HOKKAIDO UNIVERSITY

Title	Summary International Reports, July 1989-June 1990
Citation	Memoirs of the Faculty of Engineering, Hokkaido University, 18(1), 29-129
Issue Date	1990
Doc URL	https://hdl.handle.net/2115/38040
Type	other
File Information	18(1)_29-130.pdf



Hokkaido University Collection of Scholarly and Academic Papers : HUSCAP

International Seminar on Dynamic Behavior of Clays, Sands and Gravels.
Kitakyushu Japan, 24-25, November 1989

Effects of Test Procedures on the Test Results of Cyclic Undrained Triaxial Test

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To clarify the effects of test procedures on the test results of cyclic triaxial test, achievements of recent research activities in these respects were investigated and reviewed.

Detailed examinations on the cooperative test program, in which 48 research organizations were joined, and allot test results, conducted by the research committee on the test method of cyclic undrained triaxial test on saturated sand, in respect to such a point as the variations in sample density, method of consolidation, method of cyclic load application, membrane compliance and so forth were carried out.

It was concluded that if the test were performed under a rationally specified test proceduers, scattering of test results would reduced and reliabillity would increase conspicuously, even in the delicate test such as cyclic undraind triaxial test.

Technical Papers presented at the ASHRAE Winter Meeting, February 11, 1990 in Atlanta, Georgia, U. S. A.
Room Air Diffusion—Mathematical and Physical Modeling—Part II AT-90-5-4 (3370)

On the Multiple Tracer Gas Techniques for Measuring Interzonal Airflows in Buildings

M. ENAI C. Y. SHAW J. T. REARDON

Abstract

The multiple tracer gas method is often used to predict interzonal airflows in buildings. In this study, this method was applied to an isolated space consisting of two interconnected rooms

where the airflows through the common wall were controlled and measured. The results indicated that the calculated airflows based on different sets of simultaneously measured tracer gas concentrations (obtained at different sampling times during a test)were not always the same. To improve the accuracy of calculated results, a method was developed to facilitate the selection of appropriate sets of tracer gas concentrations (from the measurements) for use with the multiple tracer gas method. The proposed method was tested in the laboratory. The results are discussed.

Technical Papers presented at the ASHRAE Winter Meeting, February 11, 1990 in Atlanta, Georgia, U. S. A. Room Air Diffusion—Mathematical and Physical Modeling—Part II AT-90-5-2 (3369)

Multiple Tracer Gas Techniques for Measuring Interzosal Airflows for Three Interconnected Spaces

M. ENAI C. Y. SHAW J. T. REARDON R. J. MAGEE

Abstract

The multiple tracer gas method is often used to predict interzonal airflows in buildings. In a previous study, this method was applied to a space consisting of two interconnected rooms where the airflows through the common wall were controlled and measured. The results indicated that the predicted airflows based on different sets simultaneously measured tracer gas concentrations (obtained at different sampling times during a test) were not always the same. Guidelines are, therefore, needed to faciliate the selection of the appropriate set of tracer gas concentrations (from the measurements) for use with the multiple tracer gas method.

In this study, the test rooms were expanded to three interconnected rooms. A method was developed to determine the appropriate set of concentrations for interzonal airflow calculations. The proposed method was tested in the laboratory and the results are discussed.

Proceedings of Inter-Noise 89 1989 international conference on noise control engineering Newport Beach, California, U. S. A. 1989 December 4-6

Study on Active Noise Control in Three-Dimensional Space Using Digital Signal Processor

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Recently, active noise control is frequently used in solving a noise problem of air-conditioning duct (one dimensional sound wave propagation). On the other hand, researchers have been investigating applications to three dimensional noise problems encouraged by the development of microprocessors and digital signal processing techniques.

In the present work, the potential utility of active noise control of broadband noise in three -dimensional space has been investigated experimentally. Through the experiments, it was attempted to gain fundamental understandings and experiences about active control of broadband noise. The experiments reported herein were performed with noise generated by a first sound source, which is considered to be a point source, in an anechoic room. A second sound source located 1.4m from the first sound source served as the cancellation source, and the extent to which this source could reduce the sound-pressure level was studied in detail. In all cases, the cancellation source was driven by the output of a digital adaptive filter that continuously sampled the output of a microphone located near the first sound source.

Proceedings of Inter-Noise 89 1989 international conference on noise control engieering Newport Beach, California, U. S. A. 1989 December 4-6

Propagation of Trafflic Noise From Trunk Roads in Urban Area

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In order to protect residents in their urban dwellings, land use planning should be combined with a traffic noise estimation method which includes the effect of trunk roads to be constructed in the urban area and the effect of the access road network. In this study, we propose a method of estimation based on the theory for an ideal homogeneous city. Our estimates were compared with data from Sapporo city and good agreement was obtained.

Shaw et al. established the theory of steady-state urban noise for an ideal homogeneous city. They treated the city as a plane surface with many identical sound sources randomly distributed over its area. For a real city, however, there are prominent traffic streams making up a trunk road network in the city. In this study, we propose a quantitative urban noise evaluation method. In our method, we consider a traffic noise of trunk roads as line sources of traffic noise and of access roads as homogeneously distributed noise sources.

INTROC 90
International tire/road noise conference 8-10 August 1990
Gothenburg, Sweden

Method to Reduce Trafflic Noise by Making Use of a Snow Surface

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In this paper, the effects of the acoustic properties of the surfaces along the roads and depressed road structure to the road traffic noise propagation is discussed. We have clarified the characteristics of sound propagation along the snow surface and over the depressed road. Using the characteristics of sound propagation, especially using the acoustic properties of the snow surface, we propose a new fundamental idea to control the traffic noise. the structure of depressed road with snow surface is the best road structure to reduce the traffic noise.

23rd International Conference of Safety in Mines Research Institutes September 11-15, 1989
Washington D. C., U. S. A.

Measurements and Simulations on the Relation Between Methane Flow Rate into Headings and Surrounding Geologicas Conditions

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Abstract

In Japanese coal mines, drivage works of in-seam gate road headings are mainly carried out by blasting methods.

A large number of change of methane concentration in headings after blastings have been recorded by centralizing monitoring systems. From the results of analyses of the collected data, the changes of methane concentration with time could be divided into the five different patterns. It is conceivable that the appearance of the each pattern depends upon the geological conditions surrounding the headings. For the discussion, simulative numerical calculations were peformed by the mathematical models including geological conditions like faults, gas pressure and gas content in coal seams, gas permeability of coal seams and so on.

From the results of calculations it is confirmed that the methane flow rates into headings after blastings can be strongly affected by surrounding geological conditions.

The Fourth Asian Congress
of Fluid Mechanics August
21-25, 1989 Hong Kong

Unsteady Forces Acting on a Flat Plate in Non Periodic Pitching Motion

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Sapporo 060, Japan

Abstract

This paper presents unsteady forces acting on a flat plate performing a non-periodic pitching motion about its mid-chord position in a uniform main flow. The angle of attack of the plate was increased from zero to an angle α_T and then immediately decreased from α_T to zero at a constant angular velocity. Measurements were performed by a novel balance which could simultaneously detect all of the lift, drag and moment as functions of time during the pitching motions. A maximum of the lift and drag appeared at a particular phase of the pitching motion, being much larger than the drag and lift experienced by the same plate of the attack angle α_T being at rest in the main flow.

The Fourth Asian Congress
of Fluid Mechanics August
21-25, 1989 Hong Kong

Turbulence Structure in the Leading-Edge Separation Zone of a Blunt Circular Cylinder

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Abstract

Described in this paper is the structure of large-scale vortices and flow unsteadiness in the separation zone formed at the leading edge of a long blunt circular cylinder whose axis is parallel to the main flow. Experiments were performed in a wind tunnel with Reynolds numbers in a range 130000-240000. Results revealed the nature of growth of the large-scale vortices, the shedding of the vortices from the reattachment region, the low-frequency flapping motion of the shear layer near the separation edge, etc. The flow in the reattachment region has a cellular structure with nine cells in the circumferential direction.

Tenth Australasian Fluid Mechanics Conference-University of Melbourne 11-15 December 1989

Reduction of Sound Generated by a Pane Jet Impinging on a Circular Cylinder

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Abstract

Sound generated by a plane jet impinging on a circular cylinder was found to be significantly reduced by making a groove in the cylinder, which was filled with a low acoustic admittance material. This groove was located at a position where vortices in the jet impinge on the cylinder. In order to have high reduction the depth of the groove should be equal to a quarter of the wave length of the pressure fluctuation induced by the vortices of the impinging jet. Acoustic intensity vector field around the cylinder showed that the pressure fluctuation due to the impinging vortices does not produce pressure wave propagating upstream to maintain the feedback mechanism of self-sustained oscillating flows. The propagating pressure was suggested to be associated with vortices shed from the cylinder.

The 3rd Japan-China Joint Conference on Fluid Machinery
Osaka
April 23-25,1990

Unsteady Forces Acting on an Airfoil in Non-Periodic Pitching Motion

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Hokkaido University

Summary

This paper presents time-dependent flow fields and time histories of lift and drag acting on an airfoil (NACA 0012) in an unsteady pitching motion around the one-quarter chord position. The angle of attack of the airfoil was increased from 0 to 60 degrees and then decreased from 60 to 0 degrees at a constant reduced angular velocity in a range 0.05-0.4. The flow fields visualized by hydrogen bubbles generated from the whole surface of the airfoil were found to be dominated by vortices separated from the leading edge of the airfoil. The time histories of the lift and drag were discussed in the light of the flow fields.

The Sixth International Conference on Numerical Methods in Engineering, Swansea, U. K., July 3-7, 1989

Numerical Analysis on Transmittance of Radiative Energy Through Three-Dimensional Packed Spheres

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The transmittance of radiative energy through a volume of randomly packed spheres is determined by means of a Monte Carlo method. A computer program is developed for the arrangement of equal-diameter spheres in a packed bed with arbitrary packing density. It is disclosed from the results of thermal analysis of radiative transmittance through a parallelepiped bed that: (i) The low packing density layer adjacent to the side walls causes a decrease in the reduction rate of radiative transmittance within the bed beginning at a location one- to two-diameter depth from the surface of the radiation entrance. (ii) The layer contributes to an increase in the radiative transmittance by an order of magnitude for a bed with a 10×10-diameter cross-sectional area perpendicular to the direction of radiative transmittance. The enhancement effect diminishes with an increase in the cross-sectional area.

The Sixth International Conference on Numerical Methods in Engineering, Swansea, U. K., July 3-7, 1989

Numerical Simulation of Radiative Heat Transfer to High Pressure Turbine Nozzle Vases of Aero-Engines

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Combined radiative and convective heat transfer is analyzed numerically in the combustion chamber of aero-engines by using the Monte Carlo method to obtain the heat-flux profiles onto the surfaces of high-pressure turbine nozzle vanes and rotor blades. The combustion chamber and the nozzle-vane cascade are supposed to be two- or three-dimensional. The following results are obtained from the analyses: (1) radiative heat flux to the nozzle vanes is around 10% of the convective flux, (2) when the emissivity of the nozzle vane is increased, the radiative heat flux to the pressure side of the nozzle vane is increased, (3) the increase in the flame absorption coefficient has great effect on the increase in the radiative heat fluxes to the nozzle vane and the rotor blade, (4) three-dimensional analyses are necessary to obtain the above-mentioned quantitative results.

The Sixth International Conference on Numerical Methods in Engineering, Swansea, U. K., July 3-7, 1989

Radiative Heat Transfer Analysis of Indoor Thermal Environment

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This paper describes the numerical method of radiant environment analysis in a complicated enclosure containing human bodies and furniture. An arbitrary configuration expressed in the three-dimensional coordinate system can be treated by this method. A unique space index and another surface index are proposed to specify the geometry of solid body and surface in the enclosure. The Monte Carlo method is used to determine direct interchange areas, which are then transformed into total exchange areas using the zone method. Energy balance

equations accounting for thermal radiation, convection, wall conduction and air ventilation are then formulated for each solid surface segment in the enclosure. A human body model with skin temperatures and clothing is also proposed to simulate its heat release and to predict local thermal sensation around the body. As a practical application, this method is applied to the analysis of the radiant environment in a floor-heated meeting room with eight persons seated around a table.

CIMAC-International Symposium on Small Diesel Engines, Warsow, 21-22 May, 1990

Efficient and Low-Emissions Combustion of Heavy Fuels in DI and IDI Small Diesel Engines

Noboru MIYAMOTO, Hideyuki OGAWA, and Mitsutaka YAMAYA

The use of low-grade fuels, such as B-heavy fuel, is requested in high-speed diesel engines for their enhenced economy, although being not new in low-speed large diesel engines.

In this paper, the effect of compression ratios, swirl ratios, and fuel temperatures on the combustion and emissions of B-heavy fuel were investigated in DI and IDI high-speed small diesel engines.

In the experiments, usual diesel fuel was used as a reference. The compression ratios were adjusted by changes in the depth of piston cavity at constant cavity diametr in a DI engine, and by changes in combustion chamber volume at constant ratio of divided chamber volumes in a IDI engine.

The results indicated that, in the range of the compression ratios tested, IDI engine showed small favorable differences in combustion and emissions with B-heavy fuel and usual diesel fuel, while the DI engine showed comparatively large differences. The differences in the performance of B-heavy fuel included a decrease in NOx, aggravation of soot, CO, and thermal efficiency at higher loads and compression ratios. The aggravation of soot and thermal efficiency resulted mainly from a decrease in combustion efficiency and the degree of constant volume combustion, owing to poor mixing.

This paper also indicated that thermal efficiency and soot in heavy fuels were improved by adopting slightly lower compression ratios, higher swirl ratios, and properly high fuel temperatures, which all promote air-fuel mixing and combustion.

SAE International Congress and Exposition, Detroit 26 February-2 March, 1990

Analysis of Diesel Soot Formation under Varied Ignition Lag with a Laser Light Extinction Method

Noboru MIYAMOTO, Hideyuki OGAWA
Nobumasa GOTO, and Hiromi SASAKI

Soot emission from diesel engines generally increases with shorter ignition lags. However, the detailed process and mechanism of this phenomenon have not been well understood.

This investigation attempts to observe and analyze the in-chamber soot formation processes at varied ignition lags by high-speed photography of the direct flame images and laser shadowgraphs as well as the laser light extinction.

In the experiment, the separation of soot concentration from the soot-fuel mixture concentration was established by subtracting the laser light extinction intensity through a non-firing chamber from that through a firing chamber. It was found that the soot concentration in the swirl chamber reached a maximum value immediately after the start of combustion, and then decreased rapidly. With short ignition lags, the maximum and final soot concentrations in the chamber increased, while the maximum velocity of soot formation decreased. Photographic analysis showed that shorter ignition lags formed higher soot concentrations in flames, into which more fuel was directly injected.

International Off-Highway & Powerplant Congress and Exposition, Milwaukee, Wisconsin, September 11-14, 1989

Influence of Emulsified Fuel Properties on the Reduction of BSFC in a Diesel Engine

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Tadashi MURAYAMA
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Abstract

Micro-explosions and vaporizing behaviors of droplets of various emulsified fuels were investigated to determine the influence of emulsified fuel properties such as water content, water particle size, and viscosity of base fuel on combustion in a diesel engine. The investigation used gas oil, A heavy oil, and B heavy oil mixed with water and evaporated on a hot

surface under atmospheric pressure. The influence on the engine performance was also investigated.

It was confirmed that the viscosity of the base fuel, the water content, and the water particle size influenced the droplet evaporation on the hot surface and the occurrence and intensity of micro-explosions. There were remarkable differences in the BSFC for emulsified fuels in or outside the range where micro-explosions occurred on the hot surface.

International Off-Highway & Powerplant Congress and Exposition, Milwaukee, Wisconsin, September 11-14, 1989

The Effect of Fuel Properties on Particulate Formation (The Effect of Molecular Structure and Carbon Number)

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Abstract

Exhaust particulate in diesel engines is affected by fuel properties, but the reason for this is not clear. Interest in using low-grade fuels in diesel engines has made it necessary to understand the particulate formation mechanism and factors to decrease it.

Particulate formation has been reported to start with thermal cracking of the fuel to lower boiling point hydrocarbons followed by condensation polymerization and production of benzene ring compounds; the formation of particulate takes place via polycyclic aromatic hydrocarbons.

This report investigates the amount and configuration of particulate with a fluid reaction tube and in a nitrogen atmosphere, and analyzes polycyclic aromatic hydrocarbons (PAH) of fuels with different molecular structure and carbon number.

The results were: (1) Starting formation temperature of particulate depends on fuel properties. (2) The amount of particulate increases with the C/H ratio. (3) The soot precursor PAH has at most three, four, or five rings.

ASME 1989 Pressure Vessels and Piping Conference, Honolulu, Hawaii, U. S. A., July 23-27, 1989

Free Vibration of a Spinning Polar Orthotropic Shallow Spherical Shell

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An analysis is presented of the free vibration of a spinning polar orthotropic shallow spherical shell. For this purpose, the governing equations and the boundary conditions of the shell are derived by applying Hamilton's principle to the strain and kinetic energies of the shell. The variables in the equations can be written as a summation of the quasi-static components which are independent of time and of the dynamic components. The linear equations on the vibration about the deformed state are solved by using the transfer matrix method. The method is applied to a spinning clamped-free shallow spherical shell. The eigenvalues of vibration are calculated numerically, and the effects of the spinning velocity and the orthotropy of the shell on the free vibration are studied.

PLASTICITY'89, the Second International Symposium on Plasticity and its Current Applications Tsu, Japan, July 31-Aug. 4, 1989

Numerical Simulation of Nonproportional Cyclic Plasticity

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The study of the constitutive model for cyclic plasticity aims at the adequate description of additional hardening due to nonproportional cyclic plasticity, especially, circular loading and mechanical ratchetting. There is no constitutive equation which can describe additional hardening of nonproportional cyclic loading, accurately. The authors have previously proposed the constitutive model for nonproportional cyclic loading, which should be called the hybrid constitutive model because the yield surfaces determined from experiments are used always for the construction of the model. In this paper, to evaluate this constitutive model, the experimental results of SUS304 stainless steel under out-of-phase loading at room temperature are discussed on the basis of corresponding numerical simulation. Using the constitutive model proposed by authors, ratchetting and sinusoidal out-of-phase loading could be simulated well.

