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Appendix

Summary International Reports, July 1991-June 1992

July 1991-June 1992

The 3rd International Conference on Steel-Concrete Composite Structures Fukuoka, Japan, Sep. 25-29, 1991

An Analytical Investigation of Sandwich Composite Beams in Shear

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Shear behavior of sandwich composite beams consisting of core concrete sandwiched by skin steel plates is investigated by a finite element analysis. The composite beams are with various types and arrangements of shear reinforcing steel plates. In the analysis models for force transfer at crack in concrete and interface between concrete and steel are used. By examining stress flows in shear spans, truss-like shear resisting mechanisms under cyclic loading are presented.

Evaluation and Rehabilitation of Concrete Structures and Innovations in Design Proceedings ACI International Conference Hong Kong, 1991

An Experimental Study on Abrasion of Various Concretes Due to Ice Movement

Yoshishige ITOH
TAISEI Crop.
Yuichiro ASAI
TAISEI Crop.
Hiroshi SAEKI
Hokkaido University

Movement of the ice sheet is both horizontal, caused by the tidal currents and wind, and vertical, due to tidal ebb and flow. Therefore, it is very important in the design of concrete structures in very cold regions to clarify the amount of abrasion due to ice-concrete motion.

Through a systematic series of experiments, the authors have obtained the following information:

1) A relationship between sliding distance and amount of abrasion for various concretes and coatings.
2) A relationship between ice pressure on a concrete specimen (contact Pressure) and amount of abrasion at the concrete surface.
3) The relationship between ice strength and abrasion rate.
4) The relationship between abrasion rate for various concretes and ice with fine entrained sand ($d_{50}=0.14$ mm, $d_{50}=0.70$ mm).
5) The degree of contamination by sand in actual river and lake ice in Hokkaido, Japan.
6) A method for estimating the abrasion of concrete structures due to a movement of an ice sheet.

Inaternational Meeting on Hydraulic Transients with Water Colium Separation Valencia, Spain Sep. 4-6, 1991

Separation of oscillation flow over a wavy bed

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and
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Oscillation flow over a wavy bed is investigated. When either the amplitude of the oscillating flow is large or the wavy bed sufficiently steep, flow separations may occur on the lee side of the crests. It seems very difficult to treat such phenomena in purely analytical way. In the present paper, we investigate this kind of separation in a numerical approach where the vorticity and finite difference approximations. It is confirmed that this method describes the separations appearing every half cycle and vortex shed from the bottom is drifting upward slowly with the ambient flow. A particular attention in paid to the effect of the computational mesh configuration.

The 24th I. A. H. R. Congress
Madrid, Spain Sep. 9-13,
1991

Steady Streaming of Standing Wave in a wave Flume

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This paper describe the results of the experiments which were carried out to observe the situation of the steady streaming caused by the influence of the bottom and side walls boundary layers of standing waves. The steady streaming was observed visually using the dye tracers of Potassium permanganate ($KMnO_4$).

It was found that there was a highly three dimensional flow structure in the steady this experience has similar sizes of the width and depth. Therefore the side wall boundary layers affect to the streaming as much as the bottom boundary layer does.

To explain the three-dimensional flow structure of the steady streaming the side wall boundary layer was analyzed by use of the boundary layer theory.

POLARTECH '92 International Conference on Development and Commercial Utilization of Technologies on Polar Regions, McGill University, Montreal, Canada, Jan. 22-25, 1992

Abrasion of Concrete Offshore Structures due to Ice Movement

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From investigations on the damage of offshore concrete structures due to ice movement, most damage was the result of abrasion of the surface of concrete offshore structures. In this study, firstly, the authors conducted systematic experinemts on abrasion to various kinds of concrete due to the movement of sea ice. According to the data obtained, the authors propose an estimation method for the actual of abrasion on offshore concrete structures. Secondly, the authors examined the adequacy of our abrasion estimation method, comparing it to the results of the obsevation of the bridge pier on the Teshio River.

POLARTECH '92 International Conference on Development And Commercial Utilization of Technologies on Polar Regions, McGill University, Montreal, Canada, Jan. 22-25, 1992

The Damage of Bridge Piers in Japan and the Estimation Method of Concrete Bridge Piers due to Ice Movement

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Hokkaido Development Bureau
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This paper reports the abrative damages to concrete bridge pier suffered by the movement of river ice in Hokkaido, then proposes estimating method for the abrative damage and its preventing method through field observation and a systematic series of experiments.

The 7th International Symposium on Okhotsk Sea & Sea Ice Mombetu, Hokkaido, Japan, Feb. 2-5, 1992

The Study on the Abrasion of the Structure Surface Due to a Movement of Ice Sheet

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Abrasion resulting from movement of sea ice sheet must be considered during the design of concrete offshore structures for arctic regions. Therefore, it is very important in the design of concrete structures for very cold region to estimate the abrasion amount due to a movement of sea ice sheet.

The authors have obtained the following conclusions and results through systematic experiments:

1. The abrasion rate strongly depends on ice temperature, 1 contact pressure and contamination concentration of fine sand in sea ice.
2. Estimation method for abrasion amount of concrete offshore structures due to the movement of sea ice sheet was proposed.
3. The contact pressure acting on various type of offshore structure were found.
4. Finally, the authors proposed monographs for estimation of abrasion rate in consideration of concentration and median size of fine sands in sea ice, and contact pressure between sea ice floe and the surface of concrete offshore structures.

The 7th International Symposium on Okhothsk Sea & Sea Ice Monbetu, Hokkaido, Japan, Feb. 2-5, 1992

Interaction Between Sea Ice Floes And Protective Coastal Structure

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Coastal structures constructed in Okhotsk Sea coast of Hokkaido have been attacked by water waves and drifting sea ice floes. The weight or shape of the armor units, side slope are interrelared and comprise the principal factors in the design of a rubble-mound coastal stucture (artificial reef, coastal dyke, groin, detached breakwater and so on). In this report, the authors beal with the stability of armor concreat blocks on artificial reefs which are attacked by water waves and motion of ice floes.

The 7th International Symposium on Okhotsk sea & Sea Ice Mombetu, Hokkaido, Japan, Feb. 2-5, 1992

Characteristic of the ice boom for control of the ice floes movement

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This paper describes experimentally the effect for control of ice floes movement by the Ice Boom.

Some general conclusion obtained from a model study, are as follow:

(1) Then ice thickness is large, ice floes are trapped easily by the Ice Boom. In real scale, if ice thickness is 2 m, ice floes are trapped until its velocity is over 1 m/sec. Conversely, then ice thickness is small, ice floes flow out slow velocity frow Ice Boom. In real scale, if ice thickness is 50cm, ice floes flow out from Ice Boom when surface velocity is over 0.8 m/sec.
(2) On the form of floating pontoons of the Ice Boom, we got ready for two type, cylinder type and timber type. As a result, difference due to forms for control of ice floes movement was not distinguish practically.
(3) It was found that the conditions of the effect for control of ice floes movement were determined by the number of Floude: Fe and ratio of ice thickness: h and size floes: L.

The 7th International Symposium on Okhotsk Sea & Sea Ice Mombetu, Hokkaido, Japan, Feb. 2-5, 1992

Experimental Study on overtopping of Ice Floes at Breakwater

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Breakwaters constructed at Okhotsk Sea coast of Hokkaido have effected by water wave and drifting sea ice floes.

The overtopping of ice floes directly affects to the facilities (pipe line, seaberth, and others) just behind the breakwater, and such damages have occurred at the port of Abashiri.

The authors have experimented on the rate of ice floes overtopping at two types of breakwaters (caisson type and caisson covered with concrete blocks type).

The 7th International Symposium on Okhotsk Sea & Sea Ice Mombetu, Hokkaido, Japan, Feb. 2-5, 1992

Characteristic of New type Ice Boom and environmental force

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If ice control equipment is installed the lagoon, it must be subject to two considerations: First, it must be removable from the water during the navigation season. Secondly, it must not interfere with drift sands at the lagoon mouth. Ice booms are clearly the choice; booms have been successfully used in rivers and lakes to control the movement of ice.

This paper presents the following results.

(1) The effect of control over sea ice determined by a function of Fe and h/L (Fe: Froude number; h: ice thickness; L: representative length of ice). The effect of the new type of ice boom was half as much again as that of the traditional pattern.
(2) In practical situations, the traditional type of ice boom can control ice floes of up to 80 cm/sec velocity.
(3) In practical situations, the new type of boom can control ice floes of up to 140 cm/sec velocity.
(4) If the ice floes are stable, the ice forces acting on the ice boom are governed by the drug force between the ice floes and the water.
(5) Ice forces can be calculated from the area of ice floes and velocity.

IAHR 1992 The 11th International Symposium on Ice
Banff, Albarta, Canada, Jun. 15-19, 1992

Ice Control in Northern Harbors

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The coastline of the sea of Okhotsk in Hokkaido is affected yearly by pack ice. It has become necessary to reduce the damage to fisheries and aquaculture facilities, whole year-round operation of harbors and ports. This paper clarifies the conditions to be required at facilities to control ice, and introduce pack ice control techniques currently being used or in the process of development, along with measures used to prevent freezing over.

IAHR 1992 The 11th International Symposium on Ice
Banff, Albarta, Canada, Jun. 15-19, 1992

Ice Force on A Rectangular Pile

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Hokkaido University
Toshihiko YAMASHITA,
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Ice force acting on offshore structure designed for use in ice-infested seas has been evaluated assuming a perfect (idealized) contact between leading edge of ice sheet and offshore structure. However, in the actual sea, the leading edge of an ice sheet in highly irregular. Small-scale indentation tests were conducted in the field to examine the effects of irregular contact conditions between sheets and rectangular pile indentor on ice force using freshwater lake ice in Hokkaido. On the basis of test results in this study, ice force in an idealized contact condition in approximately 1.25 time as large as that in an irregular contact condition.

The 24th IAHR Congress
Madrid, Spain September 9-13, 1991

Calculation of Flow and Bed Deformation with a General Non-orthogonal Coordinate System

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A two dimensional numerical model is developed to calculate the flow field and the bed deformation in river channels with a general non-orthogonal coordinate system. The equations with a curvilinear coordinate system which were previously proposed by the authors are transformed into a general coordinate system. The two coordinates are not necessarily cross each other at right angle in the present model and it can be applied to the flow field having any shape of the channel geometry. The boundary conditions along the lateral boundaries can easily be set by introducing contravariant components of the flow and the sediment flux. The model is applied to the flow fields in channels with compound cross sections in which the low-water channel and flood plains have different radius of curvatures, and the bed deformation in channels with abrupt changes of the width. Good agreements are found between the calculations and the observations.

The 4th International Conference on Seismic Zonation, Stanford, California, USA August 25-29, 1991

Observation of Long Period Microtremors in San Francisco Metropolitan Area

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Long period microtremors with period ranging from 0.5 to 10 sec have been observed in

San Francisco metropolitan area. The obnervation region was divided into eleven equally spaced sections from San Francisco to San Jose. Each section consists of six to eight observation sites in S. W.-N. E. direction, spanning San Francisco peninsula via San Francisco Bay with the West coast of the Bay. Two reference sites were chosen to be at Yerba Buena Island and Treasure Island. Total of 136 records were obtained at 83 different locations during a four day period. From these records, through evaluation of the Fourier spectra, predominant period of each site is determined. Predominant periods at the observation sites are used to study the resonant motions of the sediments in the Bay area. The results show that predominant period for most of the stations is within the range 3-4 sec. Overall, predominant periods increase as we move from San Francisco to San Jose area.

The 4th International Conference on Seismic Zonation, Stanford, California, USA August 25-29, 1991

A Study on Microzonation of Perth Basin Western Austraria, Through Microtremor Measurements

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In Perth Basin, Western Australia, we made seismic microzoning maps through microtremor measurement covering the whole area of the basin. At first, a pilot measurement was performed on 2 observation lines traversing the basin and general feature of microtremors was grasped. Then full scale two-dimensional survey on 50 sites covering the basin was carried out. A reference point was set on the outcrop of baserock site. Simultaneous measurements at 5 sites and the reference site using 6 sets of digital seismometer were repeated and covered the whole area. From the spectral ratio at each site to the reference site contours were drawn in maps for period of 5, 2, 1 and 0.5 sec. It is clarified that these spatial pattern were well reflect underground conditions corresponding to the various depth.

The 4th International Conference on Seismic Zonation, Stanford, California, USA August 25-29, 1991

Two Dimensional Analysis on Site Effects in the Sapporo Urban Region, Japan, Based on Observation of 1 to 10 Second Microtremors

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Long-period microtremors observation in the Sapporo urban region, northern Japan, was carried out in order to elucidate the geological information of deep sediment layer associated with amplification characteristics of seismic motions in the period ranging from 1 to ao sec. In the entire region of 30 km×30 km, 6 lines having observation points located at the interval of about 1km were set up. Spectral analysis of the recorded microtremors gave rise to the result that a site amplification effect can be evaluated in terms of the spectral amplitude ratio to the base spectrum at a reference point. On the basis of spectral ratio at each point we got the microzoning map on the site amplification effect in long period in this region.

The 4th International Conference on Seismic Zonation, Stanford, California, USA. August 25-29, 1991

Distribution of the Seismic Intensities for the Loma Prieta Earthquake in San Francisco City by a Questionnaire Survey

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This survey was performed to evaluate the seismic intensities in the city of San Fracisco during the Loma Prieta Earthquake, 1989 and to discuss the relation of the seismic intensity and sub surface geology.

The evaluated intensity distribution is consistent to that of the USGS intensity, but the intensity distribution of USGS is so flat that it hardly reflects more complicated ground conditions.

The result of this survey shows that sub surface geology clearly has an offect on intensity.

Proceedings of the 3rd Asian Conference on Fluidized-Bed & Three-Phase Reactors, Kyongju, Korea, May 31-June 4, 1992

Force Balance Equations for Particles in Binary-solid Liquid Fluidized Beds

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In a liquid fluidized bed consisting of the binary solid particles differing in size and density, mixing of two kinds of particles occurs and degree of the mixing is controlled by the equilibrium force balance relationship. A model to predict the volume fractions of particles in the mixed layer is developed on the basis of the force balance equations of each particle species (gravitational, buoyant and drag force). In describing the drag forces of particles in a mixed layer, two imaginary mono-component beds are introduced and it is assumed that the drag force acting on the particle i in the imaginary bed comprising particle species i is equal to the drag force of i in the mixed layer. The validity of this model is tested against the experimental data.

SARDINIA '91 3rd International Landfill Symposium, S. Margherita di Pula, Italy, 14-18 October 1991

Theoretical Study on Migration of Volatile-Noninoic Compounds Through Solid Waste Landfill Layer

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Based on the authors' previous studies on interaction (sorption and decomposition) between TCE (trichloroethlene) and waste, TCE transport equations are developed, and parameters are estimated in the case that TCE is transported both with landfill gas and with unsaturated infiltrate water. By carrying out computer simulations, TCE leakage problems are studied.

SARDINIA '91, 3rd International Landfill Symposium, S. Margherita di Pula, Italy, 14-18 October 1991

Stabilization Mechanism of Leachate from Semi-Aerobic Sanitary Landifills of Organics-rich Waste

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BOD removal mechanism in a semi-aerobic landfill was studied by carrying out theoretical analysis and experiments. Leachate collection pipes play an important role to supply oxygen into waste layer, and aerobic zone formed in the vicinity of the pipes have considerable BOD removal ability. A design method of the configuration of the pipes in a landfill was presented.

The 7th International Congress on Rock Mechanics, Aachen, Germany, September 16-20, 1991

Shaft damages due to mining

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In Sumitomo Akabira Colliery, the limit angle of the shaft pillar has been changed. A program to protect the shaft has started along with the mining around the shaft. The program is composed of shaft condition monitoring, repairing system and numerical simulation. The used numerical method is based on DDM and takes into account the existence of the ground surface and faults. Simulated displacements along the shaft are in good agreement with observation.

The 24th International Conference of Safety on Mines Research Institute, Donetsk, USSR, September 23-28, 1991

Methane Content Distribution a Coal Seam Surrounding a Heading Measured With the Newly Developed Device and Method

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The new device has been developed for measuring of methane content of coal by using cuttings from boreoholes. For underground use, it works by a battery and is intrinsically safe and portable. About 20-40 g of coal cuttings of 1-4 mm diameter collected from the different depth of an in-seam borehole are sealed in six cylindrical containers and pressure buildups with time are measured by pressure sensors. The measured data are recorded and stored. Back to the surface, the stored data are connected via RS 232 port to a PC computer for methane content estimation.

The total gas content of coal is calculated by so-called " The Direct Method " after U. S. Bureau of Mines, as total of " Lost Gas ", "Desorbed Gan " and " Residual Gas ". Using this device, measurements in coal seam surrounding headings at two coal mines have been conducted. Examples of counter lines of gas content in coal seams derived from these measurements are described. This device and method will play a big role in evaluation of degree of danger of gas and coal outbursts and effectiveness of pre-gas-drainage from coal seams.

Geomechanics 91 Hradec, Ostrava, Czechslovakia, September, 24-26 1991

Water Jet assisted drilling technique for gas outburst Prevention

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Some coal mines suffer from occurrences of coal and gas outbursts. Beside drainage of gas, advance drilling by large diameter boreholes to destress the strata pressure is nsed for prevention of outbursts. This approach has been successful in some underground coal mines in Japan. However, the drilling of large diameter boreholes requires huge and high-power drilling machines.

To decrease the drilling costs, a water-jet assisted drilling system has been devised for underground applications.

Boreholes having a diameter of 250-390mm were drilled using a small drilling machine assisted with water jets at Akabira Coal Mine. The depth of the boreholes totaled about 1700m. In this paper a comparison of this system with conventional drilling methods is presented.

The Workshop on Recovery and End-Use of Coal-Bed Methane, Katowice, Poland, March, 16-21, 1992

Prediction of Gas Emission from Longwall Face based on Measured Gas Content of Coal Seam

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The situation of Japanese coal mine is in the severe environment, because the change rate of Yen is the higher, the difference cost of the production coal between in Japan and other countries is more expand. Every year one or two coal mines are forced to close. To continue the production of coal, we have to reduce the cost of production.

Therefore, the mining by super-wide longwall method which is more than 250 m was attempted at Taiheiyo coal mine to reduce the cost and the minig method have had successful results.

To get successful results by this mining method, the controlling and the prediction of gas emission from the longwall face will be the most important things.

Therefore, to predict the gas emission from the longwall face rapidly, the new transportable device for measurement of methane content in the coal seam was developed.

In this paper, the comparison of the predicted gas emission from the mining panel based on the measured gas content by using the new nevice with the observed results are described.

International Conference on Reliability, Production, and Control in Coal Mines, wollongong, Australia, Sept, 2-6, 1991

Effect of Stresses and Acoustic Emissions on Gas Permeability of Coal

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The effect of stresses and acoustic emissions on the gas permeability of coal was investigated in the field and the laboratory in order to find an entimative method of the practicability of gas drainage. In the field, acoustic emissions and gas emissions during gas drainage drilling were monitored tentatively at some mines in Japan and China.

In the laboratory, acoustic emissons from coal specimens in addition to gas permeability were measured during the triaxial compression loading in order to interpret the results monitored in the field. Besides, the opening of gas permeation channels in coal was considered on the basis of the experimental results.

From these results, the effect of gas pressure in the permeation channels in addition to stresses and acoustic emissions on the gas permeability of coal became clear. Especially, the gas permeability increased remarkably in response to the occurrence frequeny of acoustic eminnions and was related closely to the characteristics of their amplitude-frequency distribution. Consequently, these characteristics were considered to be useful as an estimative index of the practicability of gas drainage.

The International conference on Multiphase Flows '91-Tsukuba, Tsukuba, Japan, September 24-27, 1991

An experimental Investigation on Concentration Fluctuations of Turbulent Slurry Flows in an Upward Vertical Pipe

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Studies on fluctuation components of two phase flows have a long history and been conducted in various fields.

Measurements of transport phenomena in solid-liquid flows have chiefly focussed on

fluctuation components such as velocity, pressure and concentration for practical purposes. Studies have generally concentrated on averagde values at chord or sectional area of the pipe in the low frequency range. Details of local fluctuations of potential measured with a conductive probe in a horizontal pipe were the object of a recent study.

The present investigation concerns local concentration fluctuations in an upward flow in a vertical pipe using a conductive probe. Spectra, root mean square values and integral scales of concentration fluctuations are presented, together with local mean profiles of velocity and concentration.

The 24th International Conference of Safety in Mines Research Institutes, Donetsk, USSR, 23-28 September 1991

A Flexible Expert System to Prevent and to Take Countermeasures for Emergency in Underground Coal Mine

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In order to take better countermeasures in case of an unseen accident, a flexible expert system for personal computer have been developed. When it is recognized in the system that the information to take countermeasures is lacking, the information about the accident are transmitted to the specialist registered on each field using the circulating notice by file transmission or by facsimile. The answers from the specialists are displayed on CRT and the manager directs the system to either take account of the answer or not. In the paper an application to take countermeasures for rock and gas outburst at Horonai Coal Mine, Hokkaido, Japan is introduced.

Indo-US Symposium on Computers in Mineral Industry, Dhanbad, India, 11-13 November, 1991

The Present Condition of a Computer Application in Japanese Coal Mine and Some Future Views for the Application

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Coal mines in Japan are exposed to a crisis of a continuation from the increasing cost of both mining and safety. In order to overcome the crisis some big coal companies have been utilizing a computer to control mining and safety based on measuring factors related on underground condition in real time.

Achievements of a computer application in representative two major coal mines in Japan is introduced. Furthermore a flexible expert system to be able to consult unexpected accidents is introduced. This system can send/receive not only linguistic expression but also pictures to human experts registered in the system by using facsimile when the value of certification factor of countermeasures is small. It is proposed for the system in future that both hardware and software should be prepared/developed.

The 23rd International Symposium on the Application of Computers and Operations Research in the Mining Industry, Tucson, USA, 7-11 April, 1992

A Flexible Expert System to Assist Choice of Countermeasures for Prevention of Emergency in Coal Mine Underground

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A flexible expert system for a personal computer has been developed to take countermeasures for prevention of emergency in coal mine underground. The system makes a diagram to estimate maximum airflow rate of a specified branch such as coal face, advancing face and so on under the conditions of opening of regulators set in two different branches by computer simulation.

The system estimates the ventilating condition in underground by using both measured

value and safety factor derived from rules in the system. When it is recognized in the system that either safety factor or confidence factor of countermeasure has a small value, the system sends information relating to reasoning in the system to human experts registered in the system by computer communication and facsimile.

The replies in file transfer from the experts are stored in the system and reconsultation for estimation of underground condition are started automatically.

1991 International Conference on Coal Science, New Castle, UK, September 16-20, 1991

Apparent Viscosity of Softening Coal Heated at Elevated Pressures

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Needle Penetration to a 10 mm-dia. cylindrical pellet of coal particles together with its volumetric dilation was measured for six different kinds of coals under various conditions, pressures up to 10MPa in nitrogen and hydrogen gas atmospheres at heating rates of 0.5 to 20 K/min and a holding temperature of 823 K. Change of the net penetration depth with temperature obtained from the observed penetration and dilation-temperature curves was analysed on the basis of a simple mathematical model which was developed incorporating consecutive reaction kinetics of pyrolysis and carbonisation, an existing viscosity equation for molten polymers and an equation of motion for a Newtonian fluid. The model was shown to describe reasonably well the observed effect of the heating rate and pressure on the change of the net penetration depth with temperature. The activation energies assumed for the viscosity change were less than 10 kcal/mol and depended on the kind of coal.

The 7th International Conference on Fluidisation, Brisbane, Australia, May 3-8, 1992

On the Definition of Fast Fluidisation in a Circulating Fluidised-Bed Riser

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Existing definitions of fast fluidisation in a riser of circulating gas-fluidised bed, which have closely been related to the presence of S-shaped axial bed-density distribution, were critically examined on the basis of data from experiments controlling independently the solid circulation rate and the gas velocity in a 10 cm-i. d. and 5.0 m-high riser. A state of the dense-phase transport was observed without any dense/dilute layer interface, suggesting that the S-shaped distribution is not essential for the definition. A conceptual flow-regime diagram was proposed to demonstrate a physical relationship between the bed voidage and the gas-solid slip velocity, which clearly showed the existing definitions explain flow state and structure under rather limited conditions.

The 7th International Conference on Fluidisation, Brisbane, Australia, May 3-8, 1992

Circulation of Liquid-Fluidised Particles at Liquid Velocities Higher than the Terminal velocity

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Axial distributions of the bed voidage were measured for two kinds of spherican glass particles fluidised by water in a 50mm-i. d. and 4.0m-high riser column and circulated at liquid velocities up to 40 times the particles terminal velocity. Voidage variation with the liquid-solid slip velocity displayed a considerable deviation from that estimated by the Richardson-

Zaki equation for a batch liquid-fluidised bed, probably due to an unexpective transition of flow pattern from particulate to aggregative fluidisation. For the liquid-solid slip velocities higher than ca. 2 times the particle terminal velocity, the voidage variation was shown to be qualitatively well described by the Hagen-Poiseulle or Blake-Kozeny equation of laminar fluid flow in a packed bed.

