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Appendix

Summary International Reports, July 1993-June 1994

July 1993-June 1994

The 4th ASCCS International
Conference on STEEL-CON-
CRETE COMPOSITE STRUC-
TURES June 20-23, 1994,
Kosice, SLOVAKIA

**On Static and Buckling Systematic Analyses Using Composite Degree
of Two-Layered Composite Plates**

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This paper offers a set of practical evaluations on composite degree designed to enable static and buckling systematic analyses of partial (incomplete) composite plates. This paper also analyzes the relationship between lateral deflections and critical loads among complete plates, partial (incomplete) composite plates, and individual plates which do not interact with regard to simply supported rectangular composite plates defined by α , in which $\alpha=1$ signifies complete composite plates, $0 < \alpha < 1$ signifies partial composite plates, and $\alpha=0$ signifies individual plates which do not interact. This paper also submits a diagram that represents the essential features of lateral deflections and critical buckling loads of simply supported rectangular partial composite plates suitable for design purpose.

The Fourth East Asia-Pacific
conference on Structural
Engineering & Construction,
Seoul, Korea, September 20
-22, 1993

Limit Analysis of Curved Grillage Girder Bridges with Lateral Bracings

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In curved grillage girders, lateral bracings are generally provided to raise the torsional rigidity. However they are regarded as secondary members in most cases in designing curved grillage girder bridges. This study develops an analytical method for grillage girders with lateral bracings. And the method of this analysis is applied to existing three span continuous curved grillage girder bridge and the calculation result in which lateral bracings are included is compared to the result without lateral bracings. It is found out from the result that providing the lateral bracing has a tendency to increase an elastic limit load and a plastic collapse load.

According to this method of analysis, a collapse load and a collapse mechanism of the curved grillage girder bridge can be traced automatically and faithfully without assuming a plastic collapse form, so that the practical behavior of collapse is calculated effectively.

The Fourth East Asia-Pacific
conference on Structural
Engineering & Construction,
Seoul, Korea, September 20-
22, 1993

Analysis and Experiment of Triangular Cross Section Girder with Roundish Lower Flange

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Chiyoshi KON, and Kouichi SHINOZAKI
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Authors attempt to develop a triangular cross section girder with roundish lower flange for the narrow and long span pedestrian or cycling road bridges. The triangular cross section girder is expected that the wind stability is fine because of roundish lower flange, and the flexural and torsional rigidity is great because of box section. Theoretical analysis of this type of girder and experimental observations are reported in this paper. In analyzing this girder, the shear flow theory and the warping-torsional theory are used, and section properties and stresses are calculated by using simplified formulae of dividing the cross section into many straight elements. It is ascertained that these calculated value correspond to the experimental value obtained from the loading test remarkably.

The Fourth East Asia-Pacific
Conference on Structural
Engineering and Construc-
tion, September 20-22, 1993,
Seoul, KOREA

HUMAN VIBRATION SENSIBILITY ANALYSIS BY MEANS OF FUZZY REASONING

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In general, pedestrian bridges are more flexible than highway bridges, because design load is small and stiffness is low. The vibration serviceability of pedestrian bridges has become an

important problem in all over the world as well as in Japan.

In recent years, the fuzzy sets theory is often used as a method of analyzing problems including ambiguity.

In this study, the human vibration sensibility is analyzed by means of fuzzy reasoning. It is concluded that the application of fuzzy sets theory to the problems of vibration serviceability of pedestrian bridges is considerably effective. And it shows that designers obtain a quantitative solution of a human vibration sensibility by this method.

The Third Symposium on
Strait Crossing June 12-15,
1994 Alesund, NORWAY

**Study on structural characteristics of support systems for
submerged floating tunnel**

Naohiro MAEDA

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Masao MORIKAWA and Kuniteru ISHIKAWA

NKK, Tsu, Japan

Yoshio KAKUTA

Hokkaido University, Sapporo, Japan

This paper assesses tension mooring systems for supporting a submerged floating tunnel. The structural characteristics of this system are clarified analytically, paying attention to the three primary problems (mooring line arrangement, developed stress, and nonlinearity) in designing mooring lines for submerged floating tunnels.

The Third Symposium on
Strait Crossings June 12-15,
1994 Alesund, NORWAY

**Analytical study on dynamic response of submerged floating tunnels
due to wave force**

Shunji KANIE, Hiromi KOKUBUN and Yoichi MIZUTANI

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Takashi MIKAMI and Yoshio KAKUTA

Hokkaido University, Sapporo, Japan

Although actual submerged floating tunnels have not yet been constructed, they are seen as one of the most promising structures for strait crossings. In order to make the tunnel a real-

ity, it is necessary to analyze the dynamic response of the whole structure with adequate models that cover a wide range of many parameters such as buoyancy, leg arrangement and flexibility of tunnel joint. The authors proposed a suitable model for a super-long submerged floating tunnel using the modified Morison's equation. The response calculated by this method shows a close coincidence with those obtained by the diffraction theory. Super-long tunnels of 5 km in length were therefore analyzed, and the fundamental characteristics of their response due to waves were obtained.

The Fourth International
Conference on Steel-concrete
composite Structures, Kosice,
Slovakia, June 20-23, 1994

Shear Strength of Steel-Concrete Sandwich Structures with Shear Reinforcement

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Shear Strength of steel-concrete sandwich beams in which core concrete is sandwiched by steel skin plates is investigated using experiment and finite element analysis. The observed shear strengths agree with those predicted by the equations in JSCE's proposed code for steel-concrete sandwich structures. The results of the finite element analysis predict the observed ultimate load and failure mode.

The Fourth East Asia-Pacific
Conference on Structural
Engineering and Construc-
tion, Seoul, Korea, Septem-
ber 20-22, 1993

Towards Concrete Model Code for Asia

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Toshimi KABEYASAWA

Department of Architecture, Yokohama National University, Yokohama, Japan

Tamon UEDA

Department of Civil Engineering, Hokkaido, University, Sapporo, Japan

This paper summarizes the concrete codes currently used in the Asian region. Survey of the codes conducted by the Japan Concrete Institute Research Committee on Concrete Model Code for Asia clearly indicates a need and feasibility to establish a Model Code.

The Fourth East Asia-Pacific
Conference on Structural
Engineering and Construc-
tion, Seoul, Korea, Septem-
ber 20-22, 1993

Shear Strength of Steel-Concrete Sandwich Beams

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Experiment is conducted to investigate shear strength of steel-concrete sandwich linear member with shear reinforcing steel plate. The experimental results are compared with analytical ones obtained by nonlinear finite element analysis. Shear strength with diagonal compression failure of web concrete as well as contributions of full web type of shear reinforcing steel plate to shear strength are investigated experimentally and analytically.

The Fourth East Asia-Pacific
Conference on Structural
Engineering and Construc-
tion, Seoul, Korea, Septem-
ber 20-22, 1993

Prediction of Shear Strength of Concrete Beams Reinforced with FRP Rods

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The aim of this paper is to investigate shear strength of concrete beams reinforced with FRP rods. Non-linear finite element analysis in which Young's modulus of main and shear reinforcement are chosen as parameters is carried out. Shear resisting model which consists of shear forces at compression and shear cracking zones is also proposed.

FIP Symposium '93, Kyoto,
Japan, October 17-20, 1993

Effect of Axial Force on Shear Behavior of Prestressed Concrete Linear Member

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Concrete beams with stirrup prestressed by either steel tendon or aramido fiber reinforced plastic tendon are analyzed by a nonlinear finite element method. The calculated shear strengths agreed well with the experimentally observed strengths. Effects of prestressing force on stiffness, shear strength and stirrup stress are clarified. Mechanism of increase in shear strength due to prestressing force is discussed.

FIP Symposium '93, Kyoto,
Japan, October 17-20, 1993

A Study on Failure Criteria of FRP Rods Subject to Tensile and Shear Force

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Experiment on the model of FRP rod at the intersection of shear cracking is conducted. Nonlinear finite element analyses in which anisotropy of fiber reinforced plastic (FRP) rod, and nonlinearity of concrete and bond slip between concrete and FRP rod are also conducted.

Comparing the experimental results with the analytical ones, the failure mechanism of FRP rod is investigated in detail.

JCI International Workshop
on Shear in Concrete Structures,
June 20, 1994, Nagoya,
Japan

Shear Resisting Model of Reinforced and Prestressed Concrete Beams Based on Finite Element Analysis

Yasuhiko SATO, Tamon UEDA and Yoshio KAKUTA
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In this paper, shear resisting model is developed by numerical study, in which concrete strength, shear span to effective depth ratio, stiffness of main and shear reinforcement, yielding of shear reinforcement and prestressing force are chosen as parameters. The model can be applicable to nonprestressed and prestressed concrete beams reinforced with steel bars and/or fiber reinforced plastic rods.

NEVE 93
September 14-18, 1993, St
Petersburg Russia

Studies on the effect of the sink-&-float-type ice boom (SFIB) in ice flow control and measurements which prevent SFIB from burying in sand

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ABSTRACT

This is a report on the results of detailed experiments aimed to clarify: (1) the effect on ice floe control of the Sink-and-Float-type Ice Boom (SFIB) and (2) the optimal sectional form of SFIB which may prevent SFIB from becoming buried in sand when it sinks.

The SFIB consists of a number of floating bodies linked by steel wires whose ends are tied to piers. The SFIB sinks to the sea bottom when the floats are filled with water, but floats to the sea surface when the floats are filled with air, preventing ice floes from intruding into the

harbor.

Keyword: Ice Floe Control, Ice Boom, Buried in Sand

Beijing 93's
International Symposium on
Sea Ice October 19-22, 1993
Beijing China

Run-Up of Ice Floes on Impermeable Sloping Beach due to Tsunami

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ABSTRACT

In the morning of March 4, 1952, an enormous tsunami, originated in sea off the coast of Tokachi, Japan, attacked the east coast of Hokkaido. As the result of it, towns and villages on the Pacific coast of Japan, especially those in Hokkaido and the Sanriku district suffered severe damage. As the tsunami ran up the coast of Kiritappu peninsula which was located between Biwase and Hamanaka bays, with drifting ice floes, the damage of human lives and houses increased.

In this paper, the authors experimented on the mechanisms of ice floe movement due to solitary wave on impermeable sloping beach and obtained following items;

- 1) Transformation of wave height after wave braking and run-up height on sloping beach (1/30).
- 2) The relation between run-up height of ice floe and run-up height of wave.
- 3) The velocity of ice floe on dry bed due to wave action.
- 4) The relation between velocity of ice floe and size floe.

The 12th International Conference on Port and Ocean Engineering under Arctic Conditions
August 17-20, 1993 Hamburg

Factors Influencing the Coefficient of Friction Between Sea Ice and Various Materials

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Hiroshi SAEKI and Toshiyuki ONO
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ABSTRACT

This paper presents the summary of the coefficient of friction test between sea ice and various construction materials conducted by the authors.

Through the several years experimental studies on ice-material friction, the following conclusions have been drawn by the authors. The coefficient of friction have been found to be affected by i) relative velocity, ii) sea ice temperature, and iii) surface roughness of construction materials.

The 12th International Conference on Port and Ocean Engineering under Arctic Conditions
August 17-20, 1993 Hamburg

ARCH FORMATION OF ICE FLOES AT BRIDGE STRUCTURES

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ABSTRACT

This study reports on the results of experiments on the arching of ice floes in the sea, waterways or rivers which have frozen over.

Knowing the conditions of arch formation by ice floes is valuable because the data can be used in deciding the span of bridges that will not form ice arches or by creating arches artificially in order to prevent invasion of ice.

We conducted two kinds of experiments: (1) when there are many structures such as bridge piers in the watercourse; (2) when there are a few structures in the watercourse. In both experiments we tested to see if arches are formed by changing conditions such as the percentage of cover and the flow velocity, and compared the results.

The results of the experiments showed the critical conditions of arch formation by ice floes. Also, the Froude Similarity Law was proved as the results of experiment using two different scales agreed.

The 12th International Conference on Port and Ocean Engineering under Arctic Conditions
August 17-20, 1993 Hamburg

MODEL TESTS ON CONTROLLING ICE FLOES MOVEMENT AT THE INLET OF THE SAROMA LAGOON

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ABSTRACT

The Saroma lagoon located on the coast of the Sea of Okhotsk in Hokkaido suffers from damage to aquaculture facilities caused by intruding pack ice every winter. The objective of this research is to examine the effectiveness of the conventional and new type of ice boom in controlling the invasion of ice floes in model experiments. We made a model of the second Inlet of the Saroma Lagoon on the current in the inlet and pack ice in the Sea of Okhotsk. Comparisons between the spatial distribution of the vectors of current velocity observed in the model and in the lagoon and between the results of model experiments on ice booms on the scales of 1 to 50 and 1 to 150 in the control of ice floes confirmed the Froude similarity law. It was proved that ice floes can be controlled by the conventional and new type of ice boom using them with the current velocities.

The 12th International Conference on Port and Ocean Engineering under Arctic Conditions
August 17-20, 1993 Hamburg

**EXPERIMENTAL STUDY ON THE OVERTOPPING OF BREAKWATERS
BY ICE FLOES AND WAVES**

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ABSTRACT

In the winter of 1991 waves broke over the south breakwater at Abashiri harbor and bringing with them ice floes which overtopped the breakwater causing great damage to the oil pipelines behind the breakwater parapet, some harm to the dolphins now under construction behind the breakwater. Since then, with a view to using breakwaters more actively, plans have been made in recent years to build hydrophilic breakwaters at major harbors on the Okhotsk Sea coast, such as Abashiri and Mombetsu, some of which are already under construction. The use of breakwaters for pleasure trips to view ice floes is being considered as one of their important functions, but the accumulation of overtopped ice on the breakwater can affect the tourism considerably.

For the reasons stated above and considering that overtopping of ice is a phenomenon observed simultaneously with the occurrence of wave overtopping, together with the motion of ice floes caused by waves, we show in our experiments the relation between ice floe size and amount of overtopped ice. We also show the amount of overtopped ice when they are varying sizes of floe.

THE NINTH INTERNA-
TIONAL SYMPOSIUM ON
OKHOTSK SEA & SEA ICE
February 6-8 1994, Mombet-
su, Hokkaido Japan

Estimation of contact Pressure between structure and ice sheet by Shot Noise Model

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ABSTRACT

The equation to calculate indentation pressure on wide structure as a function of the number of independent ice failure zone (I. F. Z.) was derived from the assumption that ice pressures at (I. F. Z.) follow the log-normal distribution (Kry, 1978). However, ice pressures at (I. F. Z.) obtained from ice-indentation tests using freshwater lake ice in Hokkaido do not satisfy able to generate time histories on ice pressures with sharp peaks and recessions at (I. F. Z.). In this study, it is shown that the contact number between ice sheet and structure clearly decreases with increasing indentation area (structure width ÷ ice thickness), by combining time histories on ice pressures to the number of (I. F. Z.) using shot noise model.

THE NINTH INTERNA-
TIONAL SYMPOSIUM ON
OKHOTSK SEA & SEA ICE
February 6-8 1994, Mombet-
su, Hokkaido Japan

ABRASION OF OFFSHORE STRUCTURES DUE TO MOVEMENTS OF SEA ICE SHEETS

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ABSTRACT

Abrasion of offshore structures constructed in cold regions occurs during movement of ice sheets at the time of thawing. Therefore, it is very important to estimate such abrasion

amounts in the design of offshore structures of cold regions. Saeki et al. have conducted basic studies on the abrasion of various construction materials by the movement of sea ice. As natural sea ice sheet contains fine sand particles, the authors systematically tested the amount of abrasion of various materials by sea ice containing sand. According to the data obtained we propose an estimation method for the actual amount of abrasion on offshore structures. In addition, we propose countermeasures against abrasion of offshore structures due to movements of sea ice sheets.

THE NINTH INTERNA-
TIONAL SYMPOSIUM ON
OKHOTSK SEA & SEA ICE
February 6-8 1994, Mombet-
su, Hokkaido Japan

THE RELATION BETWEEN ICE FORCE AND ICE GOUGING

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ABSTRACT

The okhotsk sea coast of Hokkaido is covered with drifting sea ice every winter. When drifting sea ice moves to shallow sea area, it gouges sandy sea bottom.

We have carried out experiments on ice gouging systematically. We used steel box with coating as model ice, and measured driving force acting on model ice (F), gouging depth in front of model ice (Z_2), sloping angle (β) and velocity of model ice (V).

And we proposed new mechanical model on ice gouging by using Coulomb's earth pressure formula.

Finally, experimental results are well agreement the newly developed mechanical model proposed by us.

THE NINTH INTERNA-
TIONAL SYMPOSIUM ON
OKHOTSK SEA & SEA ICE
February 6-8 1994, Mombet-
su, Hokkaido Japan

**Ice forces on Pile Structures Due to Changes in Water Level
Under Flooding Conditions**

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ABSTRACT

This presentation is titled Ice Forces on Pile Structures Due to Changes in Water Level Under Flooding Conditions. In cold offshore regions, changes in water level can induce vertical forces on structures when sea ice cover interacts with the structures. A rise in water level generates an upward force on pile structures; likewise, a drop generates a downward force. These forces are induced on pile structures due to changes in water level if the ice cover adheres to structures. In this presentation, I propose a method of calculation that estimates the vertical ice forces on pile structures due to changes in water level under flooding conditions.

THE NINTH INTERNA-
TIONAL SYMPOSIUM ON
OKHOTSK SEA & SEA ICE
February 6-8 1994, Mombet-
su, Hokkaido Japan

Run-up Ice Floes on Sloping beach Due to Waves

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ABSTRACT

The Okhotsk Sea Coast of Hokkaido is rushed by drift ice every winter. Sometimes aquaculture and fishery resources have been damaged by the movement of drift ice. When the ice concentration is low, ice floes are brought on sloping beach by waves. On the coasts of

Omusaro, Mombetsu air port and Sanri which are facing to Okhotsk Sea, the authors observed run-up height, size and shape of ice floes on sloping dry beaches. And the position, size, thickness and run-up height of run-up ice floes on sloping beach are clarified.

The main conclusions are shown as follows :

- 1) The 60% of the ice floes on sloping dry beach are between 0.5m and 1.5 m in run-up height above mean sea level.
- 2) The 60% of the ice floes are between 1.0 m and 2.0 m in representative length.

THE NINTH INTERNATIONAL SYMPOSIUM ON OKHOTSK SEA & SEA ICE
February 6-8 1994, Mombetsu, Hokkaido Japan

RUN-UP OF ICE FLOES ON IMPERMEABLE FLAT BEACH DUE TO TSUNAMI

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Hokkaido University

ABSTRACT

In the morning of March 4, 1952, an enormous tsunami, originated in the sea off the coast of Tokachi, Japan, attacked the east coast of Hokkaido. As the result of it, towns and villages on the Pacific coast of Japan, especially those in Hokkaido and the Sanriku district suffered severe damage. When the tsunami attacked the coasts of Biwase and Hamanaka bays which were located in the eastern part of Hokkaido, the both coasts were covered by ice floes drifted from the Okhotsk Sea. As the tsunami ran up the coast of Kiritappu peninsula which was located between Biwase and Hamanaka bays, with drifting ice floes, the damage of human lives and houses increased.

In order to clarify the ice force acting on the houses and coastal structures due to tsunami action, the size of ice floes, the compressive strength and elastic modulus of ice and the velocity of ice floes due to the run-up of tsunami on flat beach should be clarified. In this paper, the authors experimented on the impermeable flat beach which had a vertical dike at its end and obtained following items ;

- 1) Transformation of wave height after wave braking and run-up height in flat of the vertical dike.
- 2) The velocity of ice floe on dry beach due to wave action.
- 3) The position of ice floe collision with the vertical dike.

THE NINTH INTERNA-
TIONAL SYMPOSIUM ON
OKHOTSK SEA & SEA ICE
February 6-8 1994, Mombet-
su, Hokkaido Japan

**THE SINK-AND-FLOAT-TYPE ICE BOOM (SFIB) IN
ICE FLOE CONTROL WITH WAVES**

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ABSTRACT

In Hokkaido pack ice usually reaches the area along the coast of the Sea of Okhotsk from Wakkanai to the north shore of Nemuro peninsula. However, sometimes ice floes also arrive at Rishiri and Rebun islands, Nemuro peninsula and Cape Erimo on the Pacific Ocean.

The following measures are required to allow year-round operation of harbors located on the Sea of Okhotsk: (1) to prevent harbors from freezing over; (2) to prevent ice floes entering the harbors; and (3) to develop ice breaker freighters suitable for operation in the Sea of Okhotsk. Measures to keep ice floes out of harbors are essential and there is a call for the development of such techniques.

In this study we report on the results of experiments concerning the effectiveness of the Sink-and-Float-type Ice Boom (SFIB) on preventing ice floes entering harbors due to wave action. The SFIB's structure consists of a number of floating bodies linked by steel cables, with their ends tied to piers. The SFIB sinks to the sea bottom when the floats are filled with water, but when the floats are filled with air the SFIB floats to the sea surface preventing ice floes entering the harbor.

THE NINTH INTERNA-
TIONAL SYMPOSIUM ON
OKHOTSK SEA & SEA ICE
February 6-8 1994, Mombet-
su, Hokkaido Japan

Ice Control by Using Newly developed Ice Boom

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Hokkaido University

ABSTRACT

Along the coast of the Sea of Okhotsk in Hokkaido there are many lagoons and lakes, such as the Saroma Lagoon and the Notoro Lagoon, which are connected to the sea by waterways. Scallop and oyster are cultivated in these lagoons, and the output of such products, especially in the Saroma Lagoon in 1989, amounted to about 3.1 billion yen. Pack ice in the Sea of Okhotsk enters these lagoons occasionally. When the lagoons are completely frozen before pack ice approaches the coast, the pack ice is generally blocked by the ice sheets frozen up in the lagoon and does not come far into it even if it intrudes into the lagoon. In the last several years, however, the lagoons have begun to freeze later than usual and pack ice sometimes the time the pack ice arrives. If a large block of pack ice enters a lagoon facilities. Such damage actually occurred about ten times between 1972 and 1993 in the Saroma Lagoon. The amount of damage in 1974 in particular exceeded 2 billion yen. The extent of damage in the past few years has been between several tens of millions of yen and hundreds of millions of yen, and the Notoro Lagoon has also suffered similar damage. Development of technology for preventing intrusion of pack ice into the lagoons is required at all costs to get rid of such damage.

The authors of this paper considered that the ice boom could be used to prevent pack ice from entering the authors report the experiment of newly developed Ice Boom used under special conditions. The newly developed Ice Boom is easier to repair and to clean up than up than new type Ice Boom that we have developed. The ice control effect of the newly developed Ice boom is the same or more effective than new type Ice Boom.

International Conference on
Development and Commer-
cial Utilization of Technol-
ogies in Polar Regions
March 22-25, 1994, Lulea
SWEDEN

**PREVENTIVE MEASURES AGAINST PACK ICE DAMAGE TO
MARINE RESOURCES AND FISHERY FACILITIES**

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ABSTRACT

The fishery on the coast in Hokkaido facing the Sea of Okhotsk suffers much damage by drift ice in winter and the freezing over of seawater near the coast. The damage can be divided into three categories, as follows.

1. Damage to kelp (seaweed), sea urchins and abalones in the area of reefs.
2. Damage to bivalves, such as scallops and hen clams (Hokki-gai), in sandy beaches.
3. Damage to cultivated marine resources, including scallops and oysters, and aquaculture facilities in lagoons on the coastal area connecting with the Sea of Okhotsk, such as Saroma Lagoon.

This study clarifies the actual damage conditions of the above-mentioned three categories and each mechanism of the damage, and deals with preventive measures for each kind of damage.

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SWEDEN

POLLUTION OF FALLEN SNOW IN URBAN AREAS

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ABSTRACT

The survey we conducted on the actual condition of pollution of fallen snow in Sapporo (latitude 43°00' N. and longitude 141°20' E.) revealed that the snow is considerably polluted by various substances contained in snow such as road particulates and daily garbage. The content and pollutants in the snow flow into waters in spring it adversely effects water environment. Additionally, a rough calculation of cigarette butts and empty cans discarded in the water environment demonstrated citizens' poor social ethics toward the environment.

International Conference on
Development and Commer-
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March 22-25, 1994, Lulea
SWEDEN

ADFREEZE BOND STRENGTH BETWEEN SEA ICE AND MATERIALS USED FOR OFFSHORE STRUCTURES

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ABSTRACT

Drift ice at times adfreezes to the surface of offshore structures where they are built in sea areas covered with ice in winter. When adfreezing occurs, vertical ice forces caused by

changes in tide levels act on the structures. A method of calculating the ice forces is established by assuming that drift ice is an elastic body, and an important parameter for calculation is the adfreeze bond strength between drift ice and materials used on the surface of the structures.

This paper summarizes systematic experiments on the adfreeze bond strength between sea ice and building materials used for offshore structures such as steel, concrete, as well as a variety of coating materials, including Enerata-160, Zebron, low density polyethylene and polyurethane.

International Conference on
Development and Commercial
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**PROMOTION OF THE REGIONAL ECONOMY BY MEANS OF
WINTER TOURISM IN THE COASTAL AREA ALONG
THE OKHOTSK SEA IN HOKKAIDO**

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ABSTRACT

There is nowhere in Japan which is visited by ice floes coastal area along the Okhotsk Sea in Hokkaido. The area is marked with a high percentage of primary industry with heavy dependence upon fishing and farming production. Ice floes and its cold climate in winter inevitably prevent the local community from being engaged in its principal industries, thereby causing a stagnation of industrial activities of the whole area.

Promotion of tourism in winter first attracted attention as a means of breaking through the stagnation of industrial and economic activities.

Gradually, winter events, such as ice floe festivals and dogsled races, were developed, as well as the area starting a service of pleasure boats viewing ice floes, and installing snow-

mobile courses. This resulted in a rapid growth in the number of tourists in winter and a revitalization of the local community.

Our study deals with what is going on in tourism featuring ice floes, snow and ice along the Okhotsk coastal area and reports on their influence on the regional economy.

International Society of
Offshore and Polar Engineers
April 10-15 1994, Osaka
Japan

Earthquake Response Analysis of Submerged Floating Tunnels Considering Water Compressibility

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ABSTRACT

A numerical model is developed for estimating the response of submerged floating tunnels to vertical seismic excitations by considering compressibility of sea water. The method is based on a two-dimensional wave potential theory, namely, the Green's function method. Influence of sea water compressibility on the hydrodynamic force and dynamic behavior of the tunnels with the prototype dimensions is discussed.

International Society of
Offshore and Polar Engineers
April 10-15 1994, Osaka
Japan

**Study on Submerged Floating Tunnel Characteristics
Under the Wave Condition**

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ABSTRACT

Many fixed crossing of waterways has been built, bridge pontoon bridge, floating bridge, bored tunnels, and immersed tunnels. In the case of longdistance between the shores, deep-water, hard sea state, and conventional structures are not feasible.

The Submerged Floating Tunnels (SFT) is a new concept (Norway, Italy, USA, UK, and Netherlands) for crossing deep watertraffic to strait crossing. SFT consists of bouyant tube and tethers supports from sea bottom.

In Japan, investigation on the development of the Submerged floating tunnel's technology has been started from 1990.

Conceptual work has been done in Japan at Hokkaido Funkawan bay, width of waterway 34 km long, water depth 100 m, significant wave height 9.3 m, and significant wave period 13.0sec. The dimensions of the main circular cylinder body of SFT are 11.4 m (4 lane car only) and 23.0 m (4 lane car and 2 lane railway) respectively. For supporting the tunnels, vertica bottom supports, and combined horizonatal and vertical supports are used.

This parer deals with the wave force characteristics and dynamic behavior to the tunnels with numerical calculation (2-D) by mean of Boundary Element Method (BEM) and Morison' s equation.

KEY WORDS : Submerge, float, tunnel, experiment, calculation, wave and tethers.

International Society of
Offshore and Polar Engineers
April 10-15 1994, Osaka
Japan

Abrasion of Heavy-Duty Coated Steel Piles by Sediment Transport

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ABSTRACT

Heavy-duty coatings are standard treatment for steel pipe piles in coastal zones to prevent corrosion. Large amounts of sand sometimes drift around piles by the action of waves. Coatings undergo abrasion by collision of sand particles. Authors carried out experimentals by a large scale U-shaped tube which generated a strong oscillatory flow with sand drift and numerical analysis of collision of the particles. Authors found out the abrasion rate of pile is nearly proportional to the collision energy of the particles. Abrasion rate of polyethylene and elastic polyurethane coatings were lower than those of other materials.

KEY WORDS: Abrasion, Heavy-duty, Steel, Sand, Polyethylene, Polyurethane

International Society of
Offshore and Polar Engineers
April 10-15 1994, Osaka
Japan

Study on the Characteristics of High-Strength Lightweight Concrete for Icy Waters

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ABSTRACT

The authors have developed a new lightweight coarse aggregate whose surface is covered by a high molecular paraffin to prevent water absorption into the aggregate under high pumping pressure. The coated aggregate makes it possible to produce lightweight concrete with

high durability against freeze/thaw cycles, abrasion and fire. In order to verify the efficiency of the coated aggregate and the durability of the concrete using the aggregate, various test on the coated aggregate and concrete have been carried out. This paper reports on the main results obtained from various tests.

KEY WORDS : Paraffin-Coated Lightweight Aggregate, Pumpability of Lightweight Concrete, Freeze/Thaw Durability, Abrasion, Fire Resistance

International Society of
Offshore and Polar Engineers
April 10-15 1994, Osaka
Japan

Effect of Imperfect Contact on Total Ice Force

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ABSTRACT

The interaction between a wide structure and ice sheet is featured by irregular contact between ice sheet and structure and nonsimultaneous failure of the ice sheet (Kry, 1978). In this study, field ice indentation tests considering three kinds of leading edges of ice sheets were conducted to examine their effects on total ice force acting on the structure. The tests were conducted under the condition of aspect ratios between 11.4 and 15.4 dividing width of indenter by thickness of ice sheet, and comparisons were made with the test results of 2.4 to 2.7 (Takeuchi et al., 1992). The test result, that indentation into the ice sheet from start of indentation until occurrence of a prominent first peak force is slight, suggests that when a convex portion of the leading edges of the ice sheet in an actual sea is larger than the amount of indentation the ice sheet will not fail simultaneously across the entire width of the structure.

KEY WORDS : Imperfect contact, total ice force, ice sheet, ice indentation test

International Society of
Offshore and Polar Engineers
April 10-15 1994, Osaka
Japan

Ice-Material Surface Interaction in Ice Friction and Ice Adfreeze Bonding

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ABSTRACT

Several test series of coefficients of friction and adfreeze bond strength between sea ice and construction materials have been conducted. This paper presents the summary of these test results focusing the ice shearing at the ice-material interface, effects of material's surface roughness in ice friction and ice adfreeze bonding. The estimation of the coefficients of friction and the adfreeze bond strength for various construction materials obtained by the authors are also presented.

KEY WORDS : Ice friction, ice adfreeze bonding

International Society of
Offshore and Polar Engineers
April 10-15 1994, Osaka
Japan

Development of the Sink-and-Float-Type Ice Boom (SFIB) in Ice Floe Control

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ABSTRACT

This is a report on the results of detailed experiments designed to clarify the effectiveness of the Sink-and-Float-type Ice Boom (SFIB) in controlling ice floes.

The SFIB consists of a number of floating bodies linked by steel cables whose ends are tied to piers. The SFIB sinks to the sea bottom when the floats are filled with water, but floats to

the sea surface when the floats are filled with air, preventing ice floes from coming into the harbor.

KEY WORDS : Ice Floe Control, ice Boom

PROCEEDING OF THE
THIRD SYMPOSIUM ON
STRAIT CROSSINGS
JUNE 12-15, 1994, ALESUND
NORWAY

**Experimental study on characteristics of submerged floating tunnels
under regular waves**

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ABSTRACT

Submerged Floating Tunnels (abbr. SFT) have been expected as one of the most prospective construction technology for crossing of straits. In Japan, the Society of Submerged Floating Tunnel Technology Research in Hokkaido, which was established in 1990, has started investigation on the development of SFT in Funka Bay. This paper is a part of the studies carried out at Hokkaido, and deals with fundamental hydrodynamic response of SFT obtained by model experiments under regular waves.

PROCEEDING OF THE
THIRD SYMPOSIUM ON
STRAIT CROSSINGS
JUNE 12-15, 1994, ALESUND
NORWAY

Response of submerged floating tunnels to vertically impinging seismic waves

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ABSTRACT

We hereby presents an analytical method to estimate response of submerged floating tunnels to vertical seismic excitations. Based on the onedimensional duplicate reflection theory, the response of the sea bottom and water to the input earthquake motion is calculated. Also hydrodynamic force on the tunnel is numerically evaluated by using a velocity potential theory. Then an equation of motion of the tunnel is established, and the response of tunnel acceleration and cable tension is calculated for a prototype tunnel.

PROCEEDING OF THE
THIRD SYMPOSIUM ON
STRAIT CROSSINGS
JUNE 12-15, 1994, ALESUND
NORWAY

**Numerical analysis of wave force and dynamic response
to the submerged floating tunnels**

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Susumu MIZUNO
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ABSTRACT

The purpose of this study is to investigate the dynamic behavior of the wave acting on the Submerged Floating Tunnel (SFT). First, the drag force and inertia force coefficients in the

Morison's equation are decomposed from the measured wave force to classify the wave force property. Second the wave force is computed using Morison's equation or Boundary Element Method (2-D and 3-D). The computed results are compared with the experimental results. Third slack of tether is discussed based on irregular wave experiments.

Workshop on Hydraulics and
Hydrology in Cold Regions,
Denver, Colorado, U.S.A.
Oct. 11-16, 1993

Transport of Snow in an Open Channel Water Flow

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In winter in the cities of cold regions it is necessary to remove snow from urban areas to somewhere else. It is very expensive to hire persons and machines, and the noise and vibration caused by the machines sometimes bothers the citizens. It is useful to transport snow in an open channel water flow.

An analysis with some assumptions is made for the transport of snow in an open channel. The flow is modelled as a 2-dimensional, 2-layer flow of snow and water.

There are some design manuals of the channels for the transport of snow which were made in fully empirical ways. The design manuals are examined by this analysis.

Fourth International Symposium
on Cold Region Development,
Helsinki University
of Technology, Finland, 13-
16 June 1994

An Application of Fuzzy Theory to Predict Runoff From Snowmelt

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Tomakomai National College of Technology
Mutsuhiro FUJITA
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It is necessary to predict the timing and volume of snowmelt runoff not only for water use, but for flood disaster protection in Hokkaido. Usually, simple empirical methods (e.g. the degree-hour factor method) have mainly been used to estimate snowmelt runoff. However, accuracy of the method is still not satisfactory, because the snowmelt rate, percolation of meltwater and runoff process are extremely complex due to many vague related factors. In

this paper, a new method to forecast snowmelt runoff using Fuzzy theory is proposed. We estimate tomorrow's hourly temperature based on weather forecast. The estimated temperature includes error. It is possible to predict snowmelt runoff with maximum lead time 6 hour by introducing Fuzzy theory.

International Conference on
Nonlinear Dynamics and Pat-
tern Formation in the Natu-
ral Environment, July 4-7,
1994, Noordwijkerhout, the
Netherlands

Effects of Geometric and Hydraulic Factors to Bed Topography in Straight and Meandering Channels

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The effects of geometric and hydraulic factors for finite amplitude bed topography in meandering and straight channels are investigated using a proposed numerical model. A series of numerical experiment is conducted by changing geometric and hydraulic parameter individually. The sensitivity of each parameter to the general characteristics of bed topography and the wavenumber components calculated by double Fourier analysis, are studied. The mutual effects of the combination of different parameters are also investigated. By the results to the numerical experiment, a series of figures are presented, which show the effects of each parameter to the finite amplitude bed topography. Some interesting phenomena, including the interaction of free and forced bars, are discussed.

INTERNATIONAL CON-
GRESS ON MODELLING
AND SIMULATION
Parth, Australia December 6
-10, 1993

Analysis of the Wind Field in Winter and Prediction of Snow Clouds When Characteristic Snow Clouds Appear

Keisuke NAKAYAMA and Kazuyoshi HASEGAWA

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Much snow precipitation is brought by snow clouds from the Sea of Japan in Sapporo. When a snow cloud moves through the Ishikari Bay, a streak of snow often appears from the

Takashima Cape, which is located in the south of the bay, to the inland. This type of snow cloud swings with a large arc having big effects on snow fall in Sapporo. The arc shape is probably caused by a topographical effect at the Takashima Cape. The purpose of the present study is to analyze the wind field influenced by local topography and to predict the time change of snow clouds observed by radar echo.

A 3-D shear flow model were employed and the solutions were obtained numerically for the analysis; the results showed the appearance of weak separation of flow behind a mountain area. When thermal effects were considered, the separation in front of mountain also could be seen in the model. The change of cloud could be predicted fairly well by the wind flow model. But, the neglecting growth and disappearance of cloud makes it difficult to improve the prediction.

IAMAP-IAHS '93 Joint
International Meeting
Symposia J2 Snow Cover and
Its Interaction with Climate
and Ecosystems Yokohama,
Japan July 1993

Presumption of average wind and direction in winter by using snow coverage data of AMeDAS, and Analysis of wind field considering with topography

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Purpose of the present study is to elucidate wind fields influenced by a local topography (i. e. Takashima cape) and the feature of snow coverage in Ishikari Bay area in Hokkaido. First, snow coverage data analysis was carried out by using AMeDAS data at 9 different places with seeking the coherence and phase between the time series of snow precipitation at a key station recorded in 1992 and that at other stations. From the results, time scales of snow fall and the average shifting speed could be estimated.

Characteristic band cloud stretching from near Takashima Cape to Ishikari Plain was observed on a winter day by means of 3-D doppler radar. Considering that such cloud may bring the partial snow fall, wind field near Ishikari Bay which yields the streak-like band cloud was analyzed by using a few flow models. Eventually, it was found qualitatively that shear flow influenced by local topography may play an important role for partial snow fall.

The Fourth International
Heat Pipe Symposium Tsu-
kuba, Japan, May. 16-18,
1994

Two-Component Heat Pipes Utilizing the Marangoni Effect

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* Faculty of Engineering, Tohoku University Sendai 980, Japan

It was suggested that the two-component heat pipes utilizing the Marangoni effect caused by the concentration difference can be available without capillary wicks even in a microgravity environment. Microgravity experiments were carried out by using a large-scale dropping tower and the behaviour of the working liquid in heat pipes under a microgravity environment was observed. It was shown that the working liquid condensed in the condenser section was turned back to the heating section by the Marangoni effect, especially when the ethanol concentration was dilute for water-ethanol heat pipe. Such heat pipe is thought to be a completely new type and would be an ideal thermal device in a space environment.

Inter noise 93
August 24-26, 1993, Leuven,
BELGIUM

Study on Active Noise Attenuation in Three-dimensional Sound Field

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Engineering, Hokkaido University, Sapporo, JAPAN

This paper describes our experimental study of the active attenuation in three-dimensional sound field, mainly based on the JMC theory. In the experiment, the theory was adapted to reduce sound pressure levels in our anechoic chamber. A multi-channel adaptive active noise control system was produced with several number of tripole secondary sources. The experimental result shows the performance of our system to reduce the sound pressure level around the error sensor microphone and to enlarge the quiet area compared to that of the simple secondary source.

The Forth International Symposium on Rock Fragmentation by Blasting, July 4-8, 1993, Vienna, AUSTRIA

The necessary Amount of Explosive and Rock Strength in Blasting

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The empirical formulae of blasting are not always reliable. It is said that the necessary amount of explosive ratio (C) is proportional to the rock strength (g). And yet experiments suggest that the relation of the two is a hypabolic curve. In the lower range of rock strength, (C) is inversely proportional to (g). In the next or middle range, the curve is rather flat, and in the last or hardest, it is proportional to (g).

The primary reason for this is due to the fact that the energy loss by adiabatic expansion of exploded gas in the enlarged borehole occurs hyperbolically according to the rock strength.

The Sixth International Symposium on Agglomeration
November 15-17, 1993, Nagoya,
Japan

Production of Zirconia Microspheres by Agglomeration in Organic Liquid and Its On-line Monitoring

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The growing utilization of media agitated mills for mixing, dispersing and ultrafine grinding of fine ceramics, super conducting materials, minerals, coals, etc. provides a natural impetus for the production of high strength microspheres with diameters less than 500 μ m. An ideal material for high strength microspheres which can serve as media in agitated mills is zirconia stabilized with yttria.

This paper presents the process and technological developments that made possible the production of high strength zirconia microspheres by agglomeration in organic liquid. Initially, the production of dense highly spherical microagglomerates in a semicontinuous agglomeration system was investigated. It is well documented that slight variations in process parameters

such as bridging liquid dosage can greatly affect the agglomerate properties. It is imperative to develop an on-line monitoring system in order to repeatedly produce agglomerates with desired properties. For this reason, a monitoring system that utilizes the changes in turbidity of suspension and noises emitted during the process of agglomeration was developed.

The Fifth China-Japan Symposium on Fluidization, May 23-26, 1994, Nagoya, JAPAN

Direct Measurement of Size Distribution for Agglomerates in a Gas-Fluidized Bed of Submicron Solid Particles

By Koichi YAMAZAKI, Koichi MATSUOKA and Tadatoshi CHIBA
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Size distributions were determined by a SEM photography for fragile agglomerates of submicron solid particles directly sampled at different heights in a 40 mm dia. bed for nine kinds of particles having different primary diameters and densities. Before each run, agglomerates of as-received or once-used particles were destroyed in a sieve vibrated with glass beads particles at a fixed amplitude and for a fixed duration. At steady fluidization the bed was shown to consist in general of three different regions formed as a result of solid segregation. It was also shown that the size of agglomerates largely depends on inherent particle properties.

The First International Congress on Science and Technology of Ironmaking, June 14-17, 1994, Sendai, JAPAN

Softening Kinetics for Pellet of Pulverized Coal Particles

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Apparent needle penetration and volumetric dilatation were measured under pressurized N₂ gas atmosphere for a cylindrical pellet of pulverized coal particles as a function of the heating rate for six different kinds of coal particles. Net penetration rates evaluated from the difference between the rates of penetration and dilatation showed a considerable dependency on the heating rate and the coal properties. The results were reasonably well explained by a model which assumes a consecutive reaction for coking and a pseudosteady state equation of motion with a presumed viscosity change of an order of magnitude from 10³ to 10⁷ MPa·s for all cases.

SAE International Congress
and Exposition, Detroit, Michigan, U. S. A., February
28-March 3, 1994

Influence of the Molecular Structure of Hydrocarbon Fuels on Diesel Exhaust Emissions

Noboru MIYAMOTO, Hideyuki OGAWA, Masahiko SHIBUYA, Keiji ARAI,
and Olivier ESMILAIRE
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The influence of the molecular structure of hydrocarbon fuels on soot, SOF, and NO_x emissions from a diesel engine was analyzed while ignition delay and other physical fuel properties were kept constant. Mixtures of normal paraffin (n-tetradecane) and iso-paraffin (heptamethylnonane) were used as a base fuel and one of 5 kinds of hydrocarbons including mono-aromatic, di-aromatic, and non-aromatic was added. The aromatic content varied in the range of 0-60 vol % for the mono-aromatic fuels and 0-40 vol % for the di-aromatic fuels. The experimental results showed that regardless of the molecular structure of the fuel, both particulate and NO_x emissions increased linearly with the C/H atomic ratio of the fuels under constant ignition lag. The increase in particulate emissions with C/H atomic ratio was caused by increases in dry soot. The SOF, THC, and BSEC were little affected by the C/H atomic ratio and molecular structure of the fuels. The fuel properties discussed here showed similar results in both DI and IDI engines.

SAE International Congress
and Exposition, Detroit, Michigan, U. S. A., February
28-March 3, 1994

Combustion and Emissions in A New Concept DI Stratified Charge Engine with Two-Stage Fuel Injection

Noboru MIYAMOTO, Hideyuki OGAWA, Toshio SHUDO,
and Fumiaki TAKEYAMA
Dept. of Mechanical Engineering, Hokkaido University

A new concept DISC engine equipped with a two-stage injection system was developed. The engine was modified from a single cylinder DI diesel engine with large cylinder diameter (135 mm). Combustion characteristics and exhaust emissions with regular gasoline were examined, and the experiments were also made with gasoline-diesel fuel blends with higher boiling temperatures and lower octane numbers. To realize stratified mixture distribution in combustion chamber flexibly, the fuel was injected in two-stages: the first stage was before the

compression stroke to create a uniform premixed lean mixture and the second stage was at the end of the compression stroke to maintain stable ignition and faster combustion.

In this paper, the effect of the two-stage injection on combustion and exhaust emissions were analyzed under several operating conditions.

The results showed that stable and smooth combustion without knocking over a wide range of operation could be realized in the new concept DISC engine, and compared with stoichiometric homogeneous combustion at a BMEP of 0.61 MPa, 30% SFC and 50% NO_x reductions were achieved. The SFC and NO_x were reduced remarkably not only in the lean conditions but also in the stoichiometric conditions by the stratified charge combustion with the two-stage injection. Optimization for spark timings, secondary fuel injection timings, the proportion of two-stage fuel injection, and the number of nozzle holes was essential for efficient combustion and ignition. Smokeless and knockfree operation could also be achieved with higher boiling temperature and lower octane number fuels. Soot was not detected even with gasoline containing 50vol.% diesel fuel.

The 10th International Symposium on Alcohol Fuels,
November 7-10, 1993, Colorado Springs, USA

Evaluation of Dual Oxidation Catalyst System for the Reduction of Formaldehyde Emission in Start-up Duration of Methanol Fueled Vehicle.

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and
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Methanol oxidation and formaldehyde (HCHO) formation in methanol engine exhaust catalyst systems employing a dual catalyst system have been investigated to understand the HCHO emission characteristics during cold engine start. Laboratory catalytic reaction experiments have been performed by simulating both the exhaust gas components and reaction temperature during cold start.

From these results, it has been determined that fairly high amount of HCHO is formed in a catalyst with excess oxygen. A map of conditions defining the region of HCHO formation was constructed as a function of the temperature and the concentration of nitric oxide present in the reactants. It suggested that catalyst preheating and use of a dual catalyst system is effective in suppressing HCHO formation by making it possible to avoid crossing the formation region described by the map.

The 10th International Symposium on Alcohol Fuels, November 7-10, 1993, Colorado Springs, USA

Seasonal Evaluation of Atmospheric Formaldehyde Level with the Introduction of Methanol Vehicles.

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As methanol vehicles are introduced, the amount of formaldehyde (HCHO) emission is expected to increase. In this study, the increase in atmospheric HCHO concentration in the Tokyo Metropolitan Area is computed under various seasonal and weather conditions.

The results show that; under clear sky summer conditions, HCHO concentration in the atmosphere is expected to be reduced because of high rate of photochemical reaction with nonmethane organic gases. In winter, when, the mixing height is very low, the influence of emission from primary sources is enhanced. The relationship between HCHO emissions and atmospheric concentration as examined in this study, has been determined to be linear in nature. It can be concluded that, the HCHO concentration in the atmosphere would not be increased by the introduction of methanol vehicles in the Tokyo Metropolitan Area, in cloudy winter, if the emission factor of methanol trucks and buses should be under 0.036 (g/km) and 0.05 (g/km), respectively.

International Symposium on
Aerospace and Fluid Science,
November 14-16, 1993, Sendai, Japan

Carbon Particles Generation in Combustion Flow under Microgravity.

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Sapporo, 060, Japan

The behaviors of soot particles in the flame of paper combustion and the butane gas jet diffusion flame were observed under microgravity. The surrounding oxygen concentration was changed as an experimental parameter. Soot particles were sampled under microgravity and observed by using the electron microscopes.

From these results, a characteristic phenomenon that soot particles agglomerated and increased its diameter to the observable level in the gas jet diffusion flames was found under microgravity. The diameter of agglomerated clusters amounted to about 0.1 μm and about 500

times as large as one under normal gravity. It was also suggested that the large carbon particles were generated in the limited area where the conditions for these particles formation such as fuel velocity and oxygen concentration were satisfied.

International Symposium on
Aerospace and Fluid Science,
November 14-16, 1993, Sen-
dai, Japan

Flame Propagation in Coal Dust Cloud under Microgravity Environment.

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Takaharu TAGASHIRA

Nippon Steel CO. Muroran Works, Muroran, 050, Japan

and

Jun'ichi SATO

Ishikawajima-Harima Heavy Industries CO., Ltd., Tokyo, 135, Japan.

Flame propagation of coal dust in a microgravity environment was observed. Ten seconds microgravity environment which is available at Japan Microgravity Center (JAMIC), Hokkaido, Japan, was used to attain a spatially homogeneous and quiescent distribution of pulverized coal.

Ignition was carried out using a Nichrome wire under various oxygen concentrations and flame spread was recorded by a high speed camera. As a result of the experiments, clear images of the flame propagation in coal dust were obtained and the propagation speed was measured from the images. Comparison of flame propagation speed have been carried out for various oxygen concentration.

Winter annual meeting of
American Society of Mechanical Engineering, November
28-December 3, 1993, New
Orleans, USA

**Measurement of Flame Propagation Speed of Coal Dust Cloud using
a Microgravity Environment**

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Flame propagation of coal dust in a microgravity environment was observed. Ten seconds microgravity environment which is available at Japan Microgravity Center (JAMIC), Hokkaido, Japan, was used to attain a spacially homogeneous and quiescent distribution of pulverized coal.

Ignition was carried out using a Nichromr wire under various oxygen concentrations and flame speed was recorded by a high speed camera. As a result of the experiments, clear image of the flame propagation in coal dust were obtained and the propagation speed was measured from the images. Detailed comparison of the flame front structure for different oxygen concentrationa have been carried out to discuss the effect of oxygen concentration on the flame propagation speed.

The 4th International Conference on Atmospheric Sciences and Applications to Air Quality, May 30-June 2, 1994, Seoul, Korea

Seasonal Variations of Atmospheric C₂-C₅ Hydrocarbons in Osaka City.

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Osaka City Institute of Public Health and Environmental Science, 543, Osaka, Japan
and

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Atmospheric C₂-C₅ chain hydrocarbons were measured by hourly for over a year, from Oct. 1992 to Jan. 1994, at center of Osaka City, Japan. These data were analyzed from the point of view of seasonal variation.

All C₂-C₅ HCs monthly mean concentration are low in summer but high in winter. C₂H₄ showed the highest mean concentrations with 3 ppb in summer and 9 ppb in winter. C₃H₆ showed the lowest, with 0.2 ppb in summer and 1 ppb in winter. In winter, the variation of all C₂-C₅ HCs and other pollutants as SPM, SO₂ and NO are very similar. Almost every day, two peaks are observed in the variation of these HCs. The first peak appeared at morning rush hours. The second one occurred when transported polluted air mass by sea breeze came back by land breeze in the evening. At the evening peak, the polluted air might be aged because C₂-C₅ HCs and NO₂ showed high correlation coefficients than those observed at the morning peak. In winter season, the evening peak is much higher than the morning peak.

SENSOREN-Technologie
und Anwendung
7. Fachtagung im Kurhaus
Bad Nauheim
14. bis 16.März 1994
Bad Nauheim, Deutschland

**Measurement of Dimensional Change of Grinding Wheel by
Laser Optical Displacement Sensor under Wet Grinding
—Possibility of Aqueous Expansion of Vitrified Grinding Wheel—**

KAGIWADA, Tadao and MATSUNO, Takashi,
Universität Hokkaido, Sapporo/J

The noncontact scanning system with laser optical displacement sensor is newly applied to the wet grinding process. It is found out, that the expansion of vitrified grinding wheels in the case of wet grinding are larger than those by thermal expansion in the case of dry grinding. The large expansion under wet grinding is not a thermal expansion. No systematic error of sensor by existence of coolant is recognized, and the influence of coolant on the accuracy of measurement is not recognized. On the other hand, the results of experiment soaking the wheel in coolant suggest the softening of the vitrified grinding wheels by the coolant, and the increasing of centrifugal expansion with the softening of the vitrified grinding wheel is expected.

The Third International
Symposium on Diagnostics
and Modeling of Combustion
in Internal Combustion
Engines
July 11-14, 1994
Yokohama, Japan

**Development of a Hyper-Intelligent System with
New Combustion Analysis Concepts**

T. CHIKAHISA, J. NAKAYA and T. MURAYAMA
Department of Mechanical Engineering Hokkaido University

This paper presents new concepts for combustion analysis of engines together with Hyper-Intelligent System developed for the analysis. The analysis involves the following three elements: (1) Constructing a database of relationships among experimental conditions and combustion characteristics to predict combustion performance for a given condition; (2) Extracting the physical relationships among the combustion factors; (3) Using the ability of the

Hyper-Intelligent System to cover deficiencies in measurements and numerical simulations by adjusting empirical parameters in the simulation to fit calculated results to measurements. These above three elements are independent, but common in establishing relationships among a number of non-linear parameters; i. e. learning the spatial distribution of experimental data in a multi-dimensional space. The experiments found that a conventional neural network is insufficient for these applications, and the present study developed an inference method which enables the analysis of nonlinear-multi-variable relationships. A feasibility study with this new Hyper-Intelligent System showed good learning and inference performance within the proposed framework.

Fuels and Lubricants Meeting and Exposition, Philadelphia, Pennsylvania
October 18-21, 1993

An Investigation on the Simultaneous Reduction of Particulate and NO_x by Controlling Both the Turbulence and the Mixture Formation in DI Diesel Engines

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

This paper presents experimental results of the reduction of both particulate and NO_x emitted from direct injection diesel engines by a two stage combustion process. The primary combustion is made very rich to reduce NO_x and then the particulate is oxidized by strong turbulence generated during the secondary combustion. The rich mixture is formed by low pressure fuel injection and a small cavity combustion chamber configuration. The strong turbulence is generated by a jet of burned gas from an auxiliary chamber installed at the cylinder head. The results showed that NO_x was reduced significantly while maintaining fuel consumption and particulate emissions. An investigation was also carried out on the particulate reduction process in the combustion chamber with the turbulence by gas sampling and in-cylinder observation with an optical fiber scope and a high speed camera.

2ng Far Eastern Conference
on Medical and Biological
Engineering
Beijing, CHINA, 16-18,
August. 1993

Static Loading Response of Human Lumbar Spinal Unit

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Cyclic axial compression-tension tests and cyclic torsion tests were carried out to investigate the static loading response of L4-5 functional spinal units (FSU) and L4/5 intervertebral discs in human lumbar spine. The slope of axial load-displacement curves of both the FSU and the disc increases with load. This nonlinearity implies that the stiffness of them is not constant over the range of physiologic loads. In this paper, experimental and analytical methods were developed to represent well the nonlinear load-displacement response of the L4-5 FSU and L4/5 disc, and to calculate the stiffness properties under cyclic loading. As a result, the relationships between the stiffness and the load were linear both under compression-tension and under torsion. The compressive stiffness of the FSU and the disc was higher than the tensile stiffness under loading and unloading. Furthermore, the structural effects of the posterior element in the FSU and the structural effects of the nucleus pulposus in a disc on the stiffness properties could be confirmed.

Societe Internationale de Re-
cherche Orthopedique et de
Traumatologie 6th General
Meeting, (SIROT 93)
Seoul, Korea, 27-30, August.
1993

The Effects of Disc Injuries and Reconstruction with Silicone Elastomer on the Stiffness Properties of the Human Lumbar Disc

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Kuniyoshi ABUMI, Shinji UMEHARA
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Cyclic axial compression-tension tests and cyclic axial torsion tests within the range of physiologic loads were performed on ten fresh human L4-5 disc body units (DBUs) in order to

investigate the relationship between the stiffness properties of L4-5 disc and the range of the displacement. In addition, the effects of an injury to the annulus fibrosus, nucleotomy and the replacement of the denucleated space with silicone elastomer on the stiffness properties of L4-5 disc were also studied. The stiffness of L4-5 disc increased with the increase of displacement under every type of loading. This did not depend on the conditions of the disc. Under each type of loading, the stiffness of a disc with nucleotomy decreased significantly in every region of displacement. The torsional stiffness was restored significantly with the insertion of silicone elastomer into the denucleated space of the disc. However, there was little restoration of both the compressive and tensile stiffness by silicone elastomer replacement.

Societe Internationale de Recherche Orthopedique et de Traumatologie 6th General Meeting, (SIROT 93)
Seoul, Korea, 27-30, August.
1993

Cineradiographic Study of the Lumbar Disc Deformation under Flexion and Extension

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* Department of Mechanical Engineering II, Hokkaido University

The purpose of this study is to confirm the continuous deformation behavior of the normal lumbar discs using cineradiography. The subjects of this measurement were five asymptomatic male volunteers (19-21 years old). While the volunteers were flexing and extending their trunks from the neutral standing position to the full position, cineradiographs of lower lumbar spines (L4 to S1) were taken at 25/sec of frame speed. A local coordinate was defined as the posterior corner of the lower vertebra. According to this coordinate system, the location of the four corners of each disc could be evaluated from the displacement of the two upper corners from the neutral standing position. The deformation of L4/5 disc was larger than L5/S1 disc at full flexion, while L4/5 disc had almost no deformation at full extension. Under flexion, the deformation of each disc increased rapidly after delay time from the start of flexion of the trunk and reached the maximum value before the full flexion. A time lag between the start of deformation of L4/5 and L5/S1 discs can be observed obviously in flexion. Namely, the deformation of L4/5 disc first occurs, and secondly that of L5/S1 disc occurs after a time lag.

Societe Internationale de Recherche Orthopedique et de Traumatologie 6th General Meeting, (SIROT 93)
Seoul, Korea, 27-30, August.
1993

**Effects of Location of Rotational Axis and Resection of Posterior Elements
on the Stiffness Properties of Lumbar Spine
under Flexion-Extension Moment**

Shinji UMEHARA, Shigeru TADANO*, Kiyoshi KANEDA,
Kuniyoshi ABUMI, Satoshi ASANO

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* Department of Mechanical Engineering II, Hokkaido University

The purpose of this study is to investigate the stiffness properties of human L4-5 FSU under continuous flexion-extension moment. The effects of location of rotational axis and resection of posterior elements on the stiffness properties of FSU are presented. As a result, flexional stiffness was the lowest when the axis of rotation was at the center or in the anterior region of the disc. Extensional stiffness was the lowest when the axis of rotation was at the center or in the posterior region of the disc. Resection of supra- and inter-spinous ligaments did not reduced the flexional stiffness of FSU, but decreased the extensional stiffness. Unilateral facetectomy reduced the flexional stiffness, while bilateral facetectomy significantly reduced the extensional stiffness. Degree of instability created by ligamentum flavum resection and unilateral facet joint resection were nearly identical in flexion tesing.

114th ASME Winter Annual
Meeting
New Orleans, USA, 28
November-8 December. 1993

**Distribution of Compressive Elastic Modulus in a
Human Lumbar Intervertebral Disc**

Shigeru TADANO, Takayoshi UKAI, Shinji UMEHARA*, Kiyoshi KANEDA*,
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The lumbar intervertebral disc is an essential element in sustaining weight and in permitting mobility of the spine, which is often subject to degeneration, injuries and disease. In order to understand the mechanics of the disc, numerous biomechanical studies by the experimental or analytical model have been reported. However, even the mechanical behavior of the

annulus fibrosus