

ABSTRACTS OF PUBLISHED PAPERS

(Accepted December-January, 1999-2000)

CONDENCED MATTER AND MATERIAL**Theory of Rapid Excitation-Energy Transfer from B800 to Optically-Forbidden Exciton States of B850 in the Antenna System LH2 of Photosynthetic Purple Bacteria**Koichiro MUKAI, Shuji ABE, Hitoshi SUMI¹¹*Univ. of Tsukuba**J. Phys. Chem. B* **103** 29(1999) 6096-6102

Excitation-energy transfer (EET) has been observed to be very rapid from B800 to B850, between two circular aggregates of bacteriochlorophyll molecules (BChls), in the light-harvesting antenna complex LH2 of photosynthetic purple bacteria. This rapid EET cannot be understood within the framework of Förster's formula, since the luminescence spectrum of B800 overlaps little with the absorption spectrum of B850. The present work shows that it can be rationalized on the basis of a recently proposed formula for EET between molecular aggregates. The formula differs from Förster's one when excited states are excitonic at least in one of the donor and the acceptor aggregates with a mutual distance not much larger than their physical sizes, as in the present case. Excited states of B850 are regarded as excitonic, while those of B800 as monomeric. The exciton-phonon coupling was taken into account over all orders for B800 and within a self-consistent second-order perturbation for B850. Calculated rates of the EET are in the range of 10^{11} - 10^{12} s⁻¹, increasing weakly with temperature, in good agreement with experiments. We demonstrate that this rapid EET occurs to optically forbidden exciton states of B850, without total transition dipole, due to strong interaction of a transition dipole on a BChl in B800 with those on nearby BChls in B850.

Characterization of Oxide Superconductors Using the Faraday Effect of Iron Garnet film

Yuko YOKOYAMA and Yoshishige SUZUKI

Bulletin of the Electrotechnical Laboratory **62** 12

(1998) 175-187

Flux density distribution in the superconductor offers direct information about the magnitude and distribution of the shielding current. The flux density distribution are observed using an iron garnet film as a sensor of magnetic field. The flux density distribution of Bi₂Sr₂CaCu₂O₈ bulk single crystal, Bi₂Sr₂CaCu₂O₈ sintered poly crystal, Bi₂Sr₂CaCu₂O₈ sintered tape, YBa₂Cu₃O_x thin film, YBa₂Cu₃O_x sintered poly specimen and YBa₂Cu₃O_x field oriented sintered specimen as typical oxide superconductors, are observed and discussed using Beans model.

Coupled-Cluster Approach to Electron Correlations in the Two-Dimensional Hubbard Model

Yoshihiro ASAI and Hideki KATAGIRI

Physical Review B Rapid Communications **60** 20

(1999) R13946-R13949

We have studied electron correlations in the doped two-dimensional (2D) Hubbard model by using the coupled-cluster method (CCM) to investigate whether or not the method can be applied to correct the independent particle approximations actually used in ab-initio band calculations. The double excitation version of the CCM, implemented using the approximate coupled pair (ACP) method, account for most of the correlation energies of the 2D Hubbard model in the weak ($U/t \sim 1$) and the intermediate U/t regions ($U/t \sim 4$). The error is always less than 1 % there. The ACP approximation gets less accurate

for large U/t ($U/t \sim 8$) and near half-filling. Further incorporation of electron correlation effects is necessary in this region. The accuracy does not depend on the system size and the gap between the lowest unoccupied level and the highest occupied level due to the finite size effect. Hence, the CCM may be favorably applied to ab-initio band calculations on metals as well as semiconductors and insulators.

Adsorption and Desorption Kinetics of Oxygen on the Pd(110) Surface

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Surface Science **442** 2 (1999) 307-317
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Adsorption and desorption of oxygen on a Pd(110) surface have been investigated by temperature programmed desorption (TPD). A number of TPD spectra for associative desorption of O₂ from O/Pd(110) surface were taken at constant heating rate with different initial coverage and at constant initial coverage with different heating rate. The TPD curves were analyzed by desorption rate isotherm and desorption rate isostere method. The variations in apparent Arrhenius parameters with coverage were obtained by fitting to Polanyi-Wigner equation. The first order associative desorption kinetics was found, suggesting the effect of lateral interaction and oxygen-induced added row reconstruction. Two different processes for associative desorption of oxygen from O/Pd(110) surface were found. The sticking probability for the dissociative adsorption of O₂ on Pd(110) surface has been measured as a function of surface coverage and surface temperature using two mass spectrometers. The sticking probability profile suggested a precursor trapping-dissociation mechanism. The initial sticking probability was independent of surface temperature.

Electronic Structure of Superconducting Layered Zirconium and Hafnium Nitride

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Physical Review B **60** 4 (1999) 1573-1581

The electronic energy band structures for β -ZrNCl and β -HfNCl, which can be superconducting by intercalation, have been calculated by using the scalar-relativistic full-potential linearized augmented-plane-wave method within the local-density approximation. For β -ZrNCl we have calculated the electronic structure for the four proposed crystal structures, and obtained two kinds of qualitatively different energy bands. For the first two structures, the calculations show that this compound is a band insulator with a gap of ~ 0.2 eV, which is significantly smaller than the experimental value. For the last two structures, this band gap is increased to ~ 1.6 eV and ~ 0.8 eV, which is closer to the experiment. Comparison between other experimental data and the calculated density of states also supports the crystal structure of the recent neutron diffraction experiment. A tight-binding analysis has revealed that the direct d-d hopping is important for the gap formation of the mother material. We have compared the experimental T_c, calculated band gap and density of states for several intercalation-derived superconductors and found some empirical trends.

d-Wave State with Multiplicative Correlation Factors for the Hubbard Model

Takashi YANAGISAWA, Soh KOIKE and Kunihiko YAMAJI
Journal of the Physical Society of Japan **68** 11 (1999) 3608-3614

A d-wave state wave function with multiplicative correlation factors for the Hubbard model is investigated by using a variational Monte Carlo method. Employing a simple Gutzwiller-BCS wave function as a starting wave function, we consider improved wave functions with off-diagonal correlation factors. The ground state energy is evaluated from an extrapolation. Our wave functions show that pair correlation functions are enhanced for a negative value of t' .

Fermi Surface Properties and de Haas-van Alphen Oscillation in both the Normal and Superconducting Mixed States of URu₂Si₂

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Philosophical Magazine B **B79** 7 (1999) 1045-1077

We have succeeded in growing a high-quality single crystal of URu₂Si₂ with a residual resistivity ratio of 255 and performed magnetoresistance and de Haas-van Alphen experiments. The dHvA oscillations were observed clearly in both the normal and superconducting mixed states.

High Quality Low Roughness Niobium Thin Films Made by Electron Cyclotron Resonance Technique

Antonio ESPOSITO, Hiroshi NAKAGAWA,
Hiroshi AKOH and Susumu TAKADA
J. Vac. Sci. Technol. A **17** 6 (1999) 3525-3528

We performed growth of body-centered-cubic Nb thin films using an electron cyclotron resonance (ECR) technique on {100} Si substrates. We deposited Nb films using both Ar and Xe plasmas. Reflection high-energy electron diffraction and atomic force microscopy analyses have been performed in order to observe the surface topography. We found that the surface roughness of films deposited by ECR is 4-5 times smoother than films deposited by magnetron sputtering systems. We obtained this result even at room temperature deposition conditions.

Growth and Characterization of the Isotopically Enriched ²⁸Si Bulk Single Crystal

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Jpn. J. Appl. Phys. **38** Part 2 12B (1999) L1493 - L1495

We report on the successful growth of an isotopically enriched ²⁸Si bulk single crystal of the size ~4 mm in diameter and ~50 mm in length. The isotopic enrichment of ²⁸Si (99.924 at%), ²⁹Si (0.073 at%), and ³⁰Si (0.003 at%) has been determined by secondary-ion-mass spectroscopy (SIMS). The crystal is entirely p-type with the room temperature free-hole concentration ~5 × 10¹⁷cm⁻³. The majority impurity is found to be aluminum which can be removed easily in the future zone purification process.

Comparison of Thin GaN and AlN Layers Deposited by Plasma Assisted Molecular Beam Epitaxy on 6H-SiC

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Sadafumi YOSHIDA

¹*STA Fellow*

Jpn. J. Appl. Phys. **38** 6A (1999) 3634-3641

We have studied the effect of the deposition temperature and high temperature annealing on the quality of thin GaN and AlN layers on 6H-SiC substrates. By systematic characterization using reflection high energy electron diffraction (RHEED) and atomic force microscopy (AFM), we have shown that the two nitrides act differently in the early stage of growth. GaN undergoes a Stransky-Krastanov transition enhanced by the post growth annealing. AlN is less sensitive to the effect of annealing and the layers are comparatively smoother than the GaN ones. GaN gives easily the cubic phase at low temperatures whereas it is less feasible for AlN. For each material, better morphology and crystallinity are achieved at the highest temperature studied (800°C) but AlN is preferable to GaN as no islands are formed with AlN.

Computer Simulation for Analysis of Lattice Polarity of Wurtzite GaN{0001} film by Coaxial Impact Collision Ion Scattering Spectroscopy

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Jpn. J. Appl. Phys. **38** (Part 2) 11A (1999) L1219-L1221

Signal intensities of coaxial limpact collision ion scattering spectra have been computed for c-axis-oriented GaN films at various incident angles in order to analyse the lattice polarity based on the three-dimensional two-atom triple-scattering model. It was found that Ga and N signal intensities show specific incident angle dependences on (0001) and (000 $\bar{1}$) surfaces. The physical image of each characteristic feature in the spectra was also clarified.

Optical Characterization of Cubic AlGa_N Epilayers by Cathodoluminescence and Spectroscopic Ellipsometry

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Phys. Sta. Sol. (b) **216** (1999) 211-214

Cubic AlGa_N epilayers grown by molecular beam epitaxy were characterized by cathodoluminescence and spectroscopic ellipsometry techniques. The linear increase of the bandgap energy against Al composition was consistently confirmed by the two techniques, which indicates the direct transition nature of cubic AlGa_N band structure. The energy dependence of optical constants for cubic GaN were also obtained by the simulation of measured ellipsometric data.

Defect related Persistent Effects in MBE Grown Gallium Nitride Epilayers

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J. Cryst. Growth **201/202** (1999) 376-381

The results of spectral as well as temperature dependent photoconductivity measurements performed on molecular beam epitaxy (MBE) grown gallium nitride (GaN) epilayers are reported in this work. It is observed that persistent photoconductivity (PPC) is seen in only those materials which contain the yellow luminescence (YL) band. It is further revealed that there exists a clear threshold for the observation of PPC in our GaN epilayers both at 77K and 297K. The relevance of this threshold with the YL band in GaN is discussed within the scope of our experimental observations.

Growth and Characterization of Cubic AlGa_N and AlN Epilayers by RF-plasma Assisted MBE

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J. Cryst. Growth **201/202** (1999) 341-345

We have succeeded in growing cubic AlGa_N epilayers in the whole Al compositional region for the first time, on 3C-SiC (001) substrates by radio frequency N₂ plasma molecular beam epitaxy. The use of AlN buffer layers was found effective for the growth on 3C-SiC substrates. The lattice constant of obtained cubic AlGa_N epilayers was confirmed to obey the Vegard's law in the whole compositional region, and several Raman modes were observed. The highest emission energies in the cathodoluminescence spectra of the cubic AlGa_N epilayers increased linearly as Al composition increased, and no significant decrease in the emission intensity was observed. These results suggest the direct transition band structure of the cubic AlGa_N, contrary to the theoretical prediction.

複合音中の超音波成分の知覚及び広帯域信号聴取時の可聴周波数上限の測定

蘆原 郁 桐生 昭吾

日本音響学会誌 **55** 12 (1999) 811-820

スピーカから複合音が提示されるとき、可聴周波数帯域外成分の有無が音質の違いとして知覚できるかどうか、また、広帯域雑音聴取時に、音として知覚できる周波数の上限がどの程度であるのかについて精神物理学的測定を行った。その結果、可聴域内に生じるスピーカの非線形ひずみが手がかりとなる場合には、超音波成分の有無を弁別することができるが、非線形ひずみが手がかりにならない場面では、広帯域信号中の17kHz付近以上の成分を検知するのが困難であることが示された。

Magnetism of $\text{La}_{8-x}\text{Sr}_x\text{Cu}_8\text{O}_{20}$: A Hybrid System with Localized One-dimensional Cu-O Chains and an Itinerant Three-dimensional Cu-O Network

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Physical Review B **60** 22 (1999) R15031

酸素欠損ペロブスカイト $\text{La}_{8-x}\text{Sr}_x\text{Cu}_8\text{O}_{20}$ は $S=1/2$ の局在スピンをもった一次元鎖とそれを取り囲む遍歴電子系三次元Cu-Oネットワークから構成されている複合磁性体と見ることができる。xが2.1以下では、磁性と輸送特性に複雑な異常を伴う二つの逐次相転移が見られる。この物質の複雑な磁性におけるこれら二つの構成要素の果たす役割について議論する。

Ab initio Pseudopotential Band Calculation of Organic Conductors

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¹ONRI

Journal of Low Temperature Physics **117** 5/6 (1999)
1753-1757

We have calculated the band structures of organic conductors TTF-TCNQ and β -(BEDT-TTF)₂I₃ using the ab initio plane-wave pseudopotential method within the local-

density approximation (LDA). The Fermi-surface shape and the origin of bands near the Fermi level are investigated for each compound.