The 44th Annual Meeting of the Division of Fluid Mechanics, The American Physical Society 24-26 November (1991), Scottsdale, Arizona, USA

Near-Field Pressure Fluctuations by a Jet Impinging on a Body

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We present near field pressure fluctuations generated by a jet impinging on a circular cylinder and a streamlined body, and propose ways to reduce an aerodynamic noise by impinging jet. The impinging jet is one of the simplest flow configuration of a self-sustained flow oscillation. The near-field pressure fluctuations are expected to play an important role in a feed -back mechanism associated with a self-sustained flow oscillation. Thus the near-field pressure and velocity field were measured by means of the phase-averaging technique. The intensity of the near field pressure fluctuations was found to depend on the strength of vortices near the surface induced by the jet vortices. This suggests two ways to reduce the noise generated by the impinging jet: one is to suppress the magnitude of the jet vortices, and the other is to prevent the growth of the vortices induced by the jet vortices.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields January 26-29, (1992), Nagoya, Japan

Fundamental Theory for Hydrodynamics of Magnetic Fluid

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A complete set of basic equations for conducting magnetic fluids were derived by the thermodynamical method that was based on the free energy and the dissipation function. Especially, the equation of energy was discussed thermodymanically in detail. The concrete expression of the equation of energy was obtained. The coefficients of volume expansion and the specific heat in magnetic fluids were defined. Using the governing equations, the fundamental flows such as a simple shear flow and a constant pressure gradient flow between two parallel plates were discussed and the effects of the electromagnetic fields on the flows were investigated.

Russia-Japan Seminar on Turbulent Flow Research May 5-8 (1992), Russia

Influence of Sinusoidal Disturbances on a Turbulent Reattaching Separated Flow

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Single-frequency sinuous disturbances were introduced along the square-cut leading edge of a blunt circular cylinder to modify the rolling-up prcess of the reattaching separated shear layer at Reynolds numbers of the order of 10^5. The separation bubble has three fundamental frequencies, which are associated with the Kelvin-Helmholtz instability of the shear layer near the separation edge, fairly periodic shedding of large scale vortices, and a low-frequency flapping motion. The vortex-shedding frequency was theoretically obtained by assuming that the separation bubble is a self-excited system. The reattachment length was found to attain a minimum at an excitation frequency which was approximately five times the vortex-shedding frequency, and a maximum at another excitation frequenccy which was approximately a half

of the frequency of the Kelvin-Helmholtz instability immediately downstream of the edge f_{KH}. The reattachment length was independent of the excitation frequency if it was greater than approximately $2f_{KH}$. The modification of the rolling-up process of the shear layer was demonstrated by the power spectra of velocity fluctuations.

Engineering Foundation Conference "Present and Future Engines for Automobile" Santa Barbara, California, USA August 25-30, 1991

Particulate and NOx Reduction with Catalytic Fuel Additives in Diesel Engines

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This paper deals with a general evaluation of the PM and NOx reduction effect of a large number of metallic additives at various diesel engine operating conditions, and also with the catalytic mechanism and processes of the soot reduction at high temperatures in combustion chambers with gas flow. The conclusions may be summarized as follows: (1) Metal additives, Ca and Ba, do not affect combustion rates and engine performances but reduce PM remarkably and NOx slightly. (2) Stronger gas turbulence, higher excess air factors in the combustion chamber, and fuels with high cetnane numbers and lower kinematic viscosities give large PM reductions with fuel additives. (3) Metallic fuel additives cause a catalytically decreased ignition temperature and enhanced oxidation of PM especially soot, which mainly contributes to the PM reduction with fuel additives. (4) The oxidation of metal containing soot proceeds in two stages; an initial stage with rapid oxidation (stage 1) followed by a stage with slower oxidation (stage 2). (5) The degree of soot oxidation in stage 1 increases significantly with increasing metal content in the soot. Soot reduction also increases in fuels where the soot oxidation is promoted more with the metal additives.

SAE International Fuels and Lubricants Meeting and Exposition, Toronto, Canada Octorber 7-10, 1991

Distinguishing the Effects of Aromatic Content and Ignitability of Fuels in Diesel Combustion and Emissions

Noboru MIYAMOTO, Hideyuki Ogawa, and Masahiko SHIBUYA

The influence of aromatic content in fuels on the soot and NOx emissions from a diesel engine was analyzed under controlled ignition lags with spark-assisted operation. Monocyclic aromatic hydrocarbons and n-hexane mixtures were used as fuels, and the aromatic content was varied from 0 to 75 v-%.

The experiments showed that, at the same equivalence ratio and regardless of the molecular structure of the fuel, the soot oncentration in the exhaust gas could be described by a linear-combination function with two variables representing the ignition lag and C/H atom -ratio of the fuels. For unchanged ignition lags, the soot emissions increased linearly with increased C/H atom-ratios, which are controlled by the aromatic content. The degree of increase in soot emissions with increasing C/H atom-ratio decreased with decreasing equivalence ratios. The NOx emission increased slightly with increases in the C/H atom-ratio and ignition lag.

ASME 15th Annual Energy-Sources Technology Conference and Exhibition (ETCE). Houston, Tex., Jan 26-30, 1992

The Properties, Formation, and Oxidation of Soot Particulate in Diesel Engines

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Hokkaido University
Yasuhiro FUJIWARA and Shigeru TOSAKA
Hokkado institute of Technology

This investigation attempts to explain and provide basic details of the formation process of particulate in diesel engines. It uses electron microscopy to observe the configuration of particulate. The cracking and condensation polymerization as well as the amount of particulate and configuration was determined in a nitrogen atmosphere. The polycyclic aromatic hydrocarbons in the particulate were also analyzed.

Gas from the combustion chamber was collected and the soot concentration, configuration,

and polycyclic aromatic hydrocarbon content was analyzed. The processes of formation and disappearance of particulate was proposed.

SAE International Congress & Exposition. Detroit, Michigan, Feb. 24-28, 1992

Catalytic Reduction of NOx in Actual Diesel Engine Exhaust

Mitsuru KONNO, Takemi CHIKAHISA, Tadashi MURAYAMA, and Masakazu IWAMOTO
Hokkaido Univ.

Copper ion-exchanged ZSM-5 zeolite catalyst, which reduces nitrogen oxides (NOx) in the presence of oxygen and hydrocarbons, was applied to actual diesel engine exhaust. Copper ion-exchanged ZSM-5 zeolite effectively reduced NOx by 25% in normal engine operation, and by 80% when hydrocarbons in the exhaust were increased. Water in the exhaust gas decreased the NOx reduction efficiency, but oxygen and sulfur appeared to have only a small effect. Maximum NOx reduction was observed at 400℃ irrespective of hydrocarbon species, and did not decrease with space velocity up to values of 20,000 l/h.

SAE International Congress & Exposition. Detroit, Michigan, Feb. 24-28, 1992

Combustion Similarity for Different Size Diesel Engines : Theoretical Prediction and Experimental Results

Takemi CHIKAHISA, Kazushige KIKUTA, and Tadashi MURAYAMA
Hokkaido Univ.

This paper presents a theoretical and experimental study on the possibility of combustion similarity in differently sized diesel engines. Combustion similarity means that the flow pattern and flame distribution develop similarly in differently sized engines. The study contributes to an understanding and correlating of data which are presently limited to specific engine designs.

The theoretical consideration shows the possibility of combustion similarity, and the similarity conditions were identified. To verify the theory, a comparison of experimental data from real engines was performed; and a comparison of results of a three dimensional computer simulation for different engine sizes was also attempted. The results showed good agreement with the theoretical predictions.

SAE International Congress & Exposition. Detroit, Michigan, Feb. 24-28, 1992

Reduction of Smoke and NOx by Strong Turbulence Generated During the Combustion Process in D. I. Diesel Engines

Mitsuru KONNO, Takemi CHIKAHISA, and Tadashi MURAYAMA
Hokkaido Univ.

This paper presents results of experiments to reduce smoke emitted from direct injection diesel engines by strong turbulence generated during the combustion process. The turbulence was created by jets of burned gas from an auxiliary chamber installed in the cylinder head. Strong turbulence, which was induced late in the combustion period, enhanced the mixing of air with unburned fuel and soot, resulting in a remarkable reduction of smoke and particulate; NOx did not show any increase with this system, and thermal efficiency was improved at high loads. The paper also shows that the combination of EGR and water injection with this system effectively reduces both smoke and NOx.

Proceedings of International Power Engineering Conference May 17-21, 1992 Hangzhou, Zhejiang, China Zhejiang University

Simultaneous Reductions in NO_X and Smoke (Without Increasing Injection Pressure)

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Simultaneous reductions in NO_X and smoke emissions are today the most important goals for all kinds of diesel engines, in cars and trucks as well as in stationary and marine applications. This must be achieved without increasing fuel consumption and maintaining the present low noise, CO, and HC levels.

Work to achieve such simultaneous reductions in NO_X and smoke emissions has been undertaken in experiments involving diesel engines in general, their fuel and injection system, and also fuels. Among these the main research effort in Japan has been directed towards high pressure injection and retarded timings.

Different from this, we have in recent years experimented with simultaneous reductions in NO_X and smoke without relying on high pressure injection.

World Congress on Medical Physics and Biomedical Engineering Kyoto, Japan, July 7-12, 1991

The Effects of Posterior Elements and Nucleus Pulposus on the Stiffness Properties of Lumbar Spine

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Three fresh functional spinal units (FSU) of L4/5 obtained from autopsies were used in this experiment. In order to evaluate the effect of postersior element on stiffness properties, the cyclic load-displacement curves of FSU and DBU (FSU without posterior element) were obtained from the axial compression-tension test and the torsion test at a constant velocity. In order to evaluate the effect of nucleus pulposus, three kinds of DBU; with an intact disc, with a disc removing nucleus pulposus, and with a disc replacing nucleus pulposus by silicone elastomer, were loaded at the same condition. In addition, these tests were taken the rate effect into account. As a result, the stiffness of FSU with posterior elements were larger than that of FSU without one under both axial loading and torsional loading. At the faster velocity of loading, the stiffness of DBU were larger in a region of large deformation. The stiffness of DBU with a disc removing nucleus pulposus decreased, and could not recover completely by the insertion of silicone elastomer into the denucleated space of a disc.

The 3rd International Conference on Residual Stress, Tokushima, Japan, July 23-26, 1991

Convenient Method of the Residual Stress Measurement with Making Use of X-ray Penetration Depth

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X-ray measurement stress is usually evaluated as a surface stress. But in truth, this is a kind of weighted mean value covers a certain penetration depth responded to a characteristic X-ray. According to many examples measuring a residual stress of a rolled plate by the authors and others, it can be supposed that the stress change for the depth has linearity in the

surface layer. The stress value and its depth can be determined by a kind of characteristic X-ray. Then if it is measured in two kinds of X-rays, a surface stress and a stress gradient can be determined. In this study, two kinds of characteristic X-rays of Cr and Co are used. And the residual stress of JIS SKS51 steel plate is measured as an example of applying this theory. It is confirmed that if it is limited to a surface layer as compared with a strict method by a serial thin layer removal used from the past, this method has sufficient practicality.

The 3rd USA-China-Japan Conference on Biomechanics, Atlanta, USA, August 25-29, 1991

Strain Distribution on the Sagittal Plane of an Intervertebral Disc

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The lumbar spine is subject to a considerable large load and complex movement. Therefore, the intervertebral discs in the section often suffer serious injuries and disease. A knowledge of the mechanical behavior of an intervertebral disc in vivo is great important to understand low-back pain from the biomechanical approach. The purpose of this work is to confirm in vivo the strain dintribution on the sagittal plane of a disc in the thoraco-lumbar spine under flexion and extension. The following conclusions were obtained from this work : The anterior disc height increases toward the lower disc level. The anterior displacement of a disc under flexion shows the maximum value at L4/5. The relationship between the anterior height and the anterior displacement of a disc under flexion is linear. The strain distribution and the deformation mode in L5/S disc are different from those in the other disc. Therefore, the strain state and the deformation mode of an intervertebral disc in vivo could be evaluated from this study.

The 112th ASME Winter Annual Meeting Atlanta, USA, December 1-6, 1991

On the Structure and the Geometry of an Artificial Intervertebral Disc

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The human intervertebral disc in an essential element in sustaining weight and in permitting mobility of the spine, which is often subject to degeneration, injuries and disease. In this paper, a new artificial intervertebral disc is proposed to reconstruct the stability and the mobility of a human functional spinal unit. The geometry and the structure of the artificial intervertebral disc were designed by the computer simulation at 3D-FEM, as the compressive and the torsional stiffnesses of this model agree with the stiffnesses of cadaveric lumbar discs. Consequently, the proposed model consists of two bioactive ceramic plates and intervenient substructure made from rubber-like materials. Glassceramics containing apatite and wollastonite was chosen as a material for the plates which come into contact with the bone, because this material is able to form a strong chemical bond with the osseous tissue. Elastic materials of medical grade in the substructure between two plates were selected, as the artificial disc has the same stiffness properties with a cadaveric lumbar disc.

The 7th International Congress on Experimental Mechanics, Las Vegas, USA, June 8-11, 1992

Photo-viscoelasto Plastic Stress Analysis of Punch Indentation

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The fringe order gives important information on the nonlinear mechanical properties of a transparent polymer. It is possible that the values of stress and/or strain of a model material under elasto-plastic deformation can be estimated by use of its optical properties. In this paper, the elastoplastic analysis of punch indentation was carried out by the photo-viscoelasto plastic method with cellulose acetate. Therefore, the cellulose acetate plate of 80 mm width and 30 mm height was examined in a plane strain state during indentation with a rigid circular punch. The diameter of punch was 20, 30 or 40 mm. The distribution of stress or strain and

the development of plastic zone in the plate were obtained taking the rate effect into account. From this investigation, the following results were confirmed: The maximum values of the difference of the principal stress or of the difference of the principal strain occurred in the subsurface of the center of the punch contact area in early stage of indentation. In the following stages, they appeared in the both edges and below the punch contact area. Both the stress distribution of the lower level and the width of punch contact did not depend on the diameter of punch. The plastic zone started from the subsurface of the punch contact area, and spread gradually insider.

Asia-Pacific Vibration Conference 1991, Melbourne, Australia, November 23-29, 1991

Vibration Analysis of a Plate with a Slit by BEM

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A boundary element method (BEM) is developed for the free and transient vibration analysis of a plate with a slit. The formulation employs a fundamental solution of a static problem of a plate and this creates not only boundary integrals but surface integrals as well owing to a presence of an inertia force. Thus the discretization consists of boundary elements as well as interior elements. The free vibration problem is reduced to a matrix eigenvalue problem. The transient problem is solved with the aid of the Laplace transform with respect to time.

IUTAM Symposium on Constitutive Relations for Finite Deformation of Polycrystalline Metals, Beijing, China, July 22-25, 1991

Constitutive Model of Cyclic Plasticity for Finite Deformation

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Finite deformation in cyclic plasticity is treated using a Eulerian constitutive model which employs both isotropic and kinematic hardening laws. Biaxial ratchetting is simulated by the model and experimental verification is performed with SUS304 stainless steel.

The 6th International Conference on Mechanical Behavior of Materials, Kyoto, Japan, July 29-August 2, 1991

Application of Hybrid Constitutive Model to Sinusoidal Loading

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The exprimental data obtained from the sinusoidal loading tests are examined for type 304 stainless steel at room temperature. The simulations of sinusoidal loading based on the proposed hybrid constitutive model are conducted by using the 4th rank anisotropy coefficient tensor. The hybrid constitutive model proposed is verified to be applicability to sinusoidal loading.

The 3rd International Symposium on Plasticity and Its Current Applications, Grenoble, France, August 12-16, 1991

Rate-Dependent Plastic Deformation-Experiments and Constitutive Modelling

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Experiments show that some metals exhibit rate-dependent behavior in room temperature. The rate-sensitivity generally increases with increasing temperature. Tests on the rate-dependent behavior have been performed mostly on specimens subject to uniaxial or combined axial-torsional loading. Even for these simple loading forms, there has been very few published data regarding the effect of strain history on a material's hardening response. Recently a series of uniaxial and biaxial tension-compression cyclic tests was performed in our laboratory. The tests included proportional and nonproportional loading paths with different strain-rate history. In this paper, the prediction of the rate-dependent constitutive model proposed by the authors are compared with the experimental results.

Joint ASME/JSME Conference on Electronic Packaging, Milpitas, USA, April 9-12, 1992

Constitutive Model for 60Sn-40Pb Solder Under Cyclic Loading

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In this paper, the authors proposed the constitutive model for 60Sn-40Pb solder which is used in electric packages. In order to verify the applicability of the proposed model to uniaxial cyclic loading and to the prediction of the fatigue failure, some cyclic tension-compression loading and fatigue tests were carried out with constant strain amplitudes under constant strain rates at room temperature using specimens made of 60Sn-40Pb solder. As a result, the simulations based on the proposed model had a good agreement with the experimental results. It was also found that the simulation is well enough to use the prediction of the fatigue failure using the relation between the plastic strain energy density and number of cycles to fatigue

failure instead of the Coffin-Manson relation.

The 7th International Congress on Experimental Mechanics, Lasvegas, USA, June 8-11, 1992

Uniaxial Ratchetting and Creep Behavior of Type 304 Stainless Steel After Cycric Loading

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A series of tests for creep and uniaxial ratchetting of type 304 stainless steel after cyclic preloading were carried out to investigate the influence of cyctlic preloading on both subsequent creep and uniaxial ratchetting. The specimens were subject to cyclic tension-compression preloading with a constant strain amplitude under a constant stress rate, and to intermittent creep at several stress levels or biaxial ratchetting. Moreover, a pair of tests to study the interaction between creep and uniaxial ratchetting were performed. As a result, creep strain could be represented by the modified Bailey-Norton law with stress levels from the current center of the yield surface, which was determined by the proposed constitutive model. It was also appear that the model could be applicable to simulate uniaxial ratchetting.

The 5th International Conference on Fusion Reactor Materials Sheraton Sand Key Resort, Clearwater, Florida, U. S. A. November 17-22, 1991

Development of a Tensile Test System for Irradiated Specimens by Robot Operation

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In order to provide small specimen mechanical testing of fusion reactor materials, a robot system for miniaturized tensile tests was developed to reduce the hazards of radiation during handling of highly radioactive specimens and to maintain precision independent of an experimenter's skill. The present robot system is designed to accommodate a miniaturized tensile

specimen with a gage section of 5.5 mm×1.2 mm, total length of 12.5 mm, width of 2.3 mm, and thickness around 0.2 mm. The system is composed of a vibrational type specimen feeder, a rotary type specimen tray, a manipulating robot, a simulated tensile testing fixture and a micro-computer for controlling the system.

The 5th International Conference on Fusion Reactor Materials Sheraton Sand Key Resort, Clearwater, Florida, U. S. A. November 17-22, 1991

The Control of Point Defect Processes by the Coherent-Iron Precipitates in Copper Alloys

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The effect of coherent-iron (γ-iron) precipitates on the processes of point defects produced by an energetic electron irradiation is clarified by transmission electron microscopy in copper-dilute iron alloys. Increasing the electron irradiation, following the formation of dislocation loops around the γ-iron precipitates, stacking fault tetrahedra (SFT) were produced in the outer region apart from the precipitates. By the elecron irradiation, moiré pattern appeared on the γ-iron precipitate image and varied continuously. From an analysis of the moiré fringes, it was derived that the γ-iron precipitates absorb abruptly the interstitials whose concentration becomes beyond 5%. By the electron irradiation at 323 K, the γ-iron precipitates did not transform to α-iron, and a part of γ-iron precipitates dissolved into the matrix. These led that, in addition to the elastic interaction, a dynamical behaviour of iron atoms induced by the electron irradiation keeps the high concentration of interstitials in the γ-iron precipitates.

The 5th International Conference on Fusion Reactor Materials Sheraton Sand Key Resort, Clearwater, Florida, U. S. A. November 17-22, 1991

Fission-Fusion Correlation in Mechanical Property of Nickel, Copper, and Gold

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Mechanical property changes of pure Ni, Cu, and Au irradiated with fission neutrons from JMTR (Japanese Materials Testing Reactor) were compared with those irradiated fusion neutrons from a rotating target neutron source in LLNL (RTNS-II). Irradiation temperatures were in the range from 473 to 673 K, and the maximum fluences were about 4×10^{22} and 10^{24} n/m^2 in RTNS-II and JMTR, respectively.

Duplicate sets of specimens were irradiated concurrently under different temperature controlling modes in JMTR. One was conventional temperature control and the other was temperature control improved to avoid the irradiation below a designed irradiation temperature, especially at the start-up of the reactor. The former brought larger irradiation hardening than the latter. This depended on the relative situation between the irradiation temperature and the temperature range of nucleation of defect clusters. In Ni, the difference in the yield strength agreed well with the estimation from the difference in their defect size and density. In order to avoid ambiguities, data obtained from the improved temperature control were compared with fusion neutron irradiation data.

The 5th International Conference on Fusion Reactor Materials Sheraton Sand Key Resort, Clearwater, Florida, U. S. A. November 17-22, 1991

The Variation of Cascade Localization Induced Bias Effect With Materials Parameters and Irradiation Conditions

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The distribution of vacancies and interstitials produced by collision cascades is expected to be different each other. The simplest picture is highly condensed vacancies surrounded by interstitial atoms. The importance of imbalance of reactions between vacancies and interstitials originating from this difference of the initial local distribution of point defects have been realized, and the effect was named as the cascade localization induced bias (CLIB) effect.

Based on the solution of the diffusion equations of cascade dissipation with variable initial and boundary conditions, the variations of the strength of the CLIB effect with materials parameters and irradiation conditions were examined.

The 5th International Conference on Fusion Reactor Materials Sheraton Sand Key Resort, Clearwater, Florida, U. S. A. November 17-22, 1991

Detection of the Role of Free Point Defects from the Variation of Defect Structures Near Permanent Sinks in Neutron Irradiated Metals

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Point defects which escape from cascade collision zones and migrate freely in the crystal play a major role in the defect structure development. The defect structure develops by the

absorption of these free point defects, and the absorption rate is determined by the concentration of free point defects at the site of reaction. Therefore the precise knowledge about the concentration during irradiation enables us to predict defect structure developments. The concentration is determined by the balance between the rate of production by irradiation and the rate of annihilation at sinks. The possible sinks are surfaces, grain boundaries, dislocations and point defect clusters. The other way around, from the investigation of the defect structures as a function of the distance from permanent sinks, not only the evaluation of the concentration of free point defects during the neutron irradiation but also the estimate of the production rate of free point defects from cascades can be made. As the production rate of free point defects strongly depends on materials and irradiation conditions especially the temperature, further analysis makes it possible to detect the reactions within cascades such as the point defect cluster annihilation subsequent to the formation either by thermal instability of the clusters or by the absorption of opposite species of point defects.

The 4th European Conference on Power Electronics and Applications, Firenze, Italy, September 3-6, 1991

A PWM Control Method Using Pulse Frequency Modulation Technique

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This paper describes a PWM pulse pattern optimization method utilizing the pulse frequency modulation (PFM). In conventional PWMs the pulse frequency is kept constant. In the proposed scheme, however, the pulse frequency is adjusted to improve the performance of PWM sinusoidal inverters. The PWM pulse patterns are basically controlled so that the time-integral function of the output voltage in the space vector representation may draw a circular locus. In addition to that, the pulse frequency as well as the pulse width are controlled so that the performance index (PI), which represents the degrees of achieved objectives, may be minimized. In this paper, two PIs, one for minimizing the distortion of the output currents and the other for minimizing the torque pulsation of driven motors, are employed. The method is finally implemented using a single-chip microprocessor, and the experimental results demonstrate its validity.

The IFIP TC/WG2.6 Second Working Conference on Visual Database Systems, Budapest, Hungary, September 30-October 3, 1991

Automatic Video Indexing and Full-Video Search for Object Appearances

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This paper proposes two fundamental algorithms for video databases; the automatic video indexing and the full-video search for the appearances of a specified object. They respectively provide similar search functions as the automatic indexing and the full-text string search do for full-text databases. The automatic video indexing fully scans a given video in real time to automatically detect every cut change in it. A small icon or micon (motion icon) showing either the first frame or the first subpart of each extracted cut works as a good representative of this cut. A list of such icons or micons works as an index for the video. We can easily associate the clicking on each icon with the replay of its corresponding video cut. The full-video search finds every frame in which a specified object appears. The reference object is specified by giving its image. The object may show different sizes, different shapes, and different facets on its different appearances. The algorithm can still find out almost all the appearances of the object.

The 20th International Conference on Phenomena in Ionized Gases, Pisa, Italy, 8-12 July, 1991

Silicon Oxide Film Deposition on Unheated Substrate Using 50Hz Plasma CVD

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Silicon oxide films are deposited in general with high frequency plasma CVD method under a condition of about 300℃ substrate temperature. Moreover, thermal deposition at above 600℃ its also possible. However, the authors found that high quality silicon nitride film and amorphous carbon film can be deposited at room temperature with 50 Hz plasma CVD, and the electron temperature in low frequency (<200 kHz) plasma was higher than that of 13.56 MHz

plasma. Therefore, it appears that dissociation of CVD gases is accelerated by the high temperature electrons in low frequency plasma. Moreover, the positive ion in low frequency plasma bombard the deposited film. We may assume that the bombarding ion energy is consumed as migration energy for rearrangement of absorbed atoms. The thin films deposited by the low frequency plasma CVD without substrate heating have higher quality properties. We report the deposition of high quality silicon oxide films using N_2O and SiH_4 mixture with the 50Hz plasma CVD without substrate heating.

