

ABSTRACTS OF PUBLISHED PAPERS

(Accepted March , 1999)

CONDENSED MATTER AND MATERIAL

Raman Studies on Phonon Modes in Cubic AlGa_xN Alloy

Hiroshi HARIMA¹, Toshiaki INOUE¹,
Shin-ichi NAKASHIMA¹, Hajime OKUMURA,
Sadafumi YOSHIDA, Takayoshi KOIZUMI²,
H. GRILLE³ and F. BECHSTEDT³

¹*Osaka University*

²*Shibaura Institute of Technology*

³*Institute für Festkörperteorie und Theoretische Optik
Appl. Phys. Lett. 74 (1999) 191*

Cubic Al_xGa_{1-x}N alloy layers have been successfully grown for x=0-1 by gas-source molecular beam epitaxy on cubic-SiC/Si substrates, and the compositional dependence of the transverse-optic (TO) and longitudinal-optic (LO) phonon modes has been studied by Raman scattering. The LO-mode frequency of mixed crystals shows a systematic variation from the pure cubic AlN phase to the cubic GaN phase (one-mode type). On the contrary, there are two branches for the TO mode varying slowly in frequency with the composition (two-mode type). This behavior is explained within a random-element-isodisplacement model including the effect of polarization field. Our result indicates a strong polarization field acting on the cation-nitrogen bonds.

Field Emission Microscope Images of Oxygen Adsorption on Tungsten at 300 K and Higher Coverages

Mieko SATO and Osamu NISHIKAWA¹

¹*Department of Electronic Engineerings, Kanazawa
Institute of Technology*

Jpn.J.Appl. Phys. 38 Part1 1A (1999) 215-216

Adsorption of oxygen at higher coverages on a tungsten tip at 300 K is characterized by the observation of FEM images and using the model proposed by the first author for FEM images of gas-adsorbed hemispherical surface of BCC transition metals. The model is applied to the interpretation of the dependence of sticking probabilities upon crystallographic planes shown in a recent review and the STM images observed in oxygen adsorption on (110) planes of FCC metals.

Coverage Properties of Nb/Al Films Made by Electron Cyclotron Resonance

Antonio ESPOSITO, Hiroshi NAKAGAWA,
Hiroshi AKOH and Susumu TAKADA¹

¹*Saitama University*

Jpn. J. Appl. Phys. 38 Part1 1A (1999) 48-51

We perform growth of thin Al films using the electron cyclotron resonance (ECR) technique on {100} Si wafer and bcc {110} Nb thin films at room temperature. The {110} Nb thin films are also prepared by means of ECR. We carry out depositions using Xe plasma gas. We analyse the surface structure of the films using reflection high-energy electron diffraction (RHEED) and atomic force microscopy (AFM). The analysis shows that Al films are polycrystalline on both Nb and Si substrates. Moreover, very thin Al films on Nb show a remarkable match with Nb surfaces that in turn, exhibit epitaxial behaviour and atomic scale flatness. This results in a good coverage of the Nb base itself.

Patterns around the (110) Plane of Field Emission Microscope Images of Tungsten Tips

Mieko SATO and Osamu NISHIKAWA¹

¹*Department of Electronic Engineering, Kanazawa
Institute of Technology
Jpn. J. Appl. Phys.* **37** Part 1 8 (1988) 4554-4556

Two types of Field Emission Microscope images of a O₂-W adsorption system are observed. While some of the Field Emission Microscope images appear to be similar to the Field Ion Microscope images of clean W tips, the other images exhibit patterns which look as if two different patterns overlap. The relative structure and position of two types of adsites on various crystallographic planes of a hemispherical surface with an ideal atomic structure are assumed, and two types of Field Emission Microscope images are examined. Such examination can also give an interpretation for the dark rectangular patterns around {110} planes usually observed on the Field Emission Microscope images of W tips cleaned by annealing.