Real-time Modulation of Si-H Vibration in Hydrogenated Amorphous Silicon

Hidetoshi OHEDA

Physical Review B **60** 24 (1999) 16531

Photomodulation of Si-H stretching vibration can be observed in hydrogenated amorphous silicon (a-S:H) as a photoinduced bleaching (PB) band around 2000 cm⁻¹ which is embedded in a photoinduced absorption spectrum coming from excess carriers trapped at tail states. Since this vibronic modulation is a real-time change following a modulated excitation, it is different from a well known metastability in a-Si:H as induced by strong light-soaking. It is suggested from the theoretical work reported by Yonezawa et al. [*J. Non-Cryst. Solids* 137&138, 135 (1991)] that the modulation of a Si-H vibration reflects a change in length of a neighbouring weak Si-Si bond following a modulated excitation. Based on this picture, we have tried to see how the spectrum of the PB band changes when the weak Si-Si bonds are broken or reformed by light soaking or thermal annealing, respectively. Change in the spectrum after the treatments could be observed over almost whole range of the PB band and, this vibronic modulation seems to be related selectively with the monohydride configuration of Si-H bond. By evaluating quantitatively the spectral change in the PB band combined with simultaneous change in dangling-bond density, density of the weak Si-Si bonds or neighbouring Si-H bonds responsible for the vibronic PB band can be estimated to be about 5×10^{17} cm⁻³. This value is much smaller than the amount of the monohydride Si-H bonds contained in specimens used here by about four orders of magnitude, indicating that only a very few part of the existing Si-H bonds participates the structural flexibility in a-Si:H.

A Tight-Binding Model of Phenylene Molecules with meta-Connections - Implications for Phenylacetylene Dendrimers

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Chemical Physics **250** 1 (1999) 13-22

A simple tight-binding model can describe the most essential features of the optical properties of phenylacetylene dendrimers. We investigate two kinds of chain models which are obtained by simplifying two series of dendrimers and are composed of linear segment of phenyl rings connected to each other at *meta*-positions. These chain models exhibit different size dependence of the gap between HOMO (highest occupied molecular orbital) and LUMO (lowest unoccupied molecular orbital), corresponding to that of the observed optical gap in dendrimers. In the chain model in which the gap decreases with molecular size, the HOMO and its consecutive orbitals are localized within each segment. In the other kind of chain in which the decrease of the gap is much more moderate, the orbitals form a fairly narrow band instead of the localization, although each orbital seems delocalized in appearance. These features are ascribed to the small absolute values of coefficients of the HOMOs at *meta*-positions in the constructing segments.

J-Aggregates in Langmuir-Blodgett Films of a Merocyanine Dye without Metallic Cations : Using FT-IR to Observe Changes in the Electronic Structure of the Molecules upon Aggregation

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J. Phys. Chem. B **103** 51 (1999) 11261-11268

Langmuir-Blodgett films of mixtures of fatty acids (FA) and a merocyanine dye (DS), bearing one long alkyl chain and one carboxylic group, were prepared at a nitrogen-pure water interface. The films exhibit a distinct and highly anisotropic J-band near 605 nm, even though they do not contain any metallic or ammonium cations. Although an isotropic band was seen in the region of 500–550 nm, the contribution of the J-aggregates was extracted from the observed visible and IR absorption spectra by using the difference in the polarization of the bands. This analysis indicates a change in the electronic structure of DS in the J-aggregates, probably corresponding to intramolecular charge transfer. Furthermore, this analysis also suggests that in this metal-free case, the formation

of the J-aggregates is strongly affected by the hydrogen bonding between the carboxylic groups in two DS and that between the carboxylic groups in DS and FA.

Structural Change of Langmuir and Langmuir-Blodgett Films of AlkylDCNQI Induced by Charge-transfer Reaction at the Air-water Interface

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J. Chem. Phys. **112** 2 (1999) 881-886

UV-visible absorption spectrum of pure 2-methyl-5-octadecyl-N,N'-dicyanoquinonediimine (C18MeDCNQI) Langmuir films and that of C18MeDCNQI-CuI mixed Langmuir films indicated the occurrence of charge-transfer (CT) reactions at the air-water interface in the latter case. These Langmuir films were deposited onto solid substrates as Langmuir-Blodgett (LB) films by the horizontal lifting method. Polarized UV-visible-IR absorption spectra and X-ray diffraction patterns recorded for the obtained LB films revealed a drastic structural change induced by the CT reactions: an interdigitated bilayer structure was suggested for the pure films, while a monolayer structure for the CT films. Furthermore, the CT degree of the major component of the mixed LB films was estimated at -1, unlike in the case of Cu-DCNQI crystals, for which the CT degree is -2/3.

計測・制御

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応用物理 **69** 1 (1999) 82

1999年9月1日から4日迄、神戸市甲南大学キャンパスで開催された第60回応用物理学会学術講演会の計測・制御分科で行われた講演に関する報告である。「計測・制御」中分類の講演件数は7であった。「測定標準・精密計測」中分類の講演件数は14で、高精度基礎計測標準に関する講演で密度の高い質疑応答が行われた。「情報処理応用計測」中分類の講演件数は2で、実利用を意識したテーマで活発な議論が行わ

れた。

Conditions for Fabrication of Highly Conductive Wires by Electron-Beam-Induced Deposition

Hiroshi HIROSHIMA, Norihito SUZUKI,
Naomi OGAWA and Masanori KOMURO
Japanese Journal of Applied Physics **38** (1999)
7135-7139

Conductive wires were fabricated by electron-beam-induced deposition (EBID) using WF_6 gas. It was difficult to fabricate highly conductive wires with good reproducibility unless samples were cleaned before EBID. Contamination appears to be reducing the conductivity of wires. O_2 plasma cleaning of samples before EBID seems to reduce contamination growth; however, it is not effective for regions in the vicinity of Au patterns. We found that by combining of annealing at 300 degree C and O_2 plasma cleaning, highly conductive wires could be fabricated with relatively good reproducibility in such regions. A linear relation was found between wire conductance and linedose at lindoses of more than $70 \mu C/cm$. The change in deposition yield estimated from conductance was about 12 % when the gas flux was halved. Wires with a length of less than 40 nm were less conductive than longer wires because of a shortage in gas supply.

Synthesis of Oriented Meso-Structure Silica Functional Thin Film

H. S. ZHOU, D. KUNDU and I. HONMA
J. European Ceramic Society **19** (1999) 1361-1364

We report the synthesis of oriented silica meso-structure films by surfactants such as hexadecyltrimethylammonium bromide (C16TMA) or 11-ferrocenylundecyl-ammonium bromide (Fe-TMA) surfactant on a sol-gel method by spin coating. X-ray diffraction of the film showed that the film oriented in a lamellar, hexagonal or cubic structure, just depending on C16TMA's concentration. In the case of lamellar oriented film by Fe-TMA, linear temperature dependent conductivity properties were observed.

Dye-Doped Photosensitive Mesostructure Materials

H. S. ZHOU and I. HONMA
Adv. Mater. **11** (1999) 683-685

Highly ordered three-dimensional mesoporous materials with pore size from 1nm to 10nm are already technologically important for a variety of applications as catalysis, sieve and adsorbent. We have developed a new approach for doping dye in the mesoporous materials to designate the photosensitive functional materials extending their applications to optic and photonic field. The photosensitive and photosynthetic molecules phthalocyanine(Pc), and chlorophyll(Chl) doping oxides meso-structure materials(MM), such as SiO_2 , V_2O_5 , WO_3 and MoO_3 , have been directly synthesized by a self-organized co-assembly method of mixing Pc or Chl with hexa-decyltrimethylammonium chloride (C16-TMA) surfactant, successfully. X-ray diffraction pattern (XRD) and the optical absorption spectra are also investigated. These materials are useful for various application such as optical nonlinearity, photocatalysis, photosynthesis and solar cell. The photocatalysis of Pc/MxOy (MxOy = SiO_2 , V_2O_5 , WO_3 and MoO_3) meso-structure materials have been explored that Pc/ WO_3 provide reductive electrons to water molecules to decompose into hydrogen by a visible light exposure.

Low-temperature Growth of Crystalline Silicon on a Chlorine-terminated Surface

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and Akihisa MATSUDA
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Applied Physics Letters **75** 22 (1999) 3515-3517

We have investigated the low-temperature growth of crystalline silicon from monosilane and/or dichlorosilane with hydrogen diluent under glow discharge plasma. Good crystallinity is obtained for the films prepared without dichlorosilane, or alternatively without monosilane. The crystallinity deteriorated markedly when both dichlorosilane and monosilane are added to the starting gas material. This cooperative roles of chlorine and hydrogen are proposed in the Si growth mechanism based on the plasma diagnostic techniques including optical emission spectroscopy and

surface infrared spectroscopy.

Homoepitaxial Diamond Film with Atomically Flat Surface in Large Area

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Sadanori YAMANAKA, Hideyo OKUSHI,
Koji KAJIMURA and Takashi SEKIGUCHI

Diamond and Related Materials **8** (1999) 1272-1276

Homoepitaxial diamond films with atomically flat surface were grown using the microwave plasma chemical vapor deposition method at a low CH₄ concentration of less than 0.05% in a CH₄ and H₂ mixed gas system. In Ib (001) diamond substrates having misorientation angles of 0.5°, atomic force microscope image on the surface of film grown at 0.025% CH₄ concentration showed that the films had atomically flat surface with mean roughness of 0.04 nm in area as large as 4×4mm² (the whole region of the substrates).

High Quality Homoepitaxial Diamond Thin Film Synthesis with High Growth Rate by a Two-step Growth Method

Daisuke TAKEUCHI, Sadanori YAMANAKA,
Hideyuki WATANABE, Hidetaka SAWABE,
Hideki ICHINOSE, Hideyo OKUSHI and
Koji KAJIMURA

Diamond and Related Materials **8** (1999) 1046-1049

Homoepitaxial diamond films grown in the condition of CH₄/H₂ ratio lower than 0.15% in an microwave assisted plasma chemical vapor deposition system had excellent electrical and optical properties without any unepitaxial crystallites (UCs). Under such low CH₄ concentration condition, however, the growth rate becomes too slow to obtain useful thickness. In order to remove the difficulty of this problem, we attempted to the two-step growth method. In the first step of this method, the substrate surface was treated by homoepitaxial growth of diamond in the presence of 0.05% CH₄ in H₂, and in the second one, the CH₄ concentration was increased. Considering the origin of UC with cross-sectional transmission electron microscope

studies, it was found that this method based on surface improvement of the initial substrate by means of ultra-low CH₄ concentration growth. This method was quite useful to obtain high quality films, with high growth rate and reproducibility.

Device Grade Homoepitaxial Diamond Thin Films Grown by Step-flow Mode

Daisuke TAKEUCHI, Sadanori YAMANAKA,
Hideyuki WATANABE, Hideyo OKUSHI and
Koji KAJIMURA

Transactions of the Materials Society of Japan **24** [4]
(1999) 595-598

High quality homoepitaxial diamond thin films were obtained with step-flow growth by microwave plasma chemical vapor deposition in the presence of CH₄ lower than 0.15% diluted by H₂. These films showed atomically flat surface and excitonic emission (5.27 eV) at room temperature that was related to the wide band-gap of diamond (5.45 eV). The atomic force microscopy observation revealed that these films had bi-atomic layer steps without any unepitaxial crystallites in the whole area of 4×4 mm² Ib (001) synthetic diamond substrates, whose terrace width depended on the off-angle of each substrate. The hydrogenated atomically flat diamond thin films, which behaved as *p*-type semiconductors, realized ideal Schottky junction properties by means of Al deposition. These results indicated that device grade diamond thin films were grown by step-flow mode. The key to obtain such an ideal diamond thin films was growth rate lower than 30 nm/h, which was much lower than conventional one.