The 20th International Conference on Phenomena in Ionized Gases, Pisa, Italy, 8-12 July, 1991

Computer Simulation Study of Correspondence between Theoretical and Experimental Electron Drift Velocities in Ar Gas

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The electron drift velocity is one of the most important parameters which describes electron swarm behaviour. Drift velocities are obtained by theoretical analyses and real experiments. However, it seems that there is no clarify the relation between theoretical and experimental drift velocities. In this article, the behaviour of electron swarm in Ar gas in Schlumbohm's (Z. Phys., 182, 306-16, 1965) and Frommhold's (Z. Phys., 156, 144-58, 1959) experiments which are typical methods when ionization is appreciable are simulated exactly using a Monte Carlo technique, then obtained drift velocities are compared with theoretical drift velocities (the diffusion modified drift velocity v_d, the average drift velocity of electrons W_v, the center of mass drift velocity W_r and the mean arrival time velocity W_m) deduced from the same cross sections. Moreover, correspondence between them is discussed.

The 20th International Conference on Phenomena in Ionized Gases, Pisa, Italy, 8-12 July, 1991

Breakdown Voltage Measurement of Fine Powder Dielectrics Suspended in the Atmospheric Air

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In our laboratory, breakdown voltage measurement for vapor-mist dielectrics which employs fluorocarbons in a buffer gas was done. The result that breakdown voltage of a gap in a buffer gas (air) increases with addition of vapor-mist dielectrics was reported. In the present work, the authors wish to investigate fine powder as new dielectrics, that have advantages of self-recovery, incombustibility, and easy conservation. Moreover, it is comparatively easy ot visualize the effect of raising the dielectric strength by fine powder. In the present paper, breakdown characteristics of fine powder in atmospheric air are measured and a comparison is made with a result of breakdown voltage measurement of vapor-mist, as compared with qualitative resemblance of each effect of mist and fine powder, based on experimental measurement of breakdown voltage with fine powder (SiO_2) suspended in the atmospheric air.

The 20th International Conference on Phenomena in Ionized Gases, Pisa, Italy, 8-12 July, 1991

Spatial Radical Distribution in SiH_4 RF Plasma

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It is well known that the quality of a-Si : H film by using the RF glow discharge depends on the properties of SiH_4 RF plasma. This also implies that the improvement of film qualities is expected by controlling the processing plasma by adjusting discharge parameters. In a previous investigation, the spatial and temporal distributions of radicals for SiH_4 RF plasma were obtained by solving continuity equations making use of the results from a Monte Carlo simulation. However, solving the continuity equations may require considerable computational time if a steady-state solution is to be obtained. One of the purposes of the present investigation is to establish a simulation technique for a steady state without an intensive calculation. The

spatial distributions of radicals for SiH_4 plasma in a steady-state are obtained and discussed.

The 20th International Conference on Phenomena in Ionized Gases, Pisa, Italy, 8-12 July, 1991

Monte Carlo Simulation of Self-Sustained Discharge in ArF Laser

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Theoretical simulation of physical processes in a discharge of excimer laser have been done, and the laser output, efficiency, etc. were estimated. In these works a space-charge free model was adopted. It is well known, however, that the actual performance of the laser is determined by the discharge characteristics, especially just prior to formation of the filamentary discharge which is promoted by space-charge.

The aim of this article is to describe a self-consistent model of a selfsustained discharge controlled by the space-charge in ArF laser with He buffer gas for a Monte Carlo method and to understand the discharge characteristics with preionization.

The 44th Annual Gaseous Electronics Conference, Albuquerque, New Mexico, USA, 22-25 October, 1991

An Analysis of Position-Dependent Electron Swarm Behavior in Steady-State Townsend Discharges by Convective-Scheme Technique

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The position-dependent swarm parameters and energy distribution $F(x, \varepsilon)$ of electrons in argon gas were analysed using a convective-scheme technique in which a proper relation between the trajectories of electrons and the cells defined in energy ε and space x was considered. The results showed the fine structures of damped fluctuation in the swarm parameters, which had been obtained by a Monte Carlo technique. When initial electrons with zero energy were ejected from a cathode, $F(\varepsilon, x)$ at $E/N=283$ Td could not reach the equilibrium condition even at the distance at which the equilibrium values of mean energy, drift velocity, etc. of electron seemed already attained.

International Conference on Liquid Radiation Detectors: Their Fundamental Properties and Applications, Tokyo, Japan, 7-10 April, 1992

High Field Electron Drift Velocity in Liquid N_2/Ar Mixtures

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The drift velocity and the life-time of photoinjected electrons in liquid mixtures 10% N_2/Ar and 20% N_2/Ar near the boiling temperatures were measured as a function of the field strength E between 5×10^3 and 5×10^4V/cm.

The pulse UV light with 193 nm wavelength and about 20 ns duration emitted from an excimer laser was taken for injection of photoelectrons into the liquid. The time profile of the electron current was a rectangular type which was almost the same as that observed in liquid Ar, but the exponential decay in the profile was observed.

International Conference on Liquid Radiation Detectors: Their Fundamental Properties and Applications, Tokyo, Japan, 7-10 April, 1992

Self-Trapping Kinetics of Electrons in Liquid Neon

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In liquid neon electrons can exist in the excited and localized state (electron bubbles). In the case of the square wall model of the density fluctuation the expressions for the electron resonant scattering cross-section σ_r and for the electron life time τ_f are well known. Taking into account that during τ_f the radius of the fluctuation practically does not change we obtained $\tau^{-1}=16\,\pi^2(h/2\,\pi m)^3 A n_c(R_o)R_o^3 k_r^2$, where R_o is the radius of the resonant fluctuations, $n_c(R)$ is the distribution function of fluctuations, k_r is the maximum wave number of the electron for which capture is possible. A is the normalizing constant of the electron distribution function, which contains all dependence of τ on the electric field E. In moderately strong elec-

tric fields, when $v_d \sim E^{1/2}$, $A \sim E^{-3/2}$. In very strong electric fields, when v_d shows saturation, $A \sim E^{-3}$. A strong dependence of τ on T is related to the exponential dependence of n_c on T. The present model for $\tau(E, T)$ agrees well with an experiment of Y. Sakai et al. (J. Electrostatics 12, 89 (1982)).

Japan-Hungary Joint Seminar on Applied Electromagnetics in Materials and Computational Technology, Budapest, Hungary, July1-3, 1991

On the Causality and Lienard-Wiechert Potentials

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One of the authors indicated that Lienard-Wiechert potentials could be written in the new representation which was different from the well-known one. In that paper, the representation was used to derive the Hertzian tensor potential which results in Lienard-Wiechert potentials. However, authors consider that the new representation has another meaning. From thhis point of view, the consideration of the representation is attempted.

Japan-Hungary Joint Seminar on Applied Electromagnetics in Materials and Computational Technology, Budapest, Hungary, July 1-3, 1991

An Analysis of Electromagnetic Fields in Helically Wound Waveguides Using FEM

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Recently, it has been shown that the finite element method (FEM) with a penalty term is a very effective scheme for the analysis of the vector wave propagation without spurious modes. In this method, the spurious solutions, which do not satisfy the divergence free condition, are removed to higher frequency region using a sufficiently large penalty coefficient. This

method allows us to accurately analyze the electromagnetic propagation in waveguides with arbitrary cross section even if they include dielectrics and magnetic materials. In this paper, we present an analysis of cut-off wavenumbers and field distributions in a hollow metal and dielectric loaded twisted waveguides using a vectorial finite element method with a penalty term.

Japan-Hungary Joint Seminar on Applied Electromagnetics in Materials and Computational Technology, Budapest, Hungary, July 1-3, 1991

Field Analysis of Magnetic Levitation Metals

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The process of levitation melting of metals has some important advantages like cleanliness and super heating. This process is a well-established technique in fundamental work in physical and chemical metallurgy. Most theoretical and numerical studies of magnetic levitation have dealt only with "solid" metals consequently, they have avoided the interesting questions of interaction between the free surface and the magnetic field.

In this paper, we, therefore, present a model which deals with "liquid" metal. In this model, we can solve the coupled aspects of the magnetic field and of the equilibrium geometry of the liquid metal. In order to determine the equilibrium free surface of the levitated liquid metal, we use a global method of the variational type which is based on the minimization of a functional of the energy.

Japan-Hungary Joint Seminar on Applied Electromagnetics in Materials and Computational Technology, Budapest, Hungary, July 1-3, 1991

Electromagneto Mechanical Coupling Analysis of Fusion Reactor First Wall

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Eddy current and mechanical vibration are analyzed as a coupling problem in first wall components of a fusion reactor. The eddy current is analyzed by using the current vector potential method (T-method). Fairly good agreement of numerical and experimental analyses results in validations of both the computational code and the measurement methods. The mechanical vibration of the first wall module in also analyzed numerically and experimentally.

Japan-Hungary Joint Seminar on Applied Electromagnetics in Materials and Computational Technology, Budapest, Hungary, July 1-3, 1991

Analysis of Plasma Phenomena Using Boundary Element Method

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In this paper, boundary element method is applied to analyze axisymmetric toroidal problems in plasma physics and fusion engineering. Firstly, two types of general forms of the fundamental solutions are discussed from the physical and mathematical approaches. Secondly, in order to study the plasma sheath model in the boundary plasmas, we solve the linearized Poisson-Boltzmann equation. Nextly, we solve the nonlinear Grad-Shafranov equation in order to obtain the magnetohydrodynamic equilibria of compact torus plasmas with the free

boundary. Finally, as one of the fundamental plasma waves, we study plasma surface waves with noncircular cross sections under the quasi-electrostatic approximation.

Conference on the Computation of Electromagnetic Fields (COMPUMAG-Sorrento), Sorrento, Italy, July 7-11, 1991

BE and FE Solutions to Open Boundary Potential Problems with Helical Symmetry

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This paper presents boundary element (BE) and finite element (FE) solutions to open boundary potential problems with helical symmetry. The BE and FE equations are introduced in the twisted coordinates in which helical potential fields can be regarded as being two-dimensional. In the FE analysis, 'transfinite' elements are used for modeling open boundaries. Magnetic fields around a helical solenoid are analyzed using the above mentioned methods and those numerical solutions are shown to be in good agreement with analytic solutions. Moreover, electric fields around a twisted-pair line are calculated and it is shown that the fields come to concentrate in the vicinity of the lines as the helical pitch is increased.

Conference on the Computation of Electromagnetic Fields (COMPUMAG-Sorrento), Sorrento, Italy, July 7-11, 1991

An Analysis of Eddy Crrent and the Lorentz Force of Thin Plates Under Moving Magnets

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The Lorentz force acting on thin plates under moving magnets is analyzed by using the

current vector potential T and the integral equation method. Passage of high speed magnetic levitation vehicle produces strong, complex and fluctuating magnetic field. Eddy current is induced to metallic material and the Lorentz force is calculated from the magnetic field and the eddy current. Solutions are examined with respect to two plates which are placed parellel and perpendicular to the vehicle. Eddy current distributions and the total Lorentz force of right-angled plates are also compared with those of an L shaped plate.

The 13th World Congress on Computation and Applied Mathematics, Dublin, Ireland, July, 22-26, 1991

Buckling Behaviors of Cylindrical Shells Due to Impulsive Electromagnetic Forces

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The buckling characteristics of cylindrical shell are experimentally studied to determine the effects of impulsive magnetic forces, and compared to calculation results. Dynamic effects including the electromagneto-mechasical coupling are observed at impulsive loads of high frequency 1-10 kHz. Large impulsive magnetic forces act on the vacuum vessel and other components of fusion devices during plasma disruptions. Therefore, the buckling problem is one of the important considerations during the design period of such devices. However, the buckling behaviors of cylindrical or toroidal shells under impulsive magnetic forces is not well known. As the first step towards addressing thin problem, experiments and analyses have been done on cylindrical shells.

Symposium of the International Association for Boundary Element Methods (IABEM-91), Kyoto, Japan, October 14-17, 1991

A Boundary Element Analysis of Space Charge Fields

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This paper presents a boundary element analysis of space charge fields which are governed by the Poisson equation and the equation of current continuity. The equation of current continuity is solved by the method of characteristics (MOC), in which the charge density is calculated from the values of the electric field on characteristic lines. On the other hand, BEM is chosen as the solver for the Poisson equation because, in general, space charge problem includes open boundaries and, in addition, accurate calculations of electric fields are indispensable for MOC. The above mentioned solution procedures are carried out by turns until a self-consistent solution is obtained.

The 1st Japan CIS Joint Seminar on Electromagneto Mechanics in Structure, Tokyo, Japan, January 22-23, 1992

Magnetic Levitation Analysis of High Tc Superconductor

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Numerical analyses of magnetic levitation of high Tc superconductor are presented. Three new computer codes have been developed based on the critical state model and the magnetization model. From the comparison of the numerical and experimental results, it has been confirmed that magnetic levitation properties of MPMG processed and sintered superconductors in an arbitrary geometry can be quantitatively evaluated by the critical state and magnetization models, respectively.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields (ISEM-Nagoya), Nagoya, Japan, January 26-29, 1992

Numerical Analysis of Electromagnetic Field and Force for Type-II Superconductors

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In order to explain type-II superconducting phenomena, the critical-state model and the magnetization model have been proposed. In the former model, magnetization of superconductor is induced by screening currents; in the latter model, by magnetic moments. It is known that the magnetization behavior strongly depends on the granular characteristic. Large supercurrents are localized within grains and supercurrents circulating between grains are extremely small in case of sintered materials. On the other hand, supercurrents are circulating in the whole sample and weak links are absent in case of single crystal materials. The magnetization model and the critical-state, model should be adopted to predict electromagnetic behaviors in the former and latter cases, respectively.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields (ISEM-Nagoya), Nagoya, Japan, January 26-29, 1992

A Numerical Analysis of Coupling Losses in a Twisted Superconducting Composite

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Coupling currents are induced in a multifilamentary superconducting composite subjected in a changing magnetic field, and consequently, so-called coupling losses are caused in normal

metal region surrounding it. The coupling losses can be analyzed by solving electric fields in the normal metal region under analytically derived boundary conditions.

Recently, a useful method based on finite element (FE) method were proposed for the analysis of the coupling losses in cables with complicated cross-sections. In the method, the two-dimensional Laplace equation described in the fixed coordinates is solved by FE method neglecting the twist of the cables. However, as the pitch decreases, the electric field distribution may become considerably different from that for a straight cable. In such cases, therefore, the coupling losses should be evaluated taking account of the twist of the cable. This paper presents an FE analysis of the coupling losses in which the helical field is rigorously and easily calculated using the twisted coordinates.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields (ISEM-Nagoya), Nagoya, Japan, January 26-29, 1992

Experimental and Numerical Estimation of Electromagnetic Force on a Ferromagnetic Thin Plate

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In magnetic levitation vehicle system, estimations of electromagnetic forces of metallic guide way structures are important for evaluations of magnetic drag force for the vehicle, structural integrities and total energy loss of the system. Especially for ferromagnetic materials which is commonly used as the guides way structures, the analyses include both eddy current and magnetization problems. Electromagnetic phenorena are very complex since magnetization has nonlinear properties which come from saturation and hysteresis of ferromagnetic material. In the present paper, mechanical vibrations are investigated experimentally and numerically to clarify effects of eddy current and magnetization on electromagnetic force acting on a ferromagnetic the plate.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields (ISEM-Nagoya), Nagoya, Japan, January 26-29, 1992

Numerical Models of Magnetic Levitation Metals

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This paper describes a numerical analysis of the levitation of liquid metals in an axisymmetric alternating electromagnetic field. The equilibrium shape of the liquid metal is determined by minimizing the functional which consists of the magnetic, gravitational and surface tension energies. In order to keep the volume of the metal constant in solution processes, an accurate evaluation of the change of the volume is introduced. Moreover, a numerical instability in the numerical determination of the free surface is reported.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields (ISEM-Nagoya), Nagoya, Japan, January 26-29, 1992

Eddy Current and Force Analyses for High Tc Superconducting Linear Drive

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Recent development of the innovative process to fabricate a large Jc and high Tc superconducting material have made industrial applications of superconducting levitation force more realistic. Several mechanical systems such as magnetic bearing, flywheel, linear drive and micro linear actuator have been proposed and experimental researches have been carried out so far. However, numerical analysis and parameter design have never been done due to the

difficulty ot treat the non-linearity of electromagnetic phenomena in a type II superconductor. Hore, we have focused on a linear drive system which is expected to be applied to the transportation system in clean rooms in LSI works. The computer code has been developed which can make its design study possible.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields (ISEM-Nagoya), Nagoya, Japan, January 26-29, 1992

An Analysis of Electromagnetic Fields in a Linear Accelerator Using Hybrid BEM

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Recently radio frequency linear accelerators (RF linac) have attracted considerable attention since they can effectively produce high-speed electron beams. Those accelerators consist of a number of cavities in series and electrons passing through them are continuously accelerated by the electromagnetic fields in them. On the other hand, it is known that as the distance between the cavities is reduced, there appear coupled electromagnetic modes. Therefore the development of numerical methods for the analysis of such coupled modes is indispensable for the design of a compact and high-performance RF linac.

The axisymmetric modes of resonant cavities in RF linac can be obtained by solving the axisymmetric Helmholtz equation. In this paper, we solve this equation using the hybrid boundary element method (H-BEM). After the formulation, we apply this method to the analysis of a cylindrical resonant cavity and show that the numerical solutions are in good agreement with exact solutions. Next, we consider a model of three-cavity system, and investigate the dependence of the modes on the distance between the cavities.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields (ISEM-Nagoya), Nagoya, Japan, January 26-29, 1992

Simulation of Relativistic Electron Wake-Fields Using Kirchhoff's Integral Equation

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In general, wake-fields are undesirable in an accelerator system because they prevent electrons from traveling on the accelerator axis. Generation of wake-fields is one of serious problems in the system. On the other hand, it was pointed out that electrons can be accelerated efficiently by using the wake-fields. In both cases, it is important to analyze the generation mechanism of them. Then, they should be analyzed numerically because the accelerator cavity has complex shape and electromagnetic fields in the cavity can not be calculated analytically. For this purpose, some simulation codes have been already developed. Those codes are based on the finite differential method.

In this paper, boundary element formulation based on Kirchhoff's integral equation is presented. This method enables us to solve time dependent boundary value problems. One can simulate wake-fields produced by a point-like particle in an accelerator cavity using this method.

The Internatinal Symposium on Nonlinear Phenomena in Electromagnetic Fields (ISEM-Nagoya), Nagoya, Japan, January 26-29, 1992

Plasma Flow Analysis of 2-D MPD Arcjet Thruster

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MPD (magnetoplasmadynamic) arcjet thruster is one of the electric propulsion systems and its power is obtained from the exhaust of plasma accelerated by the Lorentz force. Then, we have to operate MPD arcjet with moderate plasma parameters in order to obtain sufficient specific impulse and high efficiency, so that several theoretical analyses have been made of

MPD flow in the thrusters. We have presented boundary element method (BEM) to calculate current distributions on the electrodes of a self-induced MPD arcjet with the constant flow velocity. In this paper, the quasi-one-dimensional approximation is applied to obtain the plasma flow in the MPD thruster, and the plasma flow obtained is used in two-dimensional BE analysis of electromagnetic fields. This results in a coupled problem of the electromagnetic fields with plasma flow, so that we apply an iterative numerical method to obtain stable numerical results.

IUTAM Symposium on Inverse Problems in Engineering Mechanics, Tokyo, Japan, May 11-15, 1992

Estimation of an Electron Oribit Using Super-potentials of Liénard-Wiechert Potentials

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Liénard-Wiechert potentials are solutions to an inhomogeneous wave equation which describes electromagnetic fields produced by a moving point charged particle. This means that Liénard-Wiechert potentials possess duality of wave and particle and that the potentials describe interactions between electromagnetic fields and a charged particle. A typical phenomenon of them is radiation from an accelerating charged particle. Furthermore, from the duality of wave and particle, another interesting result is obtained. That is to say, one can indicate that a charged particle orbit is estimated from far electric fields produced by the charged particle without any iterative calculation, when the motion is periodic and non-relativistic. In this paper, formulation of the estimation method and the numerical calculation are presented.

1992 IEEE International Microwave Symposium, Albuquerque, USA, June 1-5, 1992

Full Wave Analysis of Tapered Microstrip Lines Using the Curvilinear FD-TD Method

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In this paper, three-dimensional full wave analysis of tapered microstrip lines is carried out in the time domain. The method used is the curvilinear FD-TD method. Computed results are compared with experimental ones and those obtained by the finite element method. The results agree well. As a result, it is shown that the propagation characteristics can be predicted by the curvilinear FD-TD method.

International Union of Radio Science (URSI) International Symposium on Electromagnetic Theory Sydney, Australia, Aug. 17-20, 1992

Time-Dependent Formulation of Scalar Potential Field with Lorentz Gauge Condition for Lossive Field

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In the analysis of electromagnetic fields, vector potential has important roles especially when sources exist. But for the analysis using the vector potentials, the consideration of the gauge condition becomes indispensable. I have already proposed the treatment for the Coulomb's gauge condition. In this paper, the unified formulation is presented by using the Lorentz gauge condition relating both electric and magnetic scalar potentials for lossive field.

The 5th International Conference on Modulated Semiconductor Structures, Nara, Japan, July 8-12, 1991

Tamm States in Superlattices

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We present experimental results on the localized "surface" states, known as Tamm states, in superlattices. A terminating layer of $Al_yGa_{1-y}As$ on $GaAs/Al_xGa_{1-x}As$ superlattices produced Tamm states at the interface, which are observed by interband optical transitions. Results clearly show the presence of localized Tamm states, either above or below the miniband states depending on the composition of the terminating layer, and their interaction with other extended superlattice states.

1991 International Conference on Solid State Devices and Related Materials, Yokohama, Japan, August 27-29, 1991

In-Situ Surface State Spectroscopy by Photoluminescence and Surface Current Transport for Compound Semiconductors

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By a rigorous computer analysis of the surface recombination process, it is shown that the surface state distributions on semiconductor free surfaces can be determined from a measurement of the dependence of band-edge photoluminescence intensity on the excitation intensity. The measurement of the Fermi level pinning position in the dark by the surface current transport measurement avoids the possible ambiguity of the interpretation. The new technique is successfully applied to variously treated GaAs surfaces and to passivated InGaAs surfaces with and without the ultrathin Si interface control layer.

1991 International Conference on Solid State Devices and Related Materials, Yokohama, Japan, August 27-29, 1991

Migration-Enhanced Epitaxy of InP Using Polycrystalline InP as Phosphorus Source

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InP was successfully grown by the migration-enhanced epitaxy (MEE) mode using polycrystalline InP as the phosphorus source in a conventional GaAs-type molecular beam epitaxy (MBE) chamber. A long and persistent reflection high-energy electron diffraction (RHEED) oscillation was observed. (2×4) RHEED patterns were observed in both In-supply and P_2-supply periods, being different from the GaAs MEE growth. Compared with the conventional MBE, the MEE growth afforded epitaxial layers of better surface morphology and greatly improved photoluminescence properties.

1991 International Conference on Solid State Devices and Related Materials, Yokohama, Japan, August 27-29, 1991

Control of GaAs and InGaAs Insulator-Semiconductor and Metal-Semiconductor Interfaces by Ultrathin Molecular Beam Epitaxy Si Layers

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Removal or control of Fermi level pinning is attempted using an ultrathin molecular beam epitaxy(MBE) Si interface control layer (Si ICL) for insulator-semiconductor (I-S) and metal-semiconductor (M-S) interfaces of GaAs and InGaAs. For successful removal of Fermi level pinning at I-S interface, the Si ICL should maintain an ordered pseudomorphic structure. The optimum thickness of the Si ICL is about 10 Å. Formation of such a Si ICL alone does not remove pinning; subsequent deposition of a SiO_2 film is necessary for unpinning. Pinning

at the air-exposed surfaces can be removed by combining an HF surface treatment with the Si ICL technique. The Si ICL technique is promising for controlling barrier heights at M-S interfaces.

The 18th International Symposium on GaAs and Related Compounds, Seattle, USA, September 9-12, 1991

Atomic Layer Epitaxy Growth of InAs/GaAs Heterostructures and Quantum Wells

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The atomic layer epitaxy (ALE) growth and characterization of InAs/GaAs heterostructures and quantum wells (QW) are presented. Trimethylgallium, Trimethylindium and AsH_3 were used in a vertical atmospheric pressure metalorganic vapor phase epitaxy (MOVPE) system. Conditions for the successful ALE growth for heterostructures and QWs by switching the gas and the growth temperature are clarified. The structures were characterized by the Hall effect, quantum Hall effect and photoluminescence (PL) measurements.

The 1st International Symposium on Atomically Controlled Surfaces and Interfaces, Tokyo, Japan November 19-22, 1991

Fabrication Process and Properties of InGaAs Wires Having Si Interface Control Layers for Removal of Fermi Level Pinning

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Removal of surface Fermi level pinning is a crucial issue for successful realization of compound semiconductor quantum effect devices. The purpose of this paper is to establish a process to fabricate InGaAs wires by selective MBE and to investigate the capability of an ultrathin Si interface control layer (ICL) on the wires in removing the surface Fermi level pinning.

$In_{0.53}Ga_{0.47}As$ wire structures with or without InAlAs buffer layers were fabricated for the first time by a selective MBE growth on the corrugated InP surfaces formed by the laser interference lithography. Then, the wire structures were covered with the Si ICL and a thick SiO_2 overlayer. For comparison, InAlAs/InGaAs/InAlAs wire structures were also prepared. The structures were characterized by SEM, C-V and photoluminescence techniques.