Optical and Electrical Properties of β -FeSi₂/Si, β -FeSi₂/InP Heterojunction Prepared by RF-Sputtering Deposition

Keiichi OKAJIMA¹, Ching-ju WEN¹, Manabu
IHARA¹, Isao SAKATA and Kouichi YAMADA¹
¹*Univ. of Tokyo*

Japanese Journal of Applied Physics **38** 2 (1998) 781

Optical and electrical properties have been measured on β -FeSi₂/Si, β -FeSi₂/InP heterojunctions prepared by an RF-sputtering method. Optical absorption edge of β -FeSi₂ is located at 0.9 eV. Internal photoemission measurements on the β -FeSi₂/Si heterojunctions have revealed that there exist interface states acting as electron traps and that a large band discontinuity exists at the conduction band edge in these junctions. Systematic changes in the position of absorption edge and the band discontinuity have also been observed when the composition of β -FeSi₂ was varied. Photovoltaic characteristics of β -FeSi₂/Si, β -FeSi₂/InP heterojunctions are also reported.

***Ab initio* Pseudopotential Calculation for (TMTSF)₂ClO₄**

Shoji ISHIBASHI, Alfred A. MANUEL¹

and Masanori KOHYAMA²

¹*U. Geneva*

²*ONRI*

J. Phys.: Condens. Matter **11** 10 (1999) 2279-2283

We have investigated the electronic structure of the quasi-one-dimensional organic conductor (TMTSF)₂ClO₄ by *ab initio* band calculation for the first time. Very anisotropic band dispersions and sheet-like Fermi surfaces are obtained. The present results are compared with previous tight-binding calculations. The overall agreement is good but some quantitative differences are observed. This work provides more accurate wave functions, which will be useful for estimating various physical properties and comparing with experimental results.

In-situ Surface and Interface Characterization by Optical Second Harmonic Generation (SHG) of Silicon Dioxide Fabrication with High Purity Ozone

Ken NAKAMURA, Akira KUROKAWA and
Shingo ICHIMURA

AIP Conference Proceedings **449** (1998) 326-330.

Application of SHG at R&D stage of semiconductor ULSI technology as well as its principle was presented and discussed through our example of its application for developing oxidation technique. Relevant application of SHG to the analysis of initial silicon oxidation kinetics is by use of fundamental beam of Nd:YAG laser with 1.17eV pump energy, i.e., 1064nm wavelength. At this energy, 532nm second harmonics are generated mainly due to surface states induced by vacant dangling bonds and also oxygen adsorbates during exposing silicon surface to ozone: the latter may be related to the strain by adsorbates on the surfaces, which was confirmed by O1s peak analysis of XPS. Because SHG on clean silicon surfaces is dependent upon surface states induced by dangling bonds, adsorption on different sites other than dangling bonds must be considered by complementary use of other

surface characterization technique with larger information depth such as XPS. In addition to Si(111), Si(100) is also contributive to SHG. In that case, however, angles of incident and scattering light must be taken large enough to induce polarization perpendicular to the surface and to detect radiated SH intensity because of C_{2v} symmetry of Si(100) surfaces.

Deposition of Ultrapure Hydrogenated Amorphous Silicon

Tohihiro KAMEI and Akihisa MATSUDA

Journal of Vacuum Science & Technology A **17** 1
(1999) 113-120

We have succeeded in a drastic reduction of impurity contents in hydrogenated amorphous silicon (a-Si:H) films by a newly developed ultra-high vacuum plasma-enhanced chemical vapor deposition (UHV/PECVD) system. High sensitivity secondary ion mass spectrometry shows that impurity contents in the films are as low as 10^{15} cm⁻³ both for oxygen and carbon, and 10^{14} cm⁻³ for nitrogen. These values represent the lowest concentrations of atmospheric contaminants for a-Si:H films reported so far. In particular, oxygen content has not been reduced below 1×10^{18} cm⁻³ using conventional UHV/PECVD techniques, and not below 5×10^{17} cm⁻³ even by high growth rate process of VHF plasma. The essential features of the present UHV/PECVD system are an extremely low outgassing rate of 8×10^{-9} Torr·ℓ/s, extremely low partial pressure of contaminant gas species $< 10^{-12}$ Torr, and purification of feed gas SiH₄ at “point of use”. The specific origins of impurities in the films are discussed: outgassing of the reactor wall, the purity of feed gas, and the plasma-wall interaction process.

ELECTRONIC DEVICES

Printing sub-100 Nanometer Features Near-Field Photolithography

Shuji TANAKA¹, Masayuki NAKAO¹,

Yotaro HATAMURA¹, Masanori KOMURO,

Hiroshi HIROSHIMA and Masahiro HATAKEYAMA²

¹Tokyo University

²Ebara Research Co. Ltd.

