ABSTRACTS OF PUBLISHED PAPERS

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CONDENSED MATTER AND MATERIAL

Arsenic Surfactant Effects and Arsenic Mediated Molecular Beam Epitaxial Growth for Cubic GaN

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Appl. Phys. Lett. **72** 23 (1998) 3056

Small amounts of As residual pressure were found to affect the structure of cubic GaN growing surfaces in molecular beam epitaxy growth, i.e., modification of surface reconstruction structures, stabilization of reconstructed flat surfaces at high substrate temperatures, and preferential growth of the cubic phase. These As surfactant effects are discussed in relation to the atomic arrangement of the As-passivated surface of GaN.It was shown that the quality of cubic GaN epilayers can be improved by utilizing a small amount of As residual pressure.

Microphotoluminescence Studies of High Quality Single Quantum Wires

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Solid-State Electronics **42** 7-8 (1998) 1217-1221

Microscopic photoluminescence and photoluminescence excitation spectroscopy are used in order to investigate exciton localization in quasi one dimensional systems such as crescent-shaped AlGaAs/GaAs quantum wires grown on a V-grooved substrate. We found that one wire is segmented into extended sections of hundreds of nanometres with slightly different confining potentials. Inside these sections one monolayer deep quantum boxes are present on the (001) top facet of the wire with lengths comparable to the exciton Bohr radius.

Polaron Versus Bipolaron in Conducting Polymers: a Density Matrix Renormalization Group Study

Makoto KUWABARA, Yukihiro SHIMOI, and Shuji ABE
Journal of the Physical Society of Japan
67 5 (1998) 1521-1524

Competition between polaron and bipolaron in conjugated polymers with nondegenerate ground state is systematically studied in the extended Hubbard-Peierls model with the symmetry-breaking Brazovskii-Kirova term, using the density matrix renormalization group method combined with lattice optimization in the adiabatic approximation. We demonstrate that the relative stability of a bipolaron over two separated polarons sensitively depends on both on-site Hubbard U and nearest-neighbor repulsion V. When U is much larger than V, the bipolaron state is more stabilized compared with mean field calculations.

Theoretical Study on the Absorption Spectra of Pseudoisocyanine Bromide (PIC Br) Molecular J-Aggregates

T. KATO, F. SASAKI, S. ABE, S. KOBAYASHI
Chem. Phys **230** (1998) 209-221

The linear dichroic absorption spectrum of pseudoisocyanine bromide (PIC-Br) molecular J-aggregates is theoretically analyzed by the dynamical coherent potential approximation and numerical calculations. The absorption

spectra with the electric field polarization parallel and perpendicular to the one dimensional axis of the oriented J-aggregates are well explained in terms of Davydov components. Above the one-phonon continuum in the dispersion curve of the exciton-phonon system, splitting of an exciton polaron band is observed. This exciton polaron state is assigned to the largest peak in the case of the latter polarization. The absorption intensity differences between the lowest peak and the 2nd peak observed in two polarization conditions are simply explained by the character of the relevant states.

Increased Rate of Ozone Adsorption on Si(111)-(7x7) with Nitrogen Preadsorption

Ken NAKAMURA, Akira KUROKAWA,
and Shingo ICHIMURA
Surface Science **402-404** (1998) 165-169

We observed by surface second harmonic generation (SHG) that initial rate of second harmonics (SH) intensity decay during ozone adsorption on nitrogen-preadsorbed Si(111) was four times faster than on clean Si(111)-(7x 7) because of the adsorption not only of atomic oxygen but also of oxygen molecules released by the dissociation of incident ozone molecules. The temperature dependence of the adsorption rate on nitrogen-adsorbed Si(111) was opposite to that on the clean Si(111)-(7x 7) surface, but similar to that of molecular oxygen on Si(111)-(7x 7). With increasing surface temperature, the sticking probability lessened in a similar way to that of molecular oxygen. This suggests that the sticking probability of molecular oxygen released by dissociating ozone molecules increases on nitrogen-adsorbed Si(111).