Optimum conditions for wire formations are established. It is shown that the Si ICL technique is useful and promising for removal of the Fermi level pinning in InGaAs quantum structures.

The 1st International Symposium on Atomically Controlled Surfaces and Interfaces, Tokyo, Japan November 19-22, 1991

Interface States at Lattice-Matched and Pseudomorphic Heterostructures

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To obtain information concerning interface states at lattice-matched and pseudomorphic heterointerfaces, a rigorous computer simulation of the capacitance-voltage (C-V) curves of the selectively doped $AlGaAs/In_xGa_{1-x}As/GaAs$ heterostructures was carried out and fitted to experimental curves.

The values of the conduction band discontinuity determined by fitting agree well with the previous results. Presence of a significantly high density of interface states of a particular nature is demonstrated for the first time. They possess a Ushaped energy distribution and consist of donor and acceptor states with a characteristic charge neutrality level. The result can be explained by the disorder-induced gap-state (DIGS) model. Previously reported negative interface fixed charge is due to filled acceptor states. The state density increases with the increase of the lattice mismatch, showing steep exponential rise above the critical layer thickness. An anomalous behavior was observed in a completely relaxed sample, indicating Fermi level pinning due to misfit dislocations.

Workshop on Quantum-Effect Physics, Electronics and Applications, Luxor, Egypt January 6-10, 1992

Control of Surface and Interface Fermi Level Pinning for Compound Semiconductor Nanometer Scale Structures

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A novel approach to control the surfaces and interfaces of GaAs and InGaAs nanometer-scale structures using an ultrathin MBE Si interface control layer (ICL) is presented. Details of the Si ICL technique and its application to InGaAs wire structures are discussed.

International Conference on Micro-Electronics 1992, Bandung, Indnesia, January 13-15, 1992

Understanding and Control of Semiconductor Quantum Interfaces for Devices in Quantum Regime

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Future trends of microelectronics are reviewed. It is pointed out that miniaturized devices are now approaching the quantum regime, opening up the possibility of "quantum microelectronics" in the 21st century. The key processing issue for its realization is shown to lie in the science and technology related to the control of interfaces in atomic scale. The present status of the atomic-scale understanding of the "quantum interfaces" are reviewed and key issues for future research and development are addressed. Some recent results obtained in the author's group are addressed.

International Workshop on Science and Technology for Surface Reaction Process, Tokyo, January 22-24, 1992

In-Situ Photoluminescence Surface State Spectroscopy for Reacted Surfaces of Compound Semiconductors

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Although the density (N_{ss}) distribution of the electronic surface states on reacted semiconductor surfaces is expected to provide important informations concerning the reaction mechanism and the electronic quality of the surface, there exists no known established way to measure the N_{ss} distributions except for the scanning tunneling microscope technique for ultraclean surfaces and the C-V technique for thick MIS structures.

We have recently developed a theory concerning photoluminescence (PL) from semiconductor surfaces which allows a quantitative determination of the N_{ss} distribution for the first time. The purpose of this paper is to present a practical measurement and analysis procedure for the new in-situ PL surface state spectroscopy method based on this PL theory and to apply the new method to various technologically important reacted "free" surfaces of GaAs, InP and InGaAs incluidng those just after crystal growth, wet or dry etching, beam exposures, gas exposure, or chemical surface treatments such as sulfur treatments.

The new method consists of a detailed measurement of the band-edge PL efficiency spectrum (PL intensity, I_{PL}, divided by excitation intensity, ϕ plotted vs. ϕ) and a subsequent rigorous computer analysis of the data.

For this purpose, a fully computer controlled PL measurement system was developed in which the PL efficiency is automatically measured on the sample surface placed in the PL chamber under vacuum or in inert gas ambients. The PL chamber is connected to growth, photo-CVD insulator deposition, chemical treatment, metal deposition and XPS analysis chambers. At high intensities, the PL efficiency approaches an intrinsic value. At low intensities, it takes a much lower value depending on the energy depth of the surface Fermi level pinning. Photo-induced unpinning takes place in the transition region where the behavior is very sensitive to N_{ss} distribution. Roughly speaking, the slope depends on the distribution shape and the intensity, ϕ_0, where transition takes place depends on the density of states.

N_{ss} distributions are generally U-shaped with the same energy position, E_{HO}, for density minima which agrees with the DIGS model concerning the surface states. Remarkable PL efficiency enhancement and N_{ss} reduction are achieved by insertion of an ultrathin MBE Si layer on the passivated surfaces. Reaction mechanisms leading to observed N_{ss} changes will be discussed.

The 4th International Conference on Indium Phosphide and Related Materials, Newport, USA, April 20-24, 1992

In-situ Photoluminescence Surface State Spectroscopy for InP and InGaAs

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A new in-situ photoluminescence (PL) surface state spectroscopy technique is presented. The new method allows for the first time an in-situ, contactless and non-destructive determination of the N_{ss} distributions on technologically important "free" surfaces of semiconductors.

A basic principle and rigorous computer analysis procedure are described. The new technique is successfully applied to various surfaces of InP and $In_{0.53}Ga_{0.47}As$.

The 1st International Workshop on Quantum Functional Devices, Nasu Heights, May 12-15, 1992

Control of Compound Semiconductor Interfaces by an Ultrathin Pseudomorphic Si Layer

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In nanostructures, surfaces and interface play far more important role than in the present-day devices. For example, the band line-up at interfaces decides the confinement potential. Capture and emission of electrons by interface states interfere with wave-motions of electrons. The far reaching depletion layer due to Fermi level pinning tends to push electrons from closely spaced nanostructures. Recently, side-gating is reported to take place GaAs quantum wires due to surface states.

The purpose of this paper is to report on the present status of our efforts to control the compound semiconductor interfaces by using of an ultrathin MBE Si interface control layer (Si ICL). Main topics are listed below:

(1) Control of band line-ups by Si ICL

Following Sorba et al, attempts were made to control the band line-ups at GaAs/AlAs and InGaAs/InAlAs interfaces by Si ICL. The samples were prepared by MBE, and the valence band discontinuity was determined by XPS. For GaAs/AlAs, the result by Sorba et al was reproduced. Smaller changes of apparent E_v were observed for InGaAs/InAlAs. However, it was also found that the observed behavior can be more reasonably explained by band-bending due to high Si doping rather than the dipole shift mechanism.

(2) Unpinning of Fermi level on InGaAs surface by Si ICL

The sample preparation consists of MBE growth of InGaAs, MBE growth of Si ICL on InGaAs, partial oxidation of Si ICL and deposition of photo-CVD SiO_2 layer using ArF excimer laser. Crucial factors to minimize the interface state density are maintenance of pseudomorphic lattice matching between Si ICL and InGaAs, and minimization of subcutaneous oxidation of InGaAs by photo-excited oxygen radicals, particularly, selective oxidation of Ga. An attempt of a monolayer level control of the interface $SiO/SiO_x/Si/InGaAs$ profile by periodic repetition of Si ICL. A complete unpinning was realized by the optimized structure and processing conditions. This technique was successfully applied to InGaAs wire structures.

(3) Control of GaAs Schottky barrier heights by Si ICL

Based on the DIGS model for Schottky barrier formation, attempts were made to control the Schottky barrier heights (SBH) by Al/Si ICL/GaAs structures. If Si ICL is pseudomorphic and the Si ICL/GaAs interface is free from pinning, SBH should be controlled over a wide range by doping. An overall variation of SBH of about 400 meV was achieved. Theoretical curves taking account of interface states at Si ICL/GaAs interface are also shown.

EXMATIC Conference,
Lyon, France, May 19-22,
1992

Photoluminescence Surface State Spectroscopy for In-Situ Semiconductor Surface and Processing Characterization

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In this paper, a new photoluminescence (PL) surface state spectroscopy technique is presented which allows, for the first time, in-situ, non-destructive and contactless evaluation of the surface state density (N_{ss}) distributions on fresh and processed semiconductor surfaces. Previously, the N_{ss} distribution can only be measured either by the scanning tunneling spectroscopy technique for ultraclean surfaces, or by the C-V technique for MIS structures where insulator deposition inevitably changes the surface properties.

The new method consists of a detailed measurement of the band-edge PL efficiency spectrum (defined as the PL intensity, I_{PL}, divided by excitation intensity, ϕ plotted vs. ϕ) and a subsequent rigorous computer analysis. The previous assumption of a constant surface recom-

bination velocity, S, is shown to be totally incorrect, and that the reducing behavior of S with excitation intensity is shown to reflect delicately the detailed properties of surface states causing surface recombination. The basic principle for data analysis is the following. At high intensities, the PL efficiency approaches an intrinsic value determined by radiative and Auger recombination. At low intensities, it takes a much lower value depending on the energy depth of the surface Fermi level pinning. In the transition region between these two limits, photo-induced unpinning takes place where the behavior is very sensitive to N_{ss} distribution. It can be shown that the Fermi level pinning position can be determined from the efficiency difference between two limits, the shape of N_{ss} distribution, from the slope of the spectrum in the transition region, and the density, from the excitation intensity around which transition takes place, respectively.

A fully computer controlled PL efficiency measurement system was developed in which the PL efficiency is automatically measured on the sample surface placed in the PL chamber under vacuum or in inert gas ambients. The PL chamber is connected to MBE growth, photo-CVD insulator deposition, chemical treatment, metal deposition and XPS analysis chambers.

The measured distributions on the wet and dry etched surfaces of Si, GaAs, InP and InGaAs are generally U-shaped with characteristic charge neutral minima, being consistent with the DIGS (disorder-induced gap state) model. Sulfur treatments on GaAs were shown to introduce fixed surface charge rather than reducing N_{ss}. Appearance of discrete state was observed on thermally annealed GaAs surfaces. Remarkable PL efficiency enhancement and N_{ss} reduction are achieved by insertion of an ultrathin MBE Si layer on the passivated surfaces of InGaAs.

WOCSDICE Conference,
Segobia, Spain, May 24-27,
1992

Interface States at AlGaAs/InGaAs/GaAs Pseudomorphic Heterointerfaces

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The AlGaAs/InGaAs/GaAs pseudomorphic heterostructure is a key structural element for high performance HEMTs. However, no information has been obtained so far on the possible existence of interfaces states and their effects on charge control.

In this paper, the entire Schottky C-V curves of the selectively doped AlGaAs/InGaAs/GaAs heterostructure are theoretically and experimentally analyzed. The equilibrium C-V curves were calculated by solving the Poisson's equation and the standard semiconductor equations with a vector-matrix type iterative procedure. Experiments were done on samples grown by MBE over 10 k-1 MHz and 77-300 K. Although such interfaces are generally believed to be perfect in atomic scale with negligible interface states, presence of significant amount of inter-

face states of a particular nature is demonstrated for the first time. Main results are the following.

(1) As compared with the previous C-V carrier profile analysis, fitting of entire C-V curves to experiment was found to be much more sensitive to interface properties. Presence of a donor and acceptor interface state continuum with a U-shaped energy distribution and a characteristic charge neutrality level, E_{HO}, was shown, which agrees with the DIGS model for interface states. The previously reported negative fixed interface charge can be explained by filled acceptor states whose occupancy does not change appreciably over a small bias swing for C-V profiling. Although previously ignored, the state density is quite high near band edges ($3\times10^{12}cm^{-2}eV^{-1}$).

(2) The values of ΔE_C were in excellent agreement with our previous results based on Shubnikov-de Haas experiments.

(3) An extremely large difference in the C-V behavior was observed for the strained and relaxed cases. The behavior of the latter is MIS-like and indicates that introduction of misfit dislocation produces high density of interface states which causes Fermi level pinning.

WOCSDICE Conference,
Segobia, Spain, May 24-27,
1992

Deep Levels in GaAs Submillimeter-Wave Schottky Diodes

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Achievement of a low noise temperature is a key issue in small area, low capacitance Schottky diodes for submillimeter-wave applications. In addition to the intrinsic shot noise, these diodes are known to exhibit current-dependent excess noise whose origin has not been amply clarified yet. Empirically, the magnitude of the excess noise depends strongly on the diode fabrication technology. In fact, it has been reported recently that a new electrochemical process using an anodic pulse etching technique leads to remarkable reduction of noise.

The purpose of the present paper is to characterize the deep levels present in the surface region of the GaAs Schottky diodes produced by various techniques including the new electrochemical process.

Deep levels are very much reduced in the samples fabricated by the electrochemical proc-

ess. This suggests that the inherently gentle nature of the electrochemical process prevents the GaAs material being damaged during the Schottky diode fabrication process. This may also be related to the reported low noise nature of these diodes.

Electronics Materials Conference, Cambrigde, USA, Jun 24-26, 1992

In-Situ Processing Characterization Technique for Compound Semiconductors Using Photoluminescence Surface State Spectroscopy

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Although the semiconductor processing steps are generally applied to surfaces, and they produce surface damages of varying characters and degrees, there exists no method to assess the electronic quality of the surface quantitatively. The density (N_{ss}) distribution of the electronic surface states can only be measured either by the scanning tunneling spectroscopy technique for ultraclean surfaces, or by the C-V technique for MIS structures where insulator deposition inevitably changes the surface properties.

The purpose of this paper is to present a new photoluminescence (PL) surface state spectroscopy technique which allows, for the first time, in-situ, non-destructive and contactless characterization of the surface. The method was applied to various technologically important "free" surfaces of GaAs, InP and InGaAs including those just after crystal growth, wet or dry etching, gas exposure, or chemical surface treatments such as sulfur treatments.

Previously, photoluminescence was used only for qualitative assessment of the surfaces due to lack of proper theoretical understanding. Here, a rigorous PL theory was developed which indicates that the previous assumption of a constant surface recombination velocity, S, is incorrect, and that the reducing behavior of S with excitation intensity strongly reflects the detailed properties of surface states causing surface recombination.

The new method consists of a detailed measurement of the band-edge PL efficiency spectrum (defined as the PL intensity, I_{PL}, divided by excitation intensity, ϕ plotted vs. ϕ) and a subsequent rigorous computer analysis. The basic principle for data analysis is the following. At high intensities, the PL efficiency approaches an intrinsic value determined by radiative and Auger recombination. At low intensities, it takes a much lower value depending on the energy depth of the surface Fermi level pinning. In the transition region between these two limits, photo-induced unpinnig takes place where the behavior is very sensitive to N_{ss} distribution. It can be shown that the Fermi level pinning position can be determined from the efficiency difference between two limits, the shape of N_{ss} distribution, from the slope of the spectrum in the transition region, and the density, from the excitation intensity around which transition tekes place, pespectively.

For measurements, a fully computer controlled PL efficiency measurement system was developed in which the PL efficiency is automatically measured on the sample surface placed in the PL chamber under vacuum or in inert gas ambients. The PL chamber is connected to MBE growth, photo-CVD insulator deposition, chemical treatment, metal deposition and XPS analysis chambers. The measured distributions on the wet and dry etched surfaces on GaAs InP and InGaAs are generally U-shaped with characteristic charge neutral minima, being consistent with the DIGS (disorderinduced gap state) model. Sulfur treatments were shown to introduce fixed surface charge rather than reducing N_{ss}. Appearance of discrete state was observed on thermally annealed surfaces. Remarkable PL efficiency enhancement and N_{ss} reduction are achieved by insertion of an ultrathin MBE Si layer on the passivated surfaces of InGaAs.

Electronics Materials Conference, Cambrigde, USA, Jun 24-26, 1992

Interface Profile Optimization in Novel Surface Passivation Scheme for InGaAs Nanostructures Using Si Interface Control Layer

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This paper attempts to control and optimize the interface atomic profiles of the novel surface passivation scheme for InGaAs nanostructures, using Si interface control layer (Si ICL). In-situ XPS characterization technique was used to establish a process sequence that satisfies the conditions of maintenance of pseudomorphic matching to InGaAs, prevention of direct oxidation of InGaAs and formation of a good SiO_2/Si interface with minimal suboxide components.

It is shown that the above conditions can be satisfied by a new process involving a repeated deposition/oxidation/annealing cycle, leading to a complete unpinning of the Fermi level. The Si ICL technique was successfully applied for passivation of InGaAs wire structures.

The 4th International Fuzzy Systems Association Congress. Brussels, Belgium July 7-12, 1991

Measure-Based Semantics for Modal Logics and Its Application to Document Retrieval

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Fuzzifications of modal operators were proposed in the framework of possible world semantics by introducing a probability measure on the set of possible worlds. Here it is extended to a more general one called measure-based semantics for modal logics, where modal operators are defined by fuzzy measures. Then, epistemic logic, or the logic of knowledge and belief, is formulated in this framework. Its application to indexing and retrieval in a document retrieval system also follows.

IEEE The 15th Annual International Computer Software & Applications Conference, Tokyo, September 11-13, 1991

An Algebraic Specification of a Reflective Language

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We present a formal, algebraic specification of a functional programming language (called Brown) with 'reflective' computation mechanisms that compute about its own computation in a causally connected way. Part of the emphasis is put on how we can specify the reflection abstractly (in the sense of abstract data types) in equational logic.

The major part of the specification consists of a set of equations (axioms) based on a denotational semantics which models environment, continuation and 'metacontinuation'. The specification is executable by term rewriting, because the equations can be regarded as the rewrite rules which replace instances of the left-hand sides with the corresponding instances of the right-hand sides.

Since the specification is abstract, rigorous, executable and has intuitively clear meaning,

we believe that it will help make the reflective language easier to be understood, implemented, extended and reasoned about.

IEEE/RSJ International Workshop on Intelligent Robots and Systems '91, Osaka, Japan, November 3-5, 1991

Multisensor-based Object Recognition Using Uncertain Geometric Models

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One of the problems in sensor integration is how to design the integration strategy for the given task. In this paper, we deal with model-based object recognition from uncertain geometric observations using uncertain object models. First, we decompose the recognition problem into a hierarchy of statistically well-defined subproblems depending on sensor uncertainties and model uncertainties. A recognition algorithm based on this approach is developed. Second, a method to preserve the consistency under model uncertainties is discussed. It is shown that information loss can be avoided by adding dummy variables to parameters in the integration. Finally, applications of the proposed method to 2D object recognition are demonstrated.

Second European Conference on Computer Vision, Santa Margherita Ligure, Italy, May 19-22, 1992

Hierachical Shape Recognition Based on 3-D Multiresolution Analysis

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This paper introduces a method to create a hierarchical description of smooth curved surfaces based on scale-space analysis. We extend the scale-space method used in 1-D signal analysis to 3-D object. A 3-D scale-space images are segmented by zerocrossings of surface curvatures at multiple scale levels and then linked between consequtive scales based on topological changes (KH-description). The KH-description is, then, parsed and translated into PS-tree which contains the number and distribution of subregions required for shape mat-

ching. The KH-description contains coarse-to fine shape information of an object and the PS-tree is suitable for shape matching. A hierarchical matching algorithm using the descriptions is proposed and examples show that the symbolic description is suited to efficient coarse -to-fine 3-D shape matching.

1992 IEEE International Symposium on Circuits and Systems. Sheraton Hotel, San Diego, CA May 10-13, 1992

An Adaptive Recognition using Self-Organized Network

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This report proposes an adaptive recognition system which is based on self-organization. The method estimates the cluster distribution of given data, and recognizes an unknown input data at the same time. The clustering/recognition of a given characteristic vector is based on Mahalanobis distance. By using the adaptation, it is possible to reconstruct the cluster set suitable for given characteristic data even if the distribution of these data are getting to change with time progress. In addition, this report shows that the total number of nodes can be minimize by using the rules of node merging. In order to design an efficient self-organized clustering system and to obtain correct recognition, the detail property on the adaptation and the generalization of the clustering and the recognition is explored in this report.

1992 IEEE International Symposium on Circuits and Systems. Sheraton Hotel, San Diego, CA May 10-13, 1992

Time-Varying Analysis Using ARMA Model With Double Inputs

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In this paper, an adaptive speech analysis method using the time-varying ARMA model with double inputs, abbreviated as ARMA-D model, is introduced. This presented method is an extended version of the model identification system, abbreviated as MIS. For improving

the ability of the time-varying parameter estimates in the MIS, the ARMA-D model, which represents two different kinds of MA parts associated with pseudo-periodical pulse train input and white-noise process input, is employed as a stochastic model to be more accurate speech production model than an ARMA model. In addition, a forgetting factor similar to the one used in the RLS is introduced into the innovations approach used in the MIS and the condition of time-varying parameter estimates in the MIS is extended. It has been shown from the results of experiments that this extended method can analyze more accurate spectra of real speech than conventional methods.

The 5th International Conference on Langmuir-Blodgett Films, Paris, August 26-30, 1991

Investigation of Fatty Acid Monolayers at the Air-Water Interface Using a Reflectance-Measuring Technique and a Phase Contrast Microscope

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1) Architecture of biodevices and biosensors to be constructed by concentration-gap between KCl and NaCl as electric sources.
2) Nonlinear responces from biomaterial assembly system.
3) How to receive and how to send nonlinear information.
4) Examples of electrical or mechanical oscillations of liquid films, monolayer LBM, and LB film assembly.
5) Molecular motion in the assembly.

The 5th International Conference on Langmuir-Blodgett Films, Paris, August 26-30 1991

Structural Evaluation of Fatty Acid Monolayers at the Air-Water Interface Using a Reflectance-Measuring Technique

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We investigated the aggregation structure of fatty acid monolayers (C_{12}~C_{22}) at the air-water interface with reflectance measurements. Reflection spectra from the water surface and surface pressure-area isotherm were measured during compression. Though fatty acids are transparent in the visible region, an increase in reflectance which increases with decreasing wave length due to the formation of aggregates (domains) was observed even below the surface pressure of 0.1mN/m. The size of aggregates in gaseous state monolayers increases with the length of alkyl-chain up to arachidic acid (C_{20}), but it decreases remarkably in behenic acid (C_{22}).

Accepted to The Second Perpendicular Magnetic Recording Conference, PMRC91, Hachimantai Japan, October 8-11, 1991

On Transition Configuration and Write Field of MIG Heads

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This paper describes the influence of the head field on transition formation. Two types of MIG heads and three thin film media which have various coercivities were used for the investigation. MIG heads generate the secondary field as a result of ferrite saturation by flux concentrated in metal films in the gap region. A degraded field gradient, such as the secondary field, produces not only a wider transition region, but also a more irregular transition configuration. The transition length is determined by the relationship of (field gradient)$^{-1/2}$, when the field is just over the coercivity. If the maximum field strength equals media coercivity, then the tran-

sition is determined by the field gradient of zero. The transition configuration fluctuates by means of increasing the transition noise, when the transition is spread by the degraded field gradient.

The 9th International Symposium on Surfactans in Solution, Varna (Bulgaria), June 10-15, 1992

An Application of Bubble Formation to Electrical Circuit Calculation

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We believe that molecular devices in the future should be made by self assembly systems of the components. In this meaning, architecture of devices and sensors should be constructed by biomaterials themselves in providing the artificial membranes.

Soap films were observed and calculated to obtain suitable forms of microsystems, because surface energy plays important role there. We would like to apply it to make blueprints for electrical circuits, by using local minimum path length solved as results. The calculation resembles to " Travelling Salesman Problem "

The 9th International Symposium on Surfactans in Solution, Varna (Bulgaria), June 10-15, 1992

Overturning of Molecules in Languir-Blodgett Films

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When a solid plate is dipped in and out of a monolayer-covered liquid surface, it is often found that once the first layer is on, a film is deposited on the plate both as it enters, and as it is removed from the liquid. In this report, molecular orientation in stearic acid Langmuir-Blodgett (LB) films were studied by contact angle and angle resolved ESCA.

Muramatsu concluded that stearic acid molecules in LB films were overturned by the treatment of Al^{3+} or $Fe^{3+}$from results of contact angles. In this study, the same results were

obtained when contact angles were detected. However, the conclusion were not the same, when angle resolved ESCA was detected. These results suggested only partly or partially overturning were occurred by the treatments.

The 13th International Symposium on Fluorine Chemistry, Bochum, F. R. G., September, 2-6, 1991

Halogen-Exchange Fluorination of Aromatic Halides Using HF or HF-Base Solutions

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Heteroaromatic halides such as chloropyridines, or some chlorobenzenes such as 2,4-dinitrochlorobenzene underwent halogenexchange fluorination by the use of HF or HF-base solutions to produce the corresponding aromatic fluorides.

$$ArCl + HF \longrightarrow ArF + HCl$$

The reaction of heteroaromatic halides takes place even at rather milder conditions (20—50℃) than those employed in the halogen-exchange aromatic fluorination using KF. The reaction in a closed container attains equilibrium fairly rapidly giving ArF in low yields. When using a more nucleophilic fluorinating reagent obtained by the addition of pyridine in HF, yields of ArF were not improved but decreased somewhat in the reaction of chloropyrimidines in particular.

On the other hand, the reaction of chlorobenzenes such as 2,4-dinitrochlorobenzene need higher temperature than 180℃ to produce the corresponding ArF, and the presence of organic bases such as γ-collidine in HF enhanced the reaction remarkably to give ArF in good yields.