Defects in Device Grade Homoepitaxial Diamond Thin Films Grown with Ultra-low CH₄/H₂ Conditions by Microwave-plasma Chemical Vapor Deposition

Daisuke TAKEUCHI, Sadanori YAMANAKA,
Hideyuki WATANABE, Hideyo OKUSHI and
Koji KAJIMURA

physica status solidi (a) **174** (1999) 101-115

Recent progress in our study of high-quality homoepitaxial diamond thin films was obtained through the low CH_4/H_2 conditions by microwave-plasma chemical vapor deposition (CVD). These showed atomically flat surfaces and excitonic emission (5.27 eV) at room temperature, while band-A emission (2.95 eV) originated from defect-related centers decreased. These films also realized excellent properties of Schottky junctions between Al and high-conductivity layer near the hydrogenated surface, indicating that these films are device grade one. On the other hand, when the CH_4 concentration was increased, homoepitaxial diamond films included unepitaxial crystallites (UCs), which degraded the Schottky junction properties. Other flat surface parts showed excitonic emission at room temperature, indicating that this region is still the device grade. We found that the band-A emission only appeared at UC sites. High-resolution transmission electron microscopy (HRTEM) revealed that many amounts of (111) $\Sigma 3$ twin boundaries and some defects around them existed.

Low Compensated Boron-doped Homoepitaxial Diamond Films using Trimethylboron

Sadanori YAMANAKA, Daisuke TAKEUCHI,
Hideyuki WATANABE, Hideyo OKUSHI and
Koji KAJIMURA

physica status solidi (a) **174** (1999) 59-64

We have grown low-compensation-controlled boron (B)-doped homoepitaxial diamond films with trimethylboron $\text{B}(\text{CH}_3)_3$ gas as a B doping source using microwave plasma chemical vapor deposition (CVD). This study was based on the approach that the synthesis of device-quality films was performed in a clean CVD system with the ability of precise growth condition control. Hall-effect measurements showed that the highest values of Hall mobility in the B-doped films were $1840 \text{ cm}^2/\text{Vs}$ at room temperature (290K), when the hole concentration was $2 \times 10^{14} \text{ cm}^{-3}$, and $3370 \text{ cm}^2/\text{Vs}$ at 170 K. The donor (compensation) concentration and the compensation ratio of this film were $(4 \pm 1) \times 10^{14} \text{ cm}^{-3}$ and about 0.4%, respectively. Both values are the lowest ones of B-doped diamonds, including natural IIb ones, reported till now. Furthermore, high-quality Schottky junctions have been obtained by using our B-doped films. These results indicate that the present B-doped CVD films are semiconducting device-grade.

High Performance Diamond MESFET with 1 μm Gate Length

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Jpn. J. Appl. Phys. **38** (1999) L1222-1224

High performance MESFETs using the *p*-type surface conductive layer on homoepitaxial diamond is demonstrated. The maximum transconductance is 110 mS/mm, which is the highest value ever reported in diamond FETs, and exceeds the normal transconductance of a Si-MOSFET in the equivalent gate length. The transconductance in the present diamond FETs is proportional to the reciprocal of gate length, and the characteristics can be improved by the refinement of gate length in the future. By using the appropriate FET fabrication process, it is expected that the transconductance of a diamond MESFET exceeds 500 mS/mm at 0.2 μm gate length.

Essential Change in Crystal Qualities of GaN Films by Controlling Lattice Polarity in Molecular Beam Epitaxy

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Jpn. J. Appl. Phys. **39** (1999) L16-L18

GaN heteroepitaxial growth on sapphire (0001) substrates was carried out by radio-frequency plasma-assisted molecular beam epitaxy. A Ga-polarity growth was achieved by using an AlN high-temperature buffer layer. The epilayer polarity was characterized directly by coaxial impact collision ion scattering spectra. It was found that the properties of the GaN films showing Ga-face polarity, including their structural and electrical properties, were dramatically improved compared to those of films with N-face polarity. This important conclusion is considered to be a breakthrough in the realization of high-quality III-nitride films by MBE for device

applications.

Plasma-Assisted Molecular Beam Epitaxy of GaN:In Film on Sapphire (0001) Having the Single Polarity of (0001)

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J. Cryst. Growth **209** (2000) 364-367

GaN:In films having the single polarity of (0001) were successfully grown on sapphire (0001) substrate by plasma-assisted molecular beam epitaxy. The determinations of polarity were carried out by coaxial impact collision ion scattering spectroscopy. The GaN:In films grown at 600°C with In flux had a single polarity of (0001), whereas the GaN:In films grown at 550°C with In flux and the GaN films grown at 600°C without In flux consisted of two kinds of domains of Ga-face and N-face, that is (0001) and (000 $\bar{1}$), respectively. From secondary ion mass spectroscopy measurements, the In content of the film grown at 600°C was found to be lower than that grown at 550°C. These facts imply that the occurrence of (0001) single polarity for the films grown at 600°C is related to In desorption during growth and/or incorporation of a small amount of In in the films.

RF MBE Growth of Quasi-InGaN Alloys by using Multilayer Structure

Sung-Hwan CHO¹ and Hajime OKUMURA

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J. Cryst. Growth **209** (2000) 401-405

InGaN and quasi-InGaN alloy were grown on sapphire (0001) substrates by using conventional and ((GaN)_m/(InN)_n)_s multilayer methods, respectively. For an InGaN alloy grown by using the conventional method, XRD showed phase separation of InN for InGaN epilayer of 0.4 micrometer thickness having In composition of about 47% and the presence of In droplets was confirmed by scanning electron microscope. For a quasi-InGaN alloy grown by using ((GaN)₂₀/(InN)₂₀)₁₅ multilayer structure, XRD showed only two diffraction peaks: one at 34.55° corresponds to GaN

buffer layer and the other at 32.95° to a quasi-InGaN with a ((GaN)₂₀/(InN)₂₀)₁₅ multilayer structure. The diffraction angle from the multilayer structure corresponds to that of an InGaN layer with an In composition of 50%. The surface morphology of this sample was flat with no In droplets.

Growth Mode of AlN Epitaxial Layers on 6H-SiC by Plasma-assisted Molecular Beam Epitaxy

Gabriel FERRO¹, Hajime OKUMURA and
Sadafumi YOSHIDA

¹STA Fellow

J. Cryst. Growth **209** (2000) 415-418

AlN layers were grown on 3.5° off 6H-SiC substrate by plasma-assisted molecular beam epitaxy. A study of the growth mechanism has been carried out by varying the growth time and the III/V ratio, at a constant growth temperature of 800°C. The layers were characterized by means of RHEED, AFM and XRD. It is shown that N-rich conditions always give rise to a three-dimensional growth with spotty RHEED patterns and rough surface. In Al-rich conditions, the growth is much more two-dimensional like with streaky RHEED patterns. By AFM, step bunching growth is observed. The size of the steps depends on the thickness of the layer as well as on the III/V ratio. All the samples grown in Al-rich conditions showed better crystalline quality than those grown in N-rich conditions.

Effect of Higher Silanes in Silane Plasmas on Properties of Hydrogenated Amorphous Silicon Films

Atsushi SUZUKI

Japanese Journal of Applied Physics **38** 11B (1999)
L1315-L1317

The properties of hydrogenated amorphous silicon (a-Si:H) were investigated and correlated to the densities of neutral higher silane (HS) molecules in silane radio frequency (rf) glow discharge plasmas which are used to grow a-Si:H films. The suppression of defect densities at the light soaked state was observed for "device-grade" a-Si:H with a decrease in the density of HS. On the basis of the dependence of the density of HS on the deposition rate, it is suggested that

deterioration of the properties of a-Si:H deposited at a high deposition rate is attributed to the increase in the number of HSs in silane plasmas.

Crystal Growth of III-V Materials on Si Substrates for Solar Cell Applications

H. KAWAKAMI and K. BASKAR

Proc. the Tenth International Workshop on the Physics of Semiconductor Devices II (1999) 1185-1190

Heteroepitaxial layers of GaAs have been grown on Si substrates by molecular beam epitaxy. In-situ thermal cycle annealing (TCA) and post-growth rapid thermal annealing (RTA) have been used to increase the crystalline quality of the heteroepitaxial layers. The transmission electron microscopy study revealed the annihilation of 60° dislocations and the presence of stacking faults by TCA. RTA after TCA had resulted the layers free from stacking faults. The double crystal x-ray diffraction (DXRD) and photoluminescence (PL) have confirmed that prolonged annealing beyond 10 sec by RTA had no effect on the crystalline quality. The best full-width at half maximum values of DXRD and PL were obtained only for the TCA samples, as 127 arc-sec and 2.6 meV respectively. The position of the band edge emissions, impurity and defects related emissions changes depending on the nature of annealing and has been attributed to the tensile strain variations in the epitaxial layers.

Local Non-Fermi Liquid Theory of Magnetic Impurity effects in Metallic Carbon Nanotubes

Kikuo HARIGAYA

J. Phys. Soc. Jpn. **69** (2000) 316-319 (Letters)

Magnetic impurity effects on metallic carbon nanotubes are studied theoretically. The resolvent method for the multi channel Kondo effect is applied to the band structure of the kp perturbation hamiltonian in the limit of the infinite onsite repulsion at the impurity site. We discuss the local non-Fermi liquid behavior at temperatures lower than the Kondo temperature T_K . The density of states of localized electron has a singularity $\sqrt{|\omega|}$ which gives rise to a pseudo gap at the Kondo resonance in low temperatures. The temperature dependence of the electronic resistivity is predicted as $\sqrt{|\tau|}$,

and the imaginary part of dynamical susceptibilities has the $\sqrt{|\omega|}$ dependence. Possible experimental observations are discussed.

ELECTRONIC DEVICES

Optimization of Transistor Structure for Transistor-Stabilized Field Emitter Arrays

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IEEE Transactions on Electron Devices **46** 11 (1999)

Reliability of the metal-oxide-semiconductor field-effect transistor (MOSFET)-stabilized field emitters at high-field operation has been assessed by comparing two different MOSFET structures. Electrical characteristics and behavior of carriers in the device structure have been investigated by means of device simulation. One structure, which is referred to as the externally-connected-MOSFET emitter, exhibits an anomalous increase in drain current, which is induced by impact ionization at the drain edge. Upon evaluating the emission characteristics, it was clarified that the anomalous current increase induced by the impact ionization degraded stability and controllability of the emission current significantly. The other structure, which is referred to as the MOSFET-structured emitter, shows higher reliability with negligible effect of impact ionization.

Epitaxial Bi₄Ti₃O₁₂ thin Film Growth using Bi Self-limiting Function

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Journal of Crystal Growth **200** (1999) 161-168

Epitaxial Bi₄Ti₃O₁₂ (BIT) thin films are grown by molecular beam epitaxy using the Bi self-limiting function. On appropriate growth conditions, Bi and Ti atoms are supplied with a large Bi/Ti supply ratio. The deficiency of Bi composition in the growing film is prevented by this large ratio, and surplus Bi atoms which do not contribute to BIT

growth are evaporated from the surface. BIT films are characterized by reflection high energy electron diffraction, atomic force microscopy, and x-ray diffraction. The films grow in a two-dimensional layer by layer manner whose layer unit is the 1.6-nm-thick BIT molecular layer. As a natural consequence of the method, the thickness of BIT films is determined simply by the total amount of Ti atom flux.

Growth Style of $\text{Bi}_4\text{Ti}_3\text{O}_{12}$ Thin Films on $\text{CeO}_2/\text{Ce}_{0.12}\text{Zr}_{0.88}\text{O}_2$ Buffered Si Substrates

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¹Waseda Univ.

Japanese Journal of Applied Physics **38** (1999) 5411-5416

Epitaxial $\text{Bi}_4\text{Ti}_3\text{O}_{12}$ thin films are grown on $\text{CeO}_2/\text{Ce}_{0.12}\text{Zr}_{0.88}\text{O}_2$ buffered Si (100) substrates. The buffer consists of 40 Å $\text{Ce}_{0.12}\text{Zr}_{0.88}\text{O}_2$ and 80 Å CeO_2 layers which are grown on Si (100) substrates by an *e*-beam evaporation method. $\text{Bi}_4\text{Ti}_3\text{O}_{12}$ films are grown by the molecular beam epitaxy method using the Bi self-limiting function. Epitaxial growth of these layers on Si is confirmed by X-ray diffraction analyses. Growth style of $\text{Bi}_4\text{Ti}_3\text{O}_{12}$ films is examined in detail by observations of reflection high-energy electron diffraction and atomic force microscopy, and the growth mechanism is discussed.

A Novel Approach to Chip-to-chip Communication using a Single Flux Quantum Pulse

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Akira SHOJI

IEEE Transactions on Applied Superconductivity **9** 2
(1999) 4049-4052

A novel approach to chip-to-chip communication for RSFQ technology is proposed. The main idea is to fabricate Josephson junctions on a substrate for multi-chip packaging, which equips the substrate as well as the chip with built-in active drivers and receivers. The driver on the chip is connected directly to the receiver on the substrate through a connector which can be considered as a lumped circuit element. Because the circuit is free from the impedance

matching constraint, broadband chip-to-chip data transfer with wide operating margins will be realized. We have designed, simulated and optimized a chip-to-chip single flux quantum (SFQ) pulse transfer circuit. For a connector inductance of 20 pH, the bias current margins and the maximum throughput have been calculated to be $\pm 24\%$ and above 50 Gb/s, respectively.