Japanese Journal of applied physics **37** 12B (1998)

In this paper, a near-field photolithography method which can realize ultra high resolution beyond the diffraction limit of light is described. Evanescent light generated on a transparent mold with a micro-relief illuminated on the condition of total internal reflection is used to expose a photoresist in contact with the mold. The plastic replica mold is flexible to eliminate the difficulty of close contact with the photoresist, and the replica mold damaged by the contact with the photoresist is disposable to maintain a high yield rate. We printed sub-100 nm features on a commercially available photoresist using 442-nm-wavelength light.

Particle-Free Superconducting Bi₂Sr₂CaCu₂O_x Ultrathin Films Prepared by Atomic-Layer-Controlled Molecular Beam Epitaxy Technique

Hiroyuki OTA¹, Shinji MIGITA, Yuji KASAI,
Hirofumi MATSUHATA and Shigeki SAKAI

¹JST Researcher

Physica C **311** (1999) 42-48

Atomic-layer-controlled molecular beam epitaxy (ALC-MBE) technique is applied for preparing Bi₂Sr₂CaCu₂O_x ultrathin films. Precise control of the composition by ALC-MBE enables successful growth of particle-free ultrathin films. Superconducting zero-resistance transitions are observed for the films more than 3.0 nm in thickness. It is also shown that growth of a Bi₂Sr₂CuO_y buffer layer between the film and SrTiO₃(100) substrate contributes to preparing such particle-free ultrathin films with good superconducting properties.

Bunched Fluxon States in One-Dimensional Josephson-Junction Arrays

Alexey V. USTINOV, Boris A. MALOMED and
Shigeki SAKAI

Physical Review B **57** (1998) 11691-11697

Dynamics of fluxons in a discrete Josephson

transmission line is investigated, combining numerical simulations and an analytical approach. It is found that, in different ranges of the parameters (the driving dc bias current and dissipative constant), two fluxons may form either a bifluxon, or various bound states, which can stably propagate along the line.

Fabrication Technology of Ultrafine SiO₂ Masks and Si Nanowires Using Oxidation of Vertical Sidewalls of a Poly-Si Layer

Toshiyuki TSUTSUMI¹, Kazutaka TOMISAWA¹,
Kenichi ISHII, Seigo KANEMARU, Tatsuro MAEDA
and Eiichi SUZUKI

¹*Meiji University*

Journal of Vacuum Science and Technology B **B17** 1
(1999) 77-81

A fabrication technology of the vertical ultrafine SiO₂ wall masks using oxidation of sidewalls of a polycrystalline silicon (poly-Si) layer and Si nanowires utilizing the SiO₂ wall masks have been developed. The vertical ultrafine SiO₂ wall masks 10 nm wide and 90 nm high with 33 nm in space have been successfully fabricated for the first time. The dimensions of width and space become essentially smaller than the size of an electron beam resist pattern. The height is sufficient for ECR plasma etching. Si nanowires 10 nm wide and 18 nm thick have been precisely obtained by the ECR plasma etching of the thinned SOI layer using the vertical ultrafine SiO₂ wall masks. The fabrication technology using the vertical ultrafine SiO₂ wall masks can be utilized for fabricating various designed nanostructures.

A Field Emitter Array with an Amorphous Silicon Thin-Film Transistor on Glass

Hidenori GAMO¹, Seigo KANEMARU and Junji ITO
¹*Toppan Printing Co., Ltd.*

Applied Physics Letters **73** 9 (1998) 1301-1303

We have designed and fabricated a field emitter array (FEA) with an amorphous silicon thin-film transistor (a-Si TFT) monolithically, as an emission control device, on a glass substrate. The TFT was fabricated on the glass

substrate at a low temperature, less than 350°C. The measured emission characteristics showed that the FEA has saturated emission currents with the aid of the a-Si TFT; thus the a-Si TFT is expected to stabilize the emission current. The emission current of the FEA was controlled in the range of 0-0.12μ A with the TFT-gate voltage from 0 to 15 V.

