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Abstracts of Express Letters

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Impact of Vicinal Sapphire (0001) Substrates on the High-Quality AlN Films by Plasma-Assisted Molecular Beam Epitaxy

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(Received September 2, 2003; accepted September 16, 2003; published October 22, 2003)

AlN films grown by plasma-assisted molecular beam epitaxy on vicinal sapphire (0001) substrates were investigated. High structural and optical qualities were confirmed by high-resolution X-ray diffraction and 77K cathodoluminescence measurements. It was found that changing the vicinal angles of sapphire substrates can easily control the surface morphologies of AlN films. Spiral-growth features were greatly suppressed. Furthermore, well-ordered straight monatomic-layer steps and multi-atomic-layer macro-steps were clearly observed by atomic force microscopy. Surface diffusion and step incorporation kinetics during the growth are the key-factors in determining the surface morphologies.
[DOI : 10.1143/JJAP.42.L1293]
KEYWORDS: AlN, vicinal sapphire (0001) substrate, surface diffusion, step bunching, rf-MBE

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High-Power Continuous Wave Green Generation by Single-Pass Frequency Doubling of a Nd:$GdVO_4$ Laser in a Periodically Poled MgO:$LiNbO_3$ Operating at Room Temperature

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Continuous-wave power of 0.89 W at 531 nm with 14.3% conversion efficiency is reported at room temperature from a 2-mm-thick periodically polled uncoated MgO:$LiNbO_3$ by single-pass frequency doubling of a diode end-pumped Nd:$GdVO_4$ laser; the corresponding internal green power and conversion efficiency were 1.03 W and 16.5%, respectively. The MgO:$LiNbO_3$ device of 6.95-μm domain period was fabricated by using a high-voltage multi-pulse poling method; uniform periodicity and 50% duty cycle were obtained on the entire 10-mm-long crystal. The sample exhibited an effective nonlinear coefficient of 14 pm/V (~88% of the ideal nonlinear coefficient), resulting in a measured normalized conversion efficiency of 2.7%/W. To the authors best knowledge this is the highest power ever obtained by quasi-phase matching process at room temperature. [DOI : 10.1143/JJAP.42.L1296]
KEYWORDS: second-harmonic generation, quasi-phase matching, periodically poled MgO:$LiNbO_3$, Nd:$GdVO_4$ laser

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Solid Phase Crystallization in Initial Growth Region of Polycrystalline Silicon Layer During Deposition at 180°C by Plasma Chemical Vapor Deposition

Toshihiko TOYAMA, Riza MUHIDA, Tomokazu HARANO, Tsuyoshi SUGANO, Masaya OKAJIMA and Hiroaki OKAMOTO
(Received September 19, 2003; accepted September 29, 2003; published November 5, 2003)

Microstructures of low-temperature-grown polycrystalline Si (poly-Si) have been studied by transmission electron microscope measurements. Two poly-Si layers with different thicknesses in the n-i-p structure were prepared by plasma chemical vapor deposition at 180°C. The ~50-nm-thick amorphous-rich layer is observed at the bottom of the 0.5-μm-thick poly-Si layer. Meanwhile, in the first hundreds of nanometers in the 2.4-μm-thick poly-Si layer, an increase in the crystalline fraction due to crystalline columns grown onto the substrate n-layer is found. Solid phase crystallization during the deposition in the initial growth region down to the substrate is discussed. [DOI : 10.1143/JJAP.42.L1347]

KEYWORDS: solid phase crystallization, microstructure, plasma chemical vapor deposition, silicon, thin film

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^{29}Si Nuclear-Spin Decoherence Process Directly Observed by Multiple Spin-Echoes for Pure and Carrier-Less Silicon

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(Received September 22, 2003; accepted September 28, 2003; published November 5, 2003)