Highly Suppressed Short-Channel Effects in Ultrathin SOI n-MOSFET's

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Tatsuro MAEDA, Toshiyuki TSUTSUMI,
Toshihiro SEKIGAWA, Kiyoko NAGAI and
Hiroshi HIROSHIMA

IEEE Transactions on Electron Devices **47** 2 (1999)
354-359

We have investigated short-channel effects of ultrathin (4-18-nm thick) silicon-on-insulator (SOI) n-channel MOSFET's in the 40-135-nm gate length regime. It is experimentally and systematically found that the threshold voltage (V_{th}) roll-off and subthreshold slope (S-slope) are highly suppressed as the channel SOI thickness is reduced. The experimental 40-nm gate length, 4-nm-thick ultrathin SOI n-MOSFET shows the S-slope of only 75 mV/decade and V_{th} roll-off of only 0.07 V as compared to the value in the case of the long-gate-length (135 nm) device. Based on these experimental results, the remarkable advantage of an ultrathin SOI channel in suppressing the short-channel effects is confirmed for future MOS devices.

Bismuth and Antimony Nanolines in a Si Epitaxial Layer

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Inst. Phys. Conf. Ser. (IOP Publishing Ltd.) **164** (1999)
167-170.

We succeeded in fabrication of bismuth and antimony nanolines in a Si epitaxial layer. Perfect Bi nanolines form in the terrace of Si(001) in the case of Bi adsorption around its desorption temperature. Although simple epitaxy on this

surface allows the surface segregation of Bi from the lines, additional Bi desorption on the line-formed surface before Si overgrowth forbids Bi surface segregation. Additional Sb adsorption instead of Bi led to Sb nanolines in the Si epitaxial layer. Those mechanisms can be explained by use of the analogy of a surfactant.

Structures of the 'nanowire' and $2\times n$ of Bi/Si(001)

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Surface Science* **447** Issues 1-3 (2000) L169-L174

Structures of the 'nanowire' and $2\times n$ phase of the submonolayer system of Bi/Si(001) have been studied by X-ray photoelectron diffraction (XPD). The general features of Bi 4d XPD patterns show that Bi atoms exist only at the topmost layer for the two phases. Single-scattering cluster simulations were performed for several structural models, including those for the 'nanowire' [Miki et al., Phys. Rev. B 59 (1999) 14868] and for the $2\times n$ phase [Hanada et al., Surf. Sci. 242 (1991) 137], to find they are very feasible.

Interface States of SiO₂/Si(111) Observed by an Atomic Force Microscope

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Surface Science* **443** Issues 3 (1999) L1055-L1058

We investigated the distribution of tunneling current through ultrathin oxide films on Si(111) with an atomic force microscope having a conductive tip. We observed enhancement of the tunneling current at step edges for the oxide grown in dry O₂ at 600°C, while the oxide grown in NHO₃ showed only small contrast over the surface. With analysis of the current-voltage characteristics, the tunneling current enhancement could reflect the interface states at the step edges.

Chaos and Quantum Interference Effect in Semiconductor Ballistic Micro-structure

Shiro KAWABATA

Quantum Coherence and Decoherence (North-Holland
Delta Series) (1999) 265-268

We study the quantum-interference effect in the ballistic Aharonov-Bohm (AB) billiard. The wave-number averaged conductance and the correlation function of the non-averaged conductance are calculated by use of semiclassical theory. Chaotic and regular AB billiards have turned out to lead to qualitatively different semiclassical formulas for the conductance with their behavior determined only by knowledge regarding the underlying classical scattering.

Observation of N-shaped Negative Differential Resistance in Ridge-Type InGaAs/InAlAs Quantum Wire-Field-Effect Transistor

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Physica B* **272** (1999) 117-122

N-shaped negative differential resistance (NDR) with high peak-to-valley ratio (PVCR) and low onset voltage (VNDR) are clearly observed in a 50-nm gate ridge-type InGaAs/InAlAs quantum wire field-effect transistor (QWR-FET). The NDR of low onset voltage (VNDR) and its dependence on the gate voltage are attributed to the real space transfer of channel carriers into a barrier layer underneath the gate by field-assisted tunneling. The NDR characteristic of the QWR-FET is enhanced compared with that of InGaAs/InAlAs quantum well field-effect transistor (QW-FET). The narrower channel-width and shorter gate-length effectively improve the PVCR and VNDR.

Continuous Output Beam Steering in Vertical-Cavity Surface-Emitting Lasers with Two p-Type Electrodes by Controlling Injection Current Profile

Toshihede IDE, Mitsuaki SHIMIZU, Seiji MUKAI, Mutsuo OGURA, Takuya KIKUCHI, Yoshihiro SUZUKI, Ryouzaku KAJI, Hideo ITOH, Masanobu WATANABE, Hiroyoshi YAJIMA and Toshio NEMOTO
Jpn. J. Appl. Phys. **38** Part 1 1 4A (1999) 1966-1970

Using vertical-cavity surface-emitting lasers with two p-type electrodes, continuous output beam steering was achieved for the first time by controlling the injection current profile. The far-field peak position can be shifted linearly by varying the ratio between injection currents into the two p-type electrodes. The deflection angle measured from the surface normal direction ranges from -1.3 degrees to +1.0 degrees. Also we investigated operating characteristics that are important for optical processing such as optical fuzzy inference.

Effect of Leakage Current on Pulse-Width Characteristic in Q-Switched Two-Section AlGaAs Multiple-Quantum-Well Semiconductor Lasers

Mitsuaki SHIMIZU, Yoshihiro SUZUKI, Seiji MUKAI, Masanobu WATANABE and Toshifumi HASAMA
Jpn. J. Appl. Phys. **38** Part 1 6A (1999) 3530-3534

We investigated the effect of leakage current on optical pulse width in Q-switched two-section AlGaAs multiple-quantum-well (MQW) lasers, employing numerical analysis using traveling-wave rate equations which include the effect of the carrier leakage. The analysis shows that the pulse width of Q-switched semiconductor lasers is broadened when carrier leakage current is present. This effect becomes significant and is one of the main reasons for the pulse-width broadening for short cavity. These numerical results agree with previously obtained experimental results.

Use of Multiple Pairs of Gain and Saturable Absorber Regions for Semiconductor Optical-Pulse Compressor

Mitsuaki SHIMIZU, Yoshihiro SUZUKI, Seiji MUKAI and Toshifumi HASAMA
Jpn. J. Appl. Phys. **39** Part 1 2A (2000) 475-479

We propose a compact semiconductor optical-pulse compressor using multiple pairs of gain and saturable absorber regions. We performed numerical analysis of the operating characteristics using traveling-wave rate equations, and determined that picosecond optical pulses such as Q-switched or gain-switched pulses could be compressed efficiently. We also confirmed that this technique was effective for compressing the 40 - 100-ps-wide optical pulse generated by commonly-used lasers, such as self-pulsating lasers. In addition, the effect of gain saturation was investigated, and found to be one of the important factors to determine the compressing characteristics.

INFORMATION SCIENCE

Sketches

Yoshiki KINOSHITA, John POWER and Makoto TAKEYAMA
Journal of Pure and Applied Algebra **143** 3 (1999) 275-291

We generalise the notion of sketch. For any locally finitely presentable category, one can speak of algebraic structure on the category, or equivalently, a finitary monad on it. For any such finitary monad, we define the notions of sketch and strict model and prove that any sketch has a generic strict model on it. This is all done with enrichment in any monoidal biclosed category that is locally finitely presentable as a closed category. Restricting our attention to enrichment in Cat , we mildly extend the definition of strict model to give a definition of model, and we prove that every sketch has a generic model on it. The leading example is the category of small categories together with the monad for small categories with finite products: we then recover the usual notions of finite product sketch and model; and that is typical. This generalises many of the extant notions of sketch.

ウェーブフロント型並列処理における分散メモリ型並列計算機の通信機構の評価

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情報処理学会論文誌 40 5 (1999) 2281-2292

本論文では, 分散メモリ型並列計算機において, 同期・通信の支援機構が行列問題の並列処理性能に与える影響について議論し, それらが有効となる条件・要因を, モデルと実験によって定量的に明らかにする。LU 分解法の代入部に現れる三角方程式の求解では, 互いに依存性のない計算要素がイテレーション間にまたがっており, その並列性はウェーブフロント状に抽出できる。この問題を, 並列性を自然に利用する細粒度アルゴリズムと, ブロック化による粗粒度アルゴリズムで表し, 並列計算機 EM-X と AP1000+ に実装した。最初に予備実験によって, これらの計算機が持つ同期・通信機構の特徴をパラメータによって表した。次に, アルゴリズムの性質をモデル化し, 通信オーバーヘッドに起因する性能上限と, 並列度の制限による有効 PE 台数を理論的に示した。問題サイズが小さい場合, あるいは十分な PE 台数が利用できる場合は, 高い並列度が得られる細粒度アルゴリズムが有望である。ただし細粒度アルゴリズムで高い性能を得るには, 通信起動のオーバーヘッドが十分小さいことが必要であり, EM-X がこの要件を満たす。逆に, 問題サイズが十分大きい場合, 比較的少ない PE 台数しか与えられない場合は粗粒度アルゴリズムの方がよい。この場合は通信性能より逐次演算性能が重要となり, AP1000+ が優位性を示す。

逐次プログラムの投機並列実行を行なう中間コードインタプリタの構成法

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¹ 筑波大学

情報処理学会論文誌: プログラミング 40 SIG10
(PRO5) (1999) 64-74

本論文では, 投機並列実行を行なうことにより逐次プログラムの自動的な並列実行を行なう中間コードインタプリタを構成する方法についての検討を行

なう。次に並列処理粒度を適切に制御するチェックポイント実行機能, 検索/登録/排他制御のオーバーヘッドを最小にして投機的メモリ操作を効率的に実現する手法など, 効率的な投機並列実行を特別なハードウェアを用いず実現するためのソフトウェア上の手法を提案する。そして, これらの方法を用いることによってどの程度の基本性能が得られるかを評価するために行なった実験の結果を示す。実験結果から, チェックポイント実行によって処理粒度を適切に設定すること, および, 投機的なメモリ操作の効率的な実現をはじめとする様々なソフトウェア上の工夫をほどこすことにより, 特別なハードウェアを用いなくても, 並列処理による速度向上効果の得られる, 投機並列実行中間コードインタプリタを構成することが可能であることが確認された。

An Estimation Method for Location, Scale, and Rotation Parameter Estimation by the ECM Algorithm

Shotaro AKAHO

*The Transactions of the Institute of Electronics,
Information and Communication Engineers D-II*

J82-D-II12 (1999) 2240-2250

We propose a shift, scale and rotation parameter estimation method for any shapes of probability distributions. The distributions are approximated in advance by the normal mixture distributions as precisely as needed. The parameters are estimated by the ECM (expectation and conditional maximization) algorithm which is a kind of the EM(expectation and maximization) algorithm for learning samples, which provides a stable and rather fast algorithm. Although the EM algorithm of mixture model becomes complicated in general, we give a closed form of the algorithm by restricting the class of normal mixture appropriately.

Real-time Registration of 3D Cerebral Vessels to X-ray Angiograms

Yasuyo KITA, Dale L. WILSON and J. Alison NOBLE

Trans. of IEICE J83-D-II 1 (1999)

A quick method to obtain the 3D transformation of a

3D free-form shape model from its 2D projection data is proposed. This method has been developed for the real-time registration of a 3D model of a cerebral vessel tree, obtained from pre-operative data (eg. MR Angiogram), to a X-ray image of the vessel (eg. Digital Subtraction Angiogram) taken during an operation. First, the skeleton of the vessel in a 2D image is automatically extracted in a model-based way using a 2D projection of a 3D model skeleton at the initial state (up to ± 20 degree difference in rotation). Corresponding pairs of points on the 3D skeleton and points on the 2D skeleton are determined based on the 2D Euclidean distance between the projection of the model skeleton and the observed skeleton. In the process, an adaptive search region for each model point, which is determined according to the projected shape, effectively removes incorrect correspondences. Based on a good ratio of correct pairs, linearization of a rotation matrix can be used to rapidly calculate the 3D transformation of the model which produces the 2D observed projection. Experiments using real data show the practical usefulness of the method."

Between-Word Distance Calculation in a Symbolic Domain and its Applications to Speech Recognition

Kazuyo TANAKA and Hiroaki KOJIMA

Journal of Information Sciences **123** 1 (2000) 25-41

This paper discusses a new framework for speech recognition processing based on the distance calculation in a symbolic domain. It presents a more efficient processing alternative to the conventional statistical method that is characterized by large amount of speech samples. We first propose a method for calculating the distance between words (i.e., between-word distance) in symbolic domain. We then present two applications in speech recognition. Distance calculation employs an optimal matching between subphonemic segment sequences using dynamic programming (DP) to take context-dependent characteristics into account. One application of the distance calculation is to use distributions of the between-word distances to estimate the relative degree of difficulty in speech recognition of given word sets. We provide effective indices for this degree of difficulty using statistical parameters of these distance

distributions. The other application is to predict plausible word candidates in relation to unknown word processing. We examine preliminary experiments in word recognition based on the distance between the subphonemic sequences, calculated in symbolic domain. The proposed recognition procedure achieves performance closely comparable to the ordinal HMM-based speech recognition procedure. The result indicates a feasible prospect for efficient processing of unknown words or for multi-category speech recognition, although some deterioration of recognition score itself is to be expected.