The 6th IUPAC Symposium on Organo-Metallic Chemistry Directed Towards Organic Synthesis, Utrecht, Netherlands, August 25-29, 1991

New Routes for the Synthesis of Allylic Boranes by Haloboration Reaction

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The allylic boranes have been used to make a carbon-carbon bond under controlling the stereochemistry in the acyclic system. However, the general and effective method for the synthesis of allylic boranes has not been developed adequately. We have found that bromoboration reaction of allene with tribromoborane gives (2-bromoallyl)borane derivative in high yield, which react with carbonyl compounds to provide 2-bromohomoallylic alcohols in good yield. The asymmetric synthesis of 2-bromohomoallylic alcohols, and as the application, the enantioselective synthesis of (+)-and (−)-ipsenols and ipsdienols which are terpenoid natural products, has been also achieved using (bromoallyl)borane. Finally, it will be shown that 3, 3-disubstituted allylic boranes can be prepared stereoselectively from haloboration adduct of 1-alkynes and are used for the diastereoselective synthesis of homoallylic alcohols having quaternary carbon.

International Symposium on Organic Synthesis-The 6th Nozaki Conference-, Kanazawa, Japan, September 17-18, 1991

New Routes for the Synthesis of Allylic Boranes by Haloboration Reaction

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Hokkaido University, Sapporo 060, Japan

Stereoselective synthesis of 3, 3-disubstituted allylic boranes using haloboration reaction and their reaction with aldehydes for the diastereoselective synthesis of homoallylic alcohols having quaternary carbon are discussed.

The 16th International Seminar on Pulping and Papermaking Technology, Seoul, Korea, November 22, 1991

Characteristics of Alkali-Oxygen Bleaching

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Selectivity of delignification by alkali-oxygen bleaching depends on characteristics of lignin in raw materials. Lignin of grasses and lignin of woods modified for cooking are easily dissolved to perform high reaction selectivity. Lignin contents in KP widely change with cooking conditions, temperature, time, and amount of effective alkali. But easiness of delignification on the bleaching mainly depends on cooking temperature. On the bleaching with 2% NaOH based on pulp and 10 kg/cm^2 oxygen at 100℃ for 2 hr, lignin in UKP cooked at 160, 170, and 180℃ were removed about 15, 25, and 50%, respectively, regardless lignin content in the pulp. On the other hand, pentosan in these UKP were removed 18, 12, and 5%, respectively. Activation energy for the delignification reaction were measured as about 10 and 20 kcal/mol for the UKP cooked at 180 and 170℃, respectively. Lignin remained in UKP also was modified corresponding to cooking temperature.

Cellulose '91, New Orleans, Louisiana, USA, December 2-6, 1991

Supermolecular Structure of Cellulose suggested from Behavior on Chemical Reactions

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On fibrous reactions and dissolving of cellulose, Rayons show lower activity than native cellulose regardless their lower crystallinity and lower degree of polymerization. By suitable pretreatments, however, they showed higher activity than native cellulose done the same pretreatment. It was considered that amorphous region between microfibrils in rayon had stronger intermolecular hydrogen bonds than those in native cellulose and not easily allowed penetration of chemical reagents. It resulted heterogeneous reactions from a surface of larger structural units and lower reactivity. The pretreatments relaxed the bonds in amorphous regions and chemical reagents easily reach to microfibril (crystallite) surface. As defects in crystalline region in rayons were larger than those in native cellulose, reactivity of the rayons

extremely increased. Mercerized native cellulose showed intermediate behavior of the both. By mercerization stronger hydrogen bonds were reformed in the amorphous regions and its reactivity proportionally decreased with degree of mercerization.

Cellulose '91, New Orleans, Louisiana, USA, December 2-6, 1991

Filtration and Permeation Characteristics of Bacterial Cellulose Composite

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Bacterial cellulose (BC) membranes laminated with β-chitin or deacetylated chitin sulfonate (S-DAC) show high solute rejection, 85% rejection in the former, 90% rejection in the latter for PEG 50000 as compared with 30% rejection of normal BC membrane. In particular the membrane thinly laminated with S-DAC is very effective for the separation of solute more than 50000 in molecular weight, and shows relatively high flux rate of 10-12 L/m^{2}h, and great strength. Water-soluble polymers such as hydroxyethyl cellulose (HEC), carboxymethyl cellulose (CMC), and carboxymethyl chitin (CM-chitin), have been incorporated into BC during incubation as high as 30wt%. CMC and CM-chitin additives provide the highest transparency index of 2 or 3 times as compared with normal BC. The composite membranes with HEC and CM-chitin are good UF membrane which show very sharp slope and the highest rejection of more than 95% for PEG 50000 and relatively high flux late. The laminated membrane with β-chitin is also effective for the separation of aqueous ethanol solution by evapomeation.

Cellulose '91, New Orleans, Louisiana, USA, December 2-6, 1991

Enhancement of Bacterial Cellulose Productivity

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Bacterial cellulose productivity has been enhanced by the presence of small amounts of denatured cellulase as high as three times that of the standard culture. The productivity is dependent on cellulase species or concentration and pH of the medium as well as the strains of

Acetobacter xylinum. The highest productivity obtained in the present work are as follows. The strain, NBI1051 produced 49.5mg of bacterial cellulose in 15 m*l* of Hestrin-Schramm medium (2% glucose etc.) included 0.5% of Cellulase AP. This corresponds to a yield of 16.5% based on glucose. This yield was improved as high as 27% by decreasing glucose concentration in the medium. The optimum pH for the medium was 5.9 in all strains and cellulase species.

Cellulose '91, New Orleans, Louisiana, USA, December 2-6, 1991

Preparation of Cellulose Esters with Aromatic Carboxylic Acids

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Esterification of cellulose with a carboxylic acid, in which neither acid anhydride nor acid chloride is used, has been desired to develop a useful and convenient method for the preparation of cellulose esters with specific acids. In this paper, we describe the preparation of cellulose esters with aromatic carboxylic acids, such as chlorobenzoic, nitrobenzoic and anisic acids, by the use of the corresponding acids in a pyridine and p-toluenesulfonyl chloride (TsCl) mixture. Cellulose, after pretreatment with water, was readily esterified with the acids in this method, and the products with high degree of substitution were obtained. The difference between o-, m- and p-isomers of the acids did not influence the reaction significantly. When the equimolar amount of the acid and TsCl was employed, the reaction proceeded most rapidly.

Cellulose '91, New Orleans, Louisiana, USA, December 2-6, 1991

Gene Manipulation for Cellulose-producing Bacterium *Acetobacter xylinum*

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As a model experiment, the β-isopropylmalate dehydrogenase (β-IPMDH) gene, which concerned with Leucine synthesis, of cellulose-producing *A. xylinum* ATCC 10245 were cloned by shotgun cloning method using *leuB*-mutant host *E. coli* C600 and plasmid vector pUC18.

Plasmid vector pUL1, carrying a 6.5 kd *Bam*HI-fragment, conferred the β-IPMDH activity to the wild type of *E. coli* C600. Restriction mapping and deletion analysis indicated that the β-IPMDH gene was located on a 1.15 kb *Hin*dIII-fragment of plasmid pULH1. The cloned β-IPMDH gene was identified with the original genes of *A. xylinum* ATCC 10245 by Southern hybridization method using a biotin-labeled probe.

International Conference on Materials Engineering for Resources, Akita, Japan, November 5-7, 1991

Non-uniform characteristics of compacted powder mass

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Usually particles don't behave as individuals but as aggregates or agglomerates in the dense phase of particle assemblage. It doesn't mean a homogeneous continuum but a non-uniform solids body. However, such characteristics have not been investigated extensively yet. Here, the interrelation is systematically dealt with among the structure, the stress, the permeability, and the strength of powder mass from the viewpoint of non-uniformity.

The 13th International Congress of Heterocyclic Chemistry, Corvallis, Oregon, USA, August 11-16, 1991

One-step General Synthesis of Furonaphthoquinones by New [2+3] Photoaddition of 2-Hydroxy-1, 4-Naphthoquinone with Various Alkenes and its Application to a Synthesis of Maturinone

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A one-step formation of 2, 3-dihydronaphtho[2, 3-*b*]furan-4, 9-diones by a new type of regioselective [2+3] photoaddition of 2-hydroxy-1, 4-naphthoquinones with a variety of alkenes is reported. 2, 3-Dihydronaphtho[2, 3-*b*]furan-4, 9-diones, thus obtained, can readily be transformed into naphtho[2, 3-*b*]furan-4, 9-diones; the photoadditions of 2-hydroxynaphthoquinone with styrene, vinyl acetate, ethyl vinyl ether, methyl methacrylate, 2-methyl-but-2-ene and 1-propenyl acetate in acetone or benzene gave, regioselectively, 2-substituted 2, 3-dihydronaphtho[2, 3-*b*]furan-4, 9-diones in 41~83% yield as a single product. The photoaddi-

tion of 2-hydroxy-5-methyl-1, 4-naphthoquinone with 1-propenyl acetate in acetone gave *trans*-2-acetoxy-2, 3-dihydro-3, 5-dimethylnaphtho[2, 3-*b*]furan-4, 9-dione. Its treatment with a base at 0℃ gave maturinone, a natural furonaphthoquinone.

The probable gross reaction pathway of the photoaddition involving furohydroquinones as the intermediates is discussed.

1991 International Symposium on Organic Reactions, Kyoto, Japan, August 19-21, 1991

New Developments in Photoinduced Radical Reactions in Organic Synthesis

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The utility of selective radical fragmentation in organic synthesis is demonstrated in term of our own synthesis of a variety of molecules, including several natural products using the fragmentation of alkoxyl radicals, which were generated by photolysis of the corresponding hypoiodites at room temperature as the key step. These selected examples of the synthesis may indicate that fragmentation of the alkoxyl radicals takes place in a very specific manner and has become an integral part of strategies in organic synthesis.

1991 International Symposium on Organic Reactions, Kyoto, Japan, August 19-21, 1991

New Synthesis of (−)-Anisomycin by Electrochemical Oxidative Cyclization of δ-Alkenylamine

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A chiral total synthesis of (−)-*N*-methylanisomycin from L-diethyl tartrate *via* 15 steps is reported. The key step in the synthesis was a regio- and stereoselective cyclization of δ-alkenylamine to give a substituted pyrrolidine. Thus, a Wittig reaction of 4-*O*-acetyl-2,3-*O*-bis(methoxymethyl)-L-threose, derived from L-diethyl tartrate *via* 6 steps, with 4-methoxyphenylmethylenetriphenylphosphorane gave (*E*)- and (*Z*)-(*3S*, *4S*)-5-acetoxy-3,4-bis[(methoxymethyl)oxy]-1-(4-methoxyphenyl)pent-1-ene. Hydrolysis of the acetate followed by a Swern oxidation gave the corresponding substituted 5-(4-methoxyphenyl)pent-4-enal. A

reductive amination of the aldehyde with methylamine gave (*E*)- or (*Z*)-(*2S, 3S*)-*N*-methyl-2,3-bis[(methoxymethyl)oxy]-5-(4-methoxyphenyl)pent-4-enylamine. The anodic cyclization of δ-alkenylamine gave (*2R, 3S, 4S*)-2-(4-methoxybenzyl)-3,4-*O*-bis(methoxymethyl)-1-methylpyrrolidine. Selective protection of the sterically less hindered 4-hydroxyl group of vicinal diol, obtained by removing the protecting groups, followed by acetylation of the resulting monoalcohol and a final deprotection of the 4-hydroxyl group of the acetate gave (−)-*N*-methylanisomycin.

1991 International Symposium on Organic Reactions, Kyoto, Japan, August 19-21, 1991

Electrochemical Allylation of Carbonyl Compounds by the Use of a Reactive-metal Anode. Convenient Synthesis of Ipsenol, Ipsdienol, and Some Terpenes

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A new convenient synthesis of pheromones and terpenes by electrochemical reductive isoprenylation or prenylation using a reactive-metal anode is reported. Thus, electrochemical isoprenylation of 3-methyl-2-butenal or isovaleraldehyde with 2-bromomethyl-1,4-dibromo-2-butene using a zinc anode and a platinum cathode gave ipsdienol or ipsenol in 65% yields, respectively. 2-Bromomethyl-1,4-dibromo-2-butene was found to be very useful for a synthetic equivalent of the isoprenyl anion. Regiocontrolled prenylation of 3-methyl-2-butenal or 1-(imidazoyl-1-yl)-3-methyl-2-buten-1-one with prenyl bromide using a cadmium-modified platinum anode gave artemisia alcohol (61%) or artemisia ketone (31%) in one step, respectively.

IUPAC International Symposium on New Polymers, Kyoto, Japan, November 30-December 1, 1991

A New Macromolecular Ionophore. The Cyclopolymerization of 1, 2 : 5, 6-Dianhydro-D-mannitol Derivative

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Macromolecular ionophores consisting essentially of (1→6) bonded D-glucitol units, namely, poly[(1→6)-2, 5-anhydro-D-glucitol]s, were synthesized by the cyclopolymerizations of 3, 4-di-*O*-methyl- and 3, 4-di-*O*-ethyl-1, 2 : 5, 6-dianhydro-D-mannitol with $BF_3 \cdot OEt_2$. The polymerization proceeded with α and β-scission of the first and the second epoxide function in a monomer molecule, respectively. The α-scission with inversion of the configuration converted D-mannitol unit in the monomer to D-glucitol unit in the polymer. Poly[(1→6)-2, 5-anhydro-D-glucitol] strongly complex with such organic cations as rhodamine 6G and methylene blue in addition ot alkali metal picrates, unlike the crown ether.

The 3rd International Conference on Materials and Mechanisms of Superconductivity High-Temperature Superconductors, Kanazawa, Japan, July 22-26, 1991.

Superconductor-Insulator Transition in Nd_{2-x} Ce_x CuO_4 Single-Crystal Thin Films

Satoshi TANDA, Minoru HONMA and Tsuneyoshi NAKAYAMA

High-T_c oxide superconductor Nd_{2-x} Ce_x CuO_4 single-crystal thin films were used to observe the critical sheet resistance at the superconducto-rinsulator transition. The films were epitaxially grown on $SrTiO_3$(100) by the method of molecular-beam epitaxy. The electron transport properties of these films are drastically influenced by oxygen-impurity concentration and show clearly the evidence of Anderson Localization attributed to two dimensionality. It is found that the critical sheet resistance $R_{\square}$ at the onset of superconductivity takes a value within a range from 6 kΩ to 8 kΩ, which is close to the value $h/4e^2=6.45$ kΩ. Our experimental evidence provides with an interesting system for revealing the physical origin of the super-

conductor-insulator transition.

International Meeting on Computational Physics for Condensed Matter Phenomena-Methodology and Application, Osaka, Japan October 21-23, 1991.

Dynamic Correlation Function of Fractal Networks

Tsuneyoshi NAKAYAMA and Kousuke YAKUBO

We have presented the dynamic structure factors $S(q, \omega)$ computed for large-scale percolating networls with site numbers of the order of 10^5, by applying a novel numerical method suitable for an array-processing supercomputer. It is confirmed that the dynamic structure factors can be scaled by a single-length scale $\Lambda(\omega)$ with the scaling function $h(q\Lambda((\omega))$. This indicates that three characteristic lengths, i. e., a wavelength $\lambda(\omega)$, elastic scattering length $l_{scat}(\omega)$ and localization length $l_{loc}(\omega)$, have the same frequency dependence. We also obtained the asymptotic form of the dynamic structure factor $S(q, \omega)$. It has been confirmed that the q and ω dependences of $S(q, \omega)$ (q-dependence for both $q \ll q_0$ and $q \gg q_0$, and the ω-dependence for both $\omega \ll \omega_0$ and $\omega \gg \omega_0$) obey the power laws.

The 1st Tohwa University International Symposium on Slow Dynamics in Condensed Matter, Fukuoka, Japan, November 4-8, 1991

Dynamical Structure Factor of Fractons — Computer Experiments —

Tsuneyoshi NAKAYAMA and Kousuke YAKUBO

The aim of this work is to demonstrate numerically the scaling properties of the dynamical structure factor $S(q, \omega)$ of fractons. Fractons are localized excitations peculiar to fractal networks characterized by the exponent $\tilde{d}$ called the fracton dimensionality. We have treated, on supercomputers, very large percolating systems containing as many as$\sim 10^6$ particles. These have become possible with use of a new numerical method based on mechanical resonance. This algorithm can easily be vectorized for implementation on a supercomputer. The calculated results for $S(\vec{q}, \omega)$ indicate the inadequacy of the ensemble-averaged ϕ_{fr} to analyze the data of scattering experiments. It is alst found that $S(\vec{q}, \omega)$ has the universal behavior scaled by a single length scale $\Lambda(\omega)$.

The 5th Conference on Sensors and Their Apprications, Edinburgh, U. K., September 22-25, 1991

Sub-nanometer sensing by a wave length locked laser diode

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A novel method is presented to measure a sub-nanometer displacement based on the optical beat frequency counting technique. A displacement is transformed once to the frequency change of a laser diode applying phase locked loop then determined via optical beat frequency counting technique. Principle and results of feasibility study on the method are described.

The 14th International Conference on Amorphous Semiconductors, Garmisch-Partenkirchen, Germany, August 19-23, 1991

Physics and Applications of Photodoping in Chalcogenide Glasses (Invited)

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Hokkaido University, Japan

Photoinduced dissolution of metals such as Ag into chalcogenide glasses, sometimes referred to as the photodoping phenomenon, was discovered a quarter century ago by Kostyshin et al., and it has become a subject of extensive studies stimulated by fundamental and technological interests. It is demonstrated that the phenomenon can be applied to a photolithographic technique having an ultrahigh resolution of 100A. However, the mechanism of the phenomenon, that is, why metal atoms are doped by illumination, is still controversial. In this talk, I will review briefly the application, and then discuss the fundamental mechanism.

Non-Crystalline Materials 5th., Sendai, September 2-6, 1991

Pressure-induced structural transformations in amorphous semiconductors

Keiji TANAKA
Department of Applied Physics, Faculty of Engineering
Hokkaido University, Jappan

Metastability is inherent to amorphous materials, which thus undergo amorphous-to-crystalline transformations in response to some excitations. It has been demonstrated that thermally-induced crystallizations can be regarded as relaxational, whereas pressure-induced crystallizations may await further studies. I have therefore examined the nature of the compression-induced amorphous-to-crystalline transformations in elemental semiconductors, Ge, As and Se.

ESŌ Conference on High-Resolution Imaging by Interferometry II, Garching, Germany, October 14-18, 1991

Preliminary observational results of wideband speckle spectroscopy

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Wideband speckle spectroscopy is a method to obtain objective prism spectra of astronomical objects with high angular resolution. We present some preliminary results of wideband speckle spectroscopy. The observation was conducted by using 188 cm telescope at the Okayama Astrophysical Observatory, OAO. The shift-and-add (SAA) method is employed as the reconstruction algorithm.

The objective prism spectrum of Zeta-Tauri (single star) was reconstructed for the calibration purpose. Its spectral region extends from 400 nm to 800 nm. The spectra of ADS16836 (binary star) was spatially resolved. This exemplifies the usefulness of high angular resolution spectroscopy.

ESŌ Conference on High-Resolution Imaging by Interferometry II, Garching, Germany, October 14-18, 1991

Speckle Imaging with sequential use of the iterative blind deconvolution method : Application to binary star data

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We present an algorithm for a high-resolution speckle imaging with use of the iterative blind deconvolution method, and describe how to evaluate a reconstructed image. Our algorithm includes sequential application of the iterative blind deconvolution method to several speckle frames. Reconstructed images satisfy both the convolution relation in all the frames in use and the nonnegativity constraint of the object. Computer simulations were carried out by using noisy speckle frames of an extended object. These results show that it is possible to reconstruct the reliable image with good accuracy without reference star data. The algorithm was applied to the binary star data observed at San Pedro Martir Observatory in Mexico, and high-resolution binary star images were reconstructed.

1991 International Geoscience and Remote Sensing Symposium, Helsinki, Finland, June, 1991

Measurement on the Dielectric Properties of Acid-Doped Ice at 9.7 GHz

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The relative complex dielectric permittivity of acid-doped ice was measured at 9.7 GHz with the standing wave method. The objective of this measurement is to clarify the basic physical properties of ice necessary for the microwave remote sensing of the cryosphere. The acid-doped ice was investigated because acid is one of the major impurities found in snow and ice in the cryosphere. The experimental results are summarized as follows: 1) The complex permittivity increases linearly with concentration of doped acid. Moreover, when concentration of acid is expressed by molarity, this linear relation is independent of the sort of acid; 2) The

complex permittivity of acid doped ice can be expressed as a function of concentration of acid and temperature definitely; 3) The possible mechanism which enhances the complex permittivity of acid-doped ice is formation of liquid phase in ice.

International Symposium on the Physics and Chemistry of Ice, Sapporo, September 1-6, 1991

Electron Density Distribution of Ice I_h Obtained by the Maximum Entropy Method

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Electronic structure of hydrogen bond in ice (I_h) was obtained by the Maximum Entropy Method (MEM). Structure factor data used in the analysis were measured by Goto, Hondoh and Mae (1990) [J. Chem. Phys., 93, 1412-17]. Judging from extremely small R-factor value, accuracy of the data is very high. The final MEM maps showed that the electron density distribution of ice network beautifully and revealed that electrons from hydrogen atoms are delocalized within ice network. Because of delocalization, there is no local maxima of electron density of hydrogen. This explains the big discrepancies of atomic coordinates of hydrogen atoms determined by X-ray and neutron diffractions. It also implies that essential difficulties of determining the atomic coordinate of hydrogen even from very accurately measured X-ray diffraction data when hydrogen bonds are formed.

International Symposium on the Physics and Chemistry of Ice, Sapporo, September 1-6, 1991

X-ray Topographic Studies on Pressure Dependence of Self-Interstitial Parameters in Ice I_h

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An experimental method for determining pressure dependence of self-interstitial parameters in ice is described. In this method, both diffusion coefficients of self-interstitials D_i and self-diffiusion coefficients D_s can be determined from in situ observations of dislocation climb

under hydrostatic pressure. Preliminary results on a migration volume and a formation volume of the self-interstitials obtained are presented.

International Symposium on the Physics and Chemistry of Ice, Sapporo, September 1-6, 1991

Temperature Dependence of X-ray Diffuse Scattering Intensity in Ice I_h

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The measurements of the X-ray diffuse scattering in ice I_h were performed by an auto-four-circle diffractometer as a function of temperature in the range from 180 K to 260 K. The integrated intensities of the spot-like diffuse scattering around the $(11\bar{2}1)$ forbidden reflection was measured by a $2\theta/\omega$-scanning technique. The existence of this diffuse spot suggests that the arrangement of water molecules in ice has instantaneously and/or locally lower crystallographic symmetry than the time- and space-averaged structure known as half-hydrogen model with the space group of $P6_3/mmc$. Since it was also found that the integrated intensity of this spot increased with temperature, this diffuse scattering must be caused by dynamic and/or static disorder under constraint of the ice rules.

International Symposium on the Physics and Chemistry of Ice, Sapporo, September 1-6, 1991

In-Situ Observations of Growth Process of Clathrate Air-Hydrates Under Hydrostatic Pressure

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The optical microscopic observations of the growth processes of air-hydrate crystals from air bubbles included in deep ice cores were carried out under high hydrostatic pressure. The transformation from a bubble to an air-hydrate crystal occurred when the annealing pressure was higher than the theoretical one of the air-hydrate dissociation. The growth patterns of

the crystal could be classified into two types.

The crystal growth rates were measured using the microscopic images and they related linearly to the excess pressure over the dissociation one at each annealing temperature. The relation indicates that the rate-determining process of the crystal growth is mainly the flux of air and water molecules to the crystal surface. The observed two different growth patterns can be explained in terms of the supply processes of water molecules to the surface.

International Symposium on the Physics and Chemistry of Ice, Sapporo, September 1-6, 1991

Characterization of the Surface of Ice Crystal by X-Ray CTR Scattering

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An attempt to characterize the surface state of a single crystal of ice was carried out by using a technique of X-ray Crystal Truncation Rod (CTR) scattering, which is elongated along the normal surface direction through each Bragg reflection in the case of an atomically flat surface of the crystal. X-ray sources with both a conventional X-ray tube and a synchrotron radiation source were used. The X-ray measurements were carried out by employing a nearly perfect ice crystal of which the surface was sublimated after planing. As a result, although the crystallinity of the specimen was very high, the CTR scattering did not appear on the Bragg point (0002) perpendicular to the (0001) surface under these present conditions. It was therefore suggested that the basal surface treated by sublimation after planing was not sufficiently flat on an atomic scale. Further investigation by CTR scattering on the surface of a negative crystal, that is to say, a hole developing to the shape of a sharp hexagonal prism within a single crystal of ice, will be discussed.

International Symposium on the Physics and Chemistry of Ice, Sapporo, September 1-6, 1991

Measurement on the Microwave Dielectric Constant of Ice by the Standing Wave Method

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The relative complex dielectric permittivity of ice Ih was measured at 9.7 GHz by the standing wave method. This measurement is a part of the study to clarify dielectric constant which is one of the basic physical properties necessary for the microwave remote sensing of the cryosphere. The principle of the method, the measurement system, experimental procedures and preliminary results using polar ice and artificial polycrystalline ice are described. The experimental results are as follows. The real part of the permittivity is between 3.15 and 3.20 at temperatures between −30℃ and the melting point. In addition, dielectric anisotropy was observed. The permittivity parallel to the c-axis is larger than that perpendicular to the c-axis by 0.04(±0.01) which is more than 1% of the permittivity. Loss tangents of about 2×10^{-3}, which were larger than the results of past investigators, were observed.

