thin Films from a Solution of Nanocrystalline Semiconductor Dots

Satoshi Kobayashi*, Yuki Tani, and Hiroshi Kawazoe[1]
(Received March 27, 2007; accepted April 5, 2007; published online April 20, 2007)

We report a new technique for fabricating organic-free luminescent thin films from solution-synthesized surfactant-capped nanocrystalline semiconductor quantum dots with a core/shell structure. Colloidal solutions of CdSe/ZnS nanocrystals with diameters of 2.1 to 5.1 nm were made into ion beams and deposited on polycrystalline substrates under high vacuum; we applied the ion beam direct deposition technique with an electrospray ionizer, supersonic jet emitter, and energy analyzer. The nanocrystalline structure was preserved in the thin films; the photoluminescence spectra were identical to those of the source solution, although the thin films were essentially surfactant- and solvent-free.
[DOI : 10.1143/JJAP.46.L392]

Keywords: quantum dot, ion beam, deposition, electrospray, thin film, luminescence, cadmium selenide, zinc sulfide

R&D Center, HOYA Corporation, 3-3-1 Musashino, Akishima, Tokyo 196-8510, Japan
1 Emeritus Professor, Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8550, Japan
* E-mail address: satoshik@sngw.rdc.hoya.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L396-L398
Part 2, No. 17, 25 May 2007

Organic Field Effect Transistors Using Composites of Semiconductive Polymers and Single-Walled Carbon Nanotubes

Jun Tsukamoto*, Junji Mata, and Tatsuya Matsuno
(Received March 23, 2007; accepted April 4, 2007; published online April 20, 2007)

We fabricated organic field effect transistors (FETs) using semiconductive polymers incorporating small amounts of single-walled carbon nanotubes (SCNTs) as an active layer. Poly(3-hexyl-thiophene) (P3HT) and poly(3,3″-dioctyl-terthiophene) (PDTT) were used as matrix semiconductive polymers. The mobility of the FETs was increased by more than two orders of magnitude maintaining high on–off ratios of over 10^5 by incorporation of SCNTs into the polymers. Uniform dispersion of SCNTs into the semi-conductive polymers was essential for this enhancement of FET mobility, which was attained by use of SCNTs wrapped with P3HT ("SCNT-complex"). [DOI : 10.1143/JJAP.46.L396]

Keywords: carbon-nanotube, semiconductive polymer, organic FET, mobility, dispersion

Electronic and Imaging Materials Research Laboratories, Toray Industries, Inc., 3-2-1 Sonoyama, Otsu, Shiga 520-0842, Japan
* E-mail address: jun_tsukamoto@nts.toray.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L399-L401
Part 2, No. 17, 25 May 2007

Millimeter-Thick Single-Walled Carbon Nanotube Forests: Hidden Role of Catalyst Support

Suguru Noda*, Kei Hasegawa, Hisashi Sugime, Kazunori Kakehi, Zhengyi Zhang[1], Shigeo Maruyama[1], and Yukio Yamaguchi
(Received March 22, 2007; accepted April 7, 2007; published online April 20, 2007)

A parametric study of so-called "super growth" of single-walled carbon nanotubes (SWNTs) was done by using combinatorial libraries of iron/aluminum oxide catalysts. Millimeter-thick forests of nanotubes grew within 10 min, and those grown by using catalysts with a thin Fe layer (about 0.5 nm) were SWNTs. Although nanotube forests grew under a wide range of reaction conditions such as gas composition and temperature, the window for SWNT was narrow. Fe catalysts rapidly grew nanotubes only when supported on aluminum oxide. Aluminum oxide, which is a well-known catalyst in hydrocarbon reforming, plays an essential role in enhancing the nanotube growth rates.
[DOI : 10.1143/JJAP.46.L399]

Keywords: single-walled carbon nanotubes, vertically aligned nanotubes, combinatorial method, growth mechanism

Department of Chemical System Engineering, School of Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
1 Department of Mechanical Engineering, School of Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
* E-mail address: noda@chemsys.t.u-tokyo.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L402-L404
Part 2, No. 17, 25 May 2007

Epitaxial Assembly Involved in Growth of $BaTiO_3$ Nanocrystals under Hydrothermal Condition

Naoki Iwaji, Ryosuke Tanaka, and Makoto Kuwabara*
(Received March 20, 2007; accepted March 31, 2007; published online April 20, 2007)

Epitaxial assembly involved in the formation of aggregates of single-crystalline barium titanate ($BaTiO_3$) nanoparticles under hydrothermal condition is reported. The aggregates of $BaTiO_3$ nanocrystals were synthesized by heating a mixture of barium hydroxide, $Ba(OH)_2$, and titanium tetra-iso-propoxide, $Ti(O^iC_3H_7)_4$, with a molar ratio of 1.1 : 1 resolved in water–ethanol solutions at 150 °C for 2 h in autoclaves. The volume ratio of water/ethanol used as the solvent gives a significant influence on the amount of organic components contained in the precipitates after the reaction completed; a pure water solution left much organic components in the obtained $BaTiO_3$ nanoparticles aggregates, whereas a 1:1 (in volume ratio) water–ethanol solution yielded aggregates of $BaTiO_3$ nanoparticles with little organic components. Transmission electron microscopy (TEM) analyses provide definite evidence for the occurrence of epitaxial assembly of more than hundred $BaTiO_3$ nanocrystals with sizes of 40–60 nm into an aggregation possessing crystallographically single-crystalline nature during the crystal growth under the hydrothermal condition. [DOI : 10.1143/JJAP.46.L402]

Keywords: epitaxial assembly, barium titanate, nanocrystal, crystal growth

Department of Applied Science for Electronics and Materials, Kyushu University, 6-1 Kasuga Koen, Kasuga, Fukuoka 816-8580, Japan
* E-mail address: kuwabara@asem.kyushu-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L420-L422
Part 2, No. 18, 25 May 2007

Back Contact Dye-Sensitized Solar Cells

Nobuhiro Fuke, Atsushi Fukui, Yasuo Chiba, Ryoichi Komiya, Ryosuke Yamanaka, and Liyuan Han*
(Received March 28, 2007; accepted April 13, 2007; published online April 27, 2007)

A new structure for dye-sensitized solar cells (DSCs) was proposed in which the transparent conducting oxide (TCO) is omitted and the cathode is located on the opposite side of the titanium dioxide (TiO_2) film surface to the side of light irradiation. DSCs with this structure are called back contact DSCs (BCDSCs). The structure and fabrication of the cathode of BCDSCs was investigated in comparison with silicon solar cells. BCDSCs with conversion efficiency of 7.1% were achieved by vacuum deposition of the cathode directly onto the TiO_2 film, suggesting that BCDSCs can function as effective solar cells with potentially increased efficiency due to the omission of the TCO.
[DOI : 10.1143/JJAP.46.L420]

Keywords: dye-sensitized solar cell, back contact, internal resistance, TiO_2 film, porous cathode

New Technology Development Center, Sharp Corporation, 282-1 Hajikami, Katsuragi, Nara 639-2198, Japan
* Corresponding author. E-mail address: han.liyuan@sharp.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L444-L445
Part 2, No. 19, 25 May 2007

Semipolar ($10\bar{1}\bar{1}$) InGaN/GaN Laser Diodes on Bulk GaN Substrates

Anurag Tyagi*, Hong Zhong, Roy B. Chung, Daniel F. Feezell, Makoto Saito, Kenji Fujito[1], James S. Speck, Steven P. DenBaars, and Shuji Nakamura

(Received April 9, 2007; accepted April 17, 2007; published online May 11, 2007)