Pseudo Contact Point Monitoring for Skillful Manipulation

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Proc. of IEEE Int. Conf. on Intelligent Robots and Systems (2000) 832-837

Contact state information is indispensable for performing skillful tasks in which an end-effector should be in contact with the environment. In previous work, the authors introduced the concept of a pseudo contact point that is useful for tasks involving contact as one expression of the contact state. In this paper, an extended definition of the pseudo contact point is proposed. The pseudo contact point is defined as the foot of the perpendicular from the nearest point on a reference object to the line on which the contact point and external force vector lie. The system may estimate the contact state and its transitions by monitoring the pseudo contact point in spite of the fact that the pseudo contact point does not always denote the real contact point. Experimental results suggest the effectiveness of our method, which is particularly valuable in providing an intuitive positional description of a contact state.

疑似接触点位置情報のペアリング組立作業への応用

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日本機械学会誌(C編) 65 638 (1999) 4107-4113

小径の自動調心コロベアリングの組み立て作業は自動化されているが、大径の自動調心コロベアリングの組み立て作業は小ロットのため、人手で行なわれている。この作業の主要な部分を占めるのが、コロの内輪への挿入作業である。この作業は作業員の肉体的負荷が大きいため、ロボットによる自動化がのぞまれている。

本稿では同作業中の、コロの内輪への挿入自動化に不可欠な接触位置情報の獲得を、疑似接触点モニタリングにより実現し、コロを挿入可能な位置にハンドリングする手法について述べる。

A Threshold Selection Method which Adopts the Weighted Mean of Midpoints of Two Means and Ground Truth for Binarization

Taiichi SAITO and Hiromitsu YAMADA

The Transactions of the Institute of Electronics,

Information and Communication Engineers D-II

J83-D-II 2 (2000) 575-583

The threshold selection method based on discriminant and least squares criteria has instability which is caused by adopting only the optimal point of an evaluation function. This report clarifies the instability of the method, and proposes a new method. In order to have more stability, the proposed method adopts the separability weighted mean of midpoints of two means. We created ground truth data for automatically evaluating binarization on hand-written character database ETL1. Using the ground truth, it is shown that the proposed method has higher performance of binarization.

連続変形法を用いたLMedS推定とその評価

梅山 伸二

電子情報通信学会論文誌 **J83-D-1 2 (2000)**

ロバスト回帰の一種であるLMedS推定を連続変形法によって実現し、ランダムサンプリングによる計算法との比較を行なった。

Mobile Sensing Robots for Nuclear Power Plant Inspection

Nobuyuki KITA, Yasuo KUNIYOSHI, Isao HARA, Toshihiro MATSUI, Toshio HORI, Shigeoki HIRAI, Andrew J. DAVISON¹ and Sebastien ROUGEAUX¹

¹Guest Researcher

Advanced Robotics **13 3 (1999) 355 - 356**

One of the most important challenges in the field of robotics is to realize robots able to move around autonomously and efficiently perform given tasks in complex and dynamically changing environments. We are investigating the sensing systems with which such mobile robots should be equipped, particularly for the case of industrial robots which are to move around a nuclear power plant and carry out inspection tasks.

オフィス移動ロボットJijo-2の音声対話システム

松井 俊浩, 麻生 英樹, John FRY¹, 浅野 太, 本村 陽一, 原 功, 栗田多喜夫, 速水 悟, 山崎 信行²

¹CSLI, スタンフォード大学

²慶応大学

日本ロボット学会誌 **18 2 (1999) 300-307**

自然言語対話を媒介として、移動ロボットがオフィス内の人々に情報サービスを提供するシステムを考える。マイクロフォンアレイを用いたビームフォーミングにより雑音の多い実環境下で音声認識の性能を保つことができた。対話の状態に応じて認識文法を切り替えることにより、ある程度幅広いバリエーションの対話を対象とすることができた。文脈と注目語を管理する手法により、断片的な発話の理解を実装することができた。

Support Vector Classifier with Asymmetric Kernel Functions

Koji TSUDA

Proc. of European Symposium on Artificial Neural Networks (1999) 183-188

In support vector classifier, asymmetric kernel functions are not used so far, although they are frequently used in other kernel classifiers. The applicable kernels are limited to symmetric semipositive definite ones because of Mercer's theorem. In this paper, SVM is extended to be applicable to asymmetric kernel functions. It is proven that, when a positive definite kernel is given, the extended SVM is identical with the conventional SVM. In the 3D object recognition experiment, the extended SVM with asymmetric kernels performed better than the conventional SVM.

Subspace Classifier in the Hilbert Space

Koji TSUDA

Pattern Recognition Letters **20** (1999) 513-519

To improve the performance of the subspace classifier, it is effective to reduce the dimensionality of the intersections between subspaces. For this purpose, the feature space is mapped implicitly to the infinite dimensional Hilbert space and the subspace classifier is applied in the Hilbert space.

Subspace Classifier in Reproducing Kernel Hilbert Space

Koji TSUDA

Proc of 1999 International Joint Conference on Neural Networks (1999) CDROM

To improve the performance of subspace classifier, it is effective to reduce the dimensionality of the intersections between subspaces. For this purpose, the feature space is mapped implicitly to a high dimensional reproducing kernel Hilbert space and the subspace classifier is applied in this space. As a result of Hiragana recognition experiment, our classifier outperformed the conventional subspace classifier.

Optimal Hyperplane Classifier based on Entropy Number Bound

Koji TSUDA

Proc. International Conference on Artificial Neural Networks (1999) 419-424

Entropy number bound is a capacity measure for learning machines, which is recently proposed by Williamson et. al. Based on this capacity measure and the structural risk minimization principle, we actually implement an optimal hyperplane classifier. In on-line character recognition experiment using the tangent distance, our method performed better than the conventional optimal hyperplane classifier based on VC dimension.

A New Approach to the KANSEI Coordinates: Automatic Color Arrangements

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¹*Chuo University*

Proceedings of 1999 IEEE International Conference on Systems, Man, and Cybernetics **6** FA15 (1999) 208-211

We propose an automatic coloring method and its system. Our method can solve the existing several coloring problems. For example, when you fill a lot kinds of colors into a lot parts of segments on a line drawing picture (texture, map, graph, drawing, etc.) and if you have no constraint, you can choose infinite numbers of ways of coloring. Actually these situation gives difficult problems to the automatic coloring system which tries to simulate and perform coloring as if you do. Our method considers the differences of the subjectivity (KANSEI) in terms of one's coloring style. When you choose one of colors in your palette and fill this color into a part of the segments on a line drawing picture, our system can perform coloring automatically into the other part on this picture, according to the general kansei model. This model can represent the statistical relationship between subjectivity and coloring styles. Our method can give a new approach to solving the kansei coordinates.

ヒルベルト空間における部分空間法

津田 宏治

電子情報通信学会誌 D-II **J82-D-II** (1999)

部分空間法は、通常、特徴量を基底とする多次元数空間 (i.e. 特徴空間) に適用される。しかし、部分空間は任意の線形空間で定義できるので、数空間だけでなく、関数空間にも、部分空間法は適用可能である。本論文では、特徴空間の各点を、その点を中心とするガウシアンカーネル関数に対応づけることにより、特徴空間を、ヒルベルト関数空間に写像し、そこで、部分空間法を用いて識別を行うことを提案する。ひらがな認識実験を行った結果、従来の部分空間法よりも、高い認識率を得ることができた。この認識率の向上は、ヒルベルト関数空間において、各クラスの部分空間同士の共通部分の次元数が 0 になることに起因すると考えられる。

The GRD Chip: Genetic Reconfiguration of DSPs for Neural Network Processing

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IEEE Transaction on Computers **48** 6 (1999) 628 - 639

This paper describes the GRD (Genetic Reconfiguration of DSPs) chip, which is evolvable hardware designed for neural network applications. The GRD chip is a building block for the configuration of a scalable neural network hardware system. Both the topology and the hidden layer node functions of a neural network mapped on the GRD chips are dynamically reconfigured using a genetic algorithm (GA). Thus, the most desirable network topology and choice of node functions (e.g. Gaussian or sigmoid function) for a given application can be determined adaptively. This approach is particularly suited to applications requiring the ability to cope with time-varying problems and real-time constraints. The GRD chip consists of a 100Mhz 32-bit RISC processor and fifteen 33Mhz 16-bit DSPs connected in a binary-tree network. The RISC processor is the NEC V830 which executes mainly the GA. According to chromosomes obtained by the GA, DSP functions and the interconnection among them are dynamically reconfigured. The GRD chip does not need a host machine for this reconfiguration. This is desirable for embedded

systems in practical industrial applications. Simulation results on chaotic time series prediction are two orders of magnitude faster than on a Sun Ultra 2.

BIOSCIENCE

Measurements and Source Estimations of Extremely Low Frequency Brain Magnetic Fields in a Short-term Memory Task by a Whole-head Neurogradiometer

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Toshiaki IMADA²

¹Univ. of Tokyo

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IEEE Transactions on Magnetics **35** 5 (1999)

4130-4132

To investigate the characteristics of visual short-term memory in humans, brain magnetic fields evoked during a delayed paired comparison task were recorded using a whole-head neuromagnetometer. The visual stimulus consisted of a circle with different colors in each quadrant. In the memory condition, subjects reacted with the index finger, when the first stimulus (Sample) was identical in color configuration to the second stimulus (Test), and with the middle finger when they differed. For the control condition, the subjects ignored the Sample, and moved the index or middle finger alternately in response to the Test. Extremely low frequency components of brain magnetic fields were observed 500 ms after the Sample onset in the temporal and/or the occipital region in the memory condition, but not in the control condition. Sources for the low frequency components were localized in the inferior part of the occipital lobe, in the vicinity of the supramarginal gyrus and the angular gyrus, and the inferior frontal gyrus. The results suggest that the activities in the inferior part of the occipital lobe controls the storage process of short-term visual memory.

Optical Recording of Cortical Activity After in Vitro Perfusion of Cerebral Arteries with a Voltage-sensitive Dye

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Brain Research **837** (1999) 314-319

Cortical neuronal architecture and connectivity can be analyzed with high-resolution optical imaging after staining the in vitro isolated guinea pig brain preparation by circulating the voltage-sensitive dye RH-795 via the arterial system. To establish this new technique, electrical field potentials evoked in the piriform and entorhinal cortices by lateral olfactory tract stimulation were correlated to the optical signal. The depth analysis of the optical response was performed by evaluating the contribution of the mono- and poly-synaptic components of the signal generated in different layers after applying a pair-pulse stimulation protocol. The tangential propagation of neuronal activity in olfactory cortices was evaluated by gathering several 4.2×4.2 mm images recorded from adjacent cortical areas. The real-time optical imaging technique applied to the isolated guinea pig brain can be successfully utilized to study the integrative properties of cortical neurons ensembles.

High-speed CCD Imaging System for Monitoring Neural Activity in Vivo and in Vitro, using a Voltage-Sensitive dye

Ichiro TAKASHIMA, Michinori ICHIKAWA¹ and Toshio IJIMA

¹*RIKEN, Brainway Group*
Journal of Neuroscience Methods **91** (1999) 147-159

We have designed and constructed a high-speed CCD imaging system for optically detecting neural activity from preparations stained externally with a voltage-sensitive dye, and have used this system to image evoked and epileptiform neural activity in the rat somatosensory cortex. The imaging system uses a commercially available 1/3-inch CCD chip, and it can continuously capture images for more than 8 seconds, at 1000 frames/sec, with

spatial resolution of 128×62 pixels. The spatial/temporal resolution of the CCD sensor is variable by changing the geometry of on-chip binning pixels, which can be controlled by a PC/AT computer. Dye bleaching correction was not necessary for long-term imaging of epileptiform neural events, since the sensitivity of the CCD sensor was increased by combining the signal from adjacent pixels.