We report on the ^{29}Si nuclear spin decoherence time at room temperature for a pure (99.99999%, 7N) and carrier-less (p-type, doping level of 10^{15}cm^{-3}) silicon in which ^{29}Si nuclei are naturally abundant (4.7%). Despite the experimental difficulties coming from the extremely long spin-lattice relaxation time T_1 (of the order of 10^4 s), we have successfully observed a series of spin-echoes of which the time dependence is characterized by the decoherence time T_2. We found that the decoherence process deviates from a single Gaussian or Lorentzian function but is well-reproduced by a bi-exponential function with the shorter T_2^S=15± 5 ms and the longer T_2^L=200± 20 ms.
[DOI : 10.1143/JJAP.42.L1350]

KEYWORDS: ^{29}Si, NMR, quantum computing, decoherece, multiple spin-echoes, Carr-Purcell method

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Carrier Injection and Transport of Steady-State High Current Density Exceeding 1000 A/cm^2 in Organic Thin Films*

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(Received October 1, 2003; accepted October 8, 2003; published November 5, 2003)

We demonstrate carrier injection and transport of steady-state high current density into organic thin films. The maximum current density reaches J=1053A/cm^2, the highest ever reported. We employ a 25 nm-thick Copper phthalocyanine (CuPc) thin film sandwiched between an indium-tin-oxide anode and a magnesium-silver alloy cathode with an active electrode dot-size (S) of S=2.0×10^{-5}cm^2 (radius: r=25 μm). We observed that the maximum current density depends on the organic materials used, and the device size and thickness. Decreasing the organic layer thickness significantly changes the current density-voltage (J-V) characteristics, demonstrating that the rate-limiting step of the J-V characteristics changes from the carrier transport process to the carrier injection process. Our achievement of high current density exceeding 1000 A/cm^2 in organic thin films is a first step towards the development of organic laser diodes that need extremely high excitation intensity.
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KEYWORDS: high current density, 1000A/cm^2, OLED, organic laser diode, CuPc

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Insulator-Coated Carbon Nanotubes Synthesized by Pulsed Laser Deposition

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(Received September 18, 2003; accepted September 29, 2003; published November 5, 2003)

We present a method for synthesizing insulator-coated carbon nanotubes by pulsed laser deposition. Isolated multi-walled carbon nanotubes (MWNTs) were coated with an SiO_x thin layer in a multishell form. The product showed that a stoichiometric SiO_2 thin layer was uniformly wrapped around a MWNT, and reflected the shape of the MWNT. The thickness of the SiO_2 thin layer was precisely controlled in the range from 2 to 28 nm. The insulating property of the product was verified using a template of vertically oriented carbon nanotubes.
[DOI : 10.1143/JJAP.42.L1356]

KEYWORDS: carbon nanotube, SiO_2, insulator-carbon nanotube composites, coating, pulsed laser deposition

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Patterning GaN Microstructures by Polarity-Selective Chemical Etching

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(Received September 22, 2003; accepted October 21, 2003; published November 18, 2003)

We have demonstrated GaN microstructures formed by polarity-selective chemical etching in KOH solution. It was found that KOH selectively etches N-polar GaN but not Ga-polar GaN. The polarity-patterned GaN was grown by plasma-assisted molecular beam epitaxy. For intermediate etching times, hexagonal GaN pyramids were formed in the N-polar regions. With prolonged etching, the N-polar GaN can be completely removed. A one-dimensional array of GaN stripes and a two-dimensional array of hexagonal holes formed in a GaN matrix have been fabricated. Extremely smooth vertical sidewalls have been achieved along with an etch depth of up to 4 μm. [DOI : 10.1143/JJAP.42.L1405]

KEYWORDS: GaN, polarity-selective chemical etching, microstructures, molecular beam epitaxy

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Room Temperature Layer by Layer Growth of GaN on Atomically Flat ZnO

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(Received October 22, 2003; accepted November 6, 2003; published December 19, 2003)