The first semipolar nitride laser diodes (LDs) have been realized on low extended defect density semipolar ($10\bar{1}\bar{1}$) GaN bulk substrates. The LDs were grown by conventional metal organic chemical vapor deposition (MOCVD). Broad area lasers were fabricated and tested under pulsed conditions. Lasing was observed at a duty cycle of 0.025% with a threshold current density (J_{th}) of 18 kA/cm^2. Stimulated emission was observed at 405.9 nm with a full width at half maximum (FWHM) of less than 0.3 nm. [DOI : 10.1143/JJAP.46.L444]

Keywords: semipolar, ($10\bar{1}\bar{1}$) plane, InGaN, laser diode, GaN bulk substrate

Materials Department and Electrical and Computer Engineering Department, University of California, Santa Barbara, CA 93106, U.S.A.
1 Optoelectronics Laboratory, Mitsubishi Chemical Corporation, 1000 Higashi-Mamiana, Ushiku, Ibaraki 300-1295, Japan
* E-mail address: anurag@ece.ucsb.edu

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L446-L447
Part 2, No. 19, 25 May 2007

Discharge Produced Plasma Extreme Ultra-Violet Source with Hollow Cathode

Nobuaki Oshima, Toru Kimura, and Weihua Jiang
(Received January 17, 2007; accepted April 17, 2007; published online May 11, 2007)

A pinch plasma has been formed by using a hollow inner electrode with negative polarity. Extreme ultra-violet (EUV) emission was detected from this pinch plasma. The diagnostic results were compared with that obtained with a part of outer electrode was covered with insulator. It is found that the discharge initiated between the hollow cathode and the grounded outer electrode without a creeping discharge. The hollow cathode pinch discharge was operated with energy of ~8.5 J/pulse, indicating potential application for compact EUV source.
[DOI : 10.1143/JJAP.46.L446]

Keywords: extreme ultra-violet, discharge produced plasma, pulsed power, hollow cathode, plasma focus

Extreme Energy-Density Research Institute, Nagaoka University of Technology, 1603-1 Kamitomioka-cho, Nagaoka, Niigata 940-2188, Japan

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L477-L479
Part 2, No. 20, 25 June 2007

New High-B_s Fe-Based Nanocrystalline Soft Magnetic Alloys

Motoki Ohta* and Yoshihito Yoshizawa
(Received March 27, 2007; accepted March 29, 2007; published online May 18, 2007)

The magnetic properties and microstructures of newly developed Fe–Cu–B and Fe–Cu–Si–B alloys produced by melt-spinning have been studied. The annealed alloys consist of nanoscale grains. The annealed alloys show a high-saturation magnetic flux density B_s of more than 1.8 T and excellent soft magnetic properties such as a low core loss of about 0.3 W/kg at 50 Hz and 1.5 T ($P_{15/50}$). For the present alloys, the addition of Cu is effective for the formation of nanoscale grains and the improvement of the soft magnetic properties. [DOI : 10.1143/JJAP.46.L477]

Keywords: soft magnetic materials, nanocrystalline, high-saturation magnetic flux density, Fe-based amorphous alloy, low core loss, melt quenching

Advanced Electronics Research Laboratory, Hitachi Metals, Ltd., 5200 Mikajiri, Kumagaya, Saitama 360-0843, Japan
* E-mail address: motoki_ohta@hitachi-metals.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L503-L505
Part 2, No. 21, 25 June 2007

A Vertical Insulated Gate AlGaN/GaN Heterojunction Field-Effect Transistor

Masakazu Kanechika*, Masahiro Sugimoto[1], Narumasa Soejima, Hiroyuki Ueda, Osamu Ishiguro, Masahito Kodama, Eiko Hayashi, Kenji Itoh, Tsutomu Uesugi, and Tetsu Kachi
(Received April 17, 2007; accepted May 10, 2007; published online May 25, 2007)

We fabricated a vertical insulated gate AlGaN/GaN heterojunction field-effect transistor (HFET), using a free-standing GaN substrate. This HFET has apertures through which the electron current vertically flows. These apertures were formed by dry etching the p-GaN layer below the gate electrodes and regrowing n^--GaN layer without mask. The HFET exhibited a specific on-resistance of as low as 2.6 mΩ·cm^2 with a threshold voltage of -16 V. This HFET would be a prototype of a GaN-based high-power switching device. [DOI : 10.1143/JJAP.46.L503]

Keywords: AlGaN, GaN, heterojunction, heterostructure, field-effect transistor (FET), insulated gate, vertical, GaN substrate

Toyota Central R&D Laboratories, Inc., Nagakute-cho, Aichi 480-1192, Japan
1 Toyota Motor Corp., 543 Kirigahora, Nishihirose-cho, Toyota, Aichi 470-0309, Japan
* E-mail address: e1005@mosk.tytlabs.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L525-L527
Part 2, No. 22, 25 June 2007

Growth of Bulk GaN with Low Dislocation Density by the Ammonothermal Method Using Polycrystalline GaN Nutrient

Tadao Hashimoto[1,2,*], Feng Wu[1,2], James S. Speck[1,2], and Shuji Nakamura[1,2]
(Received April 30, 2007; accepted May 15, 2007; published online June 1, 2007)

A bulk GaN crystal with improved structural quality was grown via ammonthermal growth with polycrystalline GaN nutrient and a sodium amide mineralizer. The threading dislocation density estimated by plan-view transmission electron microscopy observations was less than 1×10^6cm^{-2} for the Ga-face and 1×10^7cm^{-2} for the N-face. There was no dislocation generation observed at the interface on the Ga-face although a few defects were generated at the interface on the N-face. The chemical etching revealed macroscopic grains on the N-face.
[DOI : 10.1143/JJAP.46.L525]

Keywords: bulk GaN, ammonothermal growth, dislocations, etch pit density

1 Materials Department, University of California, Santa Barbara, CA 93106-5050, U.S.A.
2 ERATO/JST UCSB Group, University of California, Santa Barbara, CA 93106-5050, U.S.A.
* E-mail address: tadao@engineering.ucsb.edu

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L528-L530
Part 2, No. 22, 25 June 2007

Polymorphs Discrimination of Nickel Silicides in Device Structure by Improved Analyses of Low Loss Electron Energy Loss Spectrum

Kyoichiro Asayama, Naoto Hashikawa, Tadashi Yamaguchi[1], Shohei Terada[2], and Hirotaro Mori[3]
(Received April 30, 2007; accepted May 15, 2007; published online June 1, 2007)

Transmission electron microscope (TEM) with electron energy loss spectroscopy (EELS) is an indispensable tool in developing the nickel silicide structures in transistors of 65nm node or further. The low loss EELS is a simple method in discriminating the phases of nickel silicides, however it has an energy resolution problem, because of the electrical and mechanical instability of the hardware. This problem can be overcome by proposed energy calibration by standards (ECS) method, where the well-calibrated plasmon loss peak of Si (E_p = 16.6eV) EELS spectrum and zero loss peak are used as references. For this purpose, the low loss spectra of the nickel silicide and two references can be simultaneously acquired by the newly designed spatially resolved TEM-EELS.
[DOI : 10.1143/JJAP.46.L528]

Keywords: electron energy loss spectroscopy, low loss spectrum, nickel silicide, polymorphs discrimination, semiconductor devices