香りの計測・測定法

外池 光雄

香りのメカニズムとその測定・分析, 評価技術
第2章 (1999) 20-36

香りの計測・測定法は主に, 物理化学的計測法, 心理的計測法, 生理的計測法の3つの手法に分類される。これらの3つの手法は互いに緊密に連携しておし進めなければならない。しかし嗅覚は, 他の感覚に比べてその原理/仕組みの解明が遅れていた。そこで, この中でも特に重要な, 生理的計測法に客観的計測手法の導入を行い, 香りの脳内における生理的な活動を捉え, 科学的な観点から, 香りによる脳内の活動を明らかにする研究について紹介する。

香りの特徴抽出解析法, 嗅覚脳波の測定法と解析結果, 香りに対する脳波と心理との対応, 脳磁図を用いた非侵襲的な香りの計測・解析の例, これまで研究が欠落していた sniffing による active olfaction などについて述べ, 最後に, 今後の課題として, 香りの標準化研究の必要性, 並びに「香り標準化委員会(仮称)」等, 具体的な提案を行った。

食物関連視覚刺激のヒト中枢情報処理機構の解析

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日本味と匂学会誌(第33回大会論文集号) 63
(1999) 633-636

味覚や嗅覚が視覚情報によって如何なる影響を受けているかは, まだ十分解明されていない。そこで, 本研究では, 食物の視覚刺激情報が如何なる味覚応

答を誘発するかを脳磁図を用いて検討した。被験者は視覚、及び味覚が正常な男性7名である。被験者の前方に置いたスクリーンの中央に視覚画像を呈示し、両側視野刺激を行った。視覚刺激画像は、食物、非食物刺激をそれぞれが1対1の確率でランダムに刺激し、その応答は各80回以上の平均加算を行った。

この結果、画像刺激後、200msec以降で食物刺激と非食物刺激の応答波形の振幅値に差異が認められ、その応答部位は食物、非食物ともに、側頭葉または頭頂葉付近に求められた。また、刺激後300msec以降では、食物刺激に対して島皮質、または弁蓋部付近に活動源が推定された人があった(実験Aで3名、実験Bで2名)。また、500msec以降ではほとんどの被験者で側頭葉から中心前溝付近にかかる広い部位に応答が見られ、さらに2名の被験者で眼窩回付近に活動源が推定された。今後、さらに食物画像刺激と味覚との関連について、より詳細な実験と解析を検討していきたい。

Enhanced BOLD Contrast in fMRI by Using Navigator Echoes and Spatial Realignment on 3.0T MRI System

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Japanese Journal of Magnetic Resonance in Medicine
19 8 (1999) 520-527

The advantages of higher field strength in fMRI studies are the better SNR and higher sensitivity to BOLD signal from capillary level. We compared the effects of correction by navigator echoes and spatial realignment using finger movement tasks. Their synergistic effects on the quality of the fMRI data obtained by spiral k-space trajectory sequence at 3.0T were evaluated. The usage of navigator echoes was effective in increasing the cluster size of the activation by two to three fold, enhancing the maximum Z score and reducing artifacts. Realignment was mostly effective in reducing artifacts and increasing the cluster size to some extent. Without navigator echoes and realignment, major motion artifacts appeared in 3 of

the 12 data sets, which could be removed by combining both methods. ANOVA indicated that there were no interactions between the application of the two methods, and suggested that the confounds removed by each method were different. Navigator echoes were effective to make the most of the higher BOLD contrast obtained by spiral k-trajectory sequence on a high field magnet.

Interaction between PC Vesicles and Interfaces of Air/Water or Oil/Water

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Colloids & Surfaces A 148 (1999) 191-198.

The interactions between egg phosphatidylcholine vesicles and flat surfaces (air/water and oil/water) are investigated by measuring the change in interfacial tension after adding PC vesicles to bulk aqueous solutions.

The Role of the Posterior Parietal Cortex in Human Object Recognition: a Functional Magnetic Resonance Imaging Study

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Neuroscience Letters 276 (1999) 45-48

The mechanisms involved in visual object recognition from non-canonical viewpoints were investigated using functional magnetic resonance imaging (fMRI). We used a passive observation task and found three areas activated more strongly in the non-canonical viewing condition compared with the canonical viewing condition. First, it was found that the fusiform gyrus and posterior part of the inferior temporal cortex were involved in the processing of shape information. Next, it was found that the posterior parietal cortex, mainly the superior parietal lobule and the ventral part of premotor area were involved in visuospatial processing and accessing sensorimotor

knowledge. These results may indicate that recognition from non-canonical viewpoints is supported by using functional properties of the object, which require more real-time processing for object manipulation.

High Resolution MR Imaging of the Knee at 3 T

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ACTA RADIOLOGICA 41 (2000) 84-88

To examine the 3.0-T MR unit to obtain high quality, high-resolution images of the knee joint. Subjects and Methods. One human cadaveric and five porcine knees were imaged with the 3.0-T unit. Sets of T1-weighted spin echo images were obtained with in-plane resolution of 0.195×0.39 mm and an acquisition time of approximately 5 min. Two porcine knees were also imaged with the 1.0-T unit with an identical imaging protocol and the signal-to-noise ratios were measured on both images at 3 T and 1 T. Results. The 3-T MR system provided detailed delineation of the knees. Deep layers of the medial collateral ligament and associated fine fibers beneath the medial and lateral collateral ligament were demarcated. Precise demonstration of the tibial attachment of the anterior cruciate ligament, irregularity of the meniscal free edge, and conjoint tendon formation together with the lateral collateral ligament and the biceps femoris tendon, were demonstrated. Compared to 1-T unit, the signal-to-noise ratio with 3-T was increased by a factor of 1.39 to 1.72. Conclusion. Due to the potential advantage of obtaining detailed images, the 3-T MR system suggests practical utility for fine demonstration of the knee morphology.

Effects of Smooth Pursuit Eye Movement on Ocular Responses to Sudden Background Motion in Humans

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Yasushi KODAKA, Yuka INOUE, Aya TAKEMURA

and Kenji KAWANO

Neuroscience Research 35 (1999) 329-338

We studied the effects of horizontal smooth pursuit on the ocular tracking responses to brief perturbations of the a textured background in humans. When the subject was fixating a stationary spot, a brief perturbation (60deg/s, 40ms) of the background in any one of four directions (right, left, up, down) elicited a small tracking response. When the subject was pursuing a target moving against the stationary background, the same background perturbation elicited a larger response when in the same direction as the pursuit, but a smaller response when its direction was opposite to the pursuit; the response to vertical background perturbations was also enhanced during pursuit. When the subject was pursuing while the target and background were moving together, the same background perturbations elicited the larger responses regardless of their direction. These results indicate that the sensitivity to background motion is increased during smooth pursuit. However, when pursuit is executed against a stationary background - the usual situation in everyday life - the system is selectively insensitive to the reafferent visual input associated with pursuit, thereby reducing the potentially adverse effect of the background on pursuit performance.

Temperature Mapping Using the Water Proton Chemical Shift: Self-Referenced Method With Echo-Planar Spectroscopic Imaging

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Magnetic Resonance in Medicine 43 (2000) 220-225

An echoplanar spectroscopic imaging (EPSI) method of temperature mapping is proposed. This method is sufficiently faster than the so-called three-dimensional magnetic resonance spectroscopic imaging (3D-MRSI) method and does not require image subtractions unlike the 'conventional' phase mapping method when an internal reference signal is detectable. The water proton chemical shift measured by using the tissue lipid as an internal

reference clearly visualized the temperature change in a porcine liver sample in vitro. It was also demonstrated that the internally referenced EPSI method could markedly reduce a temperature error caused by a simple, translational motion between scans compared with the phase mapping method.

Molecular Dynamics Simulation of Biological Molecules (1) Methods

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J. Chem. Software **6** 1 (1999) 1-36

Molecular dynamics simulation has been extensively applied to analyses of structure, dynamics, and function of biological molecules. Various methods implemented in a newly developed software, PEACH (Program for Energetic Analysis of bioCHEMical molecules), are described. This review covers: (1) outline of classical molecular dynamics, (2) generation of the initial structure and temperature, (3) computation of force and potential, (4) time integration, (5) ensemble, and (6) analyses of the generated trajectories.

OPTICS AND RADIATION

モード同期 Cr:LiSAF レーザーの パルスタイミング安定化

土田 英実

Optics Letters **24** 22 (1999) 1641-1643

電氣的負帰還制御を利用して、モード同期 Cr:LiSAF レーザーと電気信号の位相同期を実現した。周波数 100MHz のオープン安定化水晶発振器を基準信号源として用い、レーザーとの位相差を検出するため、デジタル位相検出器を開発した。位相検出器は -7.84V/rad の感度を有し、検出器自身の雑音に起因するタイミングジッターの検出限界は 0.67fs である。位相検出器出力はピエゾアクチュエータに帰還し、レーザー共振器長を制御した。位相同期の結果、電気信号に対するレーザーのジッターは、25mHz-10kHz

の周波数範囲で 20fs に抑圧された。

Adsorption Structure of Formic Acid on Si(100) Studied by Surface NEXAFS

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Surface Science **433-435** (1999) 549-553

The structure of the surface formate chemisorbed on Si(100) at 300 K was studied by Near Edge X-ray Absorption Fine Structure (NEXAFS) at the carbon K-edge. By proving the incidence-angle-dependent NEXAFS spectra, it was determined that the CDO group bonds of the surface formate is tilted away from the surface normal by an average angle of 21 ± 2 degrees. This geometry is analogous to the dihedral angle (21 degrees) of the O=C-O-Si group of silyl formate in the gas phase. This finding indicates that the surface formate and the gas-phase silyl formate have similar steric structures. It could be expected that the electronic structure of the chemisorbed formate is also similar to that of the gas-phase silyl formate.

Aligning Molecules with Intense Nonresonant Laser Fields

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Journal of Chemical Physics **111** 17 (1999)

Molecules in a seeded supersonic beam are aligned by the interaction between an intense nonresonant linearly polarized laser field and the molecular polarizability. We demonstrate the general applicability of the scheme by aligning I₂, ICl, CS₂, CH₃I, and C₆H₅I molecules. The alignment is probed by mass selective two dimensional imaging of the photofragment ions produced by femtosecond laser pulses. Calculations on the degree of alignment of I₂ are in good agreement with the experiments. We discuss some future applications of laser aligned molecules.

Lifetime Effects on the Dissociation of Core-Excited N₂ and CO Molecules

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PHYSICAL REVIEW A **61** (2000) 022709

Vibrational-resolved ion and ion-pair yield spectra of N₂ and CO taken at their 1s→π* resonance excitations reveal decay-channel-dependent core hole lifetimes. The linewidths of the yield spectra tend to be shortened when the number of electrons ejected in the deexcitation process increases, finally becoming narrower than the total ion yield or absorption natural lifetime width of the core-excited states of N₂ and CO, respectively. In contrast to this, the linewidths of the yield spectra for the singly charged molecular ions, N₂⁺ and CO⁺, are shown to be broader than their corresponding natural linewidths. This linewidth shortening and broadening observed in the ion yield spectra are explained by the effect of different internuclear distances on the lifetime of an excited molecular state.

FTIR-PAS Analysis to Radiation-Induced Reaction of Alanine-Polymer Pellets

Hiromi Ikeura-SEKIGUCHI and Nobuhisa TAKATA
FOURIER TRANSFORM SPECTROSCOPY Twelfth
International conference (1999) 419-420

Fourier Transform infrared photoacoustic spectroscopy (FTIR-PAS) was applied to study the structure and its change of ⁶⁰Co gamma-ray irradiated alanine-polyethylene pellets which are used as alanine / electron spin resonance (ESR) dosimeters in radiation facilities. It was found that several peaks of FTIR/PAS spectra are changed in intensity by irradiation. The present work demonstrates that FTIR-PAS is one of the most powerful tools to investigate non-paramagnetic products resulting from radical reactions in solid form samples.

Highly Efficient Frequency Doubling with a KNbO₃ Semi-monolithic Resonator

Hidemi TSUCHIDA

Optical Review **7** 1 (2000) 22-24

A semi-monolithic standing-wave resonator has been constructed and employed for frequency doubling of a Ti:sapphire laser. The resonator consists of a 5 mm long KNbO₃ crystal with dielectric coatings on both end faces and a spherical mirror with 20 mm radius of curvature. With 31.2 mW input power at 861.4nm second harmonic power of 11.4 mW has been generated corresponding to the conversion efficiency of 36.5%.

MEASUREMENT AND STANDARD

A MEG/EEG Hybrid Method for Source Localization of a Dipole with Radial Component

Naoto UESUGI¹, Yusuke OHNO¹,
Atsushi ISHIYAMA¹ and Naoko KASAI
The Trans. of the Institute of Electrical Engineers of
Japan **119-A** 12 (1999) 1451
¹*Waseda Univ.*

The location of a current dipole in human brain is obtained with good accuracy by using MEG. However, it is difficult to estimate a radial component of the dipole by MEG, because a shape of human head resembles to a sphere. We developed a novel MEG/EEG hybrid method based on the consideration of merits of MEG and EEG to estimate a current dipole with radial component. The performance of this method was investigated by simulation. It was shown that the accuracy of the source localization by this method was better than the accuracy of the estimation by other methods such as usual MEG/EEG hybrid method. This method was also applied to the real MEG and EEG evoked by median nerve stimulation.