International Symposium on the Physics and Chemistry of Ice, Sapporo, September 1-6, 1991

Glide and Climb Processes of Dislocations in Ice

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Recent development of x-ray topographic studies on dislocation motion in ice is briefly reviewed. It is shown that self-interstitial parameters in ice have been determined by analyzing climb motion of dislocations just after a temperature change of an ice crystal. Glide motion of dislocations under shear stress is also discussed in terms of non-steady state motion during loading. Importance of real time observations is emphasized because various parameters relating to microscopic processes included in these dislocation motions can be derived by analyzing transient processes just after perturbation (temperature change) or stimulation (loading).

International Symposium on the Physics and Chemistry of Ice, Sapporo, September 1-6, 1991

Dislocation Mobility for Basal Glide in Ice Close to the Melting Temperature

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Real time observations of dislocation motion in ice were carried out using the High Speed X-ray Topography camera [1] installed at the Photon Factory (synchrotron radiation facility) in order to clarify stress dependence and temperature dependence of the dislocation velocity close to the melting point. It was found that the dislocation velocity rapidly increased by approaching the melting temperature.

International Glaciological Society Symposium on Remote Sensing on Snow and Ice, Boulder Colorado, United States, May 1992

Dielectric Anisotropy in Ice Ih at 9.7 GHz

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Dielectric anisotropy in ice Ih was investigated at 9.7 GHz with the waveguide method. The measurement of dielectric permittivity was made using single crystals collected from Mendenhall Glacier, Alaska. The result of the measurement shows that $\varepsilon'/\!/c$, the real part of dielectric permittivity parallel to the c-axis, is larger than $\varepsilon'\perp c$, the real part of dielectric permittivity perpendicular to the c-axis. This tendency is similar to that at low frequencies in the region of the Debye relaxation dispersion and it can be proposed that $\varepsilon'/\!/c > \varepsilon'\perp c$ in the HF, VHF and microwave frequency rang. $\varepsilon'/\!/c$ and $\varepsilon'\perp c$ depends slightly upon temperature but the dielectric anisotropy, $\Delta\varepsilon' = \varepsilon'/\!/c - \varepsilon'\perp c$, is constant and becomes $0.037(\pm 0.007)$. Based on the present results, a simple calculation indicates that the maximum power reflection coefficient caused by the dielectric anisotropy is about -50 dB -80 dB which is significantly larger power reflection coefficient observed in the ice sheet by the radio-echo sounding, about -70 -80 dB. This leads to a conclusion that the dielectric anisotropy is one of the dominant causes of the internal reflections.

International Glaciological Society Symposium on Remote Sensing on Snow and Ice, Boulder Colorado, United States, May 1992

Relation between Ice Sheet Internal Radio-Echo Reflections and Ice Fabric at Mizuho Station, Antarctica

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The relationship between ice fabric and the internal radio-echo reflections were investigated using observation data collected at Mizuho Station, Antarctica. The data was obtained by 179 MHz radio echo-sounding and the ice fabric was measured from 700-m Mizuho core. The dielectric permittivity tensor at given depths in the ice sheet was calculated from the ice fabric.

The calculated dielectric permittivity tensor showed that the ice sheet at Mizuho Station is uniaxially birefringent medium. The symmetrical axis of rotation was the same as the flow line. In such a medium, theory predicts that the electric field vectors are allowed only in the two directions parallel and perpendicular to the flow line. The prediction coincided well with the observation: a strong signal was observed only when the transmitting antenna and the receiving antenna, kept parallel to one another, were oriented parallel or perpendicular to the flow line. However, the observed signal strength in these two directions differed from one another at each depth.

It is also shown that the power reflection coefficient due to the variation of ice fabric with depth has comparatively the same order of that due to the density change and is large enough to produce the predominant internal radio-echo reflections.

1992 International Geoscience and Remote Sensing Symposium, Houston, United States, May, 1992

Measurement of Dielectric Anisotropy in Ice Ih at 9.7 GHz

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Dielectric anisotropy in ice Ih was investigated at 9.7 GHz with the waveguide method. Dielectric permittivity was measured with single crystals collected from Mendenhall Glacier, in the orientation parallel to the c-axis and perpendicular to the c-axis. The method of measure-

ment used in this study is " two point method " which is one of the waveguide methods.

Based on the experimental results, the difference between permittivity parallel to the c-axis ($\varepsilon'/\!/c$) and that perpendicular to the c-axis ($\varepsilon'\perp c$) is

$$\varepsilon'/\!/c-\varepsilon'\perp c=0.037(\pm 0.007)+0.00006(\pm 0.00009)T_c,$$

where T_c is temperature in °C. This value is almost more than 1% of the relative permittivity in this frequency range ($\varepsilon_\infty \cong 3.17$).

The importance of the value is summarized as follows: 1) Dielectric anisotropy changes the polarization state of the electromagnetic waves which propagate through the ice; 2) This value means the grain boundaries in the polycrystalline ice is also the boundaries of dielectric permittivity where the maximum difference and the mean difference in permittivity are 0.037 and about 0.013, respectively; 3) This value means the variation of permittivity in the ice sheets with depth due to the variation of the preferred orientation of the ice crystals is sufficiently large to produce the detectable radio-echo internal reflections.

Therefore dielectric anisotropy of ice Ih crystal is very important for the remote sensing of the cryosphere that is performed at HF-VHF and microwave frequencies.

The 5th International Conference on Chitin and Chitosan, Princeton USA, October 17-20, 1991

Dielectric Relaxation Spectroscopy of Chitin and Related Substances

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A comparative study of dielectric relaxations found in acylated chitins and in chitin, chitosan, amylose and dextran shows that the molecular motion for the relaxation observed in each of these substances in the temperature range from −90℃ to 0℃ at audiofrequencies is substantially equivalent to a combination of local motion of the main chain of dextran having no side chain and rotation of side chain proper to each substance. The effect of molecular structure of the side chain on the relaxation is studied on the basis of the theory of rate processes.

The lst JSME/ASME Joint International Conference on Nuclear Engineering, Tokyo, Japan, November 4-7, 1991

A Numerical Study of Heat Transfer to Alkali Metals Flowing Across Rod Banks

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For the purpose of getting heat transfer coefficients of alkali metals flowing across tube banks, we propose to use an inviscid-irrotational flow model. We show that the heat transfer coefficients obtained for the condition where only the test rod is heated in rod banks considerably differ from those obtained for the condition where all the rods are heated, because of thick thermal boundary layer of alkali metals. This point has not been shown quantitatively in previous papers.

We also confirm that the analytical values obtained by this flow model are in a reasonable agreement with existing experimental values, except for those obtained for the condition where the test rod and rods immediately surrounding it are heated.

Int. Coference of Materials and Mechanisms of Superconductivity III, Kanazawa, Japan, July 22-26, 1991

Superconductivity in the YBa_2 Cu_3 O_y-Like Compounds With the Disordered Ba-O Plane

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Mikihiko DOMON and Fuminori ITOH
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Oxygen-content y dependence of Tc in $CaLaBaCu_3O_y$ and $LnSrBaCu_3O_y$ (Ln=Eu, Gd, Dy) which are $YBa_2Cu_3O_y$-like compounds with the disorder in the Ba-O plane exhibited that the superconductivity disappears near $y=6.7$ in the high y region. It was found from the relation of the nominal hole density and the effective carrier density n_H induced from the Hall number that the disappearance of superconductivity in the high y region is caused by the fact that the n_H is quite small for doping of nominal hole. Origins for the small n_H are discussed in terms of the displacement of apical oxygen due to the disorder in the Ba-O plane.

Int. Coference of Materials and Mechanisms of Superconductivity III, Kanazawa, Japan, July 22-26, 1991

Properties of Transport Carriers in $Y_{1-x}Ca_xBa_2Cu_3O_y$ and $Tl_2Ba_2CuO_y$

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Resistivity and Hall coefficient of $Y_{1-x}Ca_xBa_2Cu_3O_y$ (YCBCO) were measured and analysed by a simple two-carrier model involving holes and electrons. The experimental results are reproduced well, and the carrier concentration and mobility estimated from the model are reasonable values in physics. The data of $Tl_2Ba_2CuO_y$ measured by Kubo et al. also were analysed by the same model and the result was compared with that of YCBCO. In both systems, the properties of electron carrier remarkably change for hole-doping compared with those of hole carrier.

The 3rd International Conference on Materials and Mechanisms of Superconductivity High-Temperature Superconductors, Kanazawa, Japan, 22-26 July 1991

Specific Heat Study of T_c Reduction by Zn Doping in $(La_{1-x}Ba_x)_2CuO_4$

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Low-temperature specific heat and resistivity of $(La_{0.955}Ba_{0.045})_2Cu_{1-y}Zn_yO_4$ were measured. The resistivity measurements reveal that the samples with Zn content $y \geqq 0.02$ are in the normal state down to 1.3 K. For $y \geqq 0.02$, therefore, the T-linear term in the low-temperature specific heat can be interpreted as the electronic specific heat. It is found from the measurements of low-temperature specific heat that the electronic coefficient increases gradually with increasing Zn content y.

The 3rd International Conference on Materials and Mechanisms of Superconductivity High-Temperature Superconductors, Kanazawa, Japan, 22-26 July 1991

Pressure Effect on Superconductivity and Low-Temperature Phase Transition in Ba-Doped La_2CuO_4

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The diamagnetism of superconductivity and the resistivity were measured on $(La_{1-x}Ba_x)_2CuO_4$ under pressures up to 20 kbar. It was confirmed that the superconducting transition temperature T_c is markedly restored as the resistive increment associated with the phase transition to a lowtemperature tetragonal structure is suppressed under high pressures.

Int. Workshop on Electronic Properties and Mechanisms of High Tc Superconductors, Tsukuba, Japan, July 29-31, 1991

Superconductivity of $LnSr_xBa_{2-x}Cu_3O_y$ (Ln=Eu, Gd)

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In the $Eu(Gd)Sr_xBa_{2-x}Cu_3O_y$ systems $EuSrBaCu_3O_y$ and $GdSrBaCu_3O_y$ for y=6.94 were found to be bulk superconductors with no long-range order of the Cu-O chain. The Tc monotonously decreases with decreasing y and the superconductivity disappears in the vicinity of y=6.65. The disappearance of superconductivity in the range of relatively high hole concentration is explained in terms of the absence of self-doping in which hole is created in the CuO_2 plane and consequently in the relation of Tc versus y the decrease of oxygen content results in a reduction of the hole concentration in the CuO_2 plane.

Workshop on Lattice Effects
in High-Tc Superconductors,
Santa Fe, New Mexico,
USA, January 13-15, 1992

Temperature Dependence of Ion Channeling in Superconducting Single Crystals of $YBa_2Cu_3O_{7-y}$ and $Bi_2Sr_2CaCu_2O_x$

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The temperature dependence of the Rutherford backscattering (RBS) in the 〈001〉 axial channeling mode for each constituent atom of single crystal $YB_2Cu_3O_{7-y}$(YBCO) and $Bi_2Sr_2CaCu_2O_x$(BSCCO) have been carried out to study the lattice anomalies near Tc. Anomalous channeling behaviors for all atoms of YBCO, especially for Cu and O atoms, have been observed near Tc, indicating a structure instability or a change in the lattice. It was found that the present results are consistent with those of the lattice anomalies obtaine by others experiments such as EXAFS and neutron resonance-absorption or diffraction etc. On the other hand, no anomaly of channeling has been observed near Tc in BSCCO. This is probably due to large RBS yields; the lattice anomalies near Tc is not substantially denied in BSCCO.

US-JPN Workshop Q142,
ABQ, New Mexico, USA,
11/25-28, 1991

JPN-3 Surface Properties of JT-60 Graphite Divertor*

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For graphite tiles (ETP-10) used as divertor plate of JT-60, the following surface properties were examined.

(1) Surface Roughness
(2) Surface Morphology (SEM)
(3) Crystal Structure (Raman Spectroscopy)
(4) Gas Desorption (Thermal Desorption Spectroscopy)
(5) Depth Atomic Composition (Auger Electron Spectroscopy)
(6) Impurity Deposition (PIXE)
(7) Hydrogen Retention (NRA)

The surface of tiles used for 2000 shots were largely changed compared with as received one. Entire surface was covered by deposition layer. The surface morphology observed was

sponge like, column or smooth structure. Maximum eroded or deposited thickness was less than 1 mm or 1/2 mm, respectively. The deposition region existed in the vicinty of eroded region. The structure consisted of broad graphite, broard deffective graphite and amorphous structures for every surface. Considerable amount of gas desorption was observed, i. e. maior sepecies were H_2, H_2O, CO, CO_2, CH_4 and hydrocarbons. Several impurities were observed in the surface, major species were Mo, Cr, Ni, Ti and Al. These impurities were observed also in deeper inside of the tile. The total impurity concentration including oxygen was from 1 to 10%. Hydrogen amount was approximately 10-20% for every surface. The total retained hydrogen will be evaluated based on present data.

* To be submitted to 10th PSI Conf., Monterey, CA, 3/30-4/3, 1991.

US-JPN Workshop Q142,
ABQ, New Mexico, USA,
11/25-28, 1991

JPN-10 **Adequate Use for Bulk Boronized Graphite as Plasma Facing Material***

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For bulk boronized graphite, the adequate temperature range and region inner wall was discussed based on the following results;

(1) Radiation Enhanced Sublimation Data Obtained in Hokkaido Univ.,
(2) Oxidation Experiments Performed in Hokkaido Univ.,
(3) B_4C Evaporation Experiment Performed in Hokkaido Univ.

B mixed graphite can play as oxygen getter, by forming B_2O_3. However, this boron oxide evaporated when the temperature exceeded apporoximately 900℃. Thus, the gettering action can be expected only in this range. Our erosion data showed that for RES the boron mixing was not effective for the reduction, while the chemical erosion was largely reduced. Important problem was very high evaporation rate of B content when the temperature was more than 1000℃. Total boron, for example, will be lost within 10-50 days in use at 1500℃.

Above results shows that the bulk boronized graphite should be used only at low temperature less than 900℃. Similar examination for Be showed again that Be be used less than approximately 900℃. For these materials be used effectively, the heat load to divertor must be largely reduced. We now are proposing ITER with expanded divertors (ELONGATED ITER).

* To be submitted to 10th PSI Conf., Monterey, CA, 3/30-4/3, 1991

The 10th International Conference on Plasma Surface Interactions in Controlled Fusion Device, Monterey, CA, USA, 3/30-4/3, 1992

Surface Analysis for JT-60 Graphite Divertor Tiles

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Isotropic graphite, ETP-10, had been used as divertor plate in the lower X point configuration of JT-60. The divertor tiles were exposed to approximately 2500 discharge shots with stored energy up to 100 MJ/shot in the period from Jun. 1988 to Oct. 1989. The ratio of disruption shot number was about 20%.

For these graphite tiles, the change of surface properties was investigated. The eroded depth observed was as high as 1 mm. The thickness of redeposited layer observed in the vicinity of the eroded region was less than 0.5 mm. The surface morphlogy was largely changed into sponge like, column or smooth structure. Raman spectroscopy analysis showed that the structure was composed of broadened crystal, defective and amorphous structures in every surface region.

The impurity deposition was also examined both by AES and PIXE. As impurities, O, Ni, Ti, Fe and Cr was observed. These impurities existed uniformly in the depth direction. The total impurity concentration was from 1 to 10 at. %. The gas desorption properties were examined with a technique of TDS. The total outgassing amount was considerably larger than that of as-received one. The dominant desorptions both at low and high temperatures were observed. The former one may correspond to the absorption after the machine shutdown, and the later one be due to that during plasma discharges. The hydrogen retention was measured by NRA. At surface and interior regions, the hydrogen concentrations were from 10 to 20%, and from 5 to 10%, respectively.

The 10th International Conference on Plasma Surface Interactions in Controlled Fusion Device, Monterey, CA, USA, 3/30-4/3, 1992

Evaluation for Metal Mixed Graphite and High Z Metal as Plasma Facing Material

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Since the graphite is largely eroded by the process of radiation enhanced sublimation (RES) at high temperature environment, it is indicated that the use of graphite for the region with high heat load such as divertor in next devices becomes difficult. In order to suppress the large erosion, the use of metal mixed graphites such as bulk boronized graphite (boron mixed graphite) or high Z metals such as W and Mo has been proposed. In the present study, we discuss the limits both of boron mixed graphite and high Z metal (W) as plasma facing material, and then propose the adequate plasma configuration for next devices.

From our several experiments of oxidation, hydrogen ion irradiation and evaporation for boron mixed graphites, the following results were obtained;

(1) the RES yield was roughly the same as usual graphite materials,
(2) the boron was largely lost by heating when the temperature exceeded about 1000℃,
(3) the boron was very useful as oxygen getter because of formation of B_2O_3, but B_2O_3 evaporated in the temperature range more than 900℃.

Thus, the boron mixed graphite should be used only as oxygen getter in the temperature range less than 900℃. Similar condition was obtained for Be.

In the use of high Z divertor, the high Z impurity flow to core plasma has to be well suppressed for the ignition condition to be sustained. For W, the momentum balance equation including the friction force due to plasma ions was solved. The result showed that both high plasma density of the divertor and the large throat length between the plate and X point were required to suppress the inward flow. In the next step device, these criteria are not taken into account.

Above results indicate that the divertor cofiguration must be considenably expanded or enlarged to reduce the heat flux and the inward flow. For ITER, the scheme of ELONGATED ITER is proposed for the iginition condition to be kept with high reliability.

The 1st JSME/ASME Joint International Conference on Nuclear Engineering, Tokyo Japan November 4-7, 1991

A New Model for CHF in Pool Boiling at High Pressure

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The concept of Critical heat flux (CHF) is discussed based on the mechanism that CHF is caused by the dryout of a liquid layer formed on heating surfaces. It is suggested that a liquid macrolayer is formed by the coalescence of bubbles for most boiling system, and that the dryout of the macrolayer is controlled by the hydrodynamic behavior of coalesced bubbles on the liquid macrolayer. Based on these considerations, a CHF model is constructed for saturated pool boiling by proposing boiling mechanism deduced from the measurement of bubble diameters and the photographic records by Semeria for water boiling. In the model the departure frequency of coalesced bubbles formed on a macrolayer determines the frequency of macrolayer formation. The CHF occurs when the macrolayer is dried out at the departure of the coalesced bubbles from heating surfaces. The formulation of the model leads to the well known Kutateladze or Zuber correlation for CHF in saturated pool boiling.

Conference on Pool and External Flow Boiling, Santa Barbara, California, USA, March 22-27, 1992.

Heat Transfer Correlation and Method for Predicting Boiling Curves of Saturated Nucleate Boiling

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This paper proposes a new correlation for nucleate boiling, consisting of heat flux q, superheat $\triangle T_{sat}$, density of nucleation sites n, and a group of physical properties. The correlation is based on a model where heat transfer mainly occurs by heat conduction and is enhanced by liquid agitation induced by the growth and production of primary bubbles. Nucleation site densities were calculated by combining the correlation with experimental data of $q-\triangle T_{sat}$ over a wide range of pressures. This yielded a semi-empirical correlation of the densities of nucleation sites considering the effects of growth of neighboring bubbles and changes in wettability with pressure. A correlation predicting boiling curves is derived by combining the two correlations.

Conference on Pool and External Flow Boiling, Santa Barbara, California, USA, March 22-27, 1992

Proposed Model for Kutateladze Correlation and New Correlation of CHF

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A physical model of critical heat flux (CHF), which is expressed with the relation $q_{CHF} = \delta_l \rho_l H_{fg} \cdot f$, is proposed, and new correlations of CHF, Kutateladze and Zuber correlations are formulated based on this model. In the model a macrolayer of liquid is formed by the simultaneous coalescence of bubbles (secondary bubbles). The departure frequency of large bubbles (tertiary bubbles) formed on the macrolayer determines the incidence of macrolayer formation. The proposed correlations in formulating the model are also expressed by semi-empirical correltions of macrolayer and departure frequency of tertiary bubbles for various geometries of heating surfaces. The Kutateladze or Zuber correlation is obtained by simple formulation of the model and is, therefore, not very exact.

International Conference on Radiation Effects and protection, Mito, Ibaraki, Japan, March 18-20, 1992

A Simplified Method to Estimate Effective Dose Against External Photon Irradiation

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A simplified method to evaluate approximate organ doses and the effective dose against external photon irradiation is proposed. In this method, organ doses are approximated by an exponential function of organ depths, which are defined as the depth corresponding to the distance between the center of organs and the body surface facing a plane source of external photons. The effective depth which is obtained from the weighted sum of the organ depths with the tissue weighting factors, gives a good approximation for the effective dose by using the established empirical expression. The concept of the effective depth is considered to provide useful information clarifying the reference point of effective dose, and can be applied, for example, to the calibrations of individual dosemeters in terms of the depth in radiological protection.

The 4th International Symposium, Frontiers of Electrocatalysis, Sapporo, Japan, September 20-21, 1991

Confirmation of the Fleischmann-Pons Effect (Cold Fusion)

Tadahiko MIZUNO
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Relationships between reaction products and cathodic polarization of a large size palladium are analyzed at various conditions. Cathodic current density was employed 44 and 200 mA/cm^2 and the temperature range from 75 to 140℃. The Pd sample absorbed deuterium gas up to the amount that corresponded to the composition from Pd $D_{0.61}$ to Pd $D_{0.95}$. The electrolysis lasted typically for 2×10^6s and the whole experiment was continued for 250 days. The energy spectra obtained during and the after electrolysis showed clearly the 1.45 MeV energy peak and the rate of neutron emission was 0.003~0.01 m/s. The tritium evolution rate was evaluated to be $1.44\times10^{-2}\mu$Ci; this corresponds to 1.5×10^{-12}g or 3.0×10^{11} atom of tritium. If We assume that the neutron and tritium evolution were caused by the d, d nuclear reaction, the cross section may be estimated from their production rates; the ratios showed 10^4 times difference.

The International Symposium on Nonlinear Phenomena in Electromagnetic Fields, Nagoya, Japan, January 26-29, 1992

Confirmation of the Fleischmann-Pons Effect (Relationships between reaction products and D/Pd loading ratio)

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Fac. Eng., and Catalysis Research Center, Hokkaido University

We have reported earlier a weak neutron emission of 2.45 MeV energy, tritium generation reaction which had 10^4 times higher rate compared with that of neutron, and an excess heat production during cathodic polarization of Pd. The deuterium absorption process showed two steps; the first step occurred immediately after the start of electrolysis and the second step started when the loading ratio reached the value of the β phase. The absorption rate in the second step was slower than the first step by two orders of magnitude. The loading ratio exceeded the value obtained by a gas absorption method. The slow step showed a linear rela-

tionship with time; it suggests that the process was controlled by a surface reaction.

The rate of deuterium absorption was observed to be proportion to the cathodic current density in a certain temperature range. A semiempirical relationship between equilibrium deuterium pressure (P_{eq}) and the current density (i) was obtained as $P_{eq} \approx ki$ where k is a constant. On the other hand, the relationship between the equilibrium concentration (C/C_0), and the normalized dissociation pressure (P/P_0), when it exceeded the β phase, at temperture T, may be expressed as,

$$\frac{P}{P_o}=k_2\exp\left(\frac{C}{C_o}-\frac{\triangle H}{RT}+\frac{\triangle S_H}{R}\right)$$

here $\triangle H$ and $\triangle S_H$ are the phase formation enthalpy and entropy respectively. We can directly estimate a D/Pd ratio from an electrolysis condition of a temperature and current density by this equation. For example, We could obtain the D/Pd ratio of 0.85 and 0.9 when the sample was charged with 50 and 200 mA/cm^2 at 30°C by the relationship. It will require several A/cm^2 to obtain D/Pd ratio of unity.

The 1st West Pacific Electrochemistry Symposium. Tokyo, Japan, May 24-27, 1992

The Relationship between Behaviour of Deuterium in Palladium and the Cold Fusion

Tadahiko MIZUNO, Tadashi AKIMOTO,
Kazuhisa AZUMI and Michio ENYO.
Fac. Eng., and Catalysis Research Center, Hokkaido University

The behaviour of hydrogen absorption/desorption in Pd during cathodic polarization at very high c. d. is of interest in view of cold fusion. A closed electrolysis cell system with contains H_2/O_2 recombination catalyst is convenient for in-situ measurement of hydrogen absorption /desorption behaviour. We can estimate the ratios of neutron emission, tritium evolution and heat generation concerning with the deuterium loading ratio of Pd during and after electrolysis.

A two-phase model of deuterium absorption may be suggested to explain the preceding absorption / desorption phenomena. The electrode surface is covered with a new unstable hydride layer. The growth rate of the layer obeys a linear law but very slow compared with the α and β layer.

The evolution of neutron, tritium and heat depended on the D/Pd ratio. We obtained the following results; the neutron evolution occurs at considerably low D/Pd ratio of $\sim$ 0.40, tritium evolves at higher D/Pd ratio of more than 0.80, heat can be generated at very high D/Pd ratio of more than 0.90, and behavior of the deuterium absorption/desorption during and after the electrolysis were dependent on experimental conditions.

The International Conference
RARE EARTHS '92 IN
KYOTO JUNE 1-5, 1992

Stability Constants and Structures of Uranyl and Thorium Chloro-Complexes

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Stability constants of uranyl and thorium chloro-complexes decrease rapidly with increasing ionic strength. The ionic complexes are typical outer-sphere complexes, as the Fuoss formula is applicable to this relationship and the heat of formation is remarkably small. The thermodynamic equilibrium constants of 33 and 212 $mol^{-1}l$ were also determined for these chloro-complexes.