Renesas Technology Corp., 5-20-1 Josuihon-cho, Kodaira, Tokyo 187-8588, Japan
1 Renesas Technology Corp., 4-1 Mizuhara, Itami, Hyogo 664-0005, Japan
2 Hitachi Research Laboratory, Hitachi, Ltd., 7-1-1 Ohmika-cho, Hitachi, Ibaraki 319-1292, Japan
3 Research Center for Ultra-High Voltage Electron Microscopy, Osaka University, 7-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L537-L539
Part 2, No. 23, 25 June 2007

Robust 285nm Deep UV Light Emitting Diodes over Metal Organic Hydride Vapor Phase Epitaxially Grown AlN/Sapphire Templates

Vinod Adivarahan, Qhalid Fareed, Surendra Srivastava, Thomas Katona, Mikhail Gaevski, and Asif Khan
(Received May 10, 2007; accepted May 19, 2007; published online June 8, 2007)

Highly stable deep UV light emitting diodes (LEDs) with peak emission wavelength of 285nm are reported. The LEDs were deposited via pulsed atomic layer epitaxy over a 15-μm-thick aluminum nitride-sapphire template which was prepared by metalorganic hydride vapor phase epitaxy (MOHVPE). The devices exhibited a stable output power density of 16W/cm^2 at 2kA/cm^2 during cw operation and for unpackaged on-wafer devices cw-power did not saturate till current density of 4kA/cm^2. In contrast, conventional UV LEDs grown on sapphire substrates saturated at approximately 0.5kA/cm^2. The lifetime of MOHVPE LED is estimated to be well over 5000h. We attribute this superior performance of the MOHVPE LEDs to reduced thermal impedance due to the thick AlN–sapphire template. [DOI : 10.1143/JJAP.46.L537]
Keywords: ultraviolet light emitting diode, metalorganic hydride vapor phase epitaxy, aluminum nitride, pulsed atomic layer epitaxy

Department of Electrical Engineering, University of South Carolina, 301 S. Main Street, Columbia, South Carolina 29208, U.S.A.

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L540-L542
Part 2, No. 23, 25 June 2007

Effect of Low Level O_2 Addition to N_2 on Surface Cleaning by Nonequilibrium Atmospheric-Pressure Pulsed Remote Plasma

Masahiro Iwasaki*, Keigo Takeda, Masafumi Ito[1], Takuya Yara[2], Tsuyoshi Uehara[2], and Masaru Hori
(Received April 23, 2007; accepted May 21, 2007; published online June 8, 2007)

The effect of O_2 additions below 0.2% to N_2 was investigated for the cleaning of organic contaminants on an indium tin oxide film using a nonequilibrium atmospheric-pressure pulsed plasma. A remarkably high cleaning efficiency was obtained for plasma treatment with additions from 0.025 to 0.1% O_2 to N_2. The concentration of the ground state oxygen radical [O(^{3}P)] was measured using vacuum UV laser absorption spectroscopy. It was found that the key factor for the surface cleaning was the scission of carbon bonds due to UV emissions, and subsequent oxidation due to O(^{3}P) and ozone. [DOI : 10.1143/JJAP.46.L540]
Keywords: indium tin oxide, plasma cleaning process, oxygen radical, atmospheric-pressure plasma, large area process, pulsed plasma, low gas temperature, nonequilibrium plasma, O_2/N_2

Department of Electrical Engineering and Computer Science, Graduate School of Engineering, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan
1 Department of Opto-Mechatronics, Faculty of Systems Engineering, Wakayama University, 930 Sakaedani, Wakayama 640-8510, Japan
2 Sekisui Chemical Co., Ltd., 32 Wadai, Tsukuba, Ibaraki 300-4292, Japan
* E-mail address: m_iwasak@echo.nuee.nagoya-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L574-L576
Part 2, No. 24, 25 June 2007

Calculation of Phase Separation in Wurtzite $In_{1-x-y-z}Ga_xAl_yB_zN$

Takeshi Kimura[1,2,*] and Takashi Matsuoka[1,2]
(Received May 17, 2007; accepted June 4, 2007; published online June 15, 2007)

The miscible region of InGaAlBN quinary system was simulated by using the strictly-regular-solution approximation. The interaction parameter to obtain excess enthalpies caused by mixing was calculated using the delta-lattice-parameter model. The results show that the miscible regions of the InGaAlBN are located near the InN-rich region, near BN, and near the line connecting GaN to AlN. This means that InGaAlBN quinary system makes it possible to design infrared optical devices with InN or In-rich InGaN as an active layer without any strain, which shortens device lifetime. InGaAlBN devices could possibly outperform the InGaAsP devices presently used in optical communications systems.
[DOI : 10.1143/JJAP.46.L574]

Keywords: nitride semiconductor alloy, InN, uncooled laser, miscible region, the strictly-regular-solution model

1 Institute for Materials Research, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan
2 Japan Science and Technology Agency, CREST, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan
* E-mail address: t.kimura@imr.tohoku.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L599-L601
Part 2, No. 25, 25 July 2007

GaN-Based Trench Gate Metal Oxide Semiconductor Field Effect Transistors with Over 100 $cm^2/(Vs)$ Channel Mobility

Hirotaka Otake[*], Shin Egami, Hiroaki Ohta, Yasushi Nanishi[1], and Hidemi Takasu
(Received April 29, 2007; accepted May 31, 2007; published online June 22, 2007)

Enhancement-mode metal oxide semiconductor field effect transistors (MOSFETs) with trench gate structures have been developed. These MOSFETs show excellent DC characteristics with on-voltage of 5.1 V, i.e., enhancement-mode operation and extremely high channel mobilities of 133 $cm^2/(Vs)$. This structure enables us to realize vertical switching devices with high breakdown voltage and highly integrated low on-resistance with the usage of excellent physical parameters of GaN. This excellent performance of these devices breaks though the realization of GaN-based power switching transistors.
[DOI : 10.1143/JJAP.46.L599]

Keywords: GaN, metal oxide semiconductor field effect transistor (MOSFET), trench gate, vertical, enhancement-mode, normally-off

Research and Development Headquarters, ROHM Co., Ltd., Kyoto 615-8585, Japan
1 Ritsumeikan University, 1-1-1 Noji-Higashi, Kusatsu, Shiga 525-8577, Japan
* E-mail address: Hirotaka.Otake@dsn.rohm.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L602-L604
Part 2, No. 25, 25 July 2007

Te-Free SiSb Phase Change Material for High Data Retention Phase Change Memory Application

Ting Zhang[1,*], Zhitang Song, Feng Wang, Bo Liu, Songlin Feng, and Bomy Chen[2]
(Received May 16, 2007; accepted June 5, 2007; published online June 22, 2007)

Te-free non-chalcogenide phase change material Si_xSb_{100-x} ($0<x<100$) with eximious data retention has been investigated. Archives life time at 110 °C for $Si_{10}Sb_{90}$ and $Si_{16}Sb_{84}$ materials are 10^3 and 10^6 times longer than that of $Ge_2Sb_2Te_5$, which is most widely used in research and development of phase change memory recently. The crystallization temperature for $Si_{10}Sb_{90}$ and $Si_{16}Sb_{84}$ are 191 and 225 °C, and the crystallization activation energy are 3.1 and 4.67 eV, respectively. These make $Si_{10}Sb_{90}$ and $Si_{16}Sb_{84}$ phase change materials promising candidates for the next-generation phase change memory. Furthermore, crystallization temperature and activation energy can be accurately controlled by adjusting silicon atomic content within the Si_xSb_{100-x} material.
[DOI : 10.1143/JJAP.46.L602]