HTS-dcSQUID Gradiometer for Nondestructive Evaluation

Naoko KASAI, Daisuke SUZUKI,

Hiroshi TAKASHIMA, Masao KOYANAGI and

Yoshimi HATSUKADE¹

¹Waseda Univ.

IEEE Trans. on Applied Superconductivity **9** 2 (1999)
4393-4396

We have fabricated a HTS-dcSQUID gradiometer on the basis of a single $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ film for a hand-held NDE system. The two loops of the gradiometer are coupled directly to a SQUID arranged at the center of the pickup coil. The gradiometer worked at 77 K and at normal laboratory environment without magnetic shielding. The effect of the small area of the SQUID loop on the performance of the gradiometer was experimentally estimated. The performance of the SQUID gradiometer was investigated by measuring holes in a carbon fiber reinforced plastic plate in a magnetically shielded room.

電磁気量標準の成り立ち

遠藤 忠

日本物理学会誌 **54** 10 (1999)

長さ, 時間, 電圧, 抵抗の標準を4つを実用上の基本的な標準とする体系が, 電磁気量の測定を高い精度で行いたい人々のために用意されている。一方, SI(国際単位系)標準体系を厳密に守らなければならないような精密測定では, 長さ, 質量, 時間(周波数)の3つの標準が大元の基本的な標準となっている。ここでは, 真空の透磁率を定義量とすること, ジョセフソン効果および量子ホール効果のそれぞれに関連した基礎物理定数 $2e/h (=K_J)$ および $h/e^2 (=R_K)$ の導出を通じて, 電圧標準および抵抗標準がそれぞれSIの大元の3つの基本的な標準と結びついていることを解説する。

希ガス原子の多重イオン化を用いた軟X線絶対測定

鈴木 功, 齋藤 則生

放射光 **12** (1999) 363-374

数100eV領域における軟X線の絶対強度計測法として, 希ガスの多重イオン化を考慮したダブルイオンチェンバー法を提案し, その実現に必要なイオン化における平均荷電数を軟X線領域で測定し, それを用いて, 放射光単色軟X線のフルエンス率の絶対値を計測した。軟X線の純度を向上させるために, 薄膜フィルターを用いるだけでなく, 電子蓄積リングの低エネルギー運転も行った。フルエンス率は1mm径, 100mAリング電子電流で, 1秒あたり10の7乗 - 9乗の光子数であった。

スピニングローター真空計の渦電流と温度による誤差の解析

Hideaki ISOGAI

Journal of the Vacuum society of JAPAN **42** 12 (1999)
1094-1099

This paper deals with an analysis on the offset pressure change of a Spinning Rotor Gauge (SRG), which caused from unbalanced eddy current distribution and thermal change in a stainless steel rotor. Thermal and electromagnetic analysis method (physical models, equations, simulation algorithm) were recognized to have practicability and validity in this analysis that were usefully applied to design the construction of new sensor head and to select the physical characteristics of the rotor. Then, It continues to another investigates to measured these physical characteristics of rotate materials that involved liquids with measuring method of containerless treatments as used to elementary technology of sample floating.

The Measuring Limit of Weak Infrared Radiation in Normal-Temperature Environment

Hideyuki MINATO, Yoshinari ISHIDO and
Akio NISHIMOTO

FOURIER TRANSFORM SPECTROSCOPY: Twelfth International Conference (Proceedings) 1999 321-322

Precise spectral radiometry equipment using the FT-IR spectrometer was developed in order to enable precise infrared radiation measurement of the radiation source of the low temperature level. In this equipment, it was

clarified that the infrared radiation of low temperature to -70 was precisely measurable in normal-temperature environment.

周波数掃引帯域除去フィルタと同期加算法を用いたスピーカの非線形歪測定法

蘆原 郁, 桐生 昭吾
日本音響学会誌 56 2 (2000) 69-77

複合音再生時のスピーカの非線形歪率及び歪の周波数特性を評価するため, 中心周波数が連続的に変化する周波数掃引型フィルタを用いる手法について検討した。まず, 周波数掃引型帯域除去フィルタにより, 広帯域検査音から狭帯域(観測帯域)成分を除去し, 再生した。次に, 観測帯域内に生じる音響成分を周波数掃引型帯域通過フィルタにより抽出し, SN比を向上させるため, 1500回の同期加算を行った。得られた波形を周波数分析することにより, 観測帯域内に発生する非線形歪の周波数特性が観測可能となることを確認した。

ENERGY TECHNOLOGY

Structural Design and Manufacturing of TPE-RX Vacuum Vessel

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Hitoshi KAGUCHI¹, Yoichi ISHIGAMI¹,
Kazuhiro URATA¹, Fumio KUDOUGH¹,
Mitsuru HASEGAWA², Isao OYABU²,
Yasuyuki YAGI, Shigeyuki SEKINE,
Toshio SHIMADA, Yoichi HIRANO,
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Fusion Engineering and Design 46 1 99-113

This paper reports the structural design and manufacturing of the vacuum vessel of TPE-RX, which is one of the three largest reversed-field pinches in the world. The supporting system on the bellows sections of the vessel was designed on a detailed finite element method. The integrity of the vacuum vessel against a plasma disruption has been confirmed using dynamic

inelastic analyses.

A Theoretical Approach to Steady State of Photo-modulated Heat Flux DSC and its Application to Complex Heat Capacity Measurements

Takeo OZAWA¹ and Katsuhiko KANARI
¹Chiba Institute of Technology
Thermochimica Acta 338 (1999) 7-15

Modulation of heat flux DSC can be made by modulated light irradiation to the cells or the cell holders. For this type of temperature-modulated DSC, a theoretical approach has been tried to study steady state and hence its application to heat capacity measurement. In this approach, additional heat flows, such as mutual heat exchange between the sample and the reference material and heat loss to the environment, are taken into accounts together with heat capacities in the heat paths, which have effect of amplitude decrement and phase shift of the oscillation. The effect of thermal contact between the cell and the cell holder is also considered. The results are compared with the results for other types of temperature modulated DSC made by similar approaches to make clear the features of this type of temperature-modulated DSC.

1kA-1T級交流超電導コイルの製作とクエンチ試験

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富士 広¹, 定方 伸行¹, 斎藤 隆¹,
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電気学会論文誌 B 119 11 (1999) 1249-1256

交流電力機器は, 超電導化による小形・軽量化, 高性能化, 低損失化などが期待されており, 種々の検討が活発に行われている。実用規模の容量を持つ交流超電導電力機器の開発を行うためには, 1T程度の交流磁束密度下で10kA級の交流電流を通電できる超電導導体とその巻線化技術の開発が不可欠である。

そこで本論文では, 交流超電導機器に共通する基

礎技術の開発を目的に、その第一段階として、交流1kA通電時に1Tの交流磁束密度を発生する超電導コイルを製作した。そして、製作したコイルのクエンチ試験を行い、交流コイルの安定性の検証を行った結果を報告する。

Application of Orthogonal Wavelet Decomposition to Plasma Fluctuation Study

Leonid G. BRUSKIN¹, Atsushi MASE¹,
Yasuyuki YAGI and Teruo TAMANO¹

¹*Plasma Research Center, Univ. of Tsukuba*
Jpn. J. Appl. Phys. **38** (1999) L1345-L1347

Multi-scale analysis of plasma fluctuations in fusion devices is performed using wavelet decomposition over the orthogonal compactly supported basis of wavelets. The discrete wavelet analysis allowed us to monitor separately the turbulence properties in different frequency bands during the RF heating on the tandem mirror GAMMA 10 and discrete event on the reversed-field pinch TPE-1RM20 fusion devices. Orthogonal discrete wavelet transform can be considered to be complementary to Fourier and continuous wavelet transforms, better suited for the study of wide-spectrum transitional events.

Preliminary Experiments of Thermally Regenerative Fuel Cell Utilizing Solar Heat

Yuji ANDO, Tadayoshi TANAKA and
Takumi TAKASHIMA

Journal of JSES **25** 6 (1999) 42-48

We propose a thermally regenerative fuel cell, which consists of 2-propanol dehydrogenation and acetone hydrogenation with utilizing solar thermal energy. By means of combination with chemical reaction and fuel cell, we can convert low temperature thermal energy like solar heat into electrical energy. In order to make characteristics of the cell clear, we investigated effects of catalyst metal, catalyst supporting material, catalyst loading, 2-propanol concentration and reaction temperature on the efficiency of the cell. The activity of ruthenium and platinum composite catalyst supported on carbon plate for acetone hydrogenation at 90 °C is higher

than that of ruthenium catalyst and platinum catalyst supported on the same kind of plate. We can get the following results from the experiments. 1) When ruthenium and platinum composite catalyst is supported on carbon felt or carbon cloth, the activity becomes much higher than that of the catalyst supported on carbon plate. 2) When 2-propanol concentration is 50-70 vol%, the efficiency becomes highest. 3) As catalyst loading becomes higher, the efficiency of the cell was improved. 4) As for the reaction temperature, the best efficiency of liquid-phase and gas-phase solar thermal cell is obtained when reaction temperature is 80 °C and 60 °C, respectively.

Experimental Results of Acetone Hydrogenation on a Solar Chemical Heat Pump

Takumi TAKASHIMA, Takuya DOI, Yuji ANDO and
Tadayoshi TANAKA

Renewable Energy: Technologies and Policies for Sustainable Development (1999) 503-507

Solar chemical heat pump can upgrade the low temperature solar heat about 80°C to about 150 - 200°C by the chemical reactions of 2-propanol/acetone/hydrogen. These reactions are both catalytic reactions. In this paper, the results of heat exchange experiments of acetone hydrogenation reaction with exothermic reactor for solar chemical heat pump are presented. Concentration gradient catalyst layers (CGCL) are applied in the reactor for temperature control. The experimental results showed that CGCL is possible to control temperature distribution in the reactor and the production of by-products.

Overview of "Super-ASHURA" KrF Laser Program

Y. OWADANO, I. OKUDA, Y. MATSUMOTO,
I. MATSUSHIMA, E. TAKAHASHI, E. MIURA,
H. YASHIRO, T. TOMIE, K. KUWAHARA and
M. SHINBO

Fusion Engineering and Design **44** (1999) 91-96

In the Super-ASHURA KrF Laser at ETL, main amplifier with full pumping duration (270 ns) and 12 beam

lines have been completed. At present, total output energy of 2.7 kJ has been extracted from the main amplifier by double-pass amplified 12 beams (20 ns \times 12) with aperture filling factor of 74%. Local intrinsic efficiency has reached 10%.

In the Raman amplification which is to be used for high peak power pulse generation, multi-pass forward amplification of nanosecond Stokes pulse showed energy conversion efficiency of 73%. Also, multi-joule short Stokes pulse (150 ps) has been obtained from 12.5 J, 20 ns pulse by saturated backward amplification of self-generated Stokes pulse.

To investigate the effect of irradiation smoothness, two dimensional profile of target rear surface displacement has been measured by using short (< 100 ps) 268 nm probe pulse.

An Aspect of Discrete Dynamo Event in a Reversed-field Pinch Plasma as Self-organized Criticality

Yasuyuki YAGI, Leonid G. BRUSKIN¹,
Masayuki WATANABE², Tommaso BOKZONELLA³,
Toshio SHIMADA, Hajime SAKAKITA and
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²Fac. of Eng., Iwate U.

³Consorzio RFX

J. Plasma and Fusion Research SERIES 2 (1999)
180-183

A detailed look at a discrete dynamo event in a reversed-field pinch plasma (RFP), TPE-1RM20, is given. Dynamics of the magnetic signals are especially shown for a typical case with an analytic scenario to understand the phenomena. An alternative, synthetic aspect is tried by checking the similarities to the Self Organized Criticality.

Multichord Photoemission Monitoring System in UV-Visible Range of a Reversed Field Pinch Machine TPE-RX

Shigeyuki SEKINE, Takeshi OSAKABE,
Haruhisa KOGUCHI, Hajime SAKAKITA,

Yasuyuki YAGI, Yoichi HIRANO, Toshio SHIMADA
and Yasuyuki NOGI

J. Plasma and Fusion Research SERIES 2 (1999)
192-194

Population distribution of carbon ions (C⁴⁺) in a poloidal cross section of a reversed field pinch machine TPE-RX was derived from chord-averaged emission intensities. Thirteen vertical ports of the poloidal section were used to observe photoemission. The peak of the distribution appeared at $|r/a| = 0.9$ where $a (=450 \text{ mm})$ was minor radius of the plasma. The C⁴⁺ ions were almost absent around core region.

Conductive Self-Assembled Meso-Structured Silica Films Synthesized by Ferrocenyl Surfactant

H. S. ZHOU and I. HONMA

Jpn. J. Appl. Phys. **38** (1999) L958-960

Self-assembled organic molecules into high-ordered meso-structured architectures have attracted increasing attention because these materials provide a rich source for scientific research and technological applications. We firstly report the conductive oriented silica meso-structure film synthesized by ferrocenyl surfactant templating using a spin coating method. X-ray diffraction pattern of the film shows that the phase is lamellar. The electronic conductivity properties of the film are also observed.