The Origin of Persistent Photoconductivity and its Relationship with Yellow Luminescence in Molecular Beam Epitaxy Grown Undoped GaN

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Hajime OKUMURA, Sadafumi YOSHIDA
Appl. Phys. Lett. **73** 2 (1998) 244-246

The results of persistent photoconductivity (PPC) and photoluminescence measurements made on radio-frequency plasma-assisted molecular beam epitaxy-grown undoped GaN are reported in this work. Hexagonal GaN (h-GaN) epilayers grown on sapphire and cubic GaN (c-GaN) epilayers grown on GaAs and cubic SiC substrates, are employed in this study. Three clear experimental evidences are reported to claim that the commonly seen persistent photoconductivity and yellow luminescence (YL) are related to each other through the same defect. First, PPC is observed only in those samples which show YL. Second, the threshold (the minimum photon energy) required to observe PPC is determined as 1.6±0.2eV, which is almost at the same energy at which the YL band starts rising. Third, the photocurrent increases monotonically from 1.8 to 2.2eV, which is consistent with the broad nature of YL band.

Study on the Initial Stages of Heteroepitaxial Growth of Hexagonal GaN on Sapphire by Plasma Assisted MBE

Krishnan BALAKRISHNAN, Hajime OKUMURA,
Sadafumi YOSHIDA
J. Cryst. Growth **189/190** (1998) 244-249

We have studied several growth initiation processes for heteroepitaxial growth of hexagonal GaN on (0001) sapphire substrates by molecular beam epitaxy using radio-frequency N_2 plasma. Based on the results of reflection high-energy electron diffraction, high-resolution X-ray diffraction and high-resolution transmission electron microscopy analyses, it was found that the nitridation process results in better structural quality of epilayers compared with the low-temperature buffer layer processes. By using nitrogen flux modulation during the initial period of main growth of GaN, very flat and smooth surfaces could be obtained. The best ever value of X-ray diffraction full-width at the half-maximum value of 51 arcseconds for MBE grown hexagonal GaN epilayers on sapphire was achieved.

Analysis of MBE Growth Mode for GaN Epilayers by RHEED

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J. Cryst. Growth **189/190** (1998) 364-369

The growth mode of hexagonal GaN epilayers on sapphire (0001) surfaces during N_2 plasma-assisted molecular beam epitaxy was investigated using in-situ reflection high energy electron diffraction technique. It was found that Ga-rich condition results in flat surface showing streak patterns rather than N-rich condition, and the intensities of diffraction spots show different behavior between Ga-rich and N-rich conditions. For the specular spot, oscillation-like intensity variations were observed according to the supply of Ga flux, which depends on Ga flux intensity and substrate temperature. At the lower temperature region, the growth of cubic GaN was observed with its [111] crystal axis along the normal direction of sapphire (0001) surface.

Growth of Cubic III-Nitrides by Gas Source MBE Using Atomic Nitrogen Plasma: GaN, AlGaN and AlN

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J. Cryst. Growth **189/190** (1998) 390-394

Cubic GaN, AlGaN and AlN epilayers were grown on 3C-SiC (001) substrates by gas source molecular beam epitaxy using radio-frequency N_2 plasma containing atomic nitrogen species. Due to the enhancement of growth rate by this plasma source, cubic GaN epilayers with the thickness of several micrometers were obtained, and the quality of epilayers was so much improved that they showed X-ray diffraction peak width of as small as 9min. Cubic $Al_xGa_{1-x}N$ and cubic AlN epilayers were also grown, and the variations of X-ray diffraction peak position and emission energy were observed according to the Al content.

Surface Reconstruction and As Surfactant Effects on MBE-Grown GaN Epilayers

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Materials Science Forum **264-268** (1998) 1167-1172

Surface reconstructions and their transitions have been examined for MBE-grown GaN surfaces. Several types of reconstructions and their transitions were observed depending on growth condition, crystal structure etc. It is shown that the surface reconstruction phase diagram and its phase transition line are useful for the optimization of MBE growth of GaN. Little amount of As residual pressure was found to affect the structure of GaN growing surfaces. These As surfactant effects are discussed and the growth of cubic GaN under small amount of As pressure is reported.