Keywords: SiSb, phase change memory, phase change, data retention, Te-free

Laboratory of Nanotechnology, Shanghai Institute of Micro-System and Information Technology, Chinese Academy of Sciences, Shanghai 200050, China
1 Graduate School of the Chinese Academic of Sciences, Beijing 100049, China
2 Silicon Storage Technology, Inc., 1171 Sonora Court, Sunnyvale, CA 94086, U.S.A.
* E-mail address: tzhang@mail.sim.ac.cn

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L605-L607
Part 2, No. 25, 25 July 2007

Spin Injection into a Graphene Thin Film at Room Temperature

Megumi Ohishi, Masashi Shiraishi[*], Ryo Nouchi, Takayuki Nozaki, Teruya Shinjo, and Yoshishige Suzuki
(Received June 2, 2007; accepted June 6, 2007; published online June 22, 2007)

We demonstrate spin injection into a graphene thin film with high reliability by using non-local magnetoresistance (MR) measurements, in which the electric current path is completely separated from the spin current path. Using these non-local measurements, an obvious MR effect was observed at room temperature; the MR effect was ascribed to magnetization reversal of ferromagnetic electrodes. This result is a direct demonstration of spin injection into a graphene thin film. Furthermore, this is the first report of spin injection into molecules at room temperature. [DOI : 10.1143/JJAP.46.L605]

Keywords: graphene, spin injection, spin current, non-local, room temperature

Graduate School of Engineering Science, Osaka University, 1-3 Machikaneyama-cho, Toyonaka, Osaka 560-8531, Japan
* E-mail address: shiraishi@mp.es.osaka-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L608-L610
Part 2, No. 25, 25 July 2007

Refraction-Enhanced Tomosynthesis of a Finger Joint by X-Ray Dark-Field Imaging

Daisuke Shimao*, Toshiyuki Kunisada[1], Hiroshi Sugiyama[2], and Masami Ando[3]
(Received May 10, 2007; accepted May 15, 2007; published online June 22, 2007)

A finger joint tomogram based on X-ray dark-field imaging (XDFI) was demonstrated using the simplest shift-and-add tomosynthesis algorithm. Raw XDFI image data for tomosynthesis were acquired in a total of 11 views through 10°, in increments of 1°, by rotating the object and detector synchronously. Incident X-ray energy was monochromatic 36.0keV, derived from synchrotron radiation. The total dosage in acquiring 11 views for raw image data was equivalent to that of one XDFI image. A clear tomogram was obtained of a finger joint (including articular cartilage, which is invisible by conventional tomosynthesis) without an increase in X-ray dosage. [DOI : 10.1143/JJAP.46.L608]

Keywords: tomosynthesis, shift-and-add, X-ray dark-field imaging, synchrotron radiation, Laue analyzer, articular cartilage

Department of Radiological Sciences, Ibaraki Prefectural University of Health Sciences, Inashiki-gun, Ibaraki 300-0394, Japan
1 Department of Medical Materials for Musculoskeletal Reconstruction, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences, Okayama 700-8558, Japan
2 Photon Factory, Institute of Materials Structure Science, High Energy Accelerator Research Organization, Tsukuba, Ibaraki 305-0801, Japan
3 Research Institute for Science and Technology, Tokyo University of Science, Noda, Chiba 278-8510, Japan
* E-mail address: shimao@ipu.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L642-L644
Part 2, No. 26, 25 July 2007

A Scaling Relation of Anomalous Hall Effect in Ferromagnetic Semiconductors and Metals

Tomoteru Fukumura[1,*], Hidemi Toyosaki[1], Kazunori Ueno[1], Masaki Nakano[1], Takashi Yamasaki[1], and Masashi Kawasaki[1,2]
(Received May 25, 2007; accepted June 15, 2007; published online June 29, 2007)

A scaling relation of the anomalous Hall effect recently found in a ferromagnetic semiconductor $(Ti,Co)O_2$ is compared with those of various ferromagnetic semiconductors and metals. Many of these compounds with relatively low conductivity $\sigma_{xx} \leq 10^4\Omega^{-1}\cdot cm^{-1}$ are also found to exhibit similar relation: anomalous Hall conductivity σ_{AH} approximately scales as $\sigma_{AH} \propto \sigma_{xx}^{1.6}$, that is coincident with a recent theory. This relation is valid over five decades of σ_{xx} irrespective of metallic or hopping conduction. [DOI : 10.1143/JJAP.46.L642]

Keywords: anomalous Hall effect, anomalous Hall conductivity, Co-doped TiO_2, ferromagnetic semiconductor, ferromagnetic metal, oxide semiconductor, spintronics

1 Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan
2 CREST, Japan Science and Technology Agency (JST), Kawaguchi, Saitama 332-0012, Japan
* E-mail address: fukumura@imr.tohoku.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L658-L660
Part 2, No. 27, 25 July 2007

Giant Magneto-Piezoresistance and Internal Friction in a Two-Dimensional Electron System

Hiroshi Yamaguchi[1,*], Hajime Okamoto[1], Yuki Maruta[1,2], Sunao Ishihara[2], Sen Miyashita[3], and Yoshiro Hirayama[1,4,5]
(Received May 25, 2007; accepted June 13, 2007; published online July 6, 2007)

We use a micromechanical cantilever with an integrated two-dimensional electron system to show that an extremely small strain of the order of 10^{-4} induces a localized–delocalized electronic state transition. This strong strain effect improves the piezoresistive gauge factor by more than two orders of magnitude compared to the conventional Si cantilever. Furthermore, we found that the cantilever mechanical motion is affected considerably by friction exerted by the electron systems.
[DOI : 10.1143/JJAP.46.L658]

Keywords: cantilever, 2DES, MEMS, GaAs, piezoresistance

1 NTT Basic Research Laboratories, NTT Corporation, Atsugi, Kanagawa 243-0198, Japan
2 Department of Engineering Synthesis, University of Tokyo, Bunkyo-ku, Tokyo 113-8656, Japan
3 NTT Advanced Technology, Atsugi, Kanagawa 243-0198, Japan
4 Department of Physics, Tohoku University, Sendai 980-8578, Japan
5 SORST-JST, Kawaguchi, Saitama 331-0012, Japan
* E-mail address: hiroshi@will.brl.ntt.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L682-L684
Part 2, No. 28, 25 July 2007

Super-Paramagnetic Blocking Phenomena and Room-Temperature Ferromagnetism in Wide Band-Gap Dilute Magnetic Semiconductor (Ga, Mn)N

Kazunori Sato*, Tetsuya Fukushima, and Hiroshi Katayama-Yoshida
(Received June 7, 2007; accepted June 18, 2007; published online July 13, 2007)

We present computer simulations on the super-paramagnetic blocking phenomena in wide band-gap dilute magnetic semiconductors (DMSs) in particular (Ga, Mn)N. It is shown that due to the formation of magnetic nano-clusters of magnetic impurities under the spinodal decomposition, super-paramagnetic blocking temperature (T_B) of the DMS is enhanced and hysteretic magnetic response can be observed at finite temperature even if Curie temperature of the whole system is nearly zero. T_B higher than room temperature can be expected and the blocking phenomena explains reported ferromagnetic behaviour of wide band-gap DMS at high temperature. [DOI : 10.1143/JJAP.46.L682]

Keywords: dilute magnetic semiconductor, super-paramagnetism, blocking phenomena, spinodal decomposition, hysteresis, Monte Carlo simulation, first-principles calculation

The Institute of Scientific and Industrial Research, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan
* E-mail address: ksato@cmp.sanken.osaka-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L685-L687
Part 2, No. 28, 25 July 2007