INFORMATION SCIENCE

Fine Motion Strategy in Three-Dimensional Space Using Skill-Based Backprojection

Akira NAKAMURA, Tsukasa OGASAWARA¹,
Takashi SUEHIRO and Hideo TSUKUNE

¹*Nara Institute of Science and Technology*

Artificial Life and Robotics **2** 3 (1998) 134-137

Motion of manipulation in a task can be decomposed into several motion primitives called "skills". Skill-based motion planning has the possibility to perform tasks as skillfully as human beings do. On the other hand, the backprojection method performed in configuration space has been often used in fine motion planning. This paper describes fine motion planning in three-dimensional space using skill-based backprojection. Since skill-based planning in three-dimensional space is performed, it becomes possible to plan manipulation motion like the behavior of the human hand.

Generation of Hidden Markov Model Describing Complex Motif in DNA Sequences

Tetsushi YADA¹, Yasushi TOTOKI², Kiyoshi ASAI
and Masato ISHIKAWA³

¹*Mitsubishi Research Institute, Inc.*

²*Information and Mathematical Science Laboratory,
Inc.*

³*Meiji University*

*Transactions of Information Processing Society of
Japan* **40** 2 (1999)

We have developed a method for the generation of hidden Markov model (HMM) representing complex motif in DNA sequences. The procedures of the method

are as follows : (1) design of HMMs for elemental motifs in given DNA sequences ; (2) construction of a complex motif HMM consisting of the elemental motif HMMs. Statistical analysis and genetic programming (GP) were applied to the respective procedures. At step (1) , left-to right HMMs were designed and their lengths were determined by a statistical significance. At step (2), probabilistic tree describing HMMs was defined and its structure was optimized by GP against a complex motif. Concatenation, probabilistic union, probabilistic closure, etc. were attached to nonterminal nodes. The elemental motif HMMs for any a letter were attached to terminal nodes. In the method, the advance design of elemental motif HMMs and adoption of probabilistic tree as encoding rule of GP lead to efficient generation of complex motif HMM. It was observed that the generated HMM can detect the complex motif in uncharacterized DNA sequences with high accuracy. Further, the HMM is full of interesting suggestions of the complex motif.

Yoneda Replaces Knuth-Bendix in the case of Monoid

Yoshiki KINOSHITA

Computer Software **16** 2 (1999) 72-75

It is well-known that there exists a normalising function which converts a term of the equational theory of monoids to its normal form, and that the completion method due to Knuth and Bendix is effective. Bylin and Dybjer gave another normalising algorithm without using the idea of completion. At a first glance, their method looks ad hoc. On the contrary, we show that the bicategorical Yoneda embedding and its strictification give a systematic explanation of their algorithm.

Image Enhancement and Improvement of Both Color and Brightness Contrast Based on Lateral Inhibition Method

Takashi SAKAMOTO and Toshikazu KATO¹

¹ *Chuo University*

Lecture Notes in Computer Science "Multimedia Information Analysis and Retrieval" Lecture Notes in Computer Science **1464** (1998) 124-131

We propose a new lateral inhibition method for image enhancement which improves both color and brightness contrast. Our method deserves attention for the following reasons: (1) it can adapt itself to the objective image automatically, (2) physiological and psychological behavior of early visual system has been considered and (3) it can affect locally and parallelly both the light region and dark region of the objective image. This method has been derived on the basis of our early vision system and modeled by a simple mathematical function which forms reverse-S shaped stimulus-response curve, and additionally, it can simulate lateral inhibition effects. Our model explains how the lateral inhibition mechanism with local and adaptive processing system realizes the robustness for various input images and detects objects from wide varieties of visual stimuli. The proposed method can make the maximum use of the lateral inhibition effects, perform mild and powerful image enhancement and improve image quality very naturally both at the light and dark regions.

OPTICS AND RADIATION

Stopping Powers of Rare Gases for 50 - 200 keV ³He⁺ ions

Akira FUKUDA

Journal of physics B: Atomic, Molecular and Optical Physics **32** 2 (1999) 153-159

Absolute stopping powers of Ne, Kr and Xe for ³He⁺ ions were measured for energies between 50 and 200 keV. The measurements were made using a gas cell with a differential pumping system and a 127° electrostatic energy analyser. The present author previously showed stopping powers of He and Ar for the same ions of the same energy. We have got stopping powers of all the rare gases for the ion of this energy range. The results are compared with the ⁴He⁺ stopping powers of the rare gases. All the measurements show that it might be difficult to hold the velocity proportionality in the studied energy region.