Preparation of Electrode Catalyst for Thermoregenerative Fuel Cell

Ryuichi TOHRIZAWA¹, Yoshihiro KIMURA¹,
Yasukazu SAITO¹, Yuji ANDO and
Tadayoshi TANAKA

¹Science Univ. of Tokyo

*The 5th Korea-Japan Joint Symposium '99 on
Hydrogen Energy* 394-400

A redox reaction pair of electrochemical acetone hydrogenation / thermal 2-propanol dehydrogenation was adoptable to constitute a thermoregenerative fuel cell. Carbon-supported ruthenium or ruthenium-platinum

composite particles were prepared by an impregnation method for taking the role of an electrode catalyst, where an anodic reaction took place among acetone, proton and electron. From catalytic characteristics of positive electrode processes, importance of facile C-H bond formation yielding 2-propanol was pointed out in addition to large adsorption abilities toward acetone.

Optimization of a Force-balanced Coil for Superconducting Magnetic Energy Storage

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⁴*Yamaguchi Univ.*

Trans. IEE of Japan **120-D** 1 2000

SMES is very promising for the future power storage system because of fast response, low loss and high efficiency. We proposed the Force-balanced Coil (FBC) concept for the SMES and demonstrated it by the experiment. Moreover, we studied on coil winding configuration for SMES. The results were compared with the toroidal type configuration and ordinary helical type one. It is shown that FBC is superior than the others in view points of electromagnetic force and per unit length stored energy of the superconductor. Finally, optimization of FBC for SMES has been done. The key parameters of superconductor stress, length, maximum field and stored energy were surveyed and optimized under the restriction of critical field and critical current. It is shown that the optimized FBC-SMES is obtained in case of which parameters are a pitch of 3 and an aspect ratio of 1.79.

General theory of steady state of temperature modulated DSC and its application to complex heat capacity measurements

Takeo OZAWA¹ and Katsuhiko KANARI

¹*Chiba Institute of Technology*

Journal of Thermal Analysis and Calorimetry **59** (2000)

257-270

For complex heat capacity measurements, steady state of various types of temperature-modulated DSC is theoretically investigated by a set of common comprehensive fundamental equations of heat balance. Heat capacities of heat paths, heat loss to the environment and mutual heat exchange between the sample and the reference material are taken into accounts together with thermal contact effect between the cell and its holder plate. Rigorous and general solutions have been obtained, and useful relations for complex heat capacity measurements have been derived for each type of DSC. They are compared with each other to elucidate unique features of each type of DSC.

Effects of Shell Configuration on the Performance of Reversed Field Pinch Plasma

Yasuyuki YAGI, Yoshiki MAEJIMA,
Giuseppe. ZOLLINO¹, Gianluigi SERIANNI¹,
Hajime SAKAKITA, Shigeyuki SEKINE,
Yoichi HIRANO and Toshio SHIMADA

¹*Consorzio RFX, Italy*

Nuclear Fusion **40** Num. 2 (2000) 223-244

The experimental results of three different reversed-field pinch machines at the Electrotechnical Laboratory are compared. In particular, the results are summarized in terms of the difference in the configuration of the conductive shell system. The three configurations correspond to TPE-1RM15 ($b/a = 1.18$), TPE-1RM20 ($b/a = 1.08$) and TPE-1RM20mod ($b/a = 1.12$), where b/a is a measure of the shell proximity, and a and b are the minor radii of the plasma and the inner surface of the shell closest to the plasma, respectively. The magnetic fluctuations, global confinement properties and mode-locking events induced by the external field error at the thick-shell gap, are studied. It is shown that the magnetic fluctuation amplitude increases with b/a , as expected from the linear growth rate of the dominant MHD modes, and that the multilayered, close-fitting shell system improves the performance under extreme operating conditions in the high pinch parameter region and when external field errors are considered, while the performances under normal operating conditions are comparable within the shot-to-shot deviations of the data.

Acoustic Emission Occurrence Induced from a NbTi Superconducting Coil under Alternating Current Operation

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Katsuyuki KAIHO, Hiroshi FUJI¹,

Nobuyuki SADAKATA¹ and Takashi SAITOH¹

¹*Fujikura Ltd.*

IEEE Transactions on Applied Superconductivity 9 4
(1999) 4648-4653.

Acoustic emission (AE) induced from an alternating current (ac) superconducting coil was studied during operation in liquid helium. The operating current of the coil was increased from zero with a constant ramp rate at a commercial frequency of 50 Hz until quenching in the coil. The AE signals induced from the coil around the time of the quenching initiation were compared with the operating current, the coil voltage and the phase difference between the current and the voltage in order to estimate the changes in those signals which resulted from the quenching process. The AE signals continued almost at very low levels before the quenching. At the moment of the quenching initiation, the AE signals clearly and drastically rose approximately 10 ~ 15 ms earlier than the decrease in the operating current or the phase difference. The AE signals induced by the wire motion during 50 Hz ac operation were also compared with the operating current.

Confinement Characteristics of the TPE Reversed Field Pinch Plasmas and Effects of the Boundary Configuration

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Hajime SAKAKITA, Sigeyuki SEKINE,

Yoichi HIRANO, Toshio SHIMADA,

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³*on leave from Quaid-i-Azam Univ., Pakistan*

Fusion Energy 1998 (Proc.17th International Conference, Yokohama, 1998), IAEA Vienna CD-ROM EXP4/07

Confinement characteristics of the TPE series reversed field pinch (RFP) machines, TPE-1RM15, TPE-1RM20 and TPE-1RM20mod, at Electrotechnical Laboratory (ETL) are summarized. Especially data are synthesized in respect to the effects of the different boundary structures of the machines, where shell proximity and overlapped poloidal shell gaps by the multi-layered shell structure are featured. Comparison of the experimental results is shown in terms of the characteristics of magnetic fluctuations, global confinement properties in general, operation capability of the improved confinement in high pinch parameter (Θ) discharges and locked mode events. Linear growth rate of the unstable modes as a function of the shell distance is numerically simulated. Understandings of RFP plasma physics have also made progress by the most recent intensive experiments on correlation studies between fast electrons and dynamo activities and measurement of the plasma and mode rotation. TPE-1RM20mod was shutdown in December 1996 and new RFP experiment has started in TPE-RX from March 1998. The new machine also succeeds the concept of the shell configuration of the TPE-1RM20.

"REVERSED FIELD PINCH EXPERIMENT ON A NEW LARGE MACHINE, TPE-RX"

Yoichi HIRANO, Toshio SHIMADA, Yasuyuki YAGI,

Shigeyuki SEKINE, Hajime SAKAKITA,

Haruhisa KOGUCHI, Takeshi OSAKABE¹,

Kiyoshi HAYASE, Yasuhiro SATO,

Yoshiki MAEJIMA and Isao HIROTA

¹*Nihon Univ.*

Fusion Energy 1998 (Proc.17th International Conference, Yokohama, 1998), IAEA Vienna 2 (1999) 375 and CD-ROM EX4/4

Reversed field pinch (RFP) experiment on a new large machine, TPE-RX has been started from March 1998. Major and minor radii of TPE-RX are 1.7175m and 0.45m, and the maximum designed plasma current (I_p) and discharge duration are 1MA and 100ms, respectively. TPE-RX is being operated in the medium I_p region ($I_p < 500kA$) with discharge duration about 80ms and RFP discharges with good reproducibility are routinely obtained, where the precise compensation of error field at poloidal gap of thick shell is indispensable. In a series

of initial phase of experiment, following results are obtained. Non-inductive part of toroidal loop voltage ($RpIp$) as low as 12 V is obtained at low Ip (about 150kA), but it increases with Ip and becomes 22V at Ip about 450kA. However, it is shown that $RpIp$ is gradually decreasing as the discharge cleaning has been continued. Further decrease of $RpIp$ will be expected under the improved wall condition. In almost of all discharges, especially with large Ip (>250kA) the wall and phase locking of the MHD fluctuations is observed. However, several discharges without this mode locking are found in low Ip and low filling pressure cases. Measurements of electron density ($\langle ne \rangle$) by CO₂ laser interferometer, electron temperature (Te) by soft x-ray pulse height analysis and ion temperature (Ti) by CV Doppler broadening have been started. Measured values are $\langle ne \rangle$ about $5.0E18m^{-3}$, Te about 1000-1200eV and Ti about 130+-50eV for the discharge with Ip about 270kA and reversal/pinch parameters about -0.1/1.6, although it is possible that this high Te may correspond to high energy part and low Ti may correspond to the value near the edge since the radiation profile of CV line is very hollow. An interesting dependence of plasma rotation on Ip is found in the Doppler shift measurement of CV line.

SPACE AND OCEAN TECHNOLOGY

スピニングローター真空計の渦電流と温度による誤差の解析

Hideaki ISOGAI
真空 42 12 (1999)

This paper deals with an analysis on the offset pressure change of a Spinning Rotor Gauge (SRG), which caused by unbalanced eddy current distribution and thermal change in a stainless steel rotor. Thermal and electromagnetic analysis method (physical models, equations, simulation algorithm) are recognized to have practicability and validity in this analysis that are usefully applied to design a new construction and to operate with carefully treatment.

Performance of Three-Finger Multisensory Hand on Spacevehicle "Hikoboshi"

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Yuichi MURASE¹

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Trans. of SICE 35 12 (1999) 1583-1590

A hand with dexterity and local autonomy is one of the key components of a space robot to perform precise in-orbit servicing. This paper presents performance of the three-finger multisensory hand boarded on the unmanned spacevehicle "Hikoboshi". The hand comprises a newly devised three-finger module with grip force sensors and a wrist compliance device with displacement sensors. It also has a hand-eye camera and three range sensors for non-contact sensing. The contact sensors display fine performance owing to zero-gravity of space compared with the ground. The laser/PSD type proximity range sensors retain performance under the high intensity of sunlight in orbit. Although the hand-eye camera is useful for position measurement of objects through image processing in most case, some points are noticed to use it in satellite daytime owing to intensity and direction variations of sunlight. The robot performed high precision tasks in space utilizing these hand mechanisms and multisensors through sensor-fused telerobotics.

ENVIRONMENT TECHNOLOGY

粒径分布がある場合の磁気クロマト性能の数値解析

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エバン・ホイットビー²
¹金材研

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電気学会論文誌 A 120-A 1 (2000) 62-67

新しい超伝導磁石応用技術として磁気クロマトグラフィー (以下 MC) を提案している。MC は、強磁性細線に外部磁界を印加した時に周囲にできる高勾配磁界を、従来型吸着式磁気分離とは異なり、ここを流れる微粒子にその磁性差に応じた流速差を生じさせ、分離する。粒径数 100 の超微粒子に磁気力を作用させ得るので、従来型クロマトグラフィーでは

不可能な大粒径粒子の分析に適用可能である。更に、二次廃棄物を排出しない利点がある。もし粒子が強磁性細線上へ捕捉されても、外部磁界の消去で磁気力が除去され、容易に洗浄でき、繰り返し使用できるからである。本論文は、この計算機シミュレーション法を報告する。コントロール・ボリューム法で一般伝導方程式を解く流体計算汎用コードを用い、MCカラム内の流体の流れ場、磁気力、微粒子拡散、微粒子粒径分布を考慮して、微粒子濃度の過渡解を計算した。これにより試作MCカラムの分離性能を求めた結果、単一粒径の場合と比較して、濃度がより極端に変動する分布となるが、分離性能向上には役立たず、逆に最大20%程度の性能劣化を生じることなどを明らかにした。これらは、設計に大きな影響を与える重要なMC特性である。

on the distributed-relaxation-time (DRT) models. The optimum interval of relaxation times to give the widest bandwidth is searched by the numerical calculation. It is found that the bandwidth of 5 decades with a phase-angle error, e.g., of 0.5° can be realized using twenty or less R-C pairs.

発光量評価による放電NO_x処理に関するパルス幅の影響分析

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電気学会論文誌A **120-A** 2 (2000) 167-173

針-平板電極に窒素希釈NOガスを流通させ、正極性パルスコロナ放電を適用し、パルス幅と印加電圧を変化させた場合のNO_x除去特性を求めた。また、高感度CCDカメラにより紫外発光分布を測定し、NO_x除去量との相関性を検討した。その結果、NO_x除去量と紫外発光量とは線型関係にあることを示した。この線型関係を応用し、NO_x除去の時空間分解推定を行った。パルス幅が200ns以上では、発光量が減少し、それに伴いNO_x除去エネルギー効率が低下することを示した。

OTHERS

Optimization of Fractal Immittance Networks

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Mol. Cryst. and Liq. Cryst. **337** (1999) 73-76

Fractal immittance is simulated by the analogue circuits composed of resistors R and capacitors C based