Hydrogen-doped In_2O_3 as High-mobility Transparent Conductive Oxide

Takashi Koida*, Hiroyuki Fujiwara, and Michio Kondo
(Received May 18, 2007; accepted May 31, 2007; published online July 13, 2007)

We have developed hydrogen (H)-doped In_2O_3 films on glass with high mobility and high near-infrared transparency by using sputtering process performed at room temperature, followed by post-annealing treatment at 200°C. To incorporate H-donor into In_2O_3 matrix, H_2O vapor has been introduced into a chamber during the deposition. In the post-annealing of the films, phase transition from amorphous to polycrytalline was confirmed to occur. The resulting In_2O_3 films containing 1.9–6.3 at. % H show quite large mobility as high as 98–130 $cm^2/(Vs)$ at carrier density of (1.4–1.8)× $10^{20}cm^{-3}$. We attributed the high mobility in the film to suppression of grain boundary defects as well as multich-arged and neutral impurities. [DOI : 10.1143/JJAP.46.L685]

Keywords: amorphous, ITO, In_2O_3, solid-phase crystallization, mobility, transparency, water vapor, hydrogen, TCO

Research Center for Photovoltaics, National Institute of Advanced Industrial Science and Technology (AIST), Central 2, 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan
* E-mail address: t-koida@aist.go.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L688-L690
Part 2, No. 28, 25 July 2007

Optical Amplification in Organic Dye-doped Polymeric Channel Waveguide under CW Optical Pumping

Kenichi Yamashita, Kengo Hase, Hisao Yanagi[1], and Kunishige Oe
(Received May 24, 2007; accepted June 27, 2007; published online July 13, 2007)

We have achieved amplified spontaneous emission and optical amplification in an organic dye-doped polymeric waveguide using a cw pumping source. By fabricating a channel waveguide structure, amplified spontaneous emission was found under long-pulse (0.3–4.1 ms) optical pumping with 120 mW amplitude from the waveguide end face. The optical gain for externally input 770 nm light was measured to be 13.8 dB at an optical pumping duty of 8%. The experimental results reveal that the optical pumping scheme presented here is a very effective means for attaining real cw-stimulated emission in organic materials.
[DOI : 10.1143/JJAP.46.L688]

Keywords: amplified spontaneous emission, optical amplification, polymeric waveguide, solid-state dye laser, waveguide amplifier

Department of Electronics, Graduate School of Science and Technology, Kyoto Institute of Technology, Matsugasaki Goshokaidocho, Sakyo-ku, Kyoto 606-8585, Japan
1 Graduate School of Materials Science, Nara Institute of Science and Technology, 8916-5 Takayama-cho, Ikoma, Nara 630-0192, Japan

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L717-L720
Part 2, No. 29, 25 August 2007

High-Quality Laser-Produced Proton Beam Realized by the Application of a Synchronous RF Electric Field

Shu Nakamura[1,2,*], Masahiro Ikegami[1], Yoshihisa Iwashita[1], Toshiyuki Shirai[1], Hiromu Tongu[1], Hikaru Souda[1], Hiroyuki Daido[2], Michiaki Mori[2], Masataka Kado[2], Akito Sagisaka[2], Koichi Ogura[2], Mamiko Nishiuchi[2], Satoshi Orimo[2], Yukio Hayashi[2], Akifumi Yogo[2], Alexander S. Pirozhkov[2], Sergei V. Bulanov[2], Timur Esirkepov[2], Akira Nagashima[2], Toyoaki Kimura[2], Toshiki Tajima[2], Takeshi Takeuchi[3,**], Atsushi Fukumi[3,***], Zhong Li[3,****], and Akira Noda[1,*****]
(Received June 12, 2007; accepted July 2, 2007; published online July 20, 2007)

A short-pulse (~210 fs) high-power (~1 TW) laser was focused on a tape target 3 and 5 μm in thickness to a size of 11×15 μm^2 with an intensity of 3×10^{17} W/cm^2. Protons produced by this laser with an energy spread of 100% were found to be improved to create peaks in the energy distribution with a spread of ~7% by the application of the RF electric field with an amplitude of ±40 kV synchronous to the pulsed laser. This scheme combines the conventional RF acceleration technique with laser-produced protons for the first time. It is possible to be operated up to 10 Hz, and is found to have good reproducibility for every laser shot with the capability of adjusting the peak positions by control of the relative phase between the pulsed laser and the RF electric field.
[DOI : 10.1143/JJAP.46.L717]

Keywords: laser-ion production, phase rotation, RF acceleration and deceleration, energy peak, short pulsed laser

1 Institute for Chemical Research, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan
2 Kansai Photon Science Institute, Japan Atomic Energy Agency, 8-1 Umemidai, Kizugawa, Kyoto 619-0215, Japan
3 National Institute of Radiological Sciences, 4-9-1 Anagawa, Inage-ku, Chiba 263-8555, Japan
* Present address: High Energy Accelerator Research Organization (KEK), Tsukuba, Ibaraki 305-0801, Japan.
** Present address: Accelerator Engineering Corporation, 4-9-1 Anagawa, Inage-ku, Chiba 263-8555, Japan.
*** Present address: Okayama University, 3-1-1 Tsushima-naka, Okayama 700-8530, Japan.
**** Present address: Shanghai Institute of Applied Physics, Shanghai 201800, China.
*****E-mail address: noda@kyticr.kuicr.kyoto-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L746-L748
Part 2, No. 31, 25 August 2007

Synthesis and Thermoelectric Properties of Type-I Clathrate Compounds $Si_{46-x}P_xTe_8$

Kengo Kishimoto*, Tsuyoshi Koyanagi, Koji Akai[1], and Mitsuru Matsuura[2]
(Received July 10, 2007; accepted July 19, 2007; published online August 3, 2007)

Tellurium-containing cationic clathrates $Si_{46-x}P_xTe_8$ (x = 11–17) were synthesized using powder metallurgy. This study crystallized the $Pm\bar{3}n$ (No.223) structure and showed a p-type conductivity; their band gap energy is estimated to be 1.24 eV. Although the $Si_{46-x}P_xTe_8$ samples with x = 16 and 17 were intrinsic, the samples with x = 11–15 were degenerated semiconductors; their electrical conductivity σ increased and their Seebeck coefficient S almost decreased with decreasing x. A power factor $S^2\sigma$ of 12 $\mu W cm^{-1}K^{-2}$ at 1000 K and a dimensionless figure of merit ZT of 0.45 at 900 K were achieved for a p-type silicon clathrate $Si_{33}P_{13}Te_8$. [DOI : 10.1143/JJAP.46.L746]

Keywords: thermoelectric material, silicon clathrate, cationic clathrate, p-type, thermal conductivity

Graduate School of Science and Engineering, Yamaguchi University, Ube, Yamaguchi 755-8611, Japan
1 Media and Information Technology Center, Yamaguchi University, Ube, Yamaguchi 755-8611, Japan
2 Yamaguchi Study Center, The Open University of Japan, Sanyo-Onoda, Yamaguchi 756-0884, Japan
* E-mail address: kkishi@yamaguchi-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L749-L751
Part 2, No. 31, 25 August 2007

Real-time Detection of Photocatalytic Hydrogen Production for Platinized Titanium Dioxide Thin Films in High Vacuum

Kei Noda*, Masashi Hattori, Kouichi Amari, Kei Kobayashi[1], Toshihisa Horiuchi[2], and Kazumi Matsushige
(Received June 26, 2007; accepted July 19, 2007; published online August 3, 2007)