Oscillatory Magneto-Optical Effect in a Au(001) Film Deposited on Fe: Experimental Confirmation of a Spin-Polarized Quantum Size Effect

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Physical Review Letters **80** 23 (1998) 5200-5203

Magneto-optical response of the wedge-shaped Au ultrathin film grown on an Fe layer was investigated precisely. The magnetic circular dichroism in the reflection configuration oscillates with respect to the Au layer thickness showing superposition of several oscillations with different periods. The energy dependence of the oscillation periods is clearly explained by a concept of the spin-polarized quantum size effect in the Au layer by employing fully relativistic band calculation and electron-electron correlation.

ELECTRONIC DEVICES

Alignment of Ge Three-Dimensional Islands on Faceted Si(001) Surfaces

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Thin Solid Films **321** 1-2 (1998) 55-59

Arrays of Ge three-dimensional (3D) islands were grown on a Si(001) substrate by molecular beam epitaxy without any lithographic process. Dislocation-free islands 50nm in diameter were aligned to the [1$\bar{1}$0] direction of a vicinal Si(001) substrate tilted 4-degree toward [110]. Surface undulations consisting of (001) and (11x), x=8~10, facets with a 360nm period were self-organized on the Si buffer layer. Ge 3D islands were then preferentially grown on the upper edge of the (001) facets and were arranged in line accordingly.

Thz Generation from Photoconductive Switches with Nanostructures

Taro ITATANI, Kazuhiko MATSUMOTO,
Tadashi NAKAGAWA
Journal of Surface Analysis **4** 2 (1998)

Insulator gap photoconductive switches have been fabricated by using an Atomic Force Microscope. The ultra fast response of the switch was measured by the electro-optic sampling system which can estimate longitudinal and transverse component of electric field. The ultra fast response in the femtosecond region has estimated for various photoconductive switches with various nano-structures.

BIOSCIENCE

Weighted Minimum-Norm Source Estimation of Magnetoencephalography Utilizing the Temporal Information of the Measured Data

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Journal of Applied Physics **83** 11 (1998) 6441-6443

The weighted minimum-norm estimation (wMNE) is a popular method to obtain the source distribution in the human brain from magneto- and electro- encephalographic measurements when detailed information about the generator profile is not available. We propose a method to reconstruct current distributions in the human brain based on the wMNE technique with the weighting factors defined by a simplified multiple signal classification(MUSIC) prescanning. In this method, in addition to the conventional depth normalization technique, weighting factors of the wMNE were determined by the results of MUSIC prescanning, which contains the temporal information of the measured data. We performed computer simulation of the proposed method and compared it with the conventional wMNE. The results show that the proposed method is effective for the reconstruction of the current distribution from noisy data.

Sequential Hemodynamic Activation of Motor Areas and the Draining Veins During Finger Movements Revealed by Cross-Correlation between fMRI Signals

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Kenji KAWANO
Neuroreport **l9** 9 (1998) 1969-1974

Activity in the human supplementary motor area (SMA), primary motor cortex (MI) and the draining vein of the motor cortex during a visual triggered finger opposition task was measured by functional magnetic resonance imaging with a repetition time (TR) of 1 sec. Sequential hemodynamic activation in these areas was revealed by cross-correlating a signal sequence in MI directly with the others, and applying polynomial fitting with the aid of Akaike's Information Criterion. We succeeded in detecting a time delay of ~0.5 sec between the activation of SMA and MI, and a delay of ~1.3 sec between the activation of MI and its draining vein. The new combination of techniques has attained a time resolution that was comparable to those in preceding studies that used shorter TRs of 100-200 msec.

MEASUREMENT AND STANDARD

A Maximum Step Voltage Test of 1 V Josephson Junction Arrays

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CPEM'98 Conference Digest 443-444

A maximum step voltage test of two 1-V Josephson junction arrays fabricated at different places were performed. Maximum zero-crossing voltages, frequency of the millimeter waves, and their power are measured. These items are demonstrated to be useful to discuss performance of arrays.

Estimation of Capacitance of Small Junction From Liquid He Temperature Measurement

Akio IWASA, Akio FUKUSHIMA, Akira SATO,
Yasuhiko SAKAMOTO
CPEM'98 Conference Digest 215-216

We show the way to estimate capacitance C and tunnel resistance R_T of small junction from 4.2K measurements using high temperature expansion for I-V curve. It enables us prompt feedback to fablicate the single electron tunneling elements.

A Multi-Frequency Quadrature Bridge

Yasuhiro NAKAMURA, Akio FUKUSHIMA,
Yasuhiko SAKAMOTO, Tadashi ENDO
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CPEM'98 Conference Digest

A quadrature bridge has been developed with the aim of determining capacitance values at several frequencies in terms of a resistance ultimately derived from the QHR. The bridge is evaluated by comparing a 1 nF capacitor with a 100 kΩ resistor at six frequencies from 3/8×10/2πkHz to 10/2πkHz.

Calibration of Precision Measuring Amplifiers for Strain Gauge Transducers

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CPEM'98 Conference Digest

A method is described that utilizes a ratio device consisting of multi-decade voltage dividers to calibrate precision measuring amplifiers for strain gauge transducers. Most frequently, this device is used to calibrate 2.5 mV/V ranges of the amplifiers, relative standard uncertainty being 5 ppm for the ratio of 0.0025 and at 225 Hz.

Absolute Measurement of Ir-192

Yoshio HINO, Hideaki OHGAKI
Applied Radiation and Isotopes **49** 9-11 (1998) 1179-1183

The radioactivity of Ir-192 has been measured with several different techniques. The conventional 4πβ–γ coincidence results were confirmed by the 4πβ–γ(Ge) spectroscopic coincidence method, in which a large HPGe detector [120% cf. 3"×3" NaI(Tl)] was used to avoid low γ-efficiency problems. A well type NaI(Tl) crystal was applied for the 4πγ counting, which was very effective for such multi-γ emitting nuclides. These results were in good agreement, and those of preliminary relative measurements with ionization chambers and γ-spectrometry were also in reasonable agreement.

Analysis of 4πγ Ionization Chamber Response Using EGS4 Monte Carlo Code

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Applied Radiation and Isotopes **49** 9-11 (1998) 1245-1249

The response of three types of 4πγ re-entrant well pressure ionization chambers filled with argon or nitrogen were calculated by means of the EGS4 Monte Carlo code as a function of photon energy and compared with experimental results. Excellent agreement was found between calculations

and experimental results. This code was also used for the evaluation of corrections required in the change of source conditions such as the displacement of source position. In the medium and high energy region, the chamber response increased when the source was moved to off-center position from center whereas the response decreased in low energy region. This phenomena can be explained by a change of geometry and the absorption of photons in an inner cylindrical absorber tube of the chamber.

Automatic Compensation of Dead Time Effects

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Applied Radiation and Isotopes **49** 9-11 (1998) 1123-1126

A method was proposed and demonstrated for an automatic compensation of dead time effects, where pseudo pulses whose number are equivalent to the counting losses due to dead time are generated as accidental coincidence counts by a gating method, and inserted into the observed pulse train after delay. In the present work, two gate circuits were used in order to make a 2nd order approximation to the dead time compensation. This method was tested for a NaI(Tl) scintillation detector and a GM counter. Dead time effects were completely compensated up to 200 ks^{-1} in the case of a NaI(Tl) scintillation detector with a dead time of 3 μs. Even for the case of the GM counter with an extended dead time of 250 μs, this method is still useful up to 1 ks^{-1}. Since the correction can be achieved at every instant during counting time, this method is applicable even when the count rate changes significantly with time.

ENERGY TECHNOLOGY

Two-Dimensional Measurement of Laser-Induced Target Movement by Face-on Interferometry

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Yuji MATSUMOTO, Isao OKUDA, Yoshiro OWADANO
Optics Communications **150** (1998) 56-60

Initial movement of laser irradiated foil targets has been measured by face-on interferometry with two- dimensional resolution. This interferometric method provides direct and precise information about initial movement of the rear surface of the target compared with conventional diagnostics. The target movement of 20nm-500nm from the original position has been observed.