ENERGY TECHNOLOGY

Voltammetric Observation of Carbonizing Process of Resins

Akira NEGISHI, Yoshihisa SUDA¹
and Hiroko KANEKO²

¹*Mitsubishi Pencil Co.Ltd.*

²*Tsukuba Materials Information Laboratory*

TANSO 186 (1999) 13-19

Characteristics of amorphous carbon carbonized at various temperatures from furan resin, imide resin and poly vinyl chloride, were studied by cyclic voltammetry in 1M KCl solution and in 5mM Fe(CN)₆^{4-/3-}- 1M KCl solution. Blank current(I_b), potential difference between cathodic and anodic peak(ΔE_p) and peak current(I_p) of ferro/ferricyanide redox ion were closely related to a kind of raw materials, the carbonization temperatures and the holding time. With increasing the carbonization temperatures of raw materials and the holding time, ΔE_p approached to 60 mV and I_p increased till the limiting current. The blank currents, I_b, on the electrodes of amorphous carbon carbonized at 800°C were maximum value. From these results, we have found that voltammetric measurements on the carbon materials carbonized at various temperatures as electrodes are helpful in characterizing early carbonization process.

KrF Laser Beam Smoothing and Accelerated Target Measurement

Isao MATSUSHIMA, Eiichi TAKAHASHI,
Yuji MATSUMOTO, Isao OKUDA, Toshihisa TOMIE
and Yoshiro OWADANO

Fusion Engineering and Design 44 (1999) 117-122

The beam smoothing technique for KrF laser drivers and uniformity measurement of accelerated targets are described. As a beam smoothing technique, broad-band random-phase irradiation is investigated. The rear sides of accelerated targets have been measured by face-on interferometry. This new method provides direct and precise two-dimensional information about initial deformation of the rear surface of the target.

The First Results of TPE-RX, a Large Reversed-Field Pinch Machine

Yasuyuki YAGI, Hajime SAKAKITA, Toshio SHIMADA, Kiyoshi HAYASE, Yoichi HIRANO, Isao HIROTA, Satoru KIYAMA, Haruhisa KOGUCHI, Yoshiki MAEJIMA, Takeshi OSAKABE¹, Yasuhiro SATO, Shigeyuki SEKINE and Kiwamu SUGISAKI

¹*Nihon Univ.*

Plasma Physics and Controlled Fusion 41 (1999)

255 - 263

The first experimental results of a large reversed field pinch machine, TPE-RX, are reported. Reversed field pinch configuration in TPE-RX is successfully obtained in March, 1998. The highest plasma current, I_p, of 480 kA and the longest pulse duration time of 70 ms are so far obtained separately. Minimum loop voltage of about 15 volt is obtained at I_p = 150 - 250 kA. Locked mode is found to exist in TPE-RX from the magnetic and vessel temperature measurements, while the C4+ Doppler spectrum shows a finite toroidal rotation.

Forward Raman Pulse Compression Experiments by Using ASHURA

Yuji MATSUMOTO, Eiichi TAKAHASHI,
Isao MATSUSHIMA, Kenji KUWAHARA,
Isao OKUDA and Yoshiro OWADANO

Fusion Engineering and Design 44 (1999) 383-388

High power and well controlled waveform laser light is required to achieve effective target compression for inertial confinement fusion experiments. We have developed a useful method for waveform control, called Forward Raman Pulse Compression. In this method, a multipass forward Raman amplifier is used, and adjustment of the incidence timing between pump and Stokes light into each path provides with high efficiency energy conversion from long pulse pump laser to controlled waveform Stokes light. High power Stokes light can be obtained by putting pump energy of the each pass on the short input Stokes pulse.

The forward Raman pulse compressor used in the present experiments, is the double-path amplifier of 1.5m length with Raman gain of 2. The high power Stokes light has been obtained owing to Raman conversion of 44%

and 73% of pump power in the 1st and 2nd path, respectively. It was demonstrated for the Stokes light to grow up 1.3 times of pump intensity.