Photocatalytic hydrogen production was first detected in a high vacuum condition for platinum-loaded nanocrystalline anatase-titanium dioxide (TiO_2) thin films, using a newly developed monitoring system with a quadrupole mass spectrometer. In the presence of methanol of 10^{-6} Torr, partial pressures of hydrogen (H_2) and formaldehyde (HCHO), generated due to the decomposition of methanol, were observed clearly to change simultaneously with the UV irradiation onto the TiO_2 films. Photolysis of gas-phase water was also detected, thus revealing that this new method is capable to evaluate sensitively such the photocatalytic activities in high vacuum at a real-time scale.
[DOI : 10.1143/JJAP.46.L749]

Keywords: solar hydrogen production, gaseous methanol and water, real-time detection, high vacuum, photocatalyst, titanium dioxide

Department of Electronic Science and Engineering, Kyoto University, Nishikyo, Kyoto 615-8510, Japan
1 Innovative Collaboration Center, Kyoto University, Nishikyo, Kyoto 615-8520, Japan
2 Advanced Software Technology and Mechatronics Research Institute (ASTEM), Shimogyo, Kyoto 600-8813, Japan
* E-mail address: nodakei@kuee.kyoto-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L761-L763
Part 2, No. 32, 25 August 2007

Continuous-wave Operation of AlGaN-cladding-free Nonpolar *m*-Plane InGaN/GaN Laser Diodes

Robert M. Farrell[1,3,*], Daniel F. Feezell[1,2], Mathew C. Schmidt[1,2], Daniel A. Haeger[1], Kathryn M. Kelchner[1,3], Kenji Iso[1,2], Hisashi Yamada[1,2], Makoto Saito[1,2], Kenji Fujito[4], Daniel A. Cohen[1,2], James S. Speck[1,2], Steven P. DenBaars[1,2,3], and Shuji Nakamura[1,2,3]
(Received July 16, 2007; accepted July 24, 2007; published online August 10, 2007)

We demonstrate continuous-wave (CW) operation of nonpolar *m*-plane InGaN/GaN laser diodes without Al-containing waveguide cladding layers. Thick InGaN quantum wells (QWs) are used to generate effective transverse optical mode confinement, eliminating the need for Al-containing waveguide cladding layers. Peak output powers of more than 25 mW are demonstrated with threshold current densities and voltages of 6.8 kA/cm^2 and 5.6 V, respectively. The unpackaged and uncoated laser diodes operated under CW conditions for more than 15 h. [DOI : 10.1143/JJAP.46.L761]

Keywords: nonpolar, *m*-plane, InGaN, laser diode, continuous-wave, free-standing GaN substrate

1 Solid State Lighting and Display Center, University of California, Santa Barbara, CA 93106, U.S.A.
2 Materials Department, University of California, Santa Barbara, CA 93106, U.S.A.
3 Department of Electrical and Computer Engineering, University of California, Santa Barbara, CA 93106, U.S.A.
4 Optoelectronics Laboratory, Mitsubishi Chemical Corporation, 1000 Higashi-Mamiana, Ushiku, Ibaraki 300-1295, Japan
* E-mail address: rmf@ece.ucsb.edu

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L777-L779
Part 2, No. 33, 25 September 2007

Computational Nano-materials Design for Colossal Thermoelectric-cooling Power by Adiabatic Spin-Entropy Expansion in Nano-superstructures

Hiroshi Katayama-Yoshida*, Tetsuya Fukushima, Van An Dinh, and Kazunori Sato
(Received July 10, 2007; accepted July 30, 2007; published online August 17, 2007)

In addition to the conventional Peltier effect, we propose a new class of thermoelectric-cooling mechanism based on the adiabatic spin-entropy expansion in a quasi-one-dimensional nano-superstructure by injecting the spin current from the ferromagnetic metal to paramagnetic one. The spin-entropy expansion mechanism dominates and enhances the thermoelectric-cooling power dramatically in current perpendicular to plane-giant magneto-resistance (CPP-GMR) Co/Au nano-interface. Based upon the spin-entropy expansion mechanism, we design the new thermoelectric-cooling nano-superstructures using the newly designed half-Heusler ferromagnets NiMnSi (T_C=1050 K) and self-organized quasi-one-dimensional *Konbu-phase* (Zn,Cr)Te with very high blocking temperature (>1000 K) by spinodal nano-decomposition.
[DOI : 10.1143/JJAP.46.L777]

Keywords: spin-entropy current, thermoelectric power, Peltier effect, CPP-GMR, Konbu-phase, half-Heusler ferromagnets, spin caloritronics, spinodal nano-decomposition, computational nano-materials design

The Institute of Scientific and Industrial Research, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan
* E-mail address: hiroshi@sanken.osaka-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L780-L782
Part 2, No. 33, 25 September 2007

Bending at Thinned GaAs Nodes in GaP-based Free-standing Nanowires

Kouta Tateno*, Guoqiang Zhang, Tetsuomi Sogawa, and Hidetoshi Nakano
(Received July 24, 2007; accepted July 30, 2007; published online August 17, 2007)

The ability to intentionally bend nanowires at certain points would extend their applications further. Here, we present GaP-based nanowires with three GaAs bending nodes. The GaAs parts are selectively reduced by annealing. When 20-nm Au particles are used as catalysts, apparent bending is seen at the top GaAs node. At the bottom one, however, a thicker GaAs node is seen, which is due to excess growth at the GaAs side wall. How to control the bending at each node during the growth process remains an issue, but it should be possible to control it by applying an electric field. [DOI : 10.1143/JJAP.46.L780]

Keywords: nanowire, bending node, GaAs, GaP, scanning electron microscopy, transmission electron microscopy, energy dispersive X-ray spectrometry

NTT Basic Research Laboratories, NTT Corporation, Atsugi, Kanagawa 243-0198, Japan
* E-mail address: ktateno@will.brl.ntt.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L796-L797
Part 2, No. 34, 25 September 2007

Reduction of the Threshold Voltages of Nematic Liquid Crystal Electrooptical Devices by Doping Inorganic Nanoparticles

Fumiaki Haraguchi[1], Kei-ichi Inoue[2], Naoki Toshima[3], Shunsuke Kobayashi[1,2,*], and Kohki Takatoh[1,2]
(Received July 2, 2007; accepted July 30, 2007; published online August 24, 2007)

We report the reduction of threshold voltage, V_{th}, of twisted nematic liquid crystal devices by doping the nanoparticles of MgO and SiO_2. The results are well explained by inserting the experimentally determined values of elastic constants and dielectric anisotropy in the formula $V_{th} = \pi\sqrt{K_{eff}/\varepsilon_0\Delta\varepsilon}$, where both of these quantities decrease due to the existence of these nanoparticles. The V_{th} decrease approximately as $\sqrt{S}$, where S being the order parameter. The S is also shown to decrease by doping nanoparticles. [DOI : 10.1143/JJAP.46.L796]

Keywords: nanoparticles, MgO, SiO_2, nematic liquid crystal display, LCDs

1 Department of Electronic and Information Technology, Tokyo University of Science, Yamaguchi, 1-1-1 Daigaku-dori, Sanyo-Onoda, Yamaguchi 756-0884, Japan
2 Liquid Crystal Institute and Graduate School of Science and Technology, Tokyo University of Science, Yamaguchi, 1-1-1 Daigaku-dori, Sanyo-Onoda, Yamaguchi 756-0884, Japan
3 Advanced Material Institute and Faculty of Science and Technology, Tokyo University of Science, Yamaguchi, 1-1-1 Daigaku-dori, Sanyo-Onoda, Yamaguchi 756-0884, Japan
* E-mail address: kobayashi@ed.yama.tus.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L820-L822
Part 2, No. 35, 25 September 2007