We have grown GaN on atomically flat ZnO (000-1) substrates at room temperature with pulsed laser deposition (PLD). We have found that atomically flat surfaces of ZnO (000-1) substrates with a clear step and terrace structure have been obtained by annealing in a box made of ceramic ZnO. We have also found that GaN grows epitaxially even at room temperature on the step and terrace ZnO surface. Reflection high energy electron diffraction (RHEED) observations have revealed that the GaN film grows in the layer by layer mode from the early stage of the film growth. X-ray reflectivity measurements have revealed that the heterointerface between GaN and ZnO is quite abrupt and its roughness is less than 0.5 nm. [DOI : 10.1143/JJAP.43.L53]

KEYWORDS: GaN, ZnO, epitaxial growth, layer by layer growth, pulsed laser deposition

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Accumulation and Depletion Layer Thicknesses in Organic Field Effect Transistors

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We present a simple but powerful method to determine the thicknesses of the accumulation and depletion layers and the distribution curve of injected carriers in organic field effect transistors. The conductivity of organic semiconductors in thin film transistors was measured *in situ* and continuously with a bottom contact configuration, as a function of film thickness at various gate voltages. Using this method, the thicknesses of the accumulation and depletion layers of pentacene were determined to be 0.9 nm (V_G=–15 V) and 5 nm (V_G=15 V), respectively.
[DOI : 10.1143/JJAP.42.L1408]

KEYWORDS: field effect transistor, accumulation layer, depletion layer, organic film

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Organic Field-Effect Transistor of (Thiophene/Phenylene) Co-Oligomer Single Crystals with Bottom-Contact Configuration

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(Received October 21, 2003; accepted November 20, 2003; published December 26, 2003)

A novel and simple fabrication technique of organic field-effect transistors (FETs) of organic single crystals with bottom-contact configuration was proposed. The organic single crystal that was made by vapor phase growth was used as a FET semiconductor layer. The proposed fabrication process of the device is quite simple. That is, a single crystal is only placed on an electrode-prepared substrate. The devices exhibited good bottom-contact type FET characteristics, and the field-effect mobility reached 0.15 $cm^2 \cdot V^{-1} \cdot s^{-1}$ in the best device, which was higher than that of thin film transistors that were prepared by vacuum evaporation.
[DOI : 10.1143/JJAP.43.L100]

KEYWORDS: organic semiconductor, organic single crystal, organic transistor

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Improvement of Optical Properties of Air-Exposed Regrowth Interfaces Embedded in InAs Quantum Dots and GaAs/AlGaAs Quantum Wells by Atomic Hydrogen

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We report an atomic hydrogen cleaning effect on surface oxide and contaminants on airexposed interfaces embedded in GaAs quantum well (QW) and InAs quantum dot (QD). A partly grown GaAs QW and a GaAs buffer layer for InAs QDs were air-exposed and hydrogen cleaned. After this procedure, we directly regrew a GaAs QW and InAs QDs as an active layer. Removal of surface oxide was monitored by reflection high-energy electron diffraction. The cleaned surface showed β (2×4) reconstruction. The photoluminescence properties of GaAs/AlGaAs QWs and InAs/GaAs QDs showed no degradation compared with those of the reference samples, even though the air-exposed interfaces were included in the active regions. [DOI : 10.1143/JJAP.43.L103]

KEYWORDS: atomic hydrogen etching/cleaning, GaAs quantum wells (QWs), InAs quantum dots (QDs), regrowth, photoluminescence (PL), molecular beam epitaxy (MBE)

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Structure and Dielectric Behavior of Epitaxially Grown $SrTiO_3$ Film between $YBa_2Cu_3O_{7-\delta}$ Electrodes

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(Received November 6, 2003; accepted December 1, 2003; published January 9, 2004)

To obtain a high insulating $SrTiO_3$ layer, the parallel capacitors of epitaxially grown $YBa_2Cu_3O_{7-\delta}$ / $SrTiO_3$ / $YBa_2Cu_3O_{7-\delta}$ have been fabricated by a Chemical Mechanical Planarization method. The dielectric constant and tan δ of the $SrTiO_3$ film at 2.2 K was 27000 and 0.027 at 10 kHz, respectively. The temperature variation of the dielectric constant could be well fitted by the formulae of Curie-Weiss and Barrett in the temperature ranges above 100 K and $30<T<100$ K, respectively. The best-fit parameters were coincident with those for $SrTiO_3$ single crystals. In order to examine the influence of degraded $SrTiO_3$ layers at the $YBa_2Cu_3O_{7-\delta}$ / $SrTiO_3$ interfaces on the dielectric constant, a multilayer model involving two kind of $SrTiO_3$ layers with different dielectric characteristics was proposed. The results revealed that the degraded $SrTiO_3$ layer is very thin and the dielectric constant of the $SrTiO_3$ film was dominated by that of single-crystal-like $SrTiO_3$ layer.
[DOI : 10.1143/JJAP.43.L170]

KEYWORDS: STO film, YBCO, epitaxial growth, parallel capacitor, dielectric constant, Curie-Weiss law, Barrett formula

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Fabrication of Organic Monolayer Modified Ion-Sensitive Field Effect Transistors with High Chemical Durability

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(Received October 29, 2003; accepted November 15, 2003; published December 26, 2003)

Fabrication of ion-sensitive field effect transistor (FET) with modified SiO_2 gate by various organosilane monolayers was investigated. By precise control of the fabrication processes, the FETs modified with various functional monolayers were successfully formed on the same substrate. Each modified device indicates typical transistor property with a good stability in aqueous solution. The transistor with amino monolayer modified gate showed good pH sensitivity of 58 mV/pH, whereas the profiles of transistor with the perfluoro-alkyl monolayer modified gate kept constant in any pH solutions. These monolayer-modified devices are expected to be applied as an ion-sensitive and a reference electrode for sensing devices in the solution. [DOI : 10.1143/JJAP.43.L105]

KEYWORDS: organic monolayer, modification, field effect transistor, durability, aqueous solution, pH responsibility, sensing devices

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Improved External Efficiency InGaN-Based Light-Emitting Diodes with Transparent Conductive Ga-Doped ZnO as p-Electrodes

Ken NAKAHARA*, Kentaro TAMURA, Mitsuhiko SAKAI, Daisuke NAKAGAWA, Norikazu ITO, Masayuki SONOBE, Hidemi TAKASU, Hitoshi TAMPO[1], Paul FONS[1], Koji MATSUBARA[1], Kakuya IWATA[1], Akimasa YAMADA[1] and Shigeru NIKI[1]
(Received November 18, 2003; accepted December 8, 2003; published January 9, 2004)

Transparent conductive Ga-doped ZnO (ZnO:Ga) was fabricated to serve as p-contacts of InGaN-based light-emitting diodes (LEDs) using molecular-beam epitaxy. As-grown ZnO:Ga films typically have resistivities of ρ=2-4×10^{-4} Ω·cm, and over 80% transparency in the near UV and visible wavelength ranges. The current-voltage characteristics between as-grown ZnO:Ga contacts and p-GaN layers were ohmic. The brightness of LEDs fabricated with ZnO:Ga p-contacts was nearly double compared to LEDs with conventional Ni/Au p-contacts. We obtained the external efficiency as high as 20.8% in the case of the near UV LED. The forward voltage at 20 mA was found not to increase even after the lamp LED with ZnO:Ga were kept for 80 h in high humidity and high temperature environments. [DOI : 10.1143/JJAP.43.L180]

KEYWORDS: ZnO, GaN, InGaN, LED, MBE, external efficiency, transparent, reliability, ohmic contact

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Influence of Small Amounts of Dispersed Single-Walled Carbon-Nanotubes on the Optical Properties of Poly-3-hexylthiophen

Jun TSUKAMOTO* and Junji MATA
(Received November 21, 2003; accepted December 12, 2003; published January 16, 2004)

We studied the dispersion of single-walled carbon-nanotubes (SWNTs) in poly-3-hexylthiophene (P3HT) and the influence of their dispersion on the optical properties of the polymer. The bundles of SWNTs were found to be well dispersed in P3HT solution, being broken up into finer ropes. We also found that dispersal of only a small amount (less than 1 wt%) of SWNTs in P3HT gives rise to a steep increase in optical absorbance close to the absorption edge, remarkable quenching of photoluminescence, and formation of oriented micro-domains. These results suggest that an ordered structure in the conjugation of P3HT is formed by the incorporation of SWNTs. [DOI : 10.1143/JJAP.43.L214]

KEYWORDS: carbon-nanotubes, poly-3-hexylthiophene, absorbance, conjugation, photoluminescence

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Optical Fuse by Carbon-Coated TeO_2 Glass Segment Inserted in Silica Glass Optical Fiber Circuit

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Excessive-light-induced melt down was observed in a carbon-coated TeO_2 glass segment formed between a pair of optical fiber end-faces. This structure was made by splicing single-mode silica fibers through TeO_2 glass melt to form a necked bridge, which was coated with carbon-containing paint after quenching it. Optical fusing action was induced by 0.3-1.5 W of CW light (1.54 μm) and its output power dropped by 12 dB on average. Optical decoupling seems to be induced by not only deformation but also crystallization of the glass bridge. Its quite a high insertion loss of about 2 dB can be reduced by introducing some refractive index modulations into the present structure.
[DOI : 10.1143/JJAP.43.L256]

KEYWORDS: optical fiber, tellurium oxide glass, carbon, optical fuse, hybrid device

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Electrical and Optical Control of Ferromagnetism in III-V Semiconductor Heterostructures at High Temperature (~100 K)

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(Received December 5, 2003; accepted December 15, 2003; published January 16, 2004)

We demonstrate the electrical and optical control of ferromagnetism in semiconductor heterostructures at high temperatures of 100-117 K. The heterostructures consist of Mn delta (δ)-doped GaAs and *p*-type AlGaAs. We are able to isothermally change the paramagnetic state to the ferromagnetic state and *vice versa*, by applying a gate electric-field or by light irradiation. The large modulation of T_C (ΔT_C ~15K) at high temperatures (>~100 K) demonstrated here may pave the way for functional device applications compatible with the present semiconductor technology. [DOI : 10.1143/JJAP.43.L233]

KEYWORDS: ferromagnetism, delta doping, Mn, GaAs, magnetic semiconductor, heterostructure, selective doping

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Contribution of Shape Anisotropy to the Magnetic Configuration of (Ga, Mn)As

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We report on an effect of shape anisotropy on the magnetic configuration of the magnetic semiconductor (Ga, Mn)As using magnetoresistance (MR) measurements. A substantial change in the MR curve occurs for a wire sample with a width of 0.8 μm, in which the shape anisotropy along the wire axis is more significant than the intrinsic magnetic anisotropy. Moreover, the magnetic configuration of the wire sample depends on the hole concentration which has an influence on the cubic, uniaxial and shape anisotropy, being reflected by the hole induced ferromagnetic characteristics of (Ga, Mn)As. [DOI : 10.1143/JJAP.43.L306]

KEYWORDS: III-V magnetic semiconductors, (Ga, Mn)As, magnetic anisotropy, shape anisotropy

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Liquid Crystal Biaxiality at the Polymer Alignment Surface Studied Using Infrared Dichroism

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(Received December 22, 2003; accepted December 28, 2003; published February 6, 2004)

Using infrared dichroism technique and wedge cell, we have investigated the surface order of nematic liquid crystal at the polymer alignment surface. The results show that the order parameter at surface is much lower than that of bulk, and a light biaxiality exists at the interface between a liquid crystal and the alignment layer. The distribution of both order parameter and biaxiality parameter over the liquid crystal layer follows an exponent function. [DOI : 10.1143/JJAP.43.L312]

KEYWORDS: liquid crystals, order parameter, surface, biaxiality, infrared dichroism

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Teflon Photonic Crystal Fiber as Terahertz Waveguide

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We demonstrate the construction of reasonably long and non-polarization changing photonic fiber waveguide using Teflon which is a readily available and highly flexible material. Due to its relatively low loss coefficient, the possibility of preparing longer photonic fiber waveguide, which has the potential of guiding intense THz radiation, can be easily attained. [DOI : 10.1143/JJAP.43.L317]

KEYWORDS: terahertz radiation, waveguide, photonic crystal fiber, polarization

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The First Observation of ^{1}H-NMR Spectrum of Pentacene

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Despite much interest in pentacene as a promising organic semiconductors, its chemical properties have scarcely been elucidated. Even such a fundamental data as ^{1}H-NMR spectrum has not been reported yet due to poor solubility of pentacene in various solvents. Here we report the first observation of ^{1}H NMR spectrum of pentacene by using dimethyl sulfoxide-d_6 as solvent and heating the sample to 80°C. Not only the signal assignment but also the easily oxidizable property of pentacene was verified from the comparison between the spectra measured in degassed and non-degassed solvents. [DOI : 10.1143/JJAP.43.L315]

KEYWORDS: pentacene, NMR, organic semiconductor

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Observation of Exciton Transition in 1.3-1.55μm Band from Single InAs/InP Quantum Dots in Mesa Structure

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Single InAs/InP quantum dots from the O-band (1.3 μm) to the C-band (1.55 μm) were produced in order to realize a quantum information device for optical telecommunication. Our single quantum dot in any band has a sharp and discrete exciton line. To obtain quantum dots with intensive emissions, we applied a `double-cap' growth technique to metalorganic chemical vapor deposition. To lower fabrication damage to quantum dots, we employed photolithography and wet chemical etching for fabricating 140-nm mesa structure with a quantum dot. Combination of the growth and the fabrication techniques is essential to the good optical property. [DOI : 10.1143/JJAP.43.L349]

KEYWORDS: InAs/InP, single quantum dots, double-cap growth, MOCVD, C-band, O-band

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Band Structures of Wurtzite InN and $Ga_{1-x}In_xN$ by All-Electron GW Calculation

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The experimentally reported bandgap of wurtzite-type InN dramatically decreased from 1.9 eV to 0.7-0.8 eV very recently. In this paper we report first-principles electronic band-structure calculations of InN by using the all-electron full-potential linearized augmented-plane-wave (FLAPW) method in both local-density approximation (LDA) and *GW* approximation (GWA), and provide the reliable theoretical bandgap of InN. Our calculation suggests that InN is a narrow-gap semiconductor and strongly supports the recently reported smaller bandgaps. Moreover, we reproduce the bandgap change of $Ga_{1-x}In_xN$ ternary alloys as a function of In content x. The present work supports the possibility of bandgap control in the entire range of visible light, using nitrides alone.
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KEYWORDS: InN, bandgap, GW calculation

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The Impact of Supercritical Fluoro-Compounds on Lithography Use

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This article describes the use of supercritical fluoro-compounds for supercritical resist drying. In contrast to carbon dioxide, fluoro-compounds, which are heavier than water in liquid form, can displace the rinse water on the resist due to the difference in specific gravity. The removal of rinse water from a sample surface by replacing it with a liquid fluoro-compound, followed by the conversion of the compound to the supercritical state, enables patterns to be formed without collapse and without the use of a surfactant. Furthermore, with the help of helium, which can be released quickly from the chamber, the use of supercritical fluoro-compounds like C_2HF_5 and SF_6 also enable the very fast supercritical resist drying of water-rinsed resists for advanced lithography.
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KEYWORDS: supercritical drying, supercritical fluid, fluoro-compounds, resist, advanced lithography

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InAs/AlGaSb Piezoresistive Cantilever for Sub-Angstrom Scale Displacement Detection

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We report on the fabrication and characterization of 0.3-μm-thick piezoresistive cantilevers based on the InAs/AlGaSb heterostructure. The dependence of the displacement resolution on the cantilever size, which ranges from 20×10 to 2×1μm^2, has been studied by a novel characterization method using an atomic force microscope. The results show that downscaling the cantilevers improves their performances, and an optimum resolution of 0.26Å/Hz$^{0.5}$ was obtained with a 3×1.5μm^2 cantilever at a modulation frequency of 714 Hz. A finite-element simulator allowed the calculation of the resonance frequencies and a maximum value of 20.5 MHz was obtained for the 3×1.5μm^2 cantilever.
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KEYWORDS: InAs/AlGaSb, cantilever, piezoresistivity, AFM, subangstrom

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Extraction of Trap Distribution in Organic Semiconductors by Transient Photocurrent

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The mobility of photoinjected holes in smectic-B liquid crystals as measured by time of flight shows an electric field dependence at low fields. This dependence is suspect, for whether the mobility rises or falls with field depends on the method by which the photocurrent transients are analyzed. In the context of the multiple trapping model, a general formalism is developed for analyzing the transients, in which the distribution of traps may be determined under the assumption that the Einstein relation between the mobility and the diffusion constant is obeyed. For the smectic-B liquid crystal, this distribution is adequately described by a Gaussian of depth 100 meV and width 50 meV.
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KEYWORDS: transient photocurrent, time of flight method, liquid crystal, smectic B phase, organic semiconductor

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350.9 nm UV Laser Diode Grown on Low-Dislocation-Density AlGaN

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We demonstrated a UV-laser diode grown on low-dislocation-density AlGaN. The combination of a low-temperature-deposited AlN interlayer technology and heteroepitaxial lateral overgrowth yielded crack-free and partially low-dislocation-density AlGaN on a grooved GaN substrate. A ridge waveguide was fabricated in the low-dislocation-density region. The lasing wavelength under pulsed current injection at room temperature was 350.9 nm, which is the shortest wavelength ever reported.
[DOI : 10.1143/JJAP.43.L499]

KEYWORDS: UV laser diode, dislocation, AlGaN, GaN, LT-AlN interlayer, heteroepitaxial lateral overgrowth

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New Route to Fabricate Ferromagnetic Semiconductors without Transition Metal Elements

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We propose a new route for ferromagnetic diluted magnetic semiconductors by controlling the impurity-band width (W) and the electron-correlation energy (U) in the partially occupied impurity band in the condition of highly correlated electron system ($U>W$). Based upon first-principles calculations of K_2(S,Si) and K_2(S,Ge), we demonstrate that transparent, half-metallic and room-temperature ferromagnetic DMS could be designed even without transition metal elements. The results show that it is possible to fabricate the room-temperature ferromagnets in K_2(S,Si) and K_2(S,Ge) around 8 at%-impurity concentration.
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KEYWORDS: materials design, potassium sulfide, *p*-impurity band, ferromagnetism without transition metal elements

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High Performance of Silicon Oxide Selective Etching Using F_2 Gas and Graphite Instead of Perfluorinated Compound Gases

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We have demonstrated an environmentally benign SiO_2 selective-etching process in a magnetron plasma using a graphite target and F_2 gas instead of perfluorinated compound (PFC) gases. The top electrode of graphite was supplied with power from two different 13.56 MHz and 450 kHz RF sources. The amount of C-based species in the plasma was controlled by the 450 kHz RF source bias voltage. The F atom density was controlled in the plasma by changing the amount of F_2 feed gas. High SiO_2/resist selectivity and a vertical etching pattern profile were realized. Microtrenching was suppressed by the injection of high energy electrons. [DOI : 10.1143/JJAP.43.L501]

KEYWORDS: etching, graphite, carbon, fluorine, CF, radical density, microtrenching

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Sample-and-Hold Imaging for Fast Scanning in Atomic Force Microscopy

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We have proposed to use a sample-and-hold circuit for direct monitoring of cantilever deflection signals as a novel method for fast imaging in an intermittent contact mode atomic force microscopy (AFM). This method enables us to construct a quasi-topographic image from tip heights at moments when the tip taps on a sample surface. As a result, we obtained the tip height image well corresponding to the sample topography at a scanning rate above 30 Hz/line without any other customization on both a cantilever and a piezo scanner in a commercial AFM system. [DOI : 10.1143/JJAP.43.L58]

KEYWORDS: atomic force microscopy, sample-and-hold circuit, fast imaging, quality-factor

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Emission Characteristics of Extreme Ultraviolet Radiation from CO_2 Laser-Produced Xenon Plasma

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We propose a CO_2 laser-produced plasma as the extreme ultraviolet (EUV) light source for a future optical lithography system. The EUV radiation around 13.5 nm was generated by focusing the laser beam from a transversely-excited atmospheric CO_2 laser (4 J, 50 ns full width at half-maximum (FWHM)) on a Xe gas target and a Xe cryogenic target. The EUV energy was measured by a Flying Circus II detecting system, and an output energy of more than 3 mJ/pulse and an conversion efficiency of more than 0.1% per 2π sr at 13.5 nm were obtained. These values are comparable to those of Nd:YAG laser-produced plasma, indicating the potential scalability of the EUV light source using a CO_2 laser produced plasma. [DOI : 10.1143/JJAP.43.L585]

KEYWORDS: extreme ultraviolet lithography, extreme ultraviolet sources, laser-produced plasmas, Xenon, CO_2 laser

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High Tunnel Magnetoresistance at Room Temperature in Fully Epitaxial Fe/MgO/Fe Tunnel Junctions due to Coherent Spin-Polarized Tunneling

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(Received February 24, 2004; accepted March 10, 2004; published April 2, 2004)

We fabricated fully epitaxial Fe(001)/MgO(001)/Fe(001) magnetic tunnel junctions (MTJs) and observed a magneto-resistance (MR) ratio of 88% at T = 293 K (146% at T = 20 K), the highest value yet reported. The origin of the high MR ratio is not the diffusive tunneling of Julliere's model but the coherent spin-polarized tunneling in epitaxial MTJs, in which only the electrons with totally symmetric wave functions with respect to the barrier-normal axis can tunnel. The bias-voltage dependence of the MR was very small, resulting in a high output voltage of 380 mV. This high voltage will help overcome problems in the development of high-density magnetoresistive random-access-memory (MRAM).
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KEYWORDS: tunnel magnetoresistance, TMR effect, magnetic tunnel junction, MRAM, epitaxial growth

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Observation of Revival Structure in Femtosecond-Laser-Induced Alignment of N_2 with High-Order Harmonic Generation

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We report a new sensitive method using high-order harmonic generation to observe revival structure in fs-laser induced alignment of a rotational wave packet of molecules. Pump and probe fs-laser pulses with a time delay were focused collinearly into a pulsed N_2 gas jet, so that the pump pulse induces alignment of a ground-state rotational wave packet, and the delayed probe pulse produces harmonic radiation from the aligning molecules. The harmonic signal observed as a function of time delay has clearly demonstrated a typical time-dependent revival structure in the field-free alignment of molecules. [DOI : 10.1143/JJAP.43.L591]

KEYWORDS: revival structure, rotational wave packet, molecular alignment, high-order harmonic generation, femtosecond laser

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