PLASTICITY'89, the Second International Symposium on Plasticity and its Current Applications Tsu, Japan, July 31-Aug. 4, 1989

Subsequent Loading of SUS304 After Cyclic Preloading

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To formulate the constitutive equation for nonproportional cyclic loading, the influence of preloading on subsequent loading should be investigated experimentally. In this paper, both the stress-strain relation and the equi-plastic strain surface of subsequent loading after cyclic preloading have been examined carefully from combined tension-compression and torsion test with SUS304 stainless steel. The equi-plastic strain surface could be represented by the quadratic form of stress when it was proved from the current center of the yield surface after cyclic preloading. Then, all the stress-strain curves of subsequent radia loading from the center were confirmed to be represented by the modified Bamberg-Osgood law. As a result, the modified Ramberg-Osgood law obtained shows availability to derive the constitutive equations of cyclic plasticity.

110th ASME(The American Society of Mechanical Engineers) Winter Annual Meeting, 1989 San Francisco, U. S. A, Dec. 10-15, 1989

A Finite Element Model on Whole Lumbar Spine in Flexion

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The lumbar spine is an important region on the spine, often involved in trauma, degeneration and disease. A clarification of the mechanical causes of low-back pain requires a knowledge of the states of stress and strain throughout the lumbo-sacral spine. Since a purely experimental approach cannot provide this information, the analytical model studies to supplement measurements are necessary. In this study, computational simulations of whole human

lumbar spine including the sacrum under flexion were carried out using the finite element method. The finite element models proposed are based on in-plane stress analysis considering the thickness effect of different material layers in an element. As a result, in flexion at constant moment, the stress distributions of five intervertebral discs in the lumbar spine are almost the same. On the other hand, at shear force, the stresses of discs in the lower region are higher.

Annual Meeting of International Society for Study of Lumbar Spine (ISSLS' 1989) Boston, U. S. A, June. 11-15, 1989

Stress Analysis in the Intervertebral Discs of the Whole Lumbar Spine by Quasi Three-Dimensional Finite Element Method

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A clarification of the mechanical causes of low-back pain requires a knowledge of the states of stress and strain throughout a lumbo-sacral spine. Since a purely experimental approach cannot provide this information, the analytical model studies to supplement measurements are necessary. The purpose of this study is to analyze the stress state in the intervertebral discs of the whole lumbar spine by using quasi three dimensional finite element method. In this method, the stiffness matrix of an element was determined by the equivalent values considering the thickness effect of different material layers. The model geometry was modified to be fitted with the average rotation angle of each intervertebral disc obtained by the experiments using ten fresh cadaveric whole lumbar spines under pure moment. The proposed model has the same saggital geometry of the whole lumbar cadaveric spinens. The distributions and directions of the stresses in discs of a lumbar spine were obtained from the analysis by this method.

Annual Meeting of International Society for Study of Lumbar Spine (ISSLS' 1989)
Boston, U. S. A, June. 11-15, 1989

Mechanism of Thoracolumbar Burst Fracture : A Biomechanical Study With Finite Element Model and Cadaveric Spines

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The goal of this study was to clarify the pathomechanism of the thoracolumbar burst fractures using finite element method and cadaveric spines. The FEM model of a lumbar motion-segment was developed to analyse the stress distribution under vertical compression, which was regarded to produce the burst fracture. In order to evaluate the influence of the disc degeneration on stress distribution, the magnitude of the internal pressure of nucleus was determined as five different stages of degeneration. Eleven motion-segments of thoracolumbar spines from human cadavers were compressed vertically until fracture in order to verify FEM model. As a result, axial cpmpressive load induced typical burst fracures in the thoracolumbar spine. Displaced materials of disc and fracture line from the end-plate to posterior wall cortex contributed to the mechanism of the fracture. Few burst fractures occurred in the subjects with severely degenerated disc and osteoporosis.

The 98th American Foundrymen's Society Casting Congress; April 20-24, 1990, Detroit, U. S. A.

Low Thermal Expansion Cast Irons With Various Graphite Shape and the Thermal Deformation Characteristics

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and Haruhiko NAYUKI***

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Abstract

High nickel, low thermal expansion cast irons with flake, spheroidal and compacted vermicular(CV) graphite were produced, and their mechanical, physical, and thermal properties were measured. With these values, computer simulation was performed to compare the thermal deformation characteristics of the irons.

Up to 130℃, the thermal expansion coefficient was $3.6\text{-}5.8\times10^{-6}$/℃ with Ni content of 31-36%, increased to 1.3-2.0 times at 200℃, but had no systematic variation with the graphite shape. The elastic modulus, tensile strength, and Brinell hardness were 80-140 GPa, 160-480 MPa, and 90-150 HB, high in spheroidal, low in flake, and intermediate in CV graphite irons. Thermal conductivity at room temperature was 11-39 W/mK, high in flake, low in spheroidal, and intermediate in CV graphite, decreased down to about 90% of the value at 200℃. Computer simulation showed that the low conductivity helps to decrease the thermal deformation in constant end temperature conditions and the transient response to the temperature change.

INTERTECHNO '90 Conference, Budapest 1990

Parametric Design Methods Using Petri Net for Controlling Design Process

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The design process is highly sophisticated because the design mechanism is still unclear. This paper represents on a design model and a design process control method to establish the

parametric design system. A boundary factor model proposed by Prof. N. Okino is adopted as the design model. Boundary factors become parameters for the design information units. To put the design process forward, it is necessary to control a flow of the boundary factors among the design information units. The Petri Net is used for making a role of controlling the designing process after a structure of the design model is mapped to the Petri Net. The design information is given shape to the Object and Operation (O/O) representation likely to the object oriented one.

INTERTECHNO '90 Conference, Budapest 1990

3-D Solid Modeling for Swept Volume of NC Tool Movement

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This paper presents a method for generation of the swept volume formed by the movement of the NC cutter. A generalized sweeping method is proposed and applied to generate the swept volume. The idea is as follows. An imaginary plane crosssection is set in the middle of the tool path. Then the NC cutter leaves its trace on the plane when the cutter goes through it. Since the trace, called the enveloped pattern, turns out to be a closed curve with maximum profile, it can be used reversely for generation of an entire swept volume. Namely, the enveloped pattern is swept along the tool path to generate an entire swept volume. As a result, the entire swept volume is generated as a set of space points which belong to the inside of the enveloped pattern form the start to the end of the cutter motion. The algorithm of this work has been developed and performed with the CSG-based CAD/CAM system TIPS-1.

INTERTECHNO '90 Conference, Budapest 1990

Local Modification of a Free-Formed Surface Preserving Shape Data

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This paper represents a local modification technique to model a free-formed surface. Our approach to the local modification to the free-formed surface uses the control parameter technique. Two kinds of parameters control the lst order derivatives which guarantee the lst order derivative (C^1) continuity and make connection between two patches in the free-formed surface. These parameters are called " Tension and Bias " Parameters. Two other kinds of parameters control the lst order derivatives which make C^1 discontinuity and generates nonsmooth connection such as a sharp edge. These parameters are called " Tension-continuity and Bias-continuity " parameters. Furthermore, the same techniques are expanded by dealing with the lst order derivatives approximated by 2nd order derivatives to make the local modification of the free-formed surface. It makes possible to interpolates arcs and give the surface boundary rapid rising. The uses of these parameters enables us to reconstruct the real form of the object preserving the shape data as the computer model.

INTERTECHNO '90 Conference, Budapest 1990

A Theoretical Approach to the Design of CSG Engine

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Real time methodologies have been required for applications of solid model based CAD/CAM/CAE systems to support the increasing demands for carrying out such as design and manufacturing processes in real time. In this paper, a framework for specialized computer system architecture, named *CSG Engine*, has been proposed which performs applications for CSG represented solid models. CSG Engine is organized as reconfigurable parallel connections of multiple pipeline processors. An application is performed by an appropriate configuration of CSG Engine. To this end, a methodology have been proposed for designing CSG Engine to be appropriate to a required application which is based on an axiomatic formalization of the specification of a program. The method is summarized as follows: Firstly, a syntactic representation is introduced which describes possible configurations of CSG Engine along with its

semantics described by a specific language. Secondly, a specification of an application is expressed by the language. Finally, the expected configuration is determined so that its syntactic representation corresponds to the same semantics as the application's Examples of the execution of the method are demonstrated which are applied for shaded picture generation problems.

CAPE '89 Third International IFIP Conference on Computer Applications in Production and Engineering, Tokyo 1989

A Theoretical Approach to CSG Graphics Engine

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A method has been developed for designing a spacialized processor for making a shaded picture of a CSG model: *CSG ENGINE*; The processor organization using the specialized processor is derived from formulas in terms of sets and mappings; And the specialized processor architecture for the set theoretical operations is described in its theoretical aspects.

First International Conference on New Manufacturing Technology, Tokyo 1990

A Hardware Engine for NC Tool Paths Generation/Simulation — a CSG oriented approach —

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Specialized hardware has been required for real-time processing of applications of CAD/CAM system which utilizes CSG representations. In this paper, the architectures of two specialized hardware processors have been proposed which are connected to the host computer to support the specific applications: an NC tool paths generation engine and a NC tool paths simulation engine. The former automatically generates 3 axis NC tool paths for machining a solid object, and a latter generates after milling shape of the specified too paths along with detecting the volume of over cuts and under cuts, both of which accepts a tool of an arbitrary shape, and all the solids are defined by CSG descriptions. The architectures performs the acceleration of processing time by pipiline processing of the following 3 composents: a CSG ray-casting machine, 2-D local memories, and a parallel comparator. A software simulation of the engines has been constructed, by which the possibility of practical hardware implementation has been assured.

ISIR 20th International Symposium on Industrial Robots, Tokyo 1989

Direct Derivation Problem of Analytic Solution to the Kinematic Equation of a Manipulator

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The analytic joint solution to the inverse kinematic equation of a manipulator is required to move the end effector to a given position and orientation. This problem is formulated as simultaneous nonlinear algebraic equations by equating the 4×4 transformation matirices, each of which has 12 nontrivial equations. Besides the rules proposed by R. P. Paul., two other rules were found to derive the analytic solution to the equations. The first rule solves the latter of two consecutive joint coordinates prior to the former by using trigonometric terms of the coor-

dinates. The second rule solves the sum of two or three consecutive joint coordinates prior to each one by using trigonometric terms of the sum. A symbolic proecssing system was implemented to derive the solution automatically using the five rules mentioned above.

INTERTECHNO'90
Budapest 1990

An Approach to Automatic Dimensioning Problem on Modeled CSG

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This paper describes an approach to the automatic dimensioning problem. Given a geometry data of CSG representation, dimensions are extracted depending on the types of Primitives. The extracted dimensions are arranged under the constraint that related dimensions such as size of Primitives must not be missed. These arranged dimensions are drawn automatically so as to avoid intersections and overlaps between lines and symbols. Experiments are conducted by using TIPI-1 Solid Modeler and practical mechanical parts are automatically dimensioned.

First International Conference on New Manufacturing Technology Chiba 1990

Development of 3D Packing Simulator Using Heuristics

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This paper describes an approach to build a simulator of 3D (three dimensional) packing. Given different sizes, weights and other special attributes of boxes to be packed, the simulator automatically allocates spaces of containers to each box so that the least amount of empty space is left. The realize the allocation, a combinatorial problem in 3D geometry space is solved by making a heuristic approach. Obtained calculation results of the allocation are shown as graphic outputs. The calculation results are proved to be practically useful.

Fourth International Conference on Fusion Reactor Materials December 1989 (Kyoto, Japan)

The Micro-bulge Test on Neutron-Irradiated Materials

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By utilizing a disk of 3mm diameter with thickness usually around 0.1mm for the transmission electron microscopy, the micro-bulge test have been developed for the research of the reactor materials. However, few bulge test data are available for materials irradiated to higher dose, i. e., much more than 10 dpa, and for disks with larger thickness. In the present work, the test was conducted on several kinds of Fe-Ni-Cr alloys with various Ni and Cr levels irradiated to 10 dpa at 603 and 773K in the Oak Ridge Research Reactor. The thickness of the disk is 0.3mm and the dimension of the tensile specimen used for the reference to the bulge test is 0.25mm thick with a gauge length and width of 12.7mm and 1.0mm, respectively. Several parameters were defined for the bulge test curve for the evaluation of the irradiation hardening and degradation of ductility. The validity of the testing results is discussed in terms of correlation with tensile data on identical material.

Good correlation between tensile yield strength and the bulge yield load (load at the shoulder of bulge curve) was observed in unirradiated material. In irradiated materials, the bulge yield load tended to saturate, though a larger increase in the tensile yield strength is still observed. Good correlation was also observed between the tensile ultimate strength and the maximum bulge load. Irradiation caused only a small decrease compared to those obtained from thinner disks (0.1mm thickness) in the deflection corresponding to the maximum bulge load. While irradiation promoted a significant reduction in total elongation in tensile test, it produced only a small decrease in the maximum bulge depth in the thicker disks. The irradiation-induced decrease in maximum bulge depth in thicker specimens was small, relative to the decrease typically observed in the thinner bulge specimens. The results of the previous experiment on thinner specimens and those of the present experiment suggest that the thinner specimen is more favorable for the evaluation of ductility. The area bounded by load-deflection curves shows systematic variation with alloy composition and irradiation condition which is not observed in the tensile data. It is anticipated that this parameter may prove useful in the evaluation of the materials' toughness.

Fourth International Conference on Fusion Reactor Materials December 1989 (Kyoto, Japan)

Tensile Behavior and Swelling of Ternary Austenitic Alloys Irradiated in Different Neutron Spectra

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The development of fission-fusion correlations for a given neutron-induced property change requires knowledge of the response of microstructural evolution to differences between the two environments in neutron spectra, displacement rate, temperature and other important variables. While most studies focus on the differences in helium/dpa ratio, one cannot overlook differences in recolil effectiveness, displacement rate or solid transmutants. In order to develop an understanding of the many factors which impact the development of fission-fusion correlations, a series of fundamentally oriented experiments are in progress to study the microstructural origins of neutron-induced changes in mechanical properties, concentrating not only on the influence of environmental variables but also on the effect of composition and thermomechanical variations.

The swelling and tensile behavior of ternary alloys in two similar experiments are compared in this report at comparable displacement levels, 10 to 13 dpa. While each study addressed the influence of nickel and chromium level in annealed Fe-Cr-Ni austenitic alloys, one was conducted in a spectrally tailored experiment in the Oak Ridge Resecrch Reactor (ORR) and the other was conducted in the Experimental Breeder Reactor-II (EBR-II). Whereas at first glance it appears that the primary variation is only in helium/dpa ratio, the EBR-II test was conducted at a displacement rate an order of magnitude higher than in ORR. In the ORR experiment the influence of cold work on swelling was also studied at several nickel levels.

At both high and low displacement rates the density changes at a given temperature exhibited the behavior typically observed in irradiation of Fe-Cr-Ni austenitic alloys, decreasing with nickel content in the 20-45% range and increasing with chromium level in the 7.5-22% range. Large differences in helium level therefore do not appear to overwhelm the influence of composition on swelling. Cold work generally suppressed swelling, as expected.

Tensile properties were observed to be moderately sensitive to nickel and chromium content and strongly dependent on irradiation temperature. There were, however, significant differences between the two experiments. The change in yield strength for a given irradiation temperature and alloy composition was usually significantly higher in the ORR experiment. The possible reasons for this and other tensile results are discussed in terms of differences in displacement rate, helium/dpa ratio and recoil effectiveness. The influence of thermal neutrons on damage production may be more significant than previously envisioned.

Fourth International Conference on Fusion Reactor Materials December 1989 (Kyoto, Japan)

The Mechanical Property Change and the Microstructures in Iron Irradiated with Fission and Fusion Neutrons

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For the acquisition of better understandings for the fission-fusion correlation in the mechanical property change, the microstructure observations were conducted on neutron irradiated pure iron before and after the tensile test. Irradiations were performed to several fluence levels at various temperatures with fission neutrons in JOYO and JMTR, and fusion neutrons in RTNS-II (JOYO and JMTR are fission reactors in Japan and RSNS-II is a rotating target neutron source at LLNL).

The interstitial dislocation loops with Burgers vector [100] and voids were observed in the specimen irradiated with all the neutron sources at temperatures higher than 563 K. The size of loops and voids were ranging from 90 to 300nm, and 5 to 200nm, respectively. The amounts of the increase of the yield strength could be predicted well by the calculation from the size and number density of these defect clusters for the specimens irradiated at temperatures higher than 700K, in RTNS-II, JMTR and JOYO. However, for the irradiations below this temperature, the calculated yield strength became smaller than the measured values with decreasing irradiation temperature. From the differences between the measured and calculated yield strenght, the contribution of the invisible defect clusters to irraidation hardening can be estimated by assuming their type, and their size and number density. The yield strength data plotted against 1/4 power of fluence showed that the equivalent amount of the irradiation hardening by fusion neutrons from RTNS-II at 563K was brought about by fission neutron irradiations at 573K of fluence about two orders higher than that of the fusion neutrons.

The similarity of the stress-strain curves does not always mean the same defect structure and deformation structure development. The specimens irradiated to 10^{24} and 10^{26}n/m^2 at 673K in JOYO showed almost the same stress-strain curves in spite of the quite different defect structures, viz., the dominant defect clusters were interstitial loops in the former and voids in the latter. The same thing can be said for the deformation dislocation structure development. In the specimens irradiated to 10^{25}n/m^2 at 673K in JOYO and those irradiated to 10^{23}n/m^2 at 473K in JMTR showed nearly the same curves. In the former case, irradiation induced dislocation loops were observed to remain almost unchanged and no celll structure development was seen until the specimen broke, in contrast to the well developed dislocation cell structure in the latter.

Fourth International Conference on Fusion Reactor Materials December 1989 (Kyoto, Japan)

Fission Reactor Irradiation of Materials with Improved Control of Neutron Flux-Temperature History

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From a careful inspection of temperature-reactor power histories in reactor irradiation of materials, a deficiency in the conventional control has been pointed out (M. Kiritani, J. Nucl. Mater. 160 (1988) 135). The deficiency mainly comes from the heating by γ-rays, which can not be controlled independently of reactor power. Irradiation with improved control has been performed with Japan Materials Testing Reactor (JMTR). The design of the irradiation rig, the irradiation procedure, and the comparison of the irradiation induced microstructures with those in samples irradiated with conventional control, are reported.