Pure Blue Laser Diodes Based on Nonpolar *m*-Plane Gallium Nitride with InGaN Waveguiding Layers

Kuniyoshi Okamoto*, Taketoshi Tanaka, Masashi Kubota, and Hiroaki Ohta
(Received August 9, 2007; accepted August 16, 2007; published online September 7, 2007)

Blue laser diodes (LDs) based on *m*-plane gallium nitride were demonstrated by using *m*-plane GaN substrates. The lasing wavelength and the threshold current under pulsed operation were 451.8nm and 134mA (22.3kA/cm^2), respectively. The device structures consisted of InGaN-based multi-quantum wells, InGaN guiding layers, and Al-containing cladding layers. The InGaN guiding layers play two roles; as appropriate optical waveguides for longer lasing wavelengths and for the prevention of macroscopic cracks parallel to the *c*-plane. The latter is an indispensable technology in order to fabricate nonpolar LDs for longer wavelengths beyond the blue region. [DOI : 10.1143/JJAP.46.L820]

Keywords: nonpolar, *m*-plane, InGaN, laser diode, GaN bulk substrate

Research and Development Headquarters, ROHM Co., Ltd., Kyoto 615-8585, Japan
* E-mail address: Kuniyoshi.Okamoto@dsn.rohm.co.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L823-L825
Part 2, No. 35, 25 September 2007

Room Temperature Ferromagnetism of Fe Doped Indium Tin Oxide Based on Dispersed Fe_3O_4 Nanoparticles

Koichi Okada, Shigemi Kohiki*, Sachio Nishi, Hirokazu Shimooka, Hiroyuki Deguchi, Masanori Mitome[1], Yoshio Bando[1], and Toetsu Shishido[2]
(Received June 5, 2007; accepted August 12, 2007; published online September 7, 2007)

Transmission electron microscopy revealed that Fe_3O_4 nanoparticles with diameter of ≈200nm dispersed in Fe doped indium tin oxide (Fe@ITO) powders exhibiting co-occurrence of room temperature ferromagnetism and superparamagnetism. Although we observed no X-ray diffraction peak from Fe related compounds for $Fe_{0.19}$@ITO (ITO: $In_{1.9}Sn_{0.1}O_3$) powders, the powders showed both hysteresis loop in field dependent magnetization at 300K and divergence of zero-field-cooled magnetization from field-cooled magnetization. Scanning transmission electron microscopy with energy dispersive X-ray spectroscopy demonstrated that the nanoparticle with diameter of ≈200nm consists of Fe and oxygen. Transmission electron diffraction revealed that crystal structure of the nanoparticle is inverse spinel type Fe_3O_4. The Fe_3O_4 crystalline phase by electron diffraction is consistent with the saturation magnetization of 1.3μ_B/Fe and magnetic anomaly at ≈110K observed for the powders. [DOI : 10.1143/JJAP.46.L823]

Keywords: Fe doped indium tin oxide, Fe_3O_4 nanoparticles, room temperature ferromagnetism

Kyushu Institute of Technology, Kitakyushu 804-8550, Japan
1 National Institute of Materials Science, Tsukuba, Ibaraki 305-0044, Japan
2 Tohoku University, Sendai 980-8577, Japan
* E-mail address: kohiki@che.kyutech.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L826-L829
Part 2, No. 35, 25 September 2007

Spectrally Narrow Emission at Cutoff Wavelength from Edge of Electrically Pumped Organic Light-Emitting Diodes

Daisuke Yokoyama[1,2], Hajime Nakanotani[1,2], Yousuke Setoguchi[2], Masato Moriwake[3], Dai Ohnishi[3], Masayuki Yahiro[1,2], and Chihaya Adachi[1,2,*]
(Received August 7, 2007; accepted August 16, 2007; published online September 7, 2007)

We demonstrate spectrally narrow emissions from the edge of electrically pumped organic light-emitting diodes having a fine "line-shaped" waveguide structure with a silver cathode. A 4,4'-bis[(*N*-carbazole)styryl]-biphenyl (BSB-Cz) layer, which has a very low amplified spontaneous emission threshold, was used as an emitting layer. We observed extremely narrow emissions having polarized transverse electric (TE) mode. The full width at half maximum became narrower down to 6.5nm as the peak wavelength of the emission approached the wavelength of the 0–1 transition of the BSB-Cz layer. The edge emission intensity showed a superlinear relationship with the current density, and the spectral shapes changed appreciably depending on the current density, indicating the occurrence of amplification of the emitted light. The peak wavelengths of the edge emissions were attributed to the leaky mode very close to the cutoff wavelength of the waveguide structure having the metal cladding layer.
[DOI : 10.1143/JJAP.46.L826]

Keywords: edge emission, cutoff wavelength, waveguide, OLED, organic laser diode

1 CREST Program, Japan Science and Technology Agency (JST), 1-32-12 Higashi, Shibuya, Tokyo 150-0011, Japan
2 Center for Future Chemistry, Kyushu University, 744 Motooka, Nishi, Fukuoka 819-0395, Japan
3 Research and Development Center, Rohm Co., 21 Mizosaki, Nishi-in, Ukyo, Kyoto 615-8585, Japan
* E-mail address: adachi@cstf.kyushu-u.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L830-L832
Part 2, No. 35, 25 September 2007

Intense Monochromatic Light Emission from Multiple Nanoscale Twin Boundaries in Indirect-gap AlGaAs Epilayers

Yutaka Ohno*, Naoki Yamamoto[1], Kaoru Shoda[2], and Seiji Takeda[2]
(Received August 2, 2007; accepted August 15, 2007; published online September 7, 2007)

The optical properties of multiple nanoscale twin boundaries in indirect-gap AlGaAs epilayers were studied. Twin boundaries of Σ3-type, extended on {111}B, were self-organized in an epilayer during the epitaxial growth on an AlGaAs(001) substrate by metal–organic vapor-phase epitaxy. Polarized cathodoluminescence spectroscopy in a transmission electron microscope revealed that a set of parallel twin boundaries arranged at similar intervals of nanometer length emits an intense monochromatic light polarized parallel to the boundaries. The photon energy was tunable by controlling the intervals of the boundaries, without changing the crystal structure and the composition.
[DOI : 10.1143/JJAP.46.L830]

Keywords: multiple nanoscale twin boundaries, indirect-gap AlGaAs epilayers, polarized cathodoluminescence spectroscopy, transmission electron microscopy, band-structure engineering

Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan
1 Department of Condensed Matter Physics, Tokyo Institute of Technology, Tokyo 152-8551, Japan
2 Department of Physics, Graduate School of Science, Osaka University, Osaka 560-0043, Japan
* E-mail address: yutakaohno@imr.tohoku.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L865-L867
Part 2, No. 36, 25 October 2007

Ion-Sensitive Characteristics of an Electrolyte-Solution-Gate ZnO/ZnMgO Heterojunction Field-Effect Transistor as a Biosensing Transducer

Kazuto Koike*, Daisuke Takagi, Motoki Kawasaki, Takahito Hashimoto, Tomoyuki Inoue, Ken-ichi Ogata, Shigehiko Sasa, Masataka Inoue, and Mitsuaki Yano
(Received August 6, 2007; accepted August 22, 2007; published online September 14, 2007)