A dumbbell configuration of the uranyl ion was assumed to explain the ionic strength dependence of the stability costant of uranyl chloro-complex. In this model, the chloride ion interacted electrostatically with each of the uranium and oxide ions. The inter-ionic distance was evaluated to be 0.30 nm between the uranium and chloride ions. The distance suggests that one of water molecules coordinating with the uranium ion is replaced by a chloride ion and that a complex of the type $UO_2(H_2O)_3Cl^+$ is formed. Further, the inter-ionic distance of 0.40 nm was obtained for the thorium chloro-complex, and the complex of $Th(H_2O)_6Cl^{3+}$ was proposed.

The 4th International Symposium on Computational Fluid Dynamics, Davis, California, U. S. A., September 9-12, 1991

Numerical Analysis of Coastal Waves Considering Arbitrary Topography and Moving Coastline

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Faculty of Engineering, Hokkaido University,
Sapporo 060, Japan

By using a deformable-cell method in which each cell can deform in accordance with moving boundaries, numerical analyses on the refraction, deformation, runup, and reflection of coastal waves were made taking into account arbitrary topography, moving coastline and the dispersion effect. For solitary waves, both the horizontal and the vertical analysis are shown,

and they are compared with other works. For periodic waves, the horizontal analysis is compared with our own water-tank experiment.

The 5th Toyota Conference on Nonlinear Optical Materials Nisshin, Aichi-ken, Japan, October 6-9, 1991

Efficient Compression of Femtosecond Laser Pulses Using Nonlinear Organic Fibers

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Faculty of Engineering, Hokkaido University
[b] Laser Section, Optoelectronics Division,
Electrotechnical Laboratory
[c] New Chemistry R&D Laboratory, Sumitomo Electric Industries

It is shown experimentally that a 4-(N, N-dimethylamino)-3- acetamidonitrobenzene (DAN) single-crystal cored fiber has femtosecond-response, large third-order nonlinearity. In addition, it is demonstrated that the DAN fiber enables us to compress effectively a laser output pulse to 22 fs without any amplification.

The 8th International Conference on Ultrafast Phenomena Antibes-Juan-Les-Pins, France 8-12 Juin, 1992

Compression of nonamplified femtosecond laser pulses by an organic crystalline fiber

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[a] Hokkaido U., Sapporo, Japan,
[b] Fuji Photo Film Co. Ltd., Kanagawa, Japan.

Compression of nonamplified ultrashort pulses from lasers including a semiconductor laser by nonlinear organic fibers, and optical properties of a new nonlinoar fiber are discussed.

European Quantum Electronics Conference (EQEC '91), Edinburgh, Britain, August 27-30, 1991

Real-Time Polarimetric Interferometry for Mapping Dynamic State of Polarisation of Light

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Polarimetric studies on ellipsometry and photoelasticity have been made extensively by means of optical interferometry. Any polarimetric parameter of material can be reflected into the state of polarisation (SOP) of optical wave that interacts with the material. In a coventional polarimetric interferometer, almost all the optical components such as polarisers, analysers, and quarter-wave plates are used for polarisation alignment of the optical waves, and also two area-photodetectors are frequently employed. Slow mechanical movements for alignment of the optical components during operation make it difficult to follow a rapid change in SOP. Fine position matching of the two separate images taken by the respective area -photodetectors is not convenient and takes much time. That is why the conventional polarimetric interferometers, such as linear and circular polarimeters, are suited to the sutdy of static SOP but not to the study of space-dependent dynamic SOP.

With these points as background a novel polarimetric interferometer has been developed for the study of space- and time-dependent SOP. Its major significant point is that the reference beam of light for interference consists of orthogonal linearly polarised waves with different spatial carrier frequencies. These linearly polarised waves are made to interfere with their counterpart orthogonal components of the elliptically polarised signal beam that interacts with the material. As a result, two resulting interference patterns can offer the significant parameters to determine SOP of the signal beam. Emphasis is given to the fact that no use of the optical components for polarization alignment and use of only one area-photodetector enable us to examine the space- and time-dependent SOP. Performance principle of the developed polarimetric interferometer and some measured results will be presented at the coference.

International Conference on Optical Fibre Sensors in China (OFS(C)'91), Wuhan, China, October 9-11, 1991

Optical heterodyne fiber-coil deformation sensor operating in a wide dynamic range

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This paper presents a novel fiber-coil polarimetric sensor using highly birefringent single-mode fiber. A length of fiber is cut at its midpoint; one is rotated by 90 deg. around its axis and spliced to the other. The resultant single fiber is folded at the spliced point and paired fibers, made in contact with each other along the length, are wound around a flexible cylinder. The coil deformation turns into a change in bending-induced retardation. The retardation measurement is immune from ambient temperature changes. The sensor performance is demonstrated with the sensitivity of the coil deformation 3.2[deg./mm•turn] .

International Conference on Industrial Electronics, Control and Instrumentation (IECON'91), Kobe, Japan, October 28-November 1, 1991

Wideband phase demodulation based on Fourier-transform techniques in optical heterodyne interferometry

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Hokkaido University, Sapporo 060, Hokkaido, Japan

A method for computer-aided wideband phase-demodulation has been developed for taking out any time-varying phase in optical heterodyne interferometry. The generated beat-photocurrent is memorized in a digital transient memory so that its phase can be demodulated with the aid of computer. This method allows us to measure any mode of vibration, not limited to a sinusoidal vibration, over 10 MHz in bandwidth.

International Symposium on Optical Fabrication, Testing, and Surface Evaluation, Tokyo, Japan, June 10-12, 1992

Contour mapping of dynamic stress distributions by novel polarization interferometry

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Hokkaido University, Sapporo 060, Hokkaido, Japan

A novel method for contour-mapping principal stress distributions is described. In the polarimeter developed, a reference beam of light consists of the two orthogonal linearly polarized components that interfere with their counterpart orthogonal components of an elliptically polarized signal beam of light. Two crossed interference patterns are formed over a MOS TV camera so that the significant parameters for determining a principal stress distribution can be recorded in a computer. The major advantage is that not only each of the two principal stresses but also the principal stress-difference can be independently determined, and no use of any optical component for polarization alignment makes it possible to follow a rapid change in stress distribution within the maximum frame rate $2066s^{-1}$ of the MOS TV camera.

The 9th International Conference on Electronic Properties of Two-Dimensional Systems (EP2DS-9), Nara, Japan, July 8-12, 1991

Quantized Thermoelectric Power in the Ballistic Transport Regime

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Department of Engineering Science,
Hokkaido University, Sapporo 060, Japan

The thermoelectric power of a narrow constriction in a two-dimensional electron gas (2DEG) is theoretically investigated in the form of the transverse voltage by using a model appropriate for the recent experimental system. Our theoretical model gives the quantized thermoelectric power obtained experimentally. Moreover, the oscillating chemical potentials in all the participating 2DEG regions are found.

International Workshop "Polarons and Applications", Pushchino, Russia, May 23-31, 1992

Electron-Phonon Interactions in Semiconductor Heterojunctions

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Hokkaido University, Sapporo 060, Japan

The phonon-drag thermoelectric power in addition to the mobilities and energy-loss rates of electrons in $Al_xGa_{1-x}As/GaAs$ heterojunctions at low temperatures are theoretically investigated based on the electron-phonon interactions within the perturbation theory and/or the linear approximation to the Boltzmann equation. The experimental data are well explained in terms of the deformation-potential and piezoelectric costants for bulk GaAs provided that the effects of screening are properly taken into account.

The 180th Electrochemical Society Meeting, Phoenix, Arizona, USA, October 13-17 1991

Study on Anodic Deposition of Ferric Oxy-hydroxide Films on Gold by a Quartz Crystal Microbalance

Masahiro SEO, Ichirou SAWAMURA, and Hideaki TAKAHASHI
Department of Engineering Science, Faculty of Engineering,
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In-situ quartz crystal microbalance (QCM) technique has been applied to investigate anodic deposition of ferrous ions on gold in solutions containing different electrolytes (perchlorate, phosphate, and borate) with relation to the formation of passive films on iron. The apparent molecular weight of deposited films was evaluated from comparison between in-situ QCM and coulometry, and was found to depend strongly on the electrolyte composition. The electrolyte dependece on apparent molecular weight was attributed to anodic oxidation of ferrous complex ions which were formed by the reaction of ferrous ions and electrolyte anions.

The 12th Scandinavian Corrosion Congress and Eurocorr '92, Espoo, Finland, May 31-June 4, 1992

Study on Anodic Deposition of Ferrous Ions on Gold in Aqueous Solutions Containing Chloride Ions by a Quartz Crystal Microbalance

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Department of Engineering Science, Faculty of Engineering,
Hokkaido University, Sapporo 060, Japan

An in-situ quartz crystal microbalance (QCM) technique has been applied to investigate the formation process of deposited films on gold due to anodic oxidation of ferrous ions in solutions containing chloride ions, with relation to the formation of passive films on iron. The apparent molecular weight of the deposited films was evaluated from a comparison between in-situ QCM and coulometry, and it did not strongly depend on the concentration of chloride ions within the reproducibility of the experimental data. The composition of the deposited films corresponding to the apparent molecular weight was a partially hydrated ferric oxy-hydroxide, $FeOOH \cdot nH_2O (n=0-1)$, when no chloride ions were incorporated in the films.

The 5th International Battery Materials Symposium, Sydney, Australia, November 3-6, 1991

Mechanism of Incorporation of Impurity Metal Ions into Electrolytic Manganese Dioxide (EMD)

H. TAMURA, K. ISHIZEKI, M. NAGAYAMA and R. FURUICHI

The incorporation of impurity metal ions into MnO_2 during its formation by anodization was investigated. The affinity of metal ions for incorporation is very similar to that of ion-exchange adsorption of ions to the surface hydroxyl groups on MnO_2. A mechanism was proposed that impurity ions are incorporated into MnO_2 through adsorption on growing MnO_2 particles. Calculations of the amount of incorporation from the amount of adsorption showed a good correlation to observations.

IUPAC ICAS'91 International Congress on Analytical Sciences 1991, Chiba, Japan August 25-31, 1991

A New Chemiluminescense-Delay Reaction Based on Horseradish Peroxidase Catalysed Oxidation of Fluorescein by Hydrogen Peroxide

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Sapporo 060 Japan

Fluorescein undergoes chemiluminescence (CL) reaction in the presence of H_2O_2 and horseradish peroxidase (HRP) as a catalyst. In the course of our studies on the effect of such thiols (RSH) as cysteine, cysteamine and glutathione on the CL intensity, we have found that HRP activity for the CL reaction suppressed by adding excess RSH, because of the formation of HRP-RSH complex. The activity of HRP restored by the catalytic oxidation of the RSH bonded to HRP with Cu (II). The time required for the catalytic oxidation caused a delay in the initiation for the CL reaction. The intensity and the time delay were dependent on the concentrations of Cu (II) and thiols. This paper describes a novel method for the determination of Cu (II) by using the CL-delay reaction. The maximal CL intensity exhibits a linear dependence on Cu (II) concentration between 7×10^{-7}M and 5×10^{-5}M of Cu (II).

IUPAC ICAS'91 International Congress on Analytical Sciences 1991, Chiba, Japan, August 25-31, 1991

Extraction and Concentration of Biological Compound Using Zwitterionic Surfactant-Mediated Phase Separation

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Sapporo 060 Japan
* Department of Chemistry, Wake Forest University,
Winston-Salem, U. S. A.

The aqueous micellar solutions of 3-(nonyldimethylammonio) propyl sulfate and 3-(decyldimethylammonio) propyl sulfate separate into two distinct phases below a certain temperature. The lower phase is the surfactant-rich phase into which hydrophobic steroid hormons, vitamins, vanilins, membrane protein (bacteriorhodopsin) were extracted almost quantitatively, while the extraction yields of hydrophilic cytochrome c (bovine heart) and hexokinase (bakers yeast) were 0-10%. This technique could be used for the preconcentration of hydrophobic biological compounds prior to analysis with HPLC.

IUPAC ICAS'91 International Congress on Analytical Sciences 1991, Chiba, Japan August 25-31, 1991

Fluorescein Chemiluminescent Determination of Glucose in Serum Using Glucose Oxidase

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Sapporo 060 Japan

Glucose in serum was successfully determined by simultaneous coupling of a glucose-glucose oxidase (GOD) reaction with a fluorescein (FL) chemiluminescent (CL) reaction catalyzed by horseradish peroxidase. The FL-CL reaction can be conducted at pH 7.0, thus allowing to perform in situ detection of hydrogen peroxide generated during the glucose-GOD reaction. The CL emission lasted for about 3 min, and the calibration curve was linear in the glucose concetration range of 5.0×10^{-8} to 1.0×10^{-5}M. The relative standard deviation at 5.0×10^{-7}M glucose was 1.8% (n=5). The present method was not subject to any interference from components normally present in serum. Results of glucose assay in two control sera were in good agreement with those by the colorimetric method.

The Oji Conference on Spin Chemistry, Tomakomai, Hokkaido, Japan, July 15-18, 1991

Application of Pulsed EPR Spectroscopy to the Study of Radical Reactions

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Kita-ku, Sapporo, 060, Japan

Electron spin echo (ESE)-detected EPR spectrum has been found to be a powerful way of discriminating overlapping EPR spectra by utilizing the difference of paramagnetic relaxation rates. The ESE technique has been applied on alkyl radicals generated from normal and branched alkanes by γ-irradiation at 77 K for elucidating the mechanism of radical reactions in solids.

Effect of Electron Spin Diffusion on Electron Spin Echo Decay

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The effect of electron spin flip-flop on two- and 2+1 pulse electron spin echo decay due to instantaneous diffusion was studied on hydrogen atoms in γ-irradiated quartz. The observed decay was slower than the thoeretical one including no spin flip-flop, and the descrepancy was increased with the concentration of the hydrogen atoms. Comparison of the theoretical and the experimental decay rates revealed that the main factor diminishing the effect of instantaneous diffusion is not direct flip-flop between on-resonant spins, but the fluctuation of the local magnetic fields for on-resonant spins due to flip-flop of adjacent spin pairs.

ISMAR Workshop on Electron Spin Echo Spectroscopy, Novosibirsk, USSR, September 25-28, 1991

Application of ESE spectroscopy to the study of radical reaction in solid

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ESE spectroscopy is shown to be a powerful method for studying radical reactions in solids. Overlapping EPR spectra are possible to be differentiated into each spectral component by utilizing the difference of paramagnetic relaxation rates due to the difference of molecular motion. Informations on the motion of molecules affecting radical reactions are also obtained. The ESE technique is applied to alkyl radicals generated from normal and branched alkanes by γ-irradiation at cryogenic temperature for elucidating the mechanism of selective radical formation by the detachement of C-H hydrogen. It is concluded that the selectivity is strongly dependent on the easiness of C-C-C bending motion assisting the detachment of hydrogen.

The 5th China-Japan Bilateral Symposium on Radiation Chemistry, Beijing, China, October 13-18, 1991

Pulse Radiolysis Studies on Ion Radicals of Polymers in Solutions

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Electron and positive charge migration along a polymer chain is shown by the pulse radiolysis-optical absorption study of poly (4-vinylbiphenyl-co-1-vinylpyrene) and corresponding homopolymers in solutions at room temperature.

For the copolymer with small vinylpyrene contents in 2-methyl-tetrahydrofuran solutions, excess electron is initially localized in an biphenylyl side-group to form anion radical. The electron then transfers to a pyrenyl side-group, whose electron affinity is higher than that of the biphenylyl group. The electron transfer proceeds in a 100 ns-time region. Observed results indicate that the electron migrates along the copolymer chain by hopping between neighboring biphenylyl side-groups until it is stably trapped on a pyrenyl side-group, and that the frequency of the electron hopping is $5.2\times10^{9}s^{-1}$.

For the copolymer in 1, 2-dichloroethane solutions, positive charge is initially trapped on a biphenylyl side-group to form a cation radical in dimer form, and then transfers to a pyrenyl side-group in a time region of several microseconds. The positive charge transfer also proceeds along a polymer chain, but comparatively slowly.

The 1st USSR-Japan Joint Meeting on Quantum Effect in Chemical Reaction-Low temperature Chemistry, Chernogolovka, USSR, October 27-November 2, 1991

H-Abstraction of Methyl Radical from Methanol in Solid State

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Abstraction of a H-atom from methanol by methyl radical is an interesting model reaction, because branching is possible between two reaction paths:

$$\cdot CH_3 + CH_3OH \rightarrow CH_4 + \cdot CH_2OH \quad (1)$$

$$\cdot CH_3 + CH_3OH \rightarrow CH_4 + CH_3O\cdot \quad (2)$$

Primary concern of the invesitgation is to study theoretically the reaction rate of reactions (1) and (2) at low temperature based on ab initio MO treatment and to reveal the reason why reaction (1) prevails in solid state.

Potential surfaces for reactions (1) and (2) were generated by an ab initio method at the MP2/6-31G* level. The rate constants were obtained based on the RRKM theory, the Miller's corrected version (including the tunneling), and the direct tunneling path model.

All the three methods gave the same conclusion that reaction (2) proceeds significantly faster than (1) at low temperatures. The inclusion of the tunneling does not change the order of rate constants. A reason for the actual inhibition of reaction (2) in solid methanol is the blocking of hydroxyl group of methanol due to hydrogen-bonding, whose energy was estimated to be 7.25 kcal/mol.

International Conference on Liquid Radiation Detectors: Their Fundamental Properties and Applications, Tokyo, Japan, April 7-10, 1992

Light-Induced Electron Emission from Low Vapor Pressure Organic Liquids

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Electron emission from low vapor pressure liquids induced by vacuum ultraviolet light has been measured as a function of photon energy between 6 and 10.8 eV. Absolute quantum yields were determined. The liquids comprised phthalates, dicarboxylic esters, amines and polysiloxane fluids. We found systematic changes of the yields with the molecular structure of the liquids. They can be explained by the variation of initial photoionization quantum yields and absorption coefficients.

Taniguchi Conference, Division of Polymer Chemistry, on Solid State Reaction in Radiation Chemistry, Sapporo, Japan, June 22-26, 1992

Effect of Molecular Motion on Alkyl Radical Formation in Solids by Gamma-Irradiation

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Faculty of Engineering, Hokkaido University
Sappro, 060 Japan

ESR and electron spin echo measurements of alkyl radicals generated from alkanes by γ-irradiation was carried out to elucidate the mechanism of stereoselective alkyl radical formation in low-temperature solids. Alkyl radicals generated at 77 K were the primary and the penultimate secondary radicals. Hydrogen atoms, generated by the scission of C-H bonds, and the primary radicals selectively abstracted hydrogen atoms on the penultimate secondary carbon atoms of nearby alkanes to convert to the penultimate secondary radicals. It was concluded that the stereoselectivity of C-H bond scission and C-H hydrogen abstraction is determined by the balance between the activation energy for the reactions and the amount of the strain exerted by the geometrical change of molecules from alkanes to the alkyl radicals. The low activation energy and the less strain is favorable for the formation of the alkyl radicals. The β-scission of a C-C bond for the alkyl radical with branched methyl groups at γ carbon was also observed.

Taniguchi Conference, Division of Polymer Chemistry, on Solid State Reactions in Radiation Chemistry, Sapporo, Japan, June 22-26, 1992

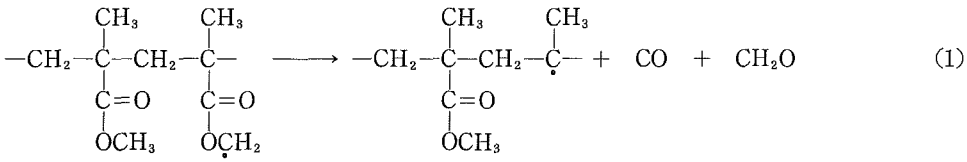
Reaction Mechanism of Radiation-Induced Degradation of Poly(methyl methacrylate)

Hiroshi YOSHIDA
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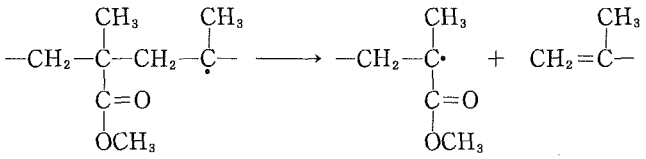
Poly(methyl methacrylate) has been known to be a typical radiation-degradable polymer. Very recently, studies of our group and other gave deeper insight into the reaction mechanisim for the radiation-induced degradation of PMMA mainly by using the ESR technique. The present status of understanding of the reaction mechanism is summarized together with some

unsolved problems.

We studied the nature and behavior of free radicals in PMMA irradiated with γ-rays at low temperatures (77 and 4.2 K) during warming up to 295 K. The behavior of free radicals indicates that the main-chain scission proceeds by the reaction mechansim as:



(1)



(2)

Although the intermediate radical was not directly observed because of its unstability, its temporary formation was strongly suggested by the experiment of photoreactions of free radicals in irradiated PMMA and poly (ethyl methacrylate).

The 5th International Conference of Industry Applications Socity, The Institute of Electrical Engineers of Japan, August 27-29, 1991

Optimal Repetitive Control and Its Application for PWM Inverter

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In this paper a new control technique, named the optimal repetitive control, for the power electronics system is presented. This control law which has both novel feature of the optimal control and the repetitive control is applied for the PWM inverter to obtain a sinusoidal output. The required pulse pattern for the PWM inverter can be calculated by the proposed control method even if the system has nonlinear load, such as the condenser input type rectifier load. The effectiveness of this control technique is confirmed by the simulation and the experiment.

IABEM-91, Kyoto. Symposium of the International Association for Boundary Element Methods, Kyoto, Japan, October 14-17, 1991

The Sweeping Primitive used for the 3D Automatic Boundary Element Mesh Generation

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In this paper, au antomatic mesh generator is proposed for the Boundary Element Method. The mesh generator can make a complicated shape from a few data on a personal computer because of adopting Constructive Solid Geometry method. Four primitives (a rectangular parallelepiped, an ellipsoid, a circular cone and a cylinder) have already been defined. The objective shape can be constructed by logical operation among the primitives having a simple mesh on it. A new added " Sweeping Primitive " is made by sweeping a 2D figure and it enables us to make a great variety of figures.

IABEM-91, Kyoto. Symposium of the International Association for Boundary Element Methods, Kyoto, Japan, October 14-17, 1991.

BEM Analysis Applied to the Electric Field near the Edge of Compound Dielectric Materials

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Controlling the electric characteristics of a device by its geometry is based on an accurate calculation of the electric field where the device has many edges and materials of the different nature in the body. The paper presents an example calculation about the eletric field near the edge of dielectric materials. The field has the singularity on the edge. In order to reduce the error of the analysis as possible, the numerical technique such as the multiplicity of flux variable, higher order elements and a performance index of potential error is applied to this boundary element calculation.

IABEM-91, Kyoto. Symposium of the International Association for Boundary Element Methods, Kyoto, Japan, October 14-17, 1991.

Formula of Boundary Integral for Potential Problem of Two Dimensional Anisotropic Materials and its Consideration

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Hokkaido University, Japan

This paper describes the analytical formulas of integration for two dimensional pseudo-Laplace equation which governs the phenomena in anisotropic materials. The formulas are formed recursively from zero order to higher order interpolation function on boundary elements. By using higher order elements, the number of elements of numerical model is decreased without lowering the accuracy and the computing time can be short. The efficiency of these formulas is shown in some sample problem of anisotropic materials.

The 13th International Colloquium on Dynamics of Explosions and Reactive Systems, Nagoya, JAPAN, July 28-August 2, 1991

Radiation Measurements in Large Scale Kerosene Pool Flames Using High-Speed Thermography

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Hiroshi KOSEKI
Fire Research Institute, Mitaka, Japan
Yoshio TASHIRO
Hokkafido University, Sapporo, Japan

Details of apparent temperature distributions in large scale kerosene pool flames in a 2.7 m square tank were measured by high-speed thermography which stores a thermal image in the form of a thermal TV color image with 25,600 data points every 0.1 seconds. The apparent temperature image can be changed to irradiance by simple approximations. The irradiance of the data (4 cases and 280 images) was compared with that of a wide angle thermopile radiometer to verify the data from the thermography. A series of data recorded at intervals of 1 and 5 seconds were also analyzed to obtain the radiance distribution in the flame. The anal-

ysis allows the following conclusions: Irradiance values obtained by high-speed thermography are not very different from those of a coventional wide angle thermopile radiometer. The high radiance zone which ordinary cameras do not show was determined by the average value of each of 70 apparent temperature images and the center of the high emission zone is located at about 0.3 D (D is the thank diameter). The moderately high apparent temperature range of 1323-1448 K apparently has a strong influence on the irradiance of pool flames.

The 16th International Conference on MEDICAL AND BIOLOGICAL ENGINEERING and IX. International Conference on MEDICAL PHYSICS, Kyoto, Japan, July 7-12, 1991

Preliminary Characterization of Rf-Sputtered Calcium Phospate Ceramics.

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Calcium phosphate coatings, especially hydroxyapatite (HA), have been applied in recent years to various medical and dental implants with the expection of enhancing implant fixation through direct bone bonding. Rf-sputtering method was applied for HA coating.

The coatiog from HA plate showed slightly higher Ca/P ratio of 2.1 than the stoichemical value of HA(1.67) in the range of sputtering power of up to 100 W. X ray analysis revealed the presence of HA crystals. The higher power showed more crystal formation, which was further pronounced by post-heat treatment of the coating at 800℃. Immersion Hank's sol. induced calcium phosphate deposition on the coating and HA operative condition, about 80-90% loss of calcium phosphate were observed, which could be prevented, however, by the post-heat treatment of the coating. In serum medium, the deposition was significantly enhanced, and reached to about 10 times as much as the sputtered HA coating. These results suggests that the rfsputtering method could be a promising approach for Ha coating on titanium implants.

The 16th Internationa Conference on MEDICAL AND BIOLOGICAL ENGINEERING and IX International Conference on MEDICAL PHYSICS, Kyoto, Japan, July 7-12, 1991

The Surface Modification of the Artificial Heart Valve by Al_2O_3 Sputter Deposition

Toshio YUHTA, Ikuya NISHIURA, Haruyoshi YATA,
Toshiyuki SHIMOOKA and Yoshinori MITAMURA
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The fracture and the thrombus formation are serious problems for the artificial heart valve. They depend mainly on the characteristics of materials which are used on the valve. We made surface modification of the artificial heart valve and examined their mechanical characteristics.

The alumina films were coated on duralumin plates by the magnetron sputtering system. The sloping structure (O_2 partial pressure: 0-4%) was deposited between duralumin and alumina film by the reactive sputter deposition.

Judging from deposition rate, surface roughness, structure of films, micro-hardness, adhesion etc., the composite materials which are based on aluminum alloy and coated with alumina film have excellent mechanical characteristics and prolong life of the artificial heart valve.

The 16th International Conference on MEDICAL AND BIOLOGICAL ENGINEERING and IX. International Conference on MEDICAL PHYSICS, Kyoto, Japan, July 7-12, 1991

Development of Adaptive Control System for Assist Heart Using Electro-Pneumatic Regulator

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The assist heart driving system using an electro-pneumatic regulator was developed. The system adaptively controls multi-controlled variables; mean left atrial pressure (mLAP) and mean aortic pressure (mAoP). The electro-pneumatic regulator can control air pressure widely by electric signals. The adaptive control was performed by vacuum pressure control. In the control algorithm, AR models were used. Then mLAP and mAoP in steady were predicted. The vacuum pressure minimizing a performance index was searched. The drive system was studied on a mock circulatory system. The initial steady states were set to setpoints. Then drive pressure of mock ventricle was suddenly decreased. As a result of control, mLAP and mAoP were controlled toward the initial level and the steady state errors were less than a few mmHg. The developed assist heart drive system can adaptively control two controlled variables to the optimal steady state when hemodynamics is changed.

The 16th International Conference on MEDICAL AND BIOLOGICAL ENGINEERING and IX International Conference on MEDICAL PHYSICS, Kyoto, Japan, July 7-12, 1991

Development of a new Bileaflet Valve Prosthesis Using Aluminum Alloy

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A new bileaflet artificial heart valve with central opening structure was developed to improve durability, hemodynamics and thromboresistant character. The new valve is composed of a housing and 2 leaflets which have arched shapes. This valve has one central flow orifice and 2 lateral fiow orifices. This opening system permits the central flow as major flow which improve flow dynamics around the valve. To observe flow dynamics around the valve, we used flow visualization method under steady state flow. Flow visualization through the valve was performed from 0.5 to 14 l/min in steady flow state model. The new valve's flow spread smoothly and had no turbulence near the valve holder. At all flow rates the new valve showed better central flow patterns than the commercial bileaflet valve (SJM). The new bileaflet valve is effective for hemodynamics around the cardiac valve prosthesis.

The 4th World Biomaterials Congress, Berlin, Germany, April 24-28, 1992

Future Developments of Mechanical Heart Valves: Surface Modification for Biocompatible and Endurable Mechanical Heart Valves

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One Major problem in designing artificial heart valves is that there are few materials satisfying both mechanical strength and blood compatibility. One approach to overcome this problem is to make the material blood compatible. In this study blood compatibility of sputter -deposited thin alumina film and TiN film was investigated. Interactions between deposited films and platelets, and between the films and coagulation factor (XII) were Investigated.

Fewer adherent platelets and lesser morphologic platelet change were observed on thin alumina and TiN films as well as on bulk single crystal alumina and TiN. The kallikrein activity was remarkably low on thin alumina film. This indicates that alumina thin film less activates the intrinsic coagulation pathway. From the results it can be concluded that alumina thin film and TiN thin film are blood compatible materials as well as single crystal alumina (bulk) and also promising materials for mechanical heart valves.

The 4th International Congress of the World Apheresis Association Sapporo, Japan, June 3-5, 1992

Enhanced Macrophage Activation by Pulsed Electromagnetic Fields.

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In order to study a possible application of pulsed electromagnetic fields (PEMFs) for immunomodulation, murine macrophages and human peripheral blood monocytes have been studied for their responses to PEMFs with INF and LPS. The PEMFs were generated by Helmhortz coil, and the peak magnetic field was 4.4 mT with the duty of 50%. The activation of macrophages were evaluated by the glucose consumptions, and showed the enhanced activation by the PEMF. When the PEMF frequency was varied from 10 to 250 Hz, the augmentation effect of PEMF increased with the frequency. The PEMF also showed enhanced activation effects on human monocytes when they were incubated with INF and LPS, and could induce the activation of such monocytes that were not activated with these stimulants. The effect of PEMF on Ca ion influx was measured by a fluorescence microscope using fura-2 as a Ca ion sensitive probe, and revealed that the PEMF enhanced Ca ion influx. These evidences suggested that the PEMF could be one of the approaches for immunomodulations.

The 4th International Congress of the World Apheresis Association Sapporo, Japan, June 3-5, 1992

Preliminary Evaluation of Ultra-fine Fibers as a Substrate for Immobilizing Immunomodulators.

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Toshio YUHTA, and Kazunori ONOE
Dept. of Biomedical Engineering

To study whether ultra-fine fibers is applicable for modulating the lymphocytes functions, Con A was immobilized on the surface of PP fibers having five different diameters ranging from 1.5 to 7.9 m. Murine splenic lymphocytes were cultured on these samples. The effect of fiber size on the lymphocytes were evaluated in terms of IL-2 production and adhesion morphology. The Con A immobilized fibers could stimulated lymphocytes as high as 70-80% of the maximum value induced by Con A solution. Statistical differences in IL-2 production were not observed among the fiber sizes, although as the fiber decreased in size, the contact area of the lymphocytes with the fiber became smaller. The results suggested the substrate size effect on the modulation of lympocyte function. Therefore, the ultra-fine fibers might be useful substrate for immobilizing immunocyte activators.

World Congress on Medical Physics and Biomedical Engineering, Kyoto, Japan, July 7-12, 1991

Application of Spread Spectrum Technique to Optical Biotelemetry

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Recently, an optical biotelemetry technique using indirect light transmission was proposed, and its usefulness in ambulatory monitoring has been proved. However, with this technique, the spatial discrimination of different transmitters has been difficult. To solve this problem, we have applied the spread spectrum (SS) technique to the optical biotelemetry.

An experimental system was developed which consists of two transmitters and one receiver. In a transmitter, original signal is multiplied with a pseudo-noise code in time domain to have an extremely wide frequency spectrum. And the resultant signal is transmitted out in light. In a receiver, the signal is differentiated from other signals by correlating the

received signal with the same pseudo-noise code as the one in the corresponding transmitter. Using different types of the pseudo-noise code for each transmitter, many channels can be multiplexed in a common space. With the SS technique, the effects of extrinsic noises, multi-path propagation and signals of other channels can be minimized.

Using this system, fundamental characteristics of this technique have been investigated. And simultaneous two channels transmission of ECG using indirect light transmission was performed successfully.

World Congress on Medical Physics and Bimedical Engineering, Kyoto, Japan, July 7-12, 1991.

Optical Trans-body Imaging (I)
— Attempts at functional imaging —

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Attempts were made to visualize the functional change inside a living biological body using a transillumination technique. First, the wavelength dependences of the light transmission and of the image contrast were analyzed. Based on this analysis, the blood vessels in a human palm were visualized. The dilation and constriction of blood vessels were observed clearly.

To examine the possibility of the functional imaging, a localized hypoxic area was made in one of the fingers by tying it at its root. Then, the transillumination images before and after releasing the restriction were obtained. The wavelengths used were 750 nm, 820 nm and 800 nm which is an isosbestic point of Hb. The spatial distribution of the change in tissue oxygenation was visuabized.

World Congress on Medical Physics and Biomedical Engineering, Kyoto, Japan, July 7-12, 1991.

Optical Trans-body Imaging (II)
— Fundamental study for optical CT —

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With the progress of light sources and detectors, it became possible to detect the light passed through a living body. However, the problem of light scattering has to be solved for the imaging of deep-seated organs. Some techniques have been developed to suppress the scattering and to improve the resolution of the images. These techniques were applied to an optical CT, or the computerized tomography using light.

The result of the tomography is presented. Three brass posts were put in a scattering medium, or milk. The cross-sectional shapes of the posts were triangle, circle and square with a typical dimension of 1 cm. The wavelength of the laser light was 632.8 nm. It was verified that the resolution of the image was significantly improved using the developed scattering suppression technique.

World Congress on Medical Physics and Biomedical Engineering, Kyoto, Japan, July 7-12, 1991.

Noninvasive Biomedical Measurements Using Optical Techniques

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In biomedical measurements, the usefulness of optical techniques has been widely recognized. Using these techniques, we can measure biological parameters in vivo without making any invasion upon a living body. An overview is presented on the biomedical applications of noninvasive measurements with optical techniques. And new techniques are proposed based on our research projects on light scattering from biological tissues.

The examples of the noninvasive measurements are summarized. As an example, a technique of the transillumination imaging of a human hand is presented. With this technique, blood vessels of human palm were visualized clearly in a moving image. This example typically shows the promising possibility to obtain physiological information in vivo noninvasively.

World Congress on Medical Physics and Biomedical Engineering, Kyoto, Japan, July 7-12, 1991.

Development of Non-invasive Stress Monitoring Technique Using Optical Telemetry

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A telemetry technique was developed which enables us to evaluate physiological stress responses non-invasively without restraining the subject. The change in peripheral circulation is ascribed to the change in diameters of peripheral blood vessels. It is measured as the change in transmitted intensity of infrared light across an ear auricle. The signal of peripheral circulation is transmitted to a remote place using the infrared light diffusely reflected from a ceiling, a floor and walls of a room. The transmitter is small and light enough to be equipped in an ear auricle of a rabbit. The feasibility of this technique was verified by detecting the reactions of a rabbit against various types of physical stresses, such as blowing cool or hot air and odor of ether. The system could detect both the constriction and dilation of peripheral blood vessels caused by the physical stresses. This technique is useful to detect the physiological and psychological effects of other stimulations. They include the strong electric field and the ion-current, the safety assessment of which have been controversial problems.

World Congress on Medical Physics and Biomedical Engineering, Kyoto, Japan, July 7-12, 1991.

Fundamental Study on Biological Effects of ELF Electric Field

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For the study of biological effects of ELF (Extremely Low Frequency) electric field, the force exerted on body hair due to field exposure was investigated. In theoretical analysis, it was shown that the force was proportional to the spatial gradient of the square of the electric field at the hair, and that it had positive correlation with a dielectric constant of hair. A technique to measure the dielectric constant of hair in an ELF range was newly developed. Using

this technique, it was found that the dielectric constant of hair increased with relative humidity. According to these results, the electric force on a human hair should vary with humidity of surrounding air.

An experimental system was developed which measures the movement of a body hair to obtain the electric force exerted on the hair. The force increases by about 10 times, as the relative humidity increases from 50% to 90%. This explains well the seasonal variation of detection threshold of electric field. This was verified in the measurement of detection threshold using human subjects. These results provide useful information for the safety standards of strong electric field.

World Congress on Medical Physics and Biomedical Engineering, Kyoto, Japan, July 7-12, 1991

Measurement of Arterial Elasticity Using an Intravascular Ultrasonic Transducer

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We have developed an intravascular ultrasonic transducer for the measurement of arterial elasticity. The transducer consists of a PZT element, a flexible Ni-Ti wire for positioning the element against an arterial wall, and a catheter-tip manometer for blood pressure measurement. With this transducer, we can measure the diameter of the artery, the pulsatile change of the diameter, and pulse pressure. Arterial wall thickness is also obtained from a spectral analysis of RF echo signals. Inserting the transducer into the aorta of dogs, we measured the above parameters and calculated the incremental elastic modulus E_{inc}.

Almost constant relative wall thickness of 10% and gradual increase of E_{inc} (4 to 20×10^6 dyne/cm^2) from the proximal to the distal end of the aorta were confirmed in the in vivo experiments. This intravascular technique may also be clinically applied to quantitative evaluation of atherosclerotic changes on patients.

World Congress on Medical Physics and Biomedical Engineering, Kyoto, Japan, July 7-12, 1991

Development of A Motor-Driven Assist Pump System.

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A totally implantable motor-driven assist pump system has been developed and evaluated in vitro experiments.

The system consists of a motor-driven assist pump and a transcutaneous energy transmission system. The motor-driven assist pump uses a specially designed miniature ball-screw to convert high-speed rotary motion into low speed rectilinear motion. The transcutaneous energy transmission system has transcutaneous optical telemetly system. Motor voltage signal and pump stroke signal are transmitted by a near infrared diode and a phototransistor (wave length of 800nm).

The system was characterized in vitro. The transcutaneous energy transmission system transmitted power of 14 W to the assist pump. The assist pump was operated in water of 37℃. Pump outflow of 4.6 l/min. was obtained against afterload of 100 mmHg at the drive rate of 80 bpm with efficiency of 13.5%. Problem of actuator sealing was not observed.

The 8th World Congress of the International Society for Artificial Organs, Montreal, Canada, August 19-23, 1991

Axial Blood Pump Implanted at the Heart Valve Position (Valvo-Pump) : Concept and Initial Results

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The Valvo-Pump, axial nonpulsatile blood pump implanted at the heart valve position preserving the diseased heart muscle, has several advantages over artificial heart replacement.

They are (a) good anatomical fitting to the natural heart, (b) less blood contacting surface, and (c) easy implantation technique as heart valve replacement.

The first prototypical Valvo-Pump was fabricated. Within a cylindrical housing, an impleller is connected to a miniature DC brushless motor measuring 23.8 mm in diameter and 30.2 mm in length. A guiding wheel is located behind the impeller.

To reduce the diameter of the pump and to have sufficient pump performance, four impellers were evaluated on a hydraulic mock circulation system. Among them the impeller of 22 mm in diameter gave pump flow of 5 l/min for the pump differential pressure of 125 mmHg at 12000 rpm. This impeller has 5 vanes and the boss of 10 mm. The mean vane angle is 5.6 degree. This performance of the pump is enough for the left heart.

The 8th World Congress of the International Society for Artificial Organs, Montreal, Canada, August 20-23, 1991

Development of A Totally Implantable Motor-Driven Assist Pump System

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* School of Engineering, Hokkaido Tokai University, Sapporo, Japan

A totally implantable motor-driven assist pump system has been developed and evaluated in vitro experiments.

The system consists of a DC brushless motor-driven assist pump and a transrcutaneous energy transmission system. The motor-driven assist pump (volume: 320 ml) uses a specially designed miniature ball-screw to convert high speed rotary motion into low speed rectilinear motion. Magnetic coupling between a blood pump and an actuator is used for active blood filling with mild negative pressure. The transcutaneous energy transmission system employs a transcutaneous optical telemetly system to transmit signals from the inside of the body.

The system was characterized in vitro. The transcutaneous energy transmission system transmitted power of 14 W to the pump. The assist pump was operated in water of 37 ℃. Pump outflow of 4.6 l/min. was obtained against afterload of 110 mmHg at the drive rate of 80 bpm with efficiency of 13.5%. Problem of actuator sealing was not observed.

The 3rd Conference between Hokkaido Univ. and Univ. Sience and Technology Beijing, Beijing, China. Sept. 9-11, 1991.

Functionally gradient material of the system Al-AlN

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Functionally gradient materials (FGM) are highly evaluated for their interdisciplinary nature and orientation towards a prolonged life of hybrid structures like composites, joinings, coatings etc. To study these characteristics, experts and researchers from industrial, university and national laboratories joined in a national project in Japan. I tried to prepare a FGM block of the system Al-AlN.

Generally speaking, the preparation of FGM blocks by the method of power metallurgy is required to extremely high temperature and high pressure. But, in this work using an ultrafine particle of aluminum-alminum nitride mixture, the FGM block of the system Al-AlN is easily prepared by the power matallurgy at lower temperature.

The 4th Sino-Japanese Conference on Material Science and Materials Technology. Beijing, China. Sept. 14-16, 1991.

Functionally gradient materials and joinings

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In our laboratory, we tried to prepare FGM blocks of the systems Ni-NiO, Ni-MgO, Ni-Si_3N_4 and Al-AlN.

Generally Speaking, the preparation of FGM blocks, especially the metal-nitride systems, by the method of power metallurgy is required to extremely high temperature and high pressure. But, in this work using a ductile nickel metal powder or an ultrafine particle of aluminum-aluminum nitride mixture, the FGM blocks are easily prepared by the powder metallurgy at lower temperature.

Because the application of the FGM blocks to joinings is useful to reduce residual thermal stress, the joinings to use the FGM blocks for fillers were examined.

The 16th Annual Conference on Composites and Advanced Ceramic Materials. Cocoa Beach, FL, USA. Jan. 7-10, 1992.

Functionally Gradient Material of The System NiO-MgO, Ni-NiO, Ni-Si_3N_4 or Al-AlN

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Generally, a FGM-block preparation is required to extremely high temperature and high pressure. But, in this work using a ductile nickel metal power or an ultrafine particle, the FGM-blocks were easily prepared at lower temperature. A mixture of a metallic powder and a non-metallic powder whose contents were gradually changed was pressed in a steel die under pressure of 200-320 MPa. This green compacts were heated at 900-1573 K in controlled atomosphere under null pressure. The FGM-blocks prepared by this method were characterized by some properties and were used to joinings. The joinings of metal/FGM/ceramics, metal/FGM and ceramics/FGM were completely accomplished at 900-1573 K.

The 3rd Conference of Hokkaido University and University Science and Technology Beijing, Beijing, China, September 9-11, 1991

Evaluation Methods of Coking Coal for Coke Manufacturing — Hydrogen and Electron Transfer Abilities of Coal —

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Evaluation methods for coking coals has been proposed for coke manufacturing. The distribution of optical textures in coke was evaluated by an automatic image analysis system. Hydrogen donor and acceptor abilities of coals were measured. The extent of the development

of anisotropic texture in the coke correlates closely to hydrogen transfer ability of coal and pitch mixture.

The studies concentrates also on hydrogen bondings and aromatic π-π interactions with respect to electron transfer between coal as host molecule and electron acceptor as guest one. Iodine as an electron acceptor interacts with coal molecules producing charge transfer complexes. A good correlation has been obtained between spin concentration, Ns-Nso, of the complex and rank of coal, where Nso and Ns are the spin concentrations of coal prior to and after acceptor doping, respectively. The values of Ns-Nso are also relating to coking characteristics of coal.

1991 International Conference
on Coal Science, Newcastle,
UK, September, 16-20, 1991

Coal Structure and Reactions

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Current advances of the investigation about chemical structure of coal and reactions were reviewed. Structure of covalent bondings with carbon, hydrogen, oxygen is primarily important governing the properties and reactivities of coal. In the lecture, the importance of non-covalent bonding between coal molecules and conformation of molecules derived from CAMD were stressed in order to design precise and efficient utilization reactions of coal.

1991 International Conference
on Coal Science, Newcastle,
UK, September, 16-20, 1991

Charge Transfer Complexes between Coal and Electron Acceptors; Non Covalent Interaction in Coal Structure

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This study concentrated particularly to hydrogen bondings and aromatic π-π interactions with respect to the charge transfer between coal and electron acceptors. Iodine as an electron acceptor interacts with coal molecules producing a charge transfer complex. A good correla-

tion is obtained between the spin concentrations, Ns, of coal-iodine complexes and coal rank. The value of Ns increases with the increase of rank up to 90% of carbon (daf). The change of spin concentration of iodine doped coal reflects the π-π interaction in condensed aromatic rings in coal structure. On the other hand, TCNQ is a molecule with strong electron accepting ability similar to iodine. The value of Ns for TCNQ doped coal increases with decrease in coal rank.

1991 International Conference on Coal Science, New Castle, UK, September 16-20, 1991

Apparent Viscosity of Softening Coal Heated at Elevated Pressures

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Needle Penetration to a 10mm-dia. cylindrical pellet of coal particles together with its volumetric dilation was measured for six different kinds of coals under various conditions, pressures up to 10MPa in nitrogen and hydrogen gas atmospheres at heating rates of 0.5 to 20 K/min and a holding temperature of 823 K. Change of the net penetration depth with temperature obtained from the observed penetration and dilation-temperature curves was analysed on the basis of a simple mathematical model which was developed incorporating consecutive reaction kinetics of pyrolysis and carbonization, an existing viscosity equation for molten polymers and an equation of motion for a Newtonian fluid. The model was shown to describe reasonably well the observed effect of the heating rate and pressure on the change of the net penetration depth with temperature. The activation energies assumed for the viscosity change were less than 10 kcal/mol and depended on the kind of coal.

1991 International Conference on Coal Science, New Castle, UK, September 16-20, 1991

Experimental Simulation of Coke Deposition in Preheater of Coal Liquefaction Process

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In an effort to examine characteristics of coke formation and deposition on to the inner surface of preheater tube in coal liquefaction plant a series of experiments were carried out in a 0.020 m^3 autoclave designed to simulate the characteristics in a range of industrial operating variables. The coke deposition was found to occur depending on the properties of coal and solvent, the oil to coal weight ratio and the slurry temperature and velocity. No coke formation was observed under conventional operating conditions with the bulk slurry temperature of ca. 700K at the preheater outlet, the oil/coal weight ratio of 60/40 to 55/45 and the superficial slurry velocities of 0.5 to 1.0 m/s. On the other hand, an appreciable coke deposition was detected when the bulk slurry temperature exceeded approximately 730 K and the slurry velocity was lowered to less than about 0.2 m/s. Within the present experimental conditions the rate of coke deposition was in an order of 1.0×10^{-6}g/(cm^2•min•g-coal).

Carbon '92 ; International Conference on Carbon, Essen, Germany, June 22-26 1992

Charge Transfer Characteristics of Polyaromatic Hydrocarbons and Pitch with Electron Acceptors

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Charge transfer complexes of polyaromatic hydrocarbons and tar pitch as host molecules were prepared with tetracyanoquinodimethane and iodine as electron acceptors. They were

characterized by means of electron paramagnetic resonance and infrared spectroscopic methods.

The degree of charge transfer in the complexes is closely dependent on chemical structure of the host molecules. Measurements of spin concentration by EPR and change of IR absorption give structural information for the host molecules. The methods proposed is useful for characterization and monitoring of pitch preparation and carbonization.

The 1st Japan-CIS Joint Seminar on ElectroMagneto-Mechanics in Structures, Tokyo, Japan, January 22-23, 1992

Nonlinear Radial Oscillations and Anomalous Growth of Internal Flux in a Pinch plasma under Alternating External Magnetic Field

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Radial oscillations of a pinch plasma under an oscillating external magnetic field are analyzed numerically. The external magnetic field consists of a slowly varying bias field and a periodically oscillating field component. On the assumption that the plasma is confined in a thin annulus and plasma conductivity is finite, the nonlinear oscillatory behavior of plasma and internal trapped magnetic flux are solved numerically. From the results of the analysis, the stable solution shows a periodical oscillation mode or a chaotic mode. The simulation about a theta pinch plasma using equations including the connection between a plasma current and an external circuit current gives a result showing the anomalous growth of internal flux in case that a small amplitude oscillatory field component is superimposed upon a normal crowbar decay magnetic field.

The 3nd JAPAN-CIS MHD Symposium, Sapporo, Japan, March 17-19, 1992

An Aspect of Coil Design for an Improved Performance of Faraday Type MHD Channel

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This paper describes the effect of the cross sectional distribution of the magnetic field upon the reduction of the MHD channel length. Employing a coal combustion plasma with the semi-perfect gaseous characteristics, the generator output performance was evaluated by the quasi 1-D gasdynamic model for various magnet coil shapes. It was shown for a supersonic constant-velocity Faraday type generator that, with effectively keeping the enthalpy extraction, the channel length can be shortened by more than 30% by an appropriate modification of the coil shape from the crescent shape producing a uniform magnetic field.

The 30th Symposium on Engineering Aspects of Magnetohydrodynamics, Baltimore, U. S. A., June 29-July 2, 1992

MHD Generator Channel Cross-sectional Shape Optimization for a 1300 MWth Coal Combustion MHD Generator

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This paper describes the effect of the cross sectional distribution of the magnetic field upon the reduction of the MHD channel length. Employing coal combustion plasma with semi-perfect gaseous characteristics, the generator output performance of various magnet-coil shapes was evaluated by the quasi 1-D gasdynamic model. It was shown for a supersonic constant-velocity Faraday-type generator that, by effectively maintaining the enthalpy extraction, the channel length can be shortened by 34% by the optimization of the coil shape from the crescent shape producing a uniform magnetic field. This cross sectional shape optimization of an MHD generator channel including a magnet coil was carried out for a 1300 MWth coal combustion supersonic MHD generator in which the inlet cross section was square.