A rig for in-core irradiation has been designed so as to maintain the sample temperature without any help of the heating with γ-rays. With this newly designed rig, the exposure of the samples to neutrons at lower and higher temperatures than that designed can be completely eliminated. So far, the irradiation of pure metals and variety of alloys has been performed up to 1×10^{24}n/m^2 at 200, 300, 350 and 400℃.

In samples irradiated with conventional control, defect microstructures which can be concluded to have been initiated from the defect reactions during the transient lower temperature exposure to neutrons at the start of irradiation have been observed. When the designed irradiation temperature is below the limit of interstitial cluster nucleation, bimodal size distribution of interstitial type dislocation loops are observed in conventional control (Example: Ni at 300℃, various Ni-alloys at 400℃). When the irradiation temperature is above the limit of interstitial cluster nucleation, the difference is drastic. In an improved control, almost no interstitial type defect structure, but, in a conventional control, dense and well developed interstitial type dislocation loops in thin foil and high density of tangled dislocation loops in bulk (Example: Ni at 400℃). Number density of voids is almost one order higher in the conventional control than in the improved control, and the increment of yield stress is more than two times in the former. Systematic data for wide variety of materials will be presented.

This paper is not only to attract attention to reconsider the conventional irradiation methods, but also to make further proposals how to conduct the irradiation with varied fluence in a consistent irraidation field and how to systematically detect the irradiation rate effects.

Fourth International Conference on Fusion Reactor Materials December 1989 (Kyoto, Japan)

PKA Energy Dependence of Cascade Damage Structure in Ion-Irradiated Copper

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Development of defect structures in solid materials by energetic particle irradiation starts from cascade collision which initiates from the primary knock-on atom (PKA) with a large energy transferred from the incident particle. Generally PKA energy is not unique and has wide spectrum and it is desired to understand the defect structure development as a function of PKA energy. In this paper, a simple method of analysis is introduced and applied to the low fluence ion irradiation of copper.

Thin foils of copper were ion-irradiated at room temperature with a Van de Graaff accelerator. The maximum PKA energy was systematically changed from 0.1MeV (0.5MeV $^{4}He^{+}$) to 1.4MeV (1.5MeV $^{40}Ar^{++}$) by the choice of ion species and accelerating voltage.

Vacancy clustered defects in the form of stacking fault tetrahedra (SFT) produced in the dense part of vacancies in cascades were observed with the transmission electron microscopy. Grouped SFT corresponding to subcascades were frequently observed with the increase of maximum PKA energy. The variation of the number density of SFT with irradiation dose and the variation of the population of the number of grouped SFT with PKA energy were measured.

All the conceivable factors were taken into consideration in the analysis, such as a) the attenuation of ion energy, b) the differential collision cross-section taking the screening effects of electrons into account, c) the percentage of damage energy in PKA energy, d) the dependence of SFT production on subcascade energy, e) the impact effect by the collisions on the SFT formation, and f) the distance between successive cascades along the ion path. Various aspects of the PKA energy dependence of cascade damage structure in ion irradiation were confirmed to be quite similar to those obtained by the analysis on defect clusters in thin foil copper irradiated by 14 MeV neutrons.

Fourth International Conference on Fusion Reactor Materials December 1989 (Kyoto, Japan)

Difference of Migration Efficiency between Vacancies and Interstitials Produced by Cascades

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The displacement cascades produced by high energy neutron irradiation contain exactly the same number of vacancies and interstitials, but their distribution is not exactly the same to each other. Highly concentrated vacancies are recognized to be surrounded by interstitial atoms. This difference of point defect distribution is expected to influence the defect structure development, not only in a localized volume of cascade zone but also in a larger volume through the reaction of freely migrating defects escaped from the cascade zone.

Present authors detected the existence of vacancy dominant atmosphere from the shrinkage of interstitial type defect clusters in 14 MeV neutron irradiated thin foil Al at 300K. Recently a more clear evidence for this vacancy predominance was found in fission neutron irradiated Ni. The defect structure evolution observed in thin foil of Ni at 673K showed that the major species which contributes to the growth and shrinkage of defect clusters changes from interstitials to vacancies and again to interstitials with the increase of specimen foil thickness. In order to understand these results, a special attention is required to be given to the initial distribution of point defects in cascades.

When the migration of point defects starts from a localized volume, their integrated migration efficiency is larger when the initial volume is smaller, i. e., more efficient for vacancies which start from smaller volume than interstitials. The integrated migration efficiency here is defined as time integral of the product of jump rate and concentration until the defects disappear to permanent sinks. Consequently the contribution of vacancies in modifying the microstructure is larger than that of interstitials. This difference is originated from the more number of jumps of vacancies before they disappear to sinks than those of interstitials, and is estimated as the number of jumps of vacancies to expand their distribution equivalent to the initial distribution of interstitial.

This effect strongly depends on sink geometry and cascade size. When the major sinks to point defects are very far from the cascade, the effect disappears. When the distance to sinks is larger but close to the size of cascade, the effect becomes remarkable. When the distance becomes comparable to cascade size, again the effect disappears because no difference in the number of jumps between two kinds of point defects is expected. For the same sink geometry, the vacancy predominant is more for larger cascades.

The vacancy predominant effect proposed in this paper is expected to play an important role depending on the sink geometry, and the evaluation of the effect is made for several repre-

sentative stages of microstructure evolution, including the void swelling with dislocation strucures.

Fourth International Conference on Fusion Reactor Materials December 1989 (Kyoto, Japan)

Positron Lifetime Measurement and Latent Vacancy Clusters in 14 MeV Neutron Irradiated Nickel

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In 14 MeV neutron irradiated pure metals such as Au, Cu and Ni, there have been strong indications of the existence of electron microscopically invisible uncollapsed small vacancy clusters (named here latent vacauncy clusters), such as (1) the appearance of vacancy clusters by postirradiation annealing at higher temperatures, (2) the existence of impact effect from other cascades to reveal microscopically observable vacancy clusters, and (3) the discrepancy between yield stress measurement and the number density of visible defect clusters.

In order to confirm the existenece of latent vacancy clusters and to clarify their characteristics, positron lifetime measurements were performed for Ni. The reason for the choice of Ni is in much less vacancies precipitated as visible vacancy clusters in this material than those in other fcc metals such as Ag, Au and Cu. Fully annealed samples of 99.997at% pure Ni were irradiated with 14 MeV D-T neutrons by the rotating target neutron source RTNS-II to a various dose up to 6×10^{22}n/m^2. The irradiation temperature was ranging from 300K to 623K. All the positron lifetime measurements were performed at room temperature.

In the specimen irradiated at 300K, a large component of long lifetime of about 350 psec was observed. The intensity of this component in specimens irradiated at above 363K was much smaller than that in specimens irradiated at lower temperatures. On the other hand, the defect structure in Ni observed by electron microscopy was composed of stacking fault tetrahedra and interstitial loops up to the irradiation temperature of 423K, and their number density did not change through this temperature range. Therefore, the long lifetime component can not be attributed to the microscopically visible defect clusters, and it is reasonable to assign it to the latent vacancy clusters.

The intensity of long lifetime component decreased at above 363K, and the decrease is attributed to the decomposition of latent vacancy clusters. This interpretation has a good agrement with the result of electron microscopy observation of the appearance of appreciable number of visible vacancy clusters at this temperature.

International Power Electronics Conference, IPEC-Tokyo, April 2-6, 1990

PWM Pulse Pattern Optimization for Sinusoidal Inverters

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This paper describes a pulse width modulated (PWM) pulse pattern optimization method using carrier frequency modulation (CFM). The new CFM technique is effective for improving the performance of sinusoidal inverters, especially voltage waveforms in a high output voltage range.

The PWM pulse patterns are basically controlled so that the voltage vectors in the space vector notation may draw a circilar locus. In addition to this, the carrier frequency, practically the sampling frequency, of PWM is also controlled so that a performance index, which represents the degrees of achieving objectives, may be minimized. In this paper a performance index for minimizing the distortion of output currents of driven motors are employed. Finally, the method is implemented using a single-chip microprocessor, and the experimental results demonstrate its validity. A reduction in magnetic acoustic noise is also observed with CFM.

International Power Electronics Conference, IPEC-Tokyo '90, April 2-6, 1990

Intelligent Motor-Control Method for Brushless Motor

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This paper describes the method of a motor driving to improve the performance of the permanent magnet pole brushless motor. The method is consisted of the vector control and the field strengthening and weakening. The developed optimal control law is employed for the control system designing, and a microprocessor-based controller is applied.

The usefulness of the proposed the PM motor control system designing method and the control method are confirmed by the simulation and the experiment.

IFIP World Computer Congress '89 San Francisco, U. S. A, Aug., 1989

Intelligent Pad: A Hypermedia System Allowing Functional Compositions of Active Media Objects Through Direct Manipulations

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Conventional data processing and information management programs specify how the data structures and the data manipulations are implemented inside a computer. Our concern, however, is not the internal implementation, but how we can define and manipulate numbers, documents, pictures, and images on a CRT display through interactive devices such as a mouse and a keyboard. There are increasing needs for direct definition and direct manipulation of data structures on the display screen. Intelligent Pad provides these functions in the processing and management of documents and tools. Intelligent Pad represents everything as a pad. It associates each pad with a function such as word processing, line drawing, tabulation, graph drawing etc. Different functions define different pads. Pasting of pads on another pad defines a new pad that with an arbitrary layout of fields and a new composed fuction.

The lst International Conference on Deductive and Object -Oriented Databases Kyoto, Japan, Dec. 4-6, 1989

A Tool Kit System for the Synthesis and the Management of Active Media Objects

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Information management deals with documents that are represented in various forms. We are concerned not only with their contents but also with the forms in which they are presented. Intelligent Pad is a tool kit for the storage and visual management of active media objects. It represents everything as a pad. It associates each pad with a function such as word processing, line drawing, tabulation, graph drawing etc. Pasting of pads on another pad defines a new pad that has both an arbitrary layout of fields and a new function composed of the constituent pads. Intelligent Pad provides four ways of managing a large amount of pads, i. e., visual catalogs of pads, hypermedia networks, form bases, and pad bases. A form base stores pads with the same format, while a pad base manages all types of pads in the system.

Second Japan-China Joint Symposium on Systems Control Theory and Its Applications, Osaka, May 15-19, 1990

Necessary and Sufficient Condition for Characteristic Transfer Function Matrices

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Let us consider a class of those systems described by the usual type of state equation shown in eq.(1).

$$\dot{x}=A\cdot x+B\cdot u$$
$$y=C\cdot x+D\cdot u \qquad \cdots\cdots(1)$$

For such systems, the transfer function matrix between u and y is given by the common polynomial det(IS-A) and the polynomial matrix [C·adj(IS-A)·B+D·det(IS-A)] as shown in eq.(2)

$$G(S)=[C\cdot adj(IS-A)\cdot B+D\cdot det(IS-A)]/det(IS-A) \qquad \cdots\cdots(2)$$

We call this type of G(S) the characteristic transfer function matrix of the system shown in eq.(1). In this paper, we will first give a necessary and sufficient condition for an arbitrary rational function matrix given in the form of a numerator polynomial matrix over a common denominator polynomial to be the characteristic transfer function matrix of a system that can be described by eq.(1). We will also give its proof in this paper.

Joint Scandinavian-Japanese Seminar on Information Modeling and Knowledge Bases. Tampere, Finland, June 5-8, 1990

Logic Programming with a Large Vocabulary

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We will show, in this paper, (1) the importance of introducing a vocabulary to knowledge-based systems, (2) how we can define basic nouns, adjectives, and verbs in a knowledge-based system, (3) how we can build our vocabulary using these basic words without referring to the underlying knowledge-based system, and (4) how we can describe rules and facts of the underlying knowledge-based system through the use of our vecabulary. A vocabulary defined in a way as described in this paper has compositional truth-theoretic seman-

tics. This enables us to build our vocabulary starting from a small set of basic words that are defined as primitive objects or constraints in the underlying knowledge base. Systems that share a vocabulary can communicate with each other using their vocabulary although they have different underlying conceptual models.

Joint Scandinavian-Japanese Seminar on Information Modeling and Knowledge Bases. Tampere, Finland, June 5-8, 1990

Generalization of Weakly Reducing EFS with Abstraction

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In this paper, we generalize the weakly reducing EFS, i. e. give more general conditions for EFS's, so that the depth-bounded resolution is applicable to them. To find EFS's satisfying the conditions, we use the abstractios. The abstraction is originally introduced to reduce the search space of theorem proving according to the resolution principle. Since the depth-bounded resolution avoids infinite derivations, our result is a new method of reducing search spaces of theorem proving through the use of this abstraction. Applying the abstractions to an EFS often clarifies that it is terminating. We show that it is a type of the well-founded ordering method. We also show that an EFS is hierarchieal if and only if it is proved to be terminating by using the propositional abstraction. At last we compare our result with the locally finite stratification.

Joint French-Japanese Seminar on Deductive Database and Artificial Intelligence
Antipolis, France, June 11-12

A Synthetic Dynamic-Media System

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Media have added various functionality to informations. Among them are visibility, recordability, stroradility, portability, and duplicatability. Media on computers were further given nonlinear organization, reactiveness, and their programmability. Our group is now interested in adding a new type of functionality to the above list. That is the *morphological and functional composability* for synthesizing new media objects from existing ones. Intelligent Pad is a toolkit system with the storage and visual management of dynamic media objects. It has adopted an object-oriented open architecture. Intelligent Pad provides fundamental and primitive facilities for a systematic approach to CSCW (Computer Supported Cooperative Work). Among them are shared pad copies, live pad copies, and the field pad.

Joint French-Japanese Seminar on Deductive Database and Artificial Intelligence
Antipolis, France, June 11-12

Procedural Semantics of Elementary Formal System and Closed World Assumption

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In this paper, we give a theoretical foundation of EFS (elementary formal system) as a logic programming language. We show that the set of all the unifiers of two atoms is finite and computable by restricting the form of axioms and goals without losing generality. The restriction makes the negation as failure rule complete. We give two conditions of EFS's such that the negation as failure rule is identical to the closed world assumption. We also give a subclass of EFS's where a procedure of CWA is given as bounding the length of derivations. We compare these classes with the Chomsly hierarchy.

4th IASTED International Conference on High Technology in the Power Industry, Valencia, Spain, July 4-7, 1989

Application of the Coordination Theory for Hierarchical Control to Power System State Estimation

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For implementation of hierarchical structures of power system control problems, we can utilize basic coordination principles in the hierarchical systems theory. Several studies have been presented, in which the model coordination method is used for power system state estimation. In this paper, the so-called overlapping decomposition model is introduced and discussions are given regarding application of the coordination theories. Especially, a basic structure based on the goal coordination is proposed.

2nd Symp. on Expert Systems Application to Power Systems, Seattle, Washington, U. S. A, July 17-20, 1989

Expert System Assisting Power System Operators to Decide Deicing Countermeasures for Snow Accretion of Transmission Lines

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In order to assist power system operators to prevent occurrence of severe accidents caused by snow accretion, a prototype expert system is developed. This prototype system may indicate many appropriate and useful informations to operators; i. e., (1) a necessity and urgent index of deicing countermeasures for every transmission lines to which the snow has adhered already and/or the snow accretion will be growing up, and (2) a list of all feasible and effective deicing countermeasures against such a transmission line. Simulation results show that the Expert System proposed here is very promising and attractive.

IFAC International Symposium on Power Systems and Power Plant Control, Seoul, Korea, Aug. 22-25, 1989

Robust Load Frequency Control

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It is highly desirable that any control system is not affected by modeling errors or parameter variations of a controlled object. This paper presents an application of a robust feedback control system to load frequency control of an interconnected power system. In the design of this control system, parameter variations in a controlled object are formulated as disturbances to the system, and then a robust compensator is introduced. This compensator makes the transfer funtions between these equivalent disturbances and the controlled output exactly or approximately zero. As a result, the frequency characteristic between the reference input and the controlled output is kept almost unchanged over a specified frequency range, even if some parameters in the controlled object vary widely from their nominal values. The robust compensator is, moreover, effective in real disturbances such as load changes. The effectiveness of the control system is demonstrated by an example applied to a simple interconnected power system model.

IFAC International Symposium on Power Systems and Power Plant Control, Seoul, Korea, Aug. 22-25, 1989

Hierarchical Static State Estimation Based on the Goal Coordination for Electric Power Systems

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A new hierarchical technique for static state estimation in tie-line-connected multi-area power systems is proposed by means of the goal coordination method. For implementation of hierarchical structures of power system control problems, we can utilize basic coordination principles in the hierarchical systems theory. Several studies have been presented, in which the model coordination method is applied, although improvement of the convergence properties has been desired. In this paper, a new coordination algorithm between an upper level and subsystems is developed based on the goal coordination for the so-called overlapping decomposition model, and discussions are also given regarding alternatives of network partitioning and the possibility of extension to dynamic cases. Simulation results show that the algorithm works excellently.

11th International Conference on Magnet Technology (MT-11), Tsukuba, Japan, Aug. 28-Sept. 1, 1989

Desired Capacity and Control Strategy of SMES for Load Change Compensation Aid of Power System

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A superconducting magnetic energy storage system (SMES), which is characterized by a very high efficiency and a very quick response time, is expected much in power systems not only as an energy storage system but also as a power system stabilizer or as a load change compensator. In this paper, some guidelines to determine fundamental specifications and a control strategy of SMES for load change compensation aid are discussed. Dynamic performances of systems are simulated by assuming a various time constant and MW capacity of SMES under several system configurations and restrictions. As a result, a required MW and MWh capacity of SMES for this aid becomes very clear. The optimal control strategy for load change compensation with SMES is also proposed based on the simulation results.

IASTED International Conference CONTROL '90, Lugano, Switzerland, June 18-21, 1990

Robust Load Frequency Control of Hydro-Thermal Interconnected Power Systems

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This papar presents an application of a robust control theory to load frequency control (LFC) of hydro-thermal interconnected power systems. The control system consists of integral compensation and state feedback control. The design procedure is based on H_∞-optimal control theory minimizing the H_∞ norm of the closed-loop transfer function between a disturbance and a controlled output. Compared with a regulator minimizing the H_2 norm, the proposed control system has a flat frequencyr-esponse characteristic to periodic load changes. Moreover, the control system is less sensitive to uncertainty of the controlled object: hydro-thermal interconnected power systems.

XIX International Conference on Phenomena in Ionized Gases, Belgrade, Yugoslavia, July 10-14, 1989

Variation of Breakdown Voltage by Repeated Discharge in Argon and C_3F_8 Mixtures

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In a process of investigating the properties of perflunropropane (C_3F_8) as gaseous dielectrics, we found an interesting behaviour of the breakdown voltage in C_3F_8 and argon mixtures. Namely, the breakdown voltage first increases with the number of repeated breakdown, then saturates and comes to a maximum, and suddenly drops by several percents to keep a more or less constant value with considerable scattering. The magnitude of the increase of the breakdown voltage, the voltage drop, and the number of shot at which the breakdown voltage suddenly drops are found to differ depending on the gas pressure, percentage partial pressure, and dissipated power. It is found by an infrared absorption study of thin films formed on the cathode that the variation of the breakdown voltage was due to the fluoropolymer thin film formation on the cathode by the discharge product.

XIX International Conference on Phenomena in Ionized Gases, Belgrade, Yugoslavia, July 10-14, 1989

Effect of Penning Ionization on Electron Swarm Parameters in Ar/Ne, Kr/Ne, and Xe/Ne Mixtures: Boltzmann Equation Analysis

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Knowledge of the effect of Penning ionization on discharge parameters in rare gas mixtures is important for analysis and simulation of gas discharges and designing gas discharge equipment. In the present study, the effect of Penning ionization on the swarm parameters in

a series of mixtures, Ar/Ne, Kr/Ne and Xe/Ne is studied. A Boltzmann equation method is used in which the effect of inization is properly taken into account. Collision cross sections are taken from previous articles of the authors and other reliable sources. The Townsend first ionization coefficient α/E, the electron drift velocity defined as the average velocity for the steady-state Townsend condition Vd and the electron energy distribution $F(\varepsilon)$ are calculated. It is found that at a fractional concentration of 10^{-2} of Ar, Kr or Xe over Ne(the parent gas), α/E, Vd and $F(\varepsilon)$ are considerably affected by the presence of Penning ionization.

Conference on Computation of Electromagnetic Fields, Tokyo, Japan, September, 3 -7 1989

Boundary Element Analysis of Free Boundary Field-Reversed Configurations

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Field-Reversed Configuration (FRC) plasmas are governed by the nonlinear Grad-Shafranov equation and it is difficult to analyze this equation for FRC devices by using domain-type methods, because the plasma boundary is a free boundary. In this paper, we solve the Grad-Shafranov equation by using the boundary element method (BEM) in order to study equilibrium configurations for FRC with a free boundary. In the numerical analysis, the simple iterative method is applied to obtain nonlinear solutions of the equation. As a result, we find that a stable solution can exist only for parameter K, which denotes the ratio of the electromagnetic force to the plasma pressure. In addition, we calculate the equilibrium configuration by using BEM for the rigid drift model and the slitted model.

Conference on Computation of Electromagnetic Fields. Tokyo, Japan, September, 3-7 1989

An Analysis of Axisymmetric Modified Helmholtz Equation by Using Boundary Element Method

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In this paper, we derive the expression of the fundamental solution of axisymmetric modified Helmholtz equation. By using this fundamental solution, we analyze several axisymmetric numerical models. Furthermore, we analyze the same models by using the integral equation method (IEM) in which we use the fundamental solution of the Laplace equation. As an engineering problem, we apply the boundary element method (BEM) and the IEM to a sheath problem of boundary plasma.

Conference on Computation of Electromagnetic Fields, Tokyo, Japan, September, 3-7 1989

An Analysis of Ion Beam Trajectories by Using Boundary Element Method

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The performance of ion beam depends on shape of plasma boundary, and the shapes and sizes of the apertures. In this paper, we treat two-dimentional extractors using the boundary element method. Ion beam trajectories with space charge are calculated by iteratively solving the equations of motion and Poisson's equation under the assumption of stationary charge flow, and we modify the shape of plasma boundary until it satisfies the Child-Langmuir relationship. Lastly, we study three-electrode structure. The results of computation show that this algorithm using boundary element method is reasonably accurate for the shape of plasma boundary.

2nd International Symposium on Applied Electromagnetics in Materials, Kanazawa, Japan, January 9-11, 1990

An Electromagnetic Field Analysis of Two-Dimensional MPD Arcjet Thrusters Using Boundary Element Method

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MPD (magnetoplasmadynamic) arcjet thruster is one of the electric propulasion systems. This paper presents the numerical simulation of the electromagnetic field of the two-dimensional MPD arcjet thrusters, using the boundary element method (BEM) with a simple iteration scheme. In the analysis, the governing equations of MPD phenomena can be reduced to the induction equation with a convective diffusion term. We solve this equation to obtain the magnetic fields and the distribution of the current density and the Lorentz force for the model (flared type and straight type) of the MPD thruster using BEM. The conclusions are summarized as follows: (1) With increase of the flow velocity, current channels are extended to down stream region and the current gradually concentrates on the cathode tip. (2) The current concentration on the cathode tip is clearer in the straight type than in the flared type. (3) The Lorentz force distribution clearly changes with increase of the flow velocity in the straight type though the distribution does not depend on the velocity in the flared type.

IUTAM Symposium Mechanical Modellings of New Electromagnetic Materials, Stockholm, Sweden, April 2-6, 1990

Boundary Element Analysis of Magnetic Fields of Axisymmetric Superconducting Materials

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In this paper, two numerical techniques are applied to the analysis of magnetic fields of axisymmetric superconducting materials. One of them is boundary element (BE) analysis by

using new expressions of the fundamental solution of the axisymmetric modified Helmholtz equation with numerical integrations. Since the fundamental solutions can not be evaluated by using the standard Gauss-Laguerre formulas, we use the double exponential formulas and obtain numerically converged solutions. The other is the integral equation method in which we use the fundamental solution of the Laplace equation by considering the axisymmetric modified Helmholtz equation as the axisymmetric Laplace equation with an inhomogeneous term. After we propose formulations for these two methods, numerical characteristics of the fundamental solutions are studied. To confirm the validities of the methods, we analyze a numerical model whose exact solution is obtained. Furthermore, when the toroidal magnetic fields is applied parallel to the superconductor surface, we analyze magnetic fields inside an axisymmetric superconductor by using two types of BEM and study the dependence of magnetic fields on the London penetration depth with high accuracies. It is shown that we can analyze the axisymmetric London equation by using two types of BEM and it is confirmed that two methods mentioned above are useful to solve the axisymmetric modified Helmholtz equation.

Third Japan-China Symposium on Boundary Element Methods, Hachiohji, Japan, April 4-7, 1990

Analysis of Ion Flow Fields by Combination of BEM with MOC

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In this paper, we present a computational scheme based on the combination of boundary element method (BEM) and method of characterisitcs (MOC) for calculating ion flow fields. In this scheme, a self-consistent solution to the ion flow field is obtained by alternately using BEM as a solver of the Poisson equation and MOC as one of the current continuity epuation. In addition, the boundary condition for the charge density, which can not be known *a priori*, is determined through the use of Peek's empirical law or Child-Langmuir law.

The solution obtained from this scheme is compared with the exact solution using a coaxial cylindrical model and the agreement of the numerical with the exact solution is proved to be sufficient for practical uses. Moreover, this scheme is applied to the analysis of the ion flow field surrounding a high voltage D. C. transmission line and an ion emitting electrode in the ion engine of the electric propulsion system. In conclusion, it is shown that the agreement of the numerical solution with the experimental value is quantitatively good in the former case and ion trajectories are strongly affected by the space charge in the latter case.

Japanese-Polish Joint Seminar on Electromagnetic Effects in Deformable Solids and Materials, Madralin, Poland, April 9-12, 1990

Mixed Boundary Element Solutions to 3-Dimensional Convective Diffusion Equation

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Convective diffusion equation is one of the most basic governing equations describing macroscopic phenomena in the classical physics with which we are usually familiar in various fields of science and engineering. However, it is still very difficult to numerically solve the convective diffusion equation, when the convective term is dominant. Indeed, it is one of the most significant current researches in computational physics that one attempts to solve such a partial differential equation accurately and stably.

Japanese-Polish Joint Seminar on Electromagnetic Effects in Deformable Solids and Materials, Madralin, Poland, April 9-12, 1990

BE and FE Analyses of Helically Symmetric MHD Equilibrium Configuration

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In this paper, we present numerical schemes based on the boundary element (BE) and finite element (FE) method for calculations of magnetohydrodynamic (MHD) equilibrium configuration in the helically symmetric systems. The present schemes, in which the helical symmetricity is taken into account, allow us to reduce the strage-space in comparison with fully three-dimensional schemes.

In this paper, firstly, we introduce a variational form of the helically symmetric MHD equilibrium equation in the twisted coordinate to obtain an FE formulation. Secondly, we intorduce a boundary integral equation for a BE formulation. The simultanious equations to be iteratively solved are derived from the above formulations. Finally, both FE and BE solutions are shown to be in good agreement with the exact one for the linear equilibrium equation.

Moreover, it is shown that, in non-linear equilibrium calculations, FE and BE solutions sufficiently fast converge by Marder-Weitzner iteration while they vibrate with slowly decreasing amplitudes by Picard iteration.

International Magnetics Conference, Brighton, UK, April 17-20, 1990

An Equilibrium Analysis of Helically Symmetric Plasmas Using Boundary Element Method

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In this paper, a computaional scheme based on boundary element method for analyzing helically symmetric equilibrium configurations which are described by MHD equilibrium equation is presented. To numerically solve the equation, a boundary integral equation is introduced. An effective scheme for calculating the principal solution, which includes an infinite series of slow convergence, to the above equation is described. The vacuum fields enclosed by a helical perfectly conducting shell are calculated on the basis of the present scheme. Moreover, the dependence of magnetic surfaces on the helical pitch and the displacement of the shell is studied.

17th EPS Conference on Controlled Fusion and Plasma Heating, Amsterdam, The Netherlands, June 25-29, 1990

Finite Element Analysis of Helically Symmetric Equilibria

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It is well-known that Taylor's force-free states, which satisfy the relation $\nabla \times B = \mu B$, can exist only for discrete values of μ when the mode number m is grater than zero and when the solution to the above equation has the lowest energy, the constant μ also takes the smallest value 3.11 for $m=1$, $h \simeq 1.25$ (where h is the helical pitch) under the condition that a plasma is enclosed by a straight perfectly conducting shell with a circular cross-section. However, the dependence of the minimum-μ states on the shape of a shell still remains unclear.

For this reason, here, we study $m=1$ Taylor's force-free minimum-μ states inside two types of shells: (a) circular cross-section helical shells, area π, displacement S, pitch h and (b) elliptic cross-section straight shells, area π, displacement zero, pitch h, eccentricity e. To calculate the above configurations, a finite element formulation is carried out after a variational form of the helically symmetric equilibrium equation is introduced in the twist coordinates.

1989 IEEE Antennas and Propagation Society International Symposium and URSI RADio Science Meeting, Dallas, Texas, U. S. A, May 7-11, 1990

The Treatment of Dispersive Media by the FD-TD Method

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Recently, the analysis of propagation characteristics in dispersive media has gained prominence. In such dispersive media, the permittivity or permeability is changed by the frequency used. Furthermore, of recent, the importance of the use of pulse waves has been increasing. When a pulse wave propagates in such a media, the wave form is distorted.

In order to solve such practical problems, a versatile and direct simulation method using a three-dimensional space and time domain is required.

In this paper, we consider a simple case for a dispersive media. The formulation of the dielectric relaxation characteristics by the FD-TD method, based on the physical equation of the media, is here described.

International Union of Radio Science (URSI) International Symposium of Electromagnetic Theory Stockholm, Sweden, Aug. 13-17, 1989

Transient Analysis of Vector Potential in Three-Dimensional Space by Spatial Network

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In the analysis of electromagnetic fields, the vector potential has important roles especially when sources exist. In this paper, we propose that the Spatial Network Method can be easily expanded to the vector potential field with Coulomb's gauge condition. The formulation is performed by using not only the magnetic vector potential but also the electric one in the three -dimensional network. The validity of the formulation is shown by both electric and magnetic fields around a loop current.

Institute of Electronics, Information and Communication Engineering
International Symposium on Antennas and Propagation Tokyo, Japan, Aug. 22-25, 1989

Simulation of Electromagnetic Fields in NRD Guide Leaky-Wave Antenna by Spatial Network Method

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Recently, for many kinds of engineering problems, numarical analysis methods have become very useful with the remarkable development of the digital computer, especially the super computer. But, the scale of the problem is limited often by the capacity of the main memory of the used computer. This paper describes that the Spatial Network Method can perform the high speed computation by using the extended memory of the super computer for simulating the propagation and the radiation characteristics of the NRD guide leaky-wave antenna.

1989 Conference on Computation of Electromagnetic Fields at Tokyo, Japan Sept. 3-7, 1989

Transient Analysis of Magnetostatic Waves in Ferrite Loaded Rectangular Waveguide by Spatial Network Method

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This paper presents the 3-dimensional and time domain analysis of a magnetostatic surface waves (MSSWs), which have been used for delay lines, by Spatial Network method (SNmethod). The application of the magnetostatic waves (MSWs) for monolithic microwave integrated circuits (MMIC) has been studied, because of their slow wave properties. Despite that many studies for the MSWs have been carried out, there is no analysis for the field distribution of MSWs devices. But the recent development of MIC demands the analysis of total field distribution including the other devices, because of considering coupling effect among devices.

In this paper, using the ferrite loaded rectangular waveguide, the fundamental analysis of MSSWs by SN-method is presented.

1989 Conference on Computation of Electromagnetic Fields at Tokyo, Japan Sept. 3-7, 1989

Transient Analysis of Electromagnetic Fields in Magnetic Medium with Hysteresis in Three-Dimensional Space

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Recently, with progress of electronic devices containing magnetic medium, it has become necessary to consider its hysteresis characteristics in the three-dimensional analysis of electromagnentic fields. Also, progress in high-speed pulse techniques demands the analysis of nonlinear behaviors in the medium in time domain. This paper presents a fundamental application of the Spatial Network Method to magnetic medium with hysteresis. Results for the propagation characteristics of plane waves show that complicated distortion occurs in instantaneous and spatial variations of field components, and also show that the rate of power attenuation agrees well with theoretical hysteresis losses.

1989 International Symposium on Electromagnetic Compatibility, Nagoya, Japan, Sept. 8-10, 1989

Simulation of Reduction Characteristics of Scattering from Aircraft Model Coated with Thin-Type Absorber by Spatial Network Method

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Recently, analyses of electromagnetic wave absorber have become important to design a good absorbing system to reduce scattering from structures which cause serious problems such as ghost images on TV and radar displays. The practical difficulty of experiments demands a numerical analysis method. In this paper, by Spatial Network Method which is a three-dimensional and time domain analysis method, we proposed the unified treatment of scattering problems involving the absorber. The scattering far field is estimated from the near field distributions by using the equivalent theorem. Then, we present the treatment of a thin coating type absorber which is desirable for practical use. The property of the absorber is verified by changing the incident wave conditions and the medium constants. At last, the significant reduction characteristics of the scattering from an aircraft model coated by the absorber are also presented.

3rd Sapporo International Computer Graphics Symposium October, Sapporo, Japan, Nov. 28-29, 1989.

Visualization of Reduction Characteristics of Electromagnetic Fields by Wave Absorber on a Complex Object

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The reduction of electromagnetic field scattering by absorbers has recently importance in EMC problems. Unified punmerical analysis considering both the three-dimensional structure and the medium conditions is necessary due to the practical difficulty in utilizing either the analytical method or experimentation. The electromagnetic field cannot been seen, or even if we can see it, we cannot usually understand the phenomenon due to its variation of high frequency, so the visualization by the simulation is indispensable especially in this field. Furthermore, the visualization helps the design of the electronic devices or components. In this pre-

sentation, the treatment of the thin-type absorber by the Spatial Network Method is considered. As an example of a complicated problem, we apply the present method to the scattering from an aircraft model coated with a thin type absorber. The significant reduction characteristics of the resultant scattering from such a complex shape and medium are presented.

IEEE Antennas and Propagation Society International Symposium and URSI National Radio Science Meeting Dalas, Texas U.S.A, May 6-11, 1990

Treatment of Hertz Vector in Three-Dimensional Lattice Netwrk of Spatial Network Method

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A Hertz vector defines a electromagnetic field expressed by a scalar potential variable and vector potential ones in terms of a single vector function. Therfore, the numerical anlysis by using the Hertz vector is useful for the problems with complex field conditions containing electric or magnetic charges and dipole moments. This paper shows that the a Hertz vector field can be expressed in the lattice network of the Spatial Network Method by using both the electric-type and the magnetic-type Hertz vectors.

IEEE Antennas and Propagation Society International Symposium and URSI National Radio Science Meeting Dallas, Texas U. S. A, May 6-11, 1990

Treatment of Dispersive and Anisotropic Properties of Substrate Mediums by Spatial Network Method

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To examine precisely the characterisitcs of the planar integrated circuit, the considerations of dispersive and anisotropic properties of a dielectric substrate have become important, especially in the time domain characteristics for pulse waves. In the Spatial Network Method, the former can be formulated by the equivalent lumped elements obtained by the adaptation of the trapezoidal rule to the kinetic equation of a dipole moment, and the latter can be expressed by the mutual inductance for the coupling between fields.

4th International Conference on Modulated Semiconductor Structures, July 17-21, 1989 Ann Arbor, Michigan, U. S. A.

Carrier Concentration in Selectively Doped N-AlGaAs/GaAs Single Heterojunctions

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Carrier concentration of two dimensional electron gas, n_s, in N-AlGaAs/GaAs heterostructures is measured with varying the spacer layer thickness. Structures are designed to eliminate the effects of the charges at the surface and interface on n_s. Thus obtained n_s is shown to be in good agreement with calculation in which 65% of the band gap difference between AlGaAs and GaAs is assumed to appear in the conduction band.

Proceedings of the Tenth Molecular-Beam Epitaxy Workshop 13-15 September 1989 North Carolina State University Raleigh, North Carolina

Epitaxy of III-V Diluted Magnetic Semiconductor Materials

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(Received 13 September 1989; accepted 5 October 1989)

A new class of III-V based diluted magnetic semiconductors, specifically In_{1-x} Mn_x As ($x \lesssim 0.2$) and InAs/InMnAs multilayer structures, has been prepared by molecular beam epitaxy. The x-ray diffraction measurements reveal that the incorporation of Mn can be predominantly either homogeneous (200℃) or inhomogeneous (300℃), depending on the growth temperature. Semiconducting properties of the films have been examined by optical absorption and Hall effect measurements, and it has been found the films of homogeneous alloy are n-type and have a band gap which decreases with increasing Mn composition. Magnetization measurements indicate that the homogeneous alloy exhibits paramagnetic behavior, whereas ferromagnetic behavior dominates for the inhomogeneous case. The growth of GaMnAs has also been examined.

European MRS Meeting, May 29-June 1, 1990 Strasbourg, France

New Diluted Magnetic Semiconductors Based on III-V Compounds

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This paper focuses on the homogeneity of Mn ions in the new diluted magnetic semiconductor (DMS) $In_{1-x}Mn_xAs$. It is demonstrated that, when grown at 200℃ substrate temperature, the In compound produces a homogeneous alloy. The most extensive proof of this lies in detailed magnetization measurements. Supportive evidence comes from x-ray (lattice constant), optical (bandgap), and transport measurements.

Progress in Electromagnetics Research Symposium (PIERS) July 25, 26, 1989, Boston, U. S. A

Effects of Carriers on Propagation of Electromagnetic Waves Along Planar Waveguides Formed on Semiconductors

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Understanding and accurate modeling of propagaiton of electromagnetic waves along planar patterns on multi-layered semiconductor structures are becoming increasingly important owing to recent rapid progress of advanced semiconductor devices and integrated circuits for high speed digital, monolithic microwave and picosecond optoelectronic applications. As compared with purely dielectric media, semiconductors are characterized by the presence of carriers and their nonlinear interactions with fields.

The purpose of the present paper is to discuss the distributed parameter effects of the carriers on the propagation of electromagnetic waves. As the "passive" effect, propagation delay along interconnects on high speed semiconductor integrated circuits is discussed. Then, the traveling-wave interaction between the carrier wave and the electromagnetic wave is discussed as their " active effect."

The 21st Conference on Solid State Devices and Materials. August 28-30, 1989, Tokyo, Japan

$In_{0.53}Ga_{0.47}As$ MISFETs Having an Ultra-thin MBE Si Interface Control Layer and Photo-CVD SiO_2 Insulator

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A novel $In_{0.53}Ga_{0.47}As$ MIS structure having an ultrathin MBE Si interface control layer (ICL) between InGaAs and photo-CVD SiO_2, is described and applied to fabrication of MISFETs. XPS and electrical characterization shows that Si ICL prevents selective oxidation of InGaAs and reduces the interface state density. Depletion mode MISFETs using the novel MIS structure gave an effective channel mobility of 1,700cm^2/V. s and excellent stabillity where the drain current drift was below 1% after 10^4s.

6th International Conference on Passivity, September 24-28, 1989, Sapporo, Japan

Physical Modeling and Control of Compound Semiconductor —Insulator Interfaces for Surface Passivation

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Properties of the insulator-semiconductor (I-S) interfaces of III-V compound semiconductors are reviewed and the origin of interface states is discussed. Emphasis is laid on the presence of striking correlation among I-S, S-S (semiconductor-semiconductor) and M-S (metal-semiconductor) interfaces. Among various medels, the unified disorder-induced gap state (DIGS) model seems to offer a most consistent explanation for the behavior of interface. Recent attempts to control the I-S interfaces by chemical surface treatments and by insertion of interface control layers (ICL) are also discussed.

6th International Conference on Passivity, September 24-28, 1989, Sapporo, Japan

Characterization of Oxide/Compound Semiconductor Interfaces by A High Resolution Electron Microscopy

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In order to study the correlation between the electronic properties and the atomic structure of the interface, the lattice images of insulator/semiconductor interfaces were observed by a high resolution transmission electron microscopy. The very smooth interface as overall was formed in InP/native oxide, although 1-2 atomic layer steps were generated along (001) interface plane. In the case of GaAs/anodic oxide, the interface was improved by annealing in hydrodgen atmosphere. At these interfaces with oxide layers, the lattice images showing the formation of very thin transient layer were often recognized at the interface. Furthermore the interface of InP/native oxide was very smooth even though the gap of lattice spacing changed in [001] direction within one or two atomic layer close to the interface. On the other hand, the interface of PCVD-SiNx/GaAs was wavy and irregular but no transient layers being observed. Thus, the atomic arrangement at interface directly reflects on the interface state density configuration, which depend on the process of preparing the semiconductor/insulator.

6th International Conference on Passivity, September 24-28, 1989, Sapporo, Japan

Surface Passivation of $In_{0.53}$ $Ga_{0.47}$ As by Ultra-Thin Pseudomorphic MBE Si Layer Combined With Photo-CVD Insulator

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A novel passivation of $In_{0.53}$ $Ga_{0.47}$ As surface, using an ultra-thin pseudomorphic MBE Si interface control layer (ICL) and photo-CVD SiO_2, is reported. In-situ XPS study indicated that uncontrollable selective oxidation of InGaAs layer is provented by Si ICL. C-V characterization of insulator-semiconductor interfaces indicated remarkable reduction of interface state density, resulting in a minimum of $1.6\times10^{11}cm^{-2}\ eV^{-1}$.

6th International Conference on Passivity, September 24-28, 1989, Sapporo, Japan

Surface Passivation of InP by Anodic Indium Phosphate Layer Combined With Photo-CVD Insulators

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Surface passivation of InP by an anodic indium phosphate $In(PO_3)_x$ interface control layer (ICL) combined with photo-CVD insulators is studied by X-ray photoelectron spectroscopy and electrical measurements. The ICL is formed by anodization of InP followed by selective chemical etching. Metal-insulator semiconductor (MIS) structures with the anodic ICL shows the reduced interface state density. By using such an ICL, the effective mobility of the MIS field effect transistor is significantly increased and the drain current drift is greatly reduced. The observed drift behavior can be explained by unified disorder-induced gap state model.

6th International Conference on Passivity, September 24-28, 1989, Sapporo, Japan

Ion Channeling Studies on Interface Disorder for SiN_x/GaAs and SiN_x/InP Systems

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In order to reveal real microscopic structures of compound semiconductors in interface regions for SiN_x/GaAs and SiN_x/InP systems, interface (surface) peaks in ion-channeling were measured in detail. In particular, the dependence of the peak intensity on temperature (40~300K) was measured systematically. As a result, anomalous temperature dependence of intensity of the interface peaks was observed in SiN_x/GaAs systems. Discussing physical origin of the interface peak, it is concluded that this peculiar dependence is attributed to displacement of host atoms from regular lattice sites in SiN_x/GaAs systems. It is estimated that the average value of the displacement is of the order of ~0.05 Å. On the other hand, no remarkable behavior was found for SiN_x/InP systems, and it is concluded that the disorder in SiN_x/InP systems is very small compared with SiN_x/GaAs systems.

16th International Symposium on GaAs and Related Compounds, September 25-29, 1989, Karuizawa, Japan

Electron concentration and conduction band discontinuity in selectively doped N-AlGaAs/InGaAs/GaAs pseudomorphic heterostructures

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The concentration, N_s, of the two-dimensional electron gas and the conduction band discontinuity ΔE_{C1} in $Al_yGa_{1-y}As/In_xGa_{1-x}As$ pseudomorphic heterostructures were investigated. The values of N_s, carefully measured by Shubnikov-de Haas and Hall measurements avoiding ambiguities in charge, indicated overall self-consistency of the charge balance relation with ΔE_{C1} of 300 ± 10meV for $x=0.15$ and $y=0.18$. The observed value of ΔE_{C1} is shown to agree with a simple theory involving matching of the hybrid orbital energy and correction for strain. This led to a general formula for arbitrary x and y.

16th International Symposium on GaAs and Related Compounds, September 25-29, 1989, Karuizawa, Japan

Surface recombination in InGaAs photoconductive detectors and its reduction by a novel passivation scheme using an MBE Si layer

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Although InGaAs photoconductive detectors (PCDs) show impressive picosecond responses for short and intense light pulses, they exhibit, for pulses with long pulse widths, and anomalous low frequency gain enhancement with related slow rise and long pulse tailing whose mechanism has not been explained. Based on the experiments using different surface passivation schemes and their theoretical analysis, band-bending and surface recombination due to surface states are shown to be responsible for such a low-frequency anomaly in InGaAs PCDs. By applying a novel passivation schere using an ultra-thin Si MBE layer together with a photo-

CVD SiO_2 film, this anomaly is greatly suppressed, reducing the surface recombination velocity from $0.5-1\times10^4$cm/sec down to 100cm/sec.

7th International Workshop on Future Electron Devices, October 2-4, 1989, Toba, Japan

Control of GaAs and InGaAs Insulator-Semiconductor Interfaces by an Ultrathin MBE Si Layer

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Control of Fermi level pinning is a crucial issue for future electron devices utilizing quantum effects in low-dimensional structures. A novel approach to control the surfaces of GaAs and InGaAs by using a ultrathin MBE Si layer is presented, resulting in a significant reduction of pinning is the GaAs surface and a complete unpinning in the $In_{0.53}Ga_{0.47}As$ surface.

International Conference on VLSI and CAD, October 17-20, 1989, Seoul, Korea

Understanding and Control of Interfaces for Compound Semiconductor ULSIs

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Interfaces play important role in future III-V compound semiconductor ULSI. The present status of understanding and control of compound semiconductor interfaces involving semiconductor, insulator and metal are reviewed and key issues for future research and development are identified with a particular emphasis laid on the passivation technology. Presence of a strong correlation among interfaces is pointed out and models for unified understanding interfaces are discussed.

17th Annual PCSI Conference, January 31-February 2, 1990 Clearwater Beach, Florida, U. S. A.

Characterization of InGaAs Surface Passivation Structure Having an Ultrathin Si Interface Control Layer

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A recently proposed passivation structure of $In_{0.53}$ $Ga_{0.47}$ As surface is characterized by XPS, C-V and DLTS measurements. It uses an ultrathin MBE Si interface control layer (ICL) and a photo-CVD SiO_2 outer insulator.

XPS study indicates that growth of Si ICL is coherent and twodimensional up to about 10 Å beyond which clustering is initiated, and that the ICL is effective in preventing the InGaAs layer from selective oxidation of Ga during photo-CVD SiO_2 deposition. C-V and DLTS measurements give N_{ss} distributions of very different shapes, the latter exhibiting two distinct peaks which may be erroneously interpreted as defect levels. Suppression of selective oxidation of InGaAs does not alter the shapes of these distributions, only reducing the magnitude. The results are explained by the disorder-induced gap state (DIGS) model rather than the defect model or the effective workfunction model.

2nd International Conference on InP and Related Materials, April 23-25, 1990, Denver, Colorado, U. S. A.

Surface Passivation of $In_{0.53}$ $Ga_{0.47}$ As Using Thin Si Layers by Novel In-Situ Interface Control Processes

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Characterization and optimization of $In_{0.53}$ $Ga_{0.47}$ As new surface passivation structure, using an ultrathin Si interface control layer (ICL) and a photo-CVD SiO_2 overlayer are made. The thickness of Si ICL is shown to posses an optimum value of about 10 Å, where N_{ss} is reduced by protecting the InGaAs surface from selective oxidation during the SiO_2 deposition process, as well as by keeping bond matching both to SiO_2 and InGaAs.

2nd International Conference on InP and Related Materials, April 23-25, 1990, Denver, Colorado, U. S. A.

MBE Growth of InP Using Polycrystalline InP as Phosphorus Source

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Feasibility of MBE and MEE growth of InP in the standard GaAs-type MBE chamber is demonstrated by using polycrystalline InP as the phosphorus source. As compared to P_2 cleaning, As_4 thermal cleaning of the InP substrate allows easier and more reproducible growth, giving better surface morphology, nearly the same electrical properties and only a very small inclusion of As. InP polycrystal is shown to be suitable for the MEE growth mode, giving a strong enhancement of photoluminescence intensity.

18th International Symposium on Acoustical Imaging Santa Barbara, California 1989

Three-Dimensional Display Technique for Fish-Finder with Fan-Shaped Multiple Beams

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In this paper we discuss technique and system to display three-dimensional (3-D) images of an echo-sounder, which collects 3-D data concerning the location of fish. The image data of proceeding direction of a vessel are collected by scanning the ocean using an echo-sunder with a fan-shaped beam, while the image data of range direction perpendicular to the proceeding direction are collected by multiple beams comprising a main beam and four side-lobe beams. Without image processing, a sequence of 2-D signal waveforms is recorded, resulting in difficulty of identifying 3-D images of fish. Here we propose a technique to construct 3-D images from an echo-sounder by storing 2-D echo signals and displaying them. Since collected data from the echo-sounder is not sufficient to display 3-D image, interpolation of data is carried out, resulting in the display of 3-D images of schools of fish. A special memory system with 2M byte IC memory was constructed to display 3-D images. Algorithms, such as a depth-shading algorithm for displaying 3-D images in 2-D CRT scope, are discussed and the experimental results show that our proposed display technique is promissing for use in a 3-D fish-finder.

1990 IEEE AP-S International Symposium and URSI National Radio Science Meeting, Dallas, Texas, USA, May 7-11, 1990

Time-Domain Measurements Using a Superresolution Technique

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Time-domain analysis with a recently developed network analyzer is useful for measuring several devices. For example, we may carry out antenna and radar-cross-section measurement using time-domain processing. The time-domain processing has been based on the fast-Fourier-transform (FFT) algorithm and gating technique. However, the resolution of the FFT essentially depends on frequency bandwidth of obtained data, and the difficulty arises in measuring narrow-bandwidth devices such as antennas. Therefore, high resolution time-domain estimation has been desired. Superresolution techniques have been studied extensively for spatial spectrum estimation by a signal processing array. In this paper, we propose to apply the superresolution technique to the frequency-domain data measured with the network analyzer, and show the high resolution capability using experimental results. Among many superresolution techniques, we employ a MUSIC (Multiple Signal Classification) algorithm because it has several advantages.

Seventh International Conference on Integrated Optics and Optical Fiber Communication, (IOOC'89), Kobe, Japan, July 18-21, 1989

Numerical Simulation of Second-Harmonic Generation in Proton-Exchanged $LiNbO_3$ Optical Waveguide Utilizing Cherenkov Radiation

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Numerical simulation based on the finite-element mothod is made for guided-wave second-harmonic generation (SHG) devices utilizing the Cherenkov radiation of light into the substrate. Numerical results are in good agreement with experimental results.

Seventh International Conference on Integrated Optics and Optical Fiber Communication, (IOOC'89), Kobe, Japan, July 18-21, 1989

Nonstationary Behavior of Nonlinearly Coupled TE-TM Waves Propagating in Dielectric Slab Waveguide Structures

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Propagation phenomena of nonlinearly coupled two orthogonal waves in a slab waveguide are demonstrated numerically for the first time. It is shown that the propagation behavior is strongly dependent on the particular nonlinear mechanism.

1989 International Symposium on Antennas and Propagation, (ISAP'89), Tokyo, Japan, Aug. 22-25, 1989

Finite-Element Analysis of Electromagnetic Wave Scattering by a Plane Grating in Case of Oblique Incidence and Arbitrary Polarization

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In this paper, a numerical approach based on the finite-element methed (FEM) is described for the analysis of scattering by a plane grating in case of oblique incidence and arbitrary polarization. The FEM is a domain-type method and, in general, requires a plenty of computer resources. However, the computation in the FEM can be efficiently performed by introducing the substructure method. In addition, the most part of the FEM computation is the manipulation of matrices, and therefore the FEM is very suitable for supercomputers. Numerical examples are calculated for three kinds of metallic strip gratings on a dielectric sheet. The validity of the approach proposed here is confirmed by comparing numerical results with the earlier theoretical results. Also, we check the required computer resources and show that the computation is efficiently performed even if the FEM is used.

Topical Meeting on Integrated Photonics Research, South Carolina, U. S. A., March 26-28, 1990

Numerical Analysis of the Absorption and Refractive Index in Arbitrary Semiconductor Quantum-Well Structures

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We present a numerical method for the analysis of the absorption spectrum and the refractive index in semiconductor quantum-wel structures (QWSs) with arbitrary potential profiles. The validity of the method is confirmed by comparing the numerical results for a rectangular quantum well (QW) with the experimental results. We also demonstrate the noteworthy results for an asymmetric double-QW structure.

The calculations are carried out as follows. First, we solve the Schrödinger equation under the effective mass approximation by using the finite-element method to obtain the subband energies and the envelope functions of electrons, heavy holes, and light holes in a QWS. Next, the variational method is used to determine the exciton Bohr radius and binding energy from these envelope functions. We then calculate the absorption spectrum due to the free-carrier transitions and the excitonic transitions. Finally, the refractive index is obtained from the absorption spectrum by the Kramers-Kronig relations.

1990 International Topical Meeting on Optical Computing, (OC'90), Kobe, Japan, Apr. 8-12, 1990

Computer Simulation of All-Optical Switching Processes in Nonlinear Coaxial Couplers

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All-optical switching processes in nonlinear coaxial couplers are simulated numerically by the split-step finite-element method. The results provide a useful performance for realizing new devices.

1989 International Conference on Coal Science, October 23-27, 1989, Tokyo, Japan.

A Proposition for the initial coalification reaction

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One hypothesis is proposed, that is, the aromatics with long alkyl chains will be formed from the reaction of phenol nuclei of lignin with long chain fatty acids, esters or alcohols originated from hydrolysis of lipid or some analogous compounds. Phenol, n-C_{18}-fatty acid (or n-C_{14}-alcohol) and activated clay were heated at 120-300℃ in a 50ml autoclave under 0.5 MPa nitrogen atmosphere. Small amount of C_{14}-substituted tetralin and naphthalene, C_1～C_4- and C_{14}-phenols were produced.

At higher reaction temperature, the yield of alkyl phenols decreased sharply. Those for alkyl-naphthalene, -phenanthrene, -dibenzofuran, -benzene and n-paraffins increased. This shows clearly that the cyclization through alkyl chain proceeds with the severity of the reaction.

Proceedings. vol. I. pp 5～8.

1989 International Conference on Coal Science, October 23-27, 1989, Tokyo, Japan.

Temperature and pressure effect on the liquefaction Model reaction

K. OUCHI, M. MAKABE

In order to elucidate the mechanism of coal liquefaction, temperature and pressure effect was investigated with dibenzyl and benzyl phenyl ether as model compounds in the system of two ring solvents (naphthalene, tetralin, decalin), stabilized nickel catalyst and hydrogen or nitrogen atmosphere, using a 50ml autoclave. When the temperature increases, the splitting of C-O bond was accelated. At 320℃ hydrogenation of aromatics reaches maximum and at higher temperatcere, dehydrogenation took phaces again. Dehydroxylation took place between 375-400℃ accompanying by the decomposition of ring to gases. With increasing hydrogen pressure the condensation reaction was prevented and the hydrogenation of aromatic ring and dehydroxylation took place. Those results confirm the conclusion in the previous paper using coal as sample.

Proceedings. vol. II. pp 835～838.

199th ACS National Meeting
Cellulose, Paper and Textile
Division, Boston, Massachusetts April 22-27, 1990

Structure-Property Relationship of α- and β-Chitin.

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High resolution ^{13}C NMR spectra of α-chitin and β-chitin in solid state can be distinguished from each other as well as the x-ray patterns or IR spectra. α-chitin from crab or shrimp shell is known to be slightly soluble and to have poor reactivity due to its rigid crystalline structure. β-chitin, on the other hand, from squid bone, *Loligo pen,* forms slurry easily when it was ground with water due to loose crystalline structure. It seems to be much easier to prepare the paper sheet from β-chitin than α-chitin because of its high affinity for water. Direct sheet preparations from *Loligo pen* gel is economically of greater advantage than non-woven sheet from crab shell. The pen sheet of higher breaking length, 6.9km and higher bursting factor, 7.4 was obtained by suction type batch-paper-making machine, which also shows lower stiffness, relative high permeability of moisture, a strong affinity for blood proteins and slow biodegradation by lysozyme. Thus the pen sheet seems to be more suitable temporarily artificial skin.

199th ACS National Meeting
Cellulose, Paper and Textile
Division, Boston, Massachusetts April 22-27, 1990

Characterization of Cellulose Polymorphs by Their Ease of Interconversion

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Polymorphs of cellulose can be classified into two families, cellulose I(I, III_I and IV_I) and cellulose II(II, III_{II} and IV_{II}). Transformation within each family were studied by heating samples of I, II, III_I or III_{II} in silicone oil at 220℃ for 20 min and measuring the ratio of the type IV material formed to starting material. Type I was stable while the conversions $III_I \rightarrow IV_I$, $II \rightarrow IV_{II}$ and $III_{II} \rightarrow IV_{II}$ were 80%, 10% and 20%, respectively. Using steam at 150℃ com-

plete conversion of III_I was possible but even at 200℃ only partial conversion occurred. Mechanical stress such as ball milling of either type III mainly resulted in a loss of crystallinity. Starting with type IV cellulose, steam resulted in partial conversion of IV_{II} to II but no effect on IV_I. Formation of cellulose I or II from the appropriate cellulose IV was facilitated by acid hydrolysis in 2.4 N HCl at elevated temperatures with the conversion $IV_{II} \rightarrow II$ occurring more readily.

To explain these results we have developed a hypothesis that celluloses in the type I family have a "bent" conformation while those in the cellulose II family have a "bent twisted" conformation. These will have different intermolecular hydrogenbonding possibilities.

The 1989 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, U. S. A. December 17-22, 1989

An Analytical Method of AKD(Alkylketendimer) in Papers

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AKD has been most widely used internal size for neutral paper making. However, there is not a convenient method of a microquantitative analysis of AKD in papers. It was found that solutions of AKD extracted with chloroform from a paper show UV absorption in enough strength to quantitative analysis in such a low concentration. The spectra showed absorbance maximum which shifts to higher wavelength with an increasing of the concentration of AKD. A calibration line for the analysis is able to obtain using both the intensity of the absorbance maximum and the wavelength of it. It was cleared that the AKD added to papers was almost extractable. The method is useful to get informations of the change of the degree of fixing of AKD by drying method and stocking conditions, and of the relationship between size and the degree of fixing.

First Pacific Polymer Conference, Maui, Hawaii, December 12-15, 1989

Preparation and Characterization of Biodegradation Sheet from Chitin.

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The direct preparation of chitin sheet from mechanically beated *Loligo Pen* chitin and some preliminal physical properties were investigated with use of continuous paper machine designated for chitin sheet together with suction type batch-paper machine. Fairly larger Dynamic Young's modulus is shown for the paper from *Loligo Pen* than that from crab shells. But *Loligo Pen* chitin paper is obviously softer than that from crab shells as shown in the term of Stiffness. Several advantages are shown for the paper from *Loligo Pen* chitin over that from crab shells such as Breaking Length, Bursting Factor and Tearing Factor. Also the higher permeability of moisture is shown for *Loligo Pen* than that for crab shells together with Water Regain. Since almost full marks were given for *Loligo Pen* chitin by the standard tests for the diaphragm of artificial heart such as pyrogenicity, antigenicity, and etc., *Loligo Pen* chitin would have high biocompatibility for animal.

The Fourth International Cellucon Conference, Wrexham, UK 4-8 September 1989

Alkali-Oxygen Pulping of Rice Straw

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Alkali-Oxygen pulping of rice straw both in a high straw consistency(HC) method and in a medium straw consistency(MC) method was developed. In the case of the immersing with 2% NaOH soln. at 40℃, pulp obtained by the oxidation with oxygen of 5kg/cm² at 120℃ in the HC method showed brightness of 61.2, breaking length of 6.8km, burst factor of 3.7, and tear factor of 72 in total screened yield of 47.2%. The HC system gave pulp have 3 to 10 point higher brightness, 0.4 to 3km lower tear factor than those in the MC method in the same condition. In the MC method oxidation reaction is restrained because of lower concentration of alkali in the reaction.

Seventh Cimtec World Ceramics Congress, Montecotini, Italy, June 24-30, 1990

Preparation and Properties of In_2O_3 Thin Films by Sol-gel Method

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Transparent and conductive tin-doped In_2O_3 (ITO) thin films were prepared at 550°~900℃ on fused silica substrates by a sol-gel method. Sol solution was prepared by hydrolysis of In and Sn sulfates with NH_4OH solution. Small amount of polyvinylalcohol was added to sol solution as a binder. Sol films applied on the substrates subsequently transformed to transparent gel films by drying. ITO films were obtained through amorphous state by releasing OH groups from the gel films during the firing, and were composed of very fine particles. The electrical resistivity of the film with 14mol% Sn prepared at 850℃ for 30 minutes was $3\times10^{-3}\Omega$ cm and after the annealing at 300℃ for 30 minutes in vacuum, it decreased to $6\sim8\times10^{-4}\Omega$cm. The optical transmittance of the film with 140 nm in thickness was over 90% in the visible region.

The 9th International Conference on Crystal Growth 20-25 August 1989, Sendai

Hydrothermal Growth of Calcite Single Crystals from H_2O-CO_2-$CaCO_3$ System

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Calcite single crystals were successfully grown at relatively high growth rate from H_2O-CO_2-$CaCO_3$ system by controlling CO_2 pressure. The maximum growth rate, 45μm/day, was obtained under a CO_2 pressure of 70MPa and a H_2O pressure of 35MPa at a seed temperature of 225℃ and a nutrient temperature of 190℃. Under both a high CO_2 pressure and a high temperature, a high degree of supersaturation would be attained, but spontaneously nucleated crystals interfered with the effective growth on the seed crystal. A highly transparent crystal was obtained at a low growth rate of 10μm/day. High growth rate of 45μm/day, however, deteriorated transparency of the grown crystal because of many cracks. In the crystal grown by a long run for 23 days, the quality such as dislocation density was improved with proceeding crystal growth. The CO_2-H_2O solution was found in this study to be an effective solvent for the hydrothermal growth of calcite single crystals.

1989 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, U. S. A., December 17-22, 1989

Mechanochemical Phenomena of Gibbsite, Bayerite and Boehmite by Grinding

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Three kinds of hydrated aluminas were ground in air for 0.25-20h using a planetary ball mill. The effect of grinding on their texture, structure and thermal behaviors was investigated by means of XRD, TG, DTA, SEM, IR, particle size distribution and nitrogen gas adsorption. It was found that in the early stage of grinding (within lh), the specific surface area increased in gibbsite, decreased in bayerite and had a maximum in boehmite, and then reached respective equilibrium values. These behaviors were correlated with changes in the median size, d_{50}, as a measure of the aggregate size of particles. With increasing grinding time, the intensity of X-ray diffraction lines decreased and the half-maximum line breadth increased. After the grinding of 4 or 8h, all hydrated aluminas changed to amorphous phase without any occurrence of the mechanochemical dehydration. This amorphous hydrated alumina transformed to amorphous alumina, to η-Al_2O_3 and to α-Al_2O_3.

The 4th Japan-China-U. S. A. Symposium on Catalysts, Sapporo, Japan, July 3-7, 1989

Mechanisms of Dehydrogenation and Steam Reforming of Ethanol over Copper-Based Catalysts

— Formation of Ethyl Acetate and Acetic Acid —

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The title reactions over copper-based catalysts were markedly affected by the kinds of the support. Acetaldehyde was formed by dehydrogenation of ethanol and transformed to ethyl acetate or acetic acid through the steps in which nucleophilic addition of C_2H_5OH (or C_2H_5O-) or H_2O (or -OH) to acetaldehyde were comprized. The transformation steps to ethyl acetate and acetic acid were appreciably affected by the presence of the support whereas the dehy-

drogenation step to acetaldehyde was unaffected. The former step proceeded at a slow rate as compared with the latter. These findings contrasted with the previous ones for the corresponding reactions of methanol in which the dehydrogenation step was rate determining. This brought about a great difference in the effect of the support upon reforming of methanol and ethanol.

On the basis of the proposed mechanism, the functions of copper were discussed for the reactions in which aldehyde and aldehyde-like species participated.

The 4th Japan-China-U. S. A. Symposium on Catalysts, Sapporo, Japan, July 3-7, 1989

TRM and TPD Studies of Nitric Oxide Reduction by Hydrogen over Copper Catalysts

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The reduction of NO with H_2 over supported and unsupported copper catalysts has been investigated by means of TRM (transient response method) and TPD. N_2 and N_2O were produced together with water. The activity and selectivity of NO reduction were highly sensitive to the types of support and the amounts of copper loading. NO was dissociated into adsorbed nitrogen(N_s) and adsorbed oxygen(O_s) over reduced sites(Cu^0), whereas molecularly adsorbed over oxidized sites(Cu^{2+}). N_s formed was desorbed as N_2 or reacted with molecularly adsorbed NO to produce N_2O. The surface redox occurred with H_2, NO and N_2O, and had a marked effect upon the amount of reduced and oxidized sites. This brought about the great change in the relative amount of adsorbed species over supported copper catalysts.

40th International Society of Electrochemistry Meeting
Kyoto, Japan, September 17-22, 1989

An Electrochemical Carbon-Carbon Bond Formation Between Carbonyl Compounds and Allylic Halides —The Use of Reactive— Metal Electrode

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Electrochemical allylations of aldehydes and ketones with various allylic halides by the use of a cadmium anode gave the corresponding homoallyl alcohols in high yields. We found that electrolysis by means of a platinum cathode and a cadmium-modified platinum anode and by alternating the cathode and anode at constant intervals gave satisfactory yields of the homoallyl alcohols and the loss of a cadmium metal was lower.

Similar electrochemical allylations of benzoic acid derivatives with metallic anodes such as Ni, Mn, Cd, Zu, or Fe gave the corresponding β, γ-unsaturated ketones in moderate yields.

These electrochemical carbon-carbon bond formations between allylic halides and carbonyl compounds by the use of a reactive-metal anode such as cadmium and nickel are discussed.

The 1989 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, U. S. A. December 17-22, 1989

A New Development in the Photochemistry of Oximes

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Unprecedented photoinduced rearrangements of steroidal α, β-unsaturated cyclic ketone oximes are reported. The photoreaction of (*E*)-1-trideuteriomethyl-2-deuterio-4, 4-dimethyl-5α-cholest-1-en-3-one oxime in a protic or an aprotic solvent gave rise to a β, γ-unsaturated oxime, 1-dideuteriomethylene-2β-deuterio-5α-cholestan-3-one oxime. The photoreaction of 4, 4-dimethyl-2-deuterio-5α-cholest-1-en-3-one oxime under the same conditions, on the other hand, led to a skeletal rearrangement to give a cholestanoisoxazole.

On the basis of extensive deuterium labelling studies, a mechanism for this photorearrangements that involve a novel stereospecific transfer of a hydroxyimino hydrogen is suggested.

International Conf. on Amorphous and Liquid Semiconductors, 13th ICALS Asheville NC., U. S. A., August 21-25, 1989

Anisttropic Amorphous Semiconductors

— Uniaxial Compression and Squeezing —

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Non-crystalline materials are inherently isotropic, and it is of interest to examine what kinds of anisotropics can be induced through some artificial treatments. Investigations on origins of anisotropies may also be valuable to elucidate the nature of amorphous semiconductors. With these motives in mind, I have carried out uniaxial pressure experiments. The study for chalcogenide glasses such as As_2S_3 compressed between pairs of diamond anvils has revealed that anisotropic glasses can be obtained through elastic and plastic deformations.

US-Japan Joint Seminar on Atomic Processes Induced by Electronic Excitation in Non-Metallic Solids, Nagoya, Japan, September 11-15, 1989

Photo-Induced Structural Changes in Chalcogenide Glasses

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Amorphous chalcogenide semiconductors show a variety of photoinduced effects, most of which are triggered by electronic excitations. I will first introduce these phonomena, then focussing my talk on the "reversible change" (photoinduced changes which can be recovered by annealing at glass-transition temperatures) accompanying the photodarkening and structural transformations. The characteristics are reviewed, and the present status of understanding is outlined. Finally, a new idea assuming two-phase amorphous structures is proposed.

1989 ASME/JSME Joint Conference on the Pressure Vessel and Piping, Honolulu, Hawaii, U. S. A., July 23-27, 1989

Highly-Sensitive Sensors Based on Optical Fabry-Perot Resonator

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A highly sensitive displacement measuring method based on an optical Fabry-Perot resonator has been devised. It is applied to construct a highly sensitive and miniature sensor. The sensor utilizes changes of the resonance characteristics of the resonator due to changes of the resonator cavity length caused by measurand. Some key techniques are used to improve linear range and long term stability of such sensor. The principle and key techniques to realize the stable and highly sensitive sensors based on an optical Fabry-Perot resonator are presented. Commercially available sensors applying the present principle are also described.

6th International Conference on the Optical Fiber Sensors, Paris, France, September 18-20, 1989

Static Strain Monitoring OFS Using FM Laser Diode

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and Ichiro UEHIRA
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Conventional interferometric measuring method detects changes of a measurand by incremental fringe-counting using a constant wavelength light source. An interferometric OFS for a static or very slowly changing measurand is, therefore, difficult for the conventional interferometric technique because of problems which are due to this incremental nature. It is possible to determine the absolute value of an optical path length using a frequency modulated laser diode. A novel principle for a static strain monitoring OFS is presented based on the method. Both the principle and some results of the experimental study of the static strain OFS based on the principle are also described.

4th International Conference on Sensors and Their Applications, Canterbury, UK, September 25-29, 1989

Interferometric Optical Fibre Sensor for Static Strains

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An interferometric fibre-optic strain sensor is proposed by applying the method which utilizes a frequency charped laser diode to detect a static optical path difference. Frequency charped light from the laser diode is launched into one inlet of a mono-mode fiber X-coupler, which consists of a fibre-optic Michelson interferometer. The light is divided by two by the coupler, each branch of which works as the respective arm of the interferometer and is fixed on either side of a cantilever. The lever is used to add the branches appropriate strains to be measured. Light rays divided to each branch are reflected back by the fibre end of the respective branch and further combined by the coupler to interfere. The number of intensity changes of the interfered light is counted while charping the frequency of the light source and gives a measure of the static strain to be measured. Results of the basic experiments performed on the basis of the method are also presented.

1989 Joint International Waste Management Conference October 22-28, 1989 Kyoto, Japan

Radiation Effects on Volumetric Change and Corrosion for Simulated Radioactive Waste Glass

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Simulated radioactive waste glasses were irradiated, using three kinds of facilities: a high-voltage electron microscope, an electron accelerator, and a nuclear reactor. Radiation effects

on microstructual change, density change, annealing properties of the density change and leaching properties were studied by the authors and were reviewed in this paper.

Waste glass swelled or shrank at most 0.6%, depending on the kind of glass when irradiated in a nuclear reactor with $^{10}B(n, \alpha)^{7}$ Li reaction up to a fluence of 6.6×10^{25} reaction/m^3. Helium bubble was observed in the irradiated glass. The cumulative irradiation is roughly equivalent to irradiation during a few tens of thousand years after disposal. The irradiated waste glasses swelled at most 0.5% when thermally annealed above the temperature of 620K. The glass which shrank as the result of the (n, α) irradiation swelled larger than glass which swelled.

The apparent diffusion coefficient of Cs obtained from normalized elemental mass loss of Cs decreased an order of magnitude when irradiated with the reaction beyond around 0.1dpa (displacements per atom).

International Society of Electrochemistry 40-th ISE Meeting Kyoto, Japan Sept. 17-22, 1989

Neutron Evolution from Palladium Cathode in D_2O-LiOD Solution

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Sapporo 060, Japan

The reasons that the difficulty of confirmation of the cold fusion and low reproducibility of the reaction were considered with some speculation for the mechanism. The crack mechanism seems to be one of the most suitable model, and explains the situation of the cold fusion. And the validity of the mechanism of the cold fusion reaction was discussed with the measurement result obtained by a deuteron accelerator. The expectation for the practical use of the cold fusion reaction as an energy source was suggested. If the crack mechanism can be taken a proper model to the cold fusion, neutron evolution for an ideal condition should be increased by $10^{8}\sim10^{9}$ orders of magnitude. At the same case, we could get the heat of $10^{-4}\sim10^{-3}$ Joule/s/kg for the metal absorbed hydrogen.

Sixth International Symposium on Passivity (Passivation of Metals and Semiconductors), Sapporo, Japan 24-28 September 1989

In-situ Analysis of Chloride Ion Concentration within Pits during Pitting of Iron

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Pitting corrosion of pure iron in borate buffer solution was studied by in-situ measurement of chloride isotope ^{36}Cl. Relationships between conentration of chloride ions and current density in a pit during pitting corrosion are discussed. And they are summarized as follows. (1) The growth process of pits is divided into two steps by the variation of concentration of chloride ions and pitting current with time. The first step: The concentration of chloride ions on a pit surface (γ_p) increases linearly with time while the current density (i_p) stays constant. The second step: γ_p stays at a constant value, on the other hand, i_p decreases gradually with time. (2) Both of γ_p and i_p increase with the external electrode potential. (3) Also γ_p and i_p increase with a logarithmic low of the concentration of chloride ions in a bulk solution.

International Symposium on Computational Fluid Dynamics-Nagoya, Nagoya, Japan, August 28-31, 1989

Generalized Boundary Conditions on the Basis of a Deformable-Cell Method

— Free Surfaces, Density Interfaces and Open Boundaries —

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In the numerical analysis of flows, we need to treat various types of boundary conditions. Especially in the fields of oceanophysics or hydraulics, "free surface," "density interface," and "open boundary" have been considered difficult to treat. On the basis of a deformable-cell method, the cells dividing the fluid can be deformed in accordance with the moving boundaries as in the Arbitrary-Lagrangian-Eulerian (ALE) method, and these boundary conditions are systematically treated on a "generalized boundary equation." The validity of this method is shown by a flow with a free surface, a density interface, and an open boundary.

Sixth International Symposium on Passivity (Passivation of Metals and Semiconductors), Sapporo, Japan
September 24-28, 1989

Piezo-electric Response to Surface Stress Change of Iron and Copper Electrodes Covered with Oxide Films

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The Piezoelectric technique combined with the admittance method has been applied to the study on iron and copper electrodes covered with oxide films in the borate buffer solutions with and without SO_4^{2-} ions. The addition of SO_4^{2-} ions enhanced the piezoelectric signal during the cathodic reduction of the oxide film on the iron electrode rather than that on the copper electrode. Similar behavior of the piezoelectric signal and the admittance were observed for the iron electrode, indicating that the cathodic reduction of the oxide films proceeds at the film/solution interface. For the copper electrode, no significant effect of SO_4^{2-} ions on the piezoelectric signals revealed that the solid state mechanism is operative in the cathodic reduction of oxide films. The potential of zero charge for iron and copper surfaces without any oxide films in borate buffer solution was also determined from the piezoelectric signals.

Sixth International Symposium on Passivity (Passivation of Metals and Semiconductors), Sapporo, Japan
September 24-28, 1989

Study on Electroluminescence from Si durdng Anodic Oxidation

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Hokkaido University, Sapporo, Japan

Electroluminescence (EL) was measured from single crystal p-type Si (100) during anodic oxidation in ethylene glycol solutions of KNO_3 containing KCl or water as an addition. The broad EL spectra with two peaks at 350nm and 670nm, respectively were observed under the galvanotatic condition. The addition of water reduced all these peak intensities, whereas the addition of KCl enhanced significantly the intensity of the 670nm peak. The origin of EL is discussed in relation to the silica film (SiO_2) formed on Si during anodic oxidation.

Sixth International Symposium on Passivity (Passivation of Metals and Semiconductors), Sapporo, Japan September 24-28, 1989

An Overview on The Passivity of Metals

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A review is made of some essential subjects on the passivation process, the passive film, and the film breakdown. Passivation of metals results from the formation of a condensed phase of continuous oxide layer on the metal surface. The electrochemical stability of passivated metals depends not only on the chemical property but also on the electronic property of the passive films. The electronic avalanche breakdown of passive film occurs when the film is thick, while the ionic breakdown emerges with thin oxide films in the presence of aggressive anions. The film breakdown is followed either by repassivation or by pitting corrosion depending on the degree of metal salt enrichement at the film breakdown sites.

Sixth International Symposium on Passivity (Passivation of Metals and Semiconductors), Sapporo, Japan September 24-28, 1989

In-Situ Gravimetry of Passivation of Copper by Means of Quartz Crystal Microbalance

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The QCM-technique was applied to the study of corrosion and passivation of copper. The QCM-results were in good agreement with the electrochemical results. The anodic current was separated into metal dissolution current and oxide film formation current, from which the ratios of the corresponding charge transfer coefficients were evaluated.

Sixth International Symposium on Passivity (Passivation of Metals and Semiconductors), Sapporo, Japan September 24-28, 1989

An Analysis of Transient Photocurrents Measured on Passivated Iron Electrodes

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The electronic properties of the passive film formed on iron in pH 6.5 borate solution were investigated by measuring the transient photocurrent. The charge and the time constant of decay of the spikelike photocurrent and the steady state photocurrent were measured as a function of potential. A simulation was made to explain the transient behavior of the photocurrent by assuming an equivalent circuit with generation of a photo-induced free carrier pair in the n-type passive film. From the simulation the transient photocurrent behavior can be explained from the relationship between thickness of the passive film, the recombination rate of photo-induced free carrier in the film, the density of surface states, and the charge transfer from or to the redox system in the solution.

Sixth International Symposium on Passivity (Passivation of Metals and Semiconductors), Sapporo, Japan September 24-28, 1989

The Dependence of Refractive Index and Thickness of Iron Passive Films upon the Oxidation Condition

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The change of refractive index of the passive film on iron which was obtained by 3-parameter reflectivity measurements was arranged in term of the electric field strength. The higher refractive index which corresponds to the higher electric field is interpreted by dehydration induced by anodically high electric field. The hydration and dehydration may be connected to the secondary Wien effect for ionic dissociation.

Third International Conference on Phonon Physics and Sixth International Conference on Phonon Scattering in Condensed Matter, Heidelberg, Germany, August 21-25, 1989

Phonon Trassmission Through Periodic, Quasiperiodic and Random Superlattices

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A review is given of the acoustic phonon propagation in semiconductor superlattices (SL's) studied extensively both theoretically and experimentally. The newly predicted stop bands arising from intermode-phonon Bragg reflection and their experimental verifications are emphasized. In a SL based on a random array of binary layers the phonon transmission spectra still exhibit distinctive distribution of phonon stop bands against our naive expectation. A phonon imaging experiment is suggested to verify all these charactoristics of phonons in SL's.

Third International Conference on Phonon Physics and Sixth International Conference on Phonon Scattering in Condensed Matter, Heidelberg, Germany, August 21-25, 1989

Phonon Scattering by 2D Electrons in GaAs/AlGaAs Heterostructures at High Magnetic Fields

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We calculate the phonon lifetime limited by the interaction with two-dimensional (2D) electrons at high magnetic fields. The results compare favorably with the experimental data of Eisenstein et al. In particular, the screening effects are essential to explain the magnitude and the temperature dependence of the observed thermal conductance at 0.1 to 10K range.

March Meeting of American Physical Society, Anaheim, U. S. A., March 12-16, 1990

Measurement of the elastic scattering rate of phonons in high-purity silicon

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We have employed the phonon-imaging technique to measure the elastic scattering rates of high frequency phonons in silicon. Comparison of the ratio of the scattered phonon flux to the total phonon flux with Monte Carlo calculations assuming the slotted geometry permits a direct measurement of the elastic scattering in the crystal. The scattering rates are close to the values predicted for pure isotope scattering in silicon.

Center for Particle Astrophysics Workshop on Phonon Scattering in Silicon for Particle Detection, Stanford, U. S. A., May 14-16, 1990

Monte Carlo Calculations for Phonons in Silicon : Lattice Dynamics Calculations with Elastic Scattering

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We study the propagation of acoustic phonons in silicon based on the lattice dynamics models, i. e., the bond-charge model and an effective force-constant model consisting of only short-range forces. For the ledge ratio of the scattered to total phonon intensities in the (110)-oriented silicon, the Monte Carlo simulations with these lattice dynamics model yield very similar values close to the elasticity theory predictions, validating our previous results on the measurement of the elastic scattering rate of silicon.

Sixth International Symposium on Passivity (Passivation of Metals and Semiconductors), Sapporo, Japan September 24-28, 1989

The Role of Anions in the Formation of Hydroxide Films on Aluminum in Hot Aqueous Solutions

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The formation characteristics of hydroxide films on aluminum were studied at 99.5℃ in neutral solutions of citrate, silicate, and phosphate ($10^{-4}-10^{-2}$M) as well as in doubly distilled water (DDW), by gravimetry, chemical analysis, TEM, and XPS.

In silicate and phosphate solutions both the oxidation of aluminum and formation of hydroxide films were retarded with increasing anion concentration, and in citrate solutions the oxidation rate increased but the film formation rate decreased. TEM showed that all the films formed in the test solutions consist of one layer except with DDW and 10^{-4}M silicate solution, and the thickness decreases with increasing anion concentration. The film formed in DDW and 10^{-4}M silicate solution had a two layered structure. According to XPS, appreciable amounts of silicate or phosphate were included in the film formed in all solutions.

The role of the anions on hydration of aluminum was discussed in terms of the stability and dissolution of surface films.

177th ECS Meeting Montreal, Quebec, Canada, May 6-11, 1990

Hydroxide Films on Aluminum Formed in Neutral Phosphate Solutions :

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Hydration of aluminum in neutral phosphate solutions has been investigated at boiling temperature as a function of phosphate concentration by gravimetry, chemical analysis, impedance measurements, electron microscopy, and X-ray photoelectron spectroscopy. It was found that hydration of aluminum was inhibited most strongly in 10^{-2}M solution by forming a this hydroxide film with 10-20nm thickness. Impedance analysis suggested the existence of this oxide layer between hydroxide and metal substrate.

The 4th Battery Material Symposium, October 1-4, 1989, York, England

Characterization of the Acid-Base Properties of MnO_2 and Other Metal Oxide Samples in Aqueous Media

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The surface charge on MnO_2, Fe_2O_3, and TiO_2 samples in $NaNO_3$ solutions were measured as a function of pH by titration. The charge is formed by the acid-base dissociation of surface hydroxyl groups, i.e., the ion exchange between H^+ and Na^+ ions and between OH^- and NO_3^- ions. The relationship between the surface charge and pH was characterized by a nonlinear least squares method with the Frumkin type equilibrium conditions, in which suppression by formed charged sites is assumed. The established equilibrium constants fit the experimental data well and the acid-base properties of oxide samples and PZC were quantitatively explained with these constants.

The 4th Battery Material Symposium, October 1-4, 1989, York, England

Characterization of the Adsorption of Co^{2+}, Ni^{2+}, Zn^{2+}, and Cu^{2+} Ions on an MnO_2 Sample

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The amounts of adsorption of Co^{2+}, Ni^{2+}, Zn^{2+}, and Cu^{2+} ions on MnO_2 were examined as a function of pH and the concentrations of metal ions and MnO_2. The metal ions are adsorbed by forming surface complexes with acid hydroxyl groups on the metal oxides replacing one or two protons. The adsorption behavior was analysed by fitting the Frumkin type equations, in which suppression of adsorption by the adsorbed metal ions is assumed. The established equilibrium constans well explain the measured adsorption isotherms. With these constants the concentrations of the surface complexes and the fraction of adsorbed metal ions were calculated as a function of pH for specified conditions. The calculations quantitatively show the affinity of metal ions and the ability of metal oxides for adsorption.

COMPUMAG, Conference on Computation of Electromagnetic Fields, Tokyo, Japan, Sep. 3-7, 1989.

An Error Estimation of the Solution of Integral Equation Method.

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Tadayoshi MIYATA and Masato IGARASHI.
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Some numerical experiments on the error estimation of the solution using integral equation method is discussed. The new error estimating method has the possibility which evaluates the local error of the solution as well as the global error of the entire solution in the meaning of average. A performance index of the error is introduced by the integral equation scheme itself and is examined in a simple 3D-Laplace problem.

Second Microoptics Conference/Eighth Topical Meeting on Gradient-Index Optical Imaging Systems (MOC/GRIN'89), Tokyo, Japan July 24-26, 1989

An All-Fiber Phase Modulator Utilizing Piezoelectric Copolymer Coating

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An all-fiber phase modulator that is a modulator integrated into optical fibers is one of the promising electro-optic phase modulator for use in optical communication and fiber sensor systems. The feasibility of jacketing a copolymer of vinylidene fluoride (VDF) with 73-mol% and trifluoroethylene (TrFE) with 27-mol% on single-mode fibers was demonstrated. In this paper we briefly report frequency response of the optical phase shifts induced in a radially poled copolymer jacketed fiber. The phase sensitivity of the fiber is also described both experimentally and analytically over a high frequency region of 2 MHz to 50 MHz.

1989 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, December 17-22, 1989

Ionization Efficiencies of Hydrocarbons, Alcohols, and Ethers

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An ionization efficiency, a quantum yield of ionization has been considered to be one of the most fundamental quantities in understanding superexcited states, which have higher excitation energy than ionization potential, and measured for limited numbers or kinds of molecules mainly by using discharge lamps. In this paper, the ionization efficiencies of C_3H_6, C_4H_8, C_6H_{12}, C_2H_6O, and C_3H_6O isomers are measured by using synchrotron radiation as a light source in the wavelength region from 105 to 134nm. The ionization efficiencies of cyclopropane and cyclohexane monotonically increase with increasing photon energy, but those for the others show a peak or a shoulder in the wavelength region of the present work. The energy difference between the first and the second ionization potentials correlates well the wavelength dependence of the ionization efficiencies.

7th World Congress of the International Society for Artificial Organs Sapporo, Japan, 2-4 October, 1989

Calcification of Synthetic Polymers in Serum

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Calcification has been identified as one of the causes of diaphragm failure associated with long-term use of artificial heart. This study was concerned with the in vitro calcification of synthetic polymers in cell-free serum.

Porous samples prepared from polyurethane, silastic rubber, polymethylmethacrylate, polyacrylonitrile by salt-casting method were immersed in fresh bovine sera whose Ca and P levels were adjusted to 10mg/d*l* and 7mg/d*l*. The sera were changed every week, and the

[Ca] and [P] changes were measured by a colorimetry method. After 6 weeks, the samples were subjected to histology, SEM, EDAX and atomic adsorption studies.

All samples except silastic showed clear evidences of calcium phosphate deposits. The amount of the deposit was well agreed with the amount of total reduction of Ca and P from the solution. The Ca/P ratios ranged from 2.0 to 2.4, which are very close to the value of hydroxyapatite of 2.16. To study the effect of adsorbed proteins on the calcification, immobilized serum proteins on polyallylamine coated glass beads were immersed in the serum. The proteins were heat treated at 60 or 80℃ before the immersion. Compared to the non-heat treated proteins, the heated samples showed enhanced mineral deposits.

This study suggested that calcification could take place through the mechanism besides dystrophic type. The adsorbed proteins may have some influence on the calcification process.

7th World Congress of the International Society for Artificial Organs Sapporo, Japan, 2-4 October, 1989

Alteration in CD_4^+T Cells/CD_8^+T Cells Ratios in Con A Stimulated Lymphocytes by Synthetic Polymers.

— In Vitro Evaluation —

Ayumi MITO, Shun MURABAYASHI, Toshio YUHTA, Chikako IWABUCHI*, Kazuya IWABUCHI*, and Kazunori ONOE*

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During extracorporeal circulation (EC) such as hemodialysis, changes in lymphocytes subpopulation and functions have been reported. Dialysis membrane effects on such changes have been considered. In the present study the effect of synthetic polymers on lymphocytes were investigated in vitro in terms of changes in T cell subpopulation and IL-2 production.

Murine splenic lymphocytes were cultured with ConA in the presence of glass beads coated with different polymers, namely cellulose acetate (CA), polyvinyle alcohol (PVA), polyacrylonitorile (PAN). After 72 hrs, the expressions of CD_4 and CD_8 antigens on the cultured lymphocytes were analyzed by FACSCAN. Further, amounts of IL-2 in the culture supernatants were quantified by Gills's method and compared.

The ratios of CD_4^+T cells/CD_8^+T cells were constantly higher (1.1) in lymphocytes cultured in presence of various polymers than those in control cultures where no polymer beads were added (0.9). However, insignificant difference was seen among lymphocytes cultured with CA, PVA and PAN. Furthermore, each cell culture produced almost same amounts of IL-2 despite the presence and absence of the polymers (CA 43, PVA 52, PAN 49 and control 43).

The present finding suggests these influences on lymphocytes should be taken into consideration, when patients are treated by EC.

7th World Congress of the International Society for Artificial Organs Sapporo, Japan, 2-4 October, 1989

Proliferation of B Lymphocytes is Enhanced by Poymer Membranes: In Vitro Study

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Blood-material interactions cause humoral and cellular changes in the blood. In the present study, LPS responses of spleen cells in the presence of polymers were investigated. Mouse spleen cells were cultured with LPS and cellulose acetate (CA) or polyethylene (PE) for 72 hrs. Before culture, CA and PE surfaces were treated with medium alone, (NONE); with mouse serum (SERUM); with mouse serum and then with anti-C3 Ab (ANTI-C3). RPMI-1640 containing mouse serum was used for culture except SERUM group. Proliferation of the spleen cells was measured by ^{3}H-thymidine incorporation, and expressed as mean stimulation index (SI)±SEM (n=9*, n=6).

Treatment:	NONE	SERUM	ANTI-C3	NO POLYMER
CA	28.6±3.1*	24.7±2.0	14.7±2.8	13.8±3.2*
PE	14.4±2.7*	13.1±1.7	7.0±1.9	

The proliferative responses to LPS were markedly enhanced by contact with CA but not with PE. Further, the responses in NONE (CA) and SERUM (CA) groups were significantly greater than that of ANTI-C3 (CA) groups ($p<0.01$). From these finding, the follow conclusions can be drawn. 1. Polymer membranes enhance the B cell proliferative response to LPS. 2. The enhancement obtained with CA requires the presence of mouse serum. 3. The major mechanism which may explain the enhancement seems to be related with complement C3 activation on polymer surfaces.

7th World Congress of the International Society for Artificial Organs Sapporo, Japan, 2-4 October, 1989

Sponge Polyurethane Graft; Possible Experimental Model for Polyurethane Biodegradation in Vivo

Naoki UCHIDA, Helen KAMBIC, Shun MURABAYASHI*, Hideo EMOTO
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The in vivo biodegradation of polyurethane coincided with a decrease in compliance of sponge type vascular grafts. Biolized sponge and solid Biomer vascular grafts, 5cm long, 4 mm ID and 0.5mm wall thickness, were implanted end to end fashion as carotid substitutes in dogs for 6 weeks. Sponge graft have 35-50μm pore size.

Patent sponge grafts showed a decrease in mean compliance values of 13.5 to 7.14×10^{-2}%/mmHg; solid grafts were unchanged at mean value of 1.0×10^{-2}%/mmHg. Calcification within the perfusion fixed graft wall was observed histologically by Von Kossa stain and by electron microscopy. None of the solid grafts but 8 out of 9 sponge grafts showed calcification. Early crystalline formation was detected on sponge wall surfaces. Five of each type of explanted graft were analyzed by gel permeation chromatography. The elution count witdths for sponge and solid grafts were significantly different, 2.33 ± 0.32 and 1.99 ± 0.02 ($p< 0.05$), respectively. The widths of non-implanted grafts were 2.05 and 2.0 for sponge and solid grafts, respectively. The peak heights were not comparable due to low molecular weight contaminants.

The porous polyurethane structure shows early calcification and increases in molecular weight distribution due to its large surface area and vulnerability to mechanical stresses as early as 6 weeks. Sponge grafts serve as a model for early detection of polyurethane biodegradation.

7th World Congress of the International Society for Artificial Organs Sapporo, Japan, 2-4 October, 1989

Scanning Electron Microscopic (SEM) Studies on Ceramics/Blood Interface

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Fine ceramic heart valve, consisting of a single crystal alumina disc and titanium nitride (TiN) housing, has been successfully implanted in sheep (J. Biomater. Appl., in press). Interaction between ceramic materials and platelet was studied in dogs to investigate blood compatibility of ceramics.

A test ring was implanted in the inferior vena cava in 10 dogs for 2 hours. The ring was 7 mm in inner diameter, 8mm in outer diameter, and 9mm in length. Test materials were single crystal alumina, TiN, polycrystalline alumina, seqmented polyurethane (Toyobo, TM-3), silicone (Pierce, SurfaSil), and glass. After the experiment, the test material was fixed in 2.5% glutaraldehyde, dehydrated by ethanol, and dried by critical-point method. The test material was examined by SEM every 100μm from the edge of the ring. Number of platelets in the area of $50\times50\mu m^2$ was counted.

Adhered platelets were 161 ± 17 (mean$\pm$S. E.)/$10^4\mu m^2$ ($n=41$) on single crystal alumina, 285 ± 35 ($n=19$) on TiN, 360 ± 37 ($n=21$) on polyurethane, 430 ± 23 ($n=25$) on polycrystalline alumina, 439 ± 31 ($n=5$) on glass, and 534 ± 64 ($n=15$) on silicone. Platelets were significantly ($p<0.01$) few on single crystal alumina compared with other materials. Also significantly few platelets adhered on TiN compared with silicone ($p<0.01$), glass ($p<0.05$), and polycrystalline alumina ($p<0.05$).

It can be concluded that single crystal alumina and TiN have weak interaction with platelet, and have good blood compatibility.

7th World Congress of the International Society for Artificial Organs Sapporo, Japan, 2-4 October, 1989

Investigation of Parameter Estimator and Adaptive Controller for Assist Pump by Computer Simulation

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The parameter estimation and adaptive control of pneumatic assist pump was studied.

For the estimation of system parameters, second order single input- single output AR (autoregressive) models are introduced. The controlled output is mean arterial prossure (mAoP), mean atrial pressure(mLAP), or mean blood flow and the control input is vacuum pressure of the pump. Recursive least- squares method is used to estimate the parameters. Based on the estimated parameters, controlled outputs in steady state with given vacuum pressures are predicted, and desired vacuum pressure minimizing the performance index is searched. The performance index is weighted summation of square errors.

Feasibility of parameter estimator and controller was demonstrated against the various changes in the circulatory condition by the computer simulation. In one example, left ventricular contractility suddenly decreased, the natural heart ejected no flow, and additionally peripheral resistance increased by 5% at the same time. mAoP dropped (115→97.5mmHg) and mLAP rose (3→4.2mmHg) instantaneously. But the controller smoothly restored the desired steady state (mAoP of 114mmHg, mLAP of 3.0mmHg) after 30 beats.

The developed controller adaptively controlled two variables; mean arterial and atrial pressures, against the various changes of circulation system. The estimator and controller can work on a personal computer.

7th World Congress of the International Society for Artificial Organs Sapporo, Japan, 2-4 October, 1989

Appliction of CCD Camera for Flow Visualization of Artificial Heart Valve

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Implantation of artificial heart valve is a safe procedure. However, there are some late valve related complications still remain to be solved. Hemolysis and thrombus formation have been allocated to the hemodyanamic disturbance due to the improper value design. Therefore, a through fluid dynamic characterization and evaluation of differnt artificial valve is important for the better valve development.

A new flow visualization system was developed, which utilized a CCD camera (FCD-10, Ikegami Co, Japan) combined with a image processing device (TV-200, Japan Abiotronics Co.). By utilizing the system, flow fields downstream of 22mm St. Jude Medical, Meditronics Hall, and Duromedics valves were evaluated in a steady-state flow condition. The test fluid was a 48% glycerol/water solution with a dynamic viscocity of 0.05(St) at room temperature. Polystyrene beads (Amberite XAD-7, 20-60 mesh) were used as visual tracer. The data input of the brightness was accumulated for the time duration of 1/3, 1, and 2 seconds. The stream lines of the tracer were obtained clearly, which showed comformable flow pattern reported by others. The velosity profile of the fleld could be calculated easily by the computer processing.

This new system utilizlng CCD camera is a very easy and useful method to study the fluid dynamics of artificial heart valve.

4th China-Japan International Symposium on Biomedical Rehabilitation Engineering Shanghai, China, 15-17 March, 1990

Parameter Estimation for LVAD System and Its Application

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Left ventricular assist devices (LVADs) are used to support the circulation and to reduced the load of the diseased heart. LVADs are clinically used to many patients in recent years, but long time survival rate is not satisfactory. To improve the results, it should be studied when the LVAD has to be applied and when it has to be removed. And also better results are expected if the LVAD is adaptively controlled according to the patient's hemodynamics. In this study, the parameters of the LVAD and circulatory system were estimated with auto-regressive (AR) model. And the applications to the LVAD driving were studied by computer simulation; one was the adaptive controller of the LVAD and the other was predictor of the hemodynamics with LVAD-off.

The 3rd International Symposium on Artificial Heart & Assist Device. February 16-17, 1990, Tokyo

Development of a Totally Implantable Electric Artificial Heart System (TIAH)

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The TIAH has been improved. Efforts were mainly made to reduce the volume and energy loss.

The volume of the motor-driven artificial heart (stroke volume of 60m*l*) was reduced by utilizing a specially designed miniature ball-screw and the weight was also reduced by using titanium. The volume is 490m*l* with total hearts and the controller 330m*l*. To detect rotor position and motor speed, a magnetic encoder was employed. This actuator can be used for both total hearts and an assist heart by changing attachments. The transcutaneous energy

transmission system employs an auto-tuning circuit which locks switching frequency to resonant frequency to maximize energy transmission efficiency. The volume is reduced to 45% of the previous model.

The TIAH system has been characterized in vitro. Pump outflow of over 5 *l*/min was obtained against the afterload of 100mmHg under motor input power of 9.8W. The developed system is a promising totally implantable artificial heart system.

36th Annual Meeting on American Society for Artificial Internal Organs. April 24-27, 1990, Washington

Transcutaneous Optical Information Transmission System for Implantable Motor-Driven Artificial Hearts

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Precise regulation of secondary output voltage (motor voltage) and monitor of the implanted pump were obtained in the transcutaneous energy transmission system. Information on both motor voltage and pump stroke is transmitted through the skin by frequency-modulated infrared pulses using a single pair of infrared LED and photo-transistor. The motor voltage is compared with the nominal value, and according to the error signal, the firing angle of inverter switching pulse is regulated. Infrared pulses up to 100kHz were transmitted through the porcine muscle up to 1cm thick. Both the pump stroke and motor voltage signals were transferred across the muscle without interference. The output voltage was kept almost constant for the change in tissue gap of 3-8 mm and in radial displacement of 0-10 mm. The developed system is useful for the implantable artificial hearts.

Nihon University International Symposium on The Development of Biomation in 21st Century—Artificial heart—. May 12-14, 1990, Tokyo

Development of a Totally Implantable Assist Heart Systen

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A totally implantable motor-driven assist heart system has been developed, characterized in vitro, and evaluated in vivo. The system consists of two subsystems; DC brushless motor-driven assist pump and transcutaneous energy transmission system. The motor-driven assist pump utilizes a ball-screw to convert high-speed rotary motion into low-speed rectilinear motion. Magnetic coupling is utilized between the actuator and the blood pump to fill the pump with blood by magnetic attractive force. The energy transmission system employs an auto-tuning circuit which locks switching frequency to resonant frequency to maximize energy transmission efficiency. Information on the output voltage and pump stroke is transmitted through the skin by infrared pulses.

The in vitro test showed that the pump outflow of 4.8 *l*/min was obtained against the afterload of 100mmHg under the preload of 15mmHg at the drive rate of 80bpm.

1989 International Symposium on Electromagnetic Compatibility, Nagoya, Japan, Sep. 8-10, 1989

Measurement and Analysis of ELF Electric Field on Human Body Surface

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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 human hair, the measurements were conducted with different temperatures and humidities of

surrounding air. It was found that the dielectric constant of hair increased with the relative humidity. These results provide useful information concerning the mechanism of biological effects of electric field. They explain well the seasonal variation of the threshold level of field perception.

International Symposium on Control of Breathing and Dyspnea, Sendai, Japan, October 27-28, 1989

Effect of Sudden Withdrawal of Respiratory CO_2 Oscillation on the Phrenic Nerve Activity

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We examined the effect of sudden withdrawal of CO_2 oscillations on the respiratory center output in 8 anesthetized, paralyzed, and vagotomized dogs. The CO_2 oscillations in the control calculated from the arterial pH oscillations measured with a rapidly responding intra-arterial pH electrode was 2.8 ± 1.0mmHg (mean$\pm$SD, $n=24$). When the oscillations were completely abolished by alternately ventilating each lung without affecting the mean level of arterial P_{CO_2} (deviation from the control: -0.05 ± 0.62mmHg; $p>0.7$, $n=24$), we found negligible changes in the minute phrenic activity to the withdrawal of CO_2 oscillations ($1.4\pm8.5\%$, $p>0.4$, $n=28$; 95% confidence limit, -1.9% to 4.6%). Thus we conclude that CO_2 oscillations do not exert an important effect on the respiratory center output at rest.

The Combustion Institute, Joint International Conference, Australia/New Zealand and Japanese Sections, Sydney, Australia, Sep. 24-27, 1989

Estimation of Thermal Radiation from Large Pool Fires

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The Radiative Heat Ray method (R. H. R. method for short) is introduced to calculate radiative heat flux around a large experimental fuel tank (6m dia.). The measured temperature distribution of a large pool fire is used to estimate thermal radiation near the tank. In this paper, an analytical procedure of the R. H. R. method is shown and the result of radiative heat flux distribution is compared with the result obtained from the point source model.

11th Joint Meeting of the UJNR Panel on Fire Research and Safety Berkeley, U. S. A., Oct. 19-24, 1989

Estimation of Thermal Radiation from Large Pool Fires

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* Fire Research Institute, Tokyo 181, Japan

Thermal radiation plays a very important role in pool fires, because the burning rate of large pool fires is greatily influenced by radiative heat transfer. The problem of thermal radiation hazards also depends on the characteristics of radiative heat transfer. In an attempt to estimate thermal radiation from pool fires having diameters over 10m, the authors have been devising a new and simple simulation model which is called the one mesh model. The analytical results of the one mesh model were compared with the experimental results and values in the literatures.

4th International Conference on Engineering Computer Graphics and Descriptive Geometry Miami, U. S. A., June 11-15, 1990

Hypercard Stacks for Dnscriptive Geometry Education

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HyperCard is the name of world-wide well-known soft ware package for the Macintosh computer, originating in the U. S. A. Stacks, a kind of software made by HyperCard, have been applied to descriptive geometry education on trial at Hokkaido University in Japan. Students of the general education course are now obtaining information directly from a large computer screen projected with a special overhead projector system. This paper gives general information of HyperCard, particularly its graphic capabilities and of the stacks developed for descriptive geometry education by the author.

The First European East-West Symposium on Materials and Processes, Helsinki, Finland, June 10-18, 1990

Nickel-Magnesia Joining Using Composite of Nickel-Metal and Nickelous Oxide

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The direct joining of nickel-metal to magnesia was previously examined at 1573K under null pressure in air. The fracture strength of the joints ranged from 30 to 70MPa by three-point bending tests, and a fracture pass spread into the interface between nickel-metal and the solid-solution of nickelous oxide and magnesia. Such a flat discontinuous interface is a weak point of any joints.

In order to improve the interfacial structure, a composite of nickel-metal and nickelous oxide having a stepwise controlled compositional gradient was used for fillers. This composite was placed between nickel-metal and magnesia, and this set was annealed at 1573K under null pressure in air. The fracture strength of the joints increased than that of the previous joints. The strength up to 128MPa was achieved. This result suggests that thermal stress was released by the improved interfacial structures.

4th International Conference
on Fusion Reactor Materials
Kyoto, December 4-8, 1989

Compatibility of a V-15Cr-5Ti Alloy with SiC at High Temperatures

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To clarify the chemical compatibility between a V-15Cr-5Ti alloy and silicon carbide, the extent of reaction, the reaction products and the structure of reaction layer were studied at temperatures ranging from 1423K to 1523K in an argon gas stream. The reaction layers formed in the interfacial reactions consisted of the silicides, V_5Si_3 and V_3Si, and minor amounts of TiC over the temperature range, and a remarkable internal titanium carbide was also observed. The enrichment of chromium in the alloy matrix adjacent to the reaction layer was caused by the preferential diffusion of vanadium toward the SiC side. The growth of reaction layers followed a parabolic rate law. The parabolic growth rate constant was expressed by

$$kp(m^2s^{-1}) = 1.8 \times 10^{-8} \exp(-197 kJmol^{-1}/RT).$$

198th ACS National Meeting,
Miami Beach, Florida, U.S.A.,
September 10-15, 1989

Role of Pyrite during the Thermal Degradation of Kerogen Using In-situ High Terperature ESR Technique

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Thermal maturation of kerogen in sedimentary rocks has been studied extensively with the intent of the generation and accumulation of oil and gas. In-situ ESR studies between room temperature and 700℃ on the pyrolysis of kerogen in the presence and absence of added pyrite are reported. Basend on temperature dependency of spin concentrations, pyrite acts indirectly as a catalytic agent via sulfur. Pyrite sulfur enhances the formation of free radicals which may reflects enhancement in the hydrocarbon generation.

Seminar, Amoco-Argonne Coal Chemistry Research Program, Naperville, Illinois, U. S. A., September 20, 1989

Structure and Reactivity of Coal and Petroleum Residue

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Investigations on structure and reactivity of coal and petroleum residue at Coal and Carbon Lab., Metals Research Institute, Hokkaido University have been performed for last decade and have been introduced.

Agenda are divided mainly into following fields.

(1) High temperature and pressure ^{1}H-NMR, ^{13}C-NMR and ESR.
(2) Hydrogen transfer ability of coal and resid at pyrolysis temperatures.
(3) Charge transfer complex of iodine with coal and pitch.

The methodologies mentioned above have potential in the chemistry of coal and petroleum.

1989 International Conference on Coal Science, Tokyo, Japan, October 23-27, 1989

Pyrolysis Studies on Pristine and Oxidized Coal

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In-situ ESR spectroscopy has been used to study pyrolysis of coal. General profile of spin concentration of pristine coals has a good relation with rank. Weathered coal produced larger maxima of free radicals than pristine coal either in nitrogen or air atmospheres.

It has been pronounced that in-situ ESR is a useful method distinguishing pyrolysis behaviors of pristine and oxidized coals.

1989 International Conference on Coal Science, Tokyo, Japan, October 23-27, 1989

Change of Apparent Slurry Viscosity Due to Particle Swelling during Coal Liquefaction

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Relationship between the coal slurry viscosity and the swelling of coal particles were examined by use of a viscometer and a dilatometer, both of which were designed for high pressure measurements.

It was found that the apparent viscosity of slurry heated at a constant rate changes in accordance with volumetric swelling of coal particles and the liquid viscosity and that the change is reasonably described by revising an existing viscosity equation of solid suspension.

The 1989 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, U. S. A., December 17-22, 1989

A Novel Characterization of Argonne Premium Coals with Electron Donor or Acceptor Agents by ESR

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A novel characterization methods of coal has been proposed by ESR. Doping of electron acceptor such as iodine and TCNQ in coal causes charge transfer complex formation resulting the changes of concentration of electron spin in coal. Non-covalent bonding in coal structure has been characterized from the formation of the complexes between electron acceptors and coal.

The 1989 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, U. S. A., December 17-22, 1989

High Terperature ESR and NMR of Argonne Premium Coals

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High temperature ESR and NMR of Argonne Premium coals have been measured probes of structure and reactivity of coal.

Chemical structure, molecular motion and pyrolysis behaviors have been discussed from the temperature dependency of NMR and ESR spectra.

Japan-Australia Joint Research Progran, Development of Efficient Conversion Processes for Victorian Brown Coal, Osaka, Japan, October 16th, 1989

Catalyst Effectivities by Influence of Surface Area of Support on Upgrading Reaction of Model Feedstock and Coal Derived Liquid

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Catalyst effectivity for upgrading reaction has been investigated for the influence on surface area of supports. Four different catalysts which were prepared with different surface area of supports impregnated by Ni and Mo and reference catalyst Shell 424 were subject to upgrading reaction for model feedstock (MFS) and coal derived liquide (CDL). For MFS, increasing high conversion of O, S, and N containing compound were obtained with increasing surface area of catalysts, suggesting exhibition of high activities with higher surface area catalysts. Following upgrading reaction of MFS, CDL were carried out upgrading reaction under same reaction condition with four different catalyst and Shell 424 catalyst. Distributaion of various compound classes for CDL feed and its upgraded products were also correlated to surface area of catalyst and could be presumed the occurance of similar reaction, deoxygenation and

hydrogenation, to MFS for higher surface area catalyst.

1989 International Conference on Coal Science, Tokyo, Japan, October 23-27, 1989

Chemical Structural Change in Product Oil during Upgrading Reaction for SRC-II by GC-MS

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Upgrading reaction for catalytic hydroprocessing for primary coal hydrogenation liquids have been discussed and their products were studied as average structure by ^{1}H-nmr structural analysis. GC-MS and library search structural analyses are superior method for complicated mixtures like coal liquids. In this study, GC-MS analysis was performed in order to elucidating the chemical structure of upgraded products. A database of reference spectra of various components appearing in coal liquids was compiled using data from the experimanters' own liquid samples, and this database was used as reference for a library search to identify components of test samples. This library search analysis enabled over 90% of the components of upgraded products to be unambigously identified.