Characteristics of an ion-sensitive ZnO/ZnMgO heterojunction field-effect transistor (HFET) with an amine-modified single-crystalline O-polar ZnMgO gate electrode are discussed to develop the application to biosensing transducers. The ion-sensitivity was based on the proton transfer to/from the amino groups on the gate electrode, the amine-modification of which was performed using a silanization technique by immersing the HFET into an aminosilane based solution. Stable operation in electrolyte solution in accordance with the standard FET theory with small hysteresis and small leakage current was confirmed, and the amperometric operation revealed a high pH sensitivity of -20μA/pH with a reproducible result. A potential application of the ion-sensitive HFET to amperometric biosensing transducers was also demonstrated by immobilizing enzyme molecules of glucose oxidase on the amine-modified gate electrode. [DOI : 10.1143/JJAP.46.L865]

Keywords: ZnO/ZnMgO heterojunction FET, electrolyte-solution-gate, pH sensing, biosensor, glucose oxidase

Nanomaterials Microdevices Research Center, Osaka Institute of Technology, Asahi-ku, Ohmiya, Osaka 535-8585, Japan
* E-mail address: koike@elc.oit.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L868-L870
Part 2, No. 36, 25 October 2007

A Reversible Change of Reflected Light Intensity between Molten and Solidified Ge–Sb–Te Alloy

Masashi Kuwahara*, Rie Endo[1], Toshio Fukaya, Takayuki Shima, Yasuhiko Iwanabe, Paul Fons, Junji Tominaga, and Masahiro Susa[1]
(Received July 19, 2007; accepted August 20, 2007; published online September 14, 2007)

The reflected light intensity (I_R) from the solid and liquid phases of Ge–Sb–Te alloy has been statically measured. I_R rapidly decreased after crossing the melting point during the heating process, and increased to its initial intensity level after solidifying during the cooling process. A special sample preparation technique using a quartz cell enabled reliable measurements to be carried out. The structure and composition of the Ge–Sb–Te alloy was investigated using Raman scattering and X-ray fluorescence after the melting process. Germanium was found to preferentially diffuse from the bulk to the surface leading to a germanium oxide surface phase. [DOI : 10.1143/JJAP.46.L868]

Keywords: optical disk, Ge–Sb–Te alloy, melting point, reflected light intensity, static measurement

Center for Applied Near-Field Optics Research (CAN-FOR), AIST, Central 4, 1-1-1 Higashi, Tsukuba, Ibaraki 305-8562, Japan
1 Department of Metallurgy and Ceramics Science, Tokyo Institute of Technology, Ookayama, Meguro, Tokyo 152-8552, Japan
* E-mail address: kuwaco-kuwahara@aist.go.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L871-L873
Part 2, No. 36, 25 October 2007

Single Photon Emission from Individual Nitrogen Pairs in GaP

Michio Ikezawa*, Yoshiki Sakuma[1], and Yasuaki Masumoto
(Received August 11, 2007; accepted August 23, 2007; published online September 14, 2007)

Luminescence from single isoelectronic traps in nitrogen δ-doped gallium phosphide was studied by micro-photoluminescence spectroscopy. These single traps were found to emit photons that were nearly identical in both emission energy and brightness. Furthermore, single photon emission from a single nitrogen pair is confirmed by a strong antibunching under continuous optical excitation at 30 K. These results imply that single nitrogen pairs in GaP might be useful for realizing unique sources of energetically-defined single photons, and even indistinguishable photons. [DOI : 10.1143/JJAP.46.L871]

Keywords: single photon emitter, isoelectronic trap, nitrogen impurity, antibunching, indistinguishable photons

Institute of Physics and Center for Tsukuba Advanced Research Alliance (TARA), University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki 305-8571, Japan
1 National Institute for Materials Science, 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan
* E-mail address: mikezawa@sakura.cc.tsukuba.ac.jp

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L874-L876
Part 2, No. 36, 25 October 2007

Position-Sensitive Cholesteric Liquid Crystal Dye Laser Covering a Full Visible Range

Koji Sonoyama, Yoichi Takanishi*, Ken Ishikawa, and Hideo Takezoe
(Received August 7, 2007; accepted August 24, 2007; published online September 14, 2007)

We fabricated a cholesteric-liquid-crystal distributed-feedback laser cell with spatial gradient structures not only of the helical pitch but also of the concentrations of two dyes. By utilizing the energy transfer between two dyes, lasing was achieved covering a full visible range from 470 to 670 nm continuously by translating the cell with respect to a pumping beam without changing the excitation wavelength.
[DOI : 10.1143/JJAP.46.L874]

Keywords: lasing, cholesteric liquid crystal, pitch gradient, tunability, DFB laser

Department of Organic and Polymeric Materials, Tokyo Institute of Technology, 2-12-1-S8-42, O-okayama, Meguro-ku, Tokyo 152-8552, Japan
* Present address: Department of Physics, Kyoto University, Kitashirakawa-oiwake-cho, Sakyo-ku, Kyoto 606-8502, Japan.

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L889-L891
Part 2, No. 37, 25 October 2007

Growth of Bulk GaN Crystals by the Basic Ammonothermal Method

Tadao Hashimoto[1,2 *], Feng Wu[1,2], James S. Speck[1,2], and Shuji Nakamura[1,2]
(Received August 18, 2007; accepted September 5, 2007; published online September 21, 2007)

A remarkable progress was made in GaN wafer fabrication via the basic ammonothermal method. Bulk GaN crystals were grown on GaN platelets in supercritical ammonia at 575 °C and 220 MPa with sodium amide. The grown crystals showed three-dimensional polyhedron shape in size of more than 5 mm. Clear crystallographic facets of N-face and *m* planes were observed although Ga-face was decorated with angled facets of {10$\bar{1}$1} planes. X-ray diffraction revealed multiple grains whose individual full width half maximum of ω scan was 200–400 arcsec. *C* plane and *m* plane wafers were fabricated by slicing the GaN boules.
[DOI : 10.1143/JJAP.46.L889]

Keywords: bulk GaN, GaN wafer, ammonothermal growth, low-angle grains

1 Materials Department, University of California, Santa Barbara, CA 93106-5050, U.S.A.
2 ERATO/JST UCSB Group, University of California, Santa Barbara, CA 93106-5050, U.S.A.
* Present affiliation: SixPoint Mateirals, Inc., Buellton, CA 93427, U.S.A.
E-mail address: tadao@engineering.ucsb.edu

Jpn. J. Appl. Phys. Vol.46 (2007) pp. L892-L894
Part 2, No. 37, 25 October 2007

Growth of Nitride-Based Fe_3N/AlN/Fe_4N Magnetic Tunnel Junction Structures on Si(111) Substrates

Akari Narahara and Takashi Suemasu
(Received August 9, 2007; accepted September 4, 2007; published online September 21, 2007)

We have fabricated nitride-based Fe_3N(30 nm)/AlN(2 nm)/Fe_4N(25 nm) magnetic tunnel junctions (MTJs) structures on Si(111) substrates by molecular beam epitaxy of Fe_3N layers onto AlN/α-Fe/Si(111). The X-ray diffraction peaks of α-Fe disappeared after the growth of the Fe_3N layer, and those of Fe_4N appeared instead. Rutherford backscattering spectroscopy (RBS) measurements revealed that the α-Fe layer was nitrided to form the Fe_4N layer. In the magnetization versus magnetic field curves measured at room temperature, a two-step hysteresis loop was clearly observed, meaning that the two ferromagnetic layers were separated by the 2-nm-thick AlN barrier layer.
[DOI : 10.1143/JJAP.46.L892]

Keywords: magnetic tunnel junction, Fe_3N, Fe_4N, AlN, MBE, RF magnetron sputtering

Institute of Applied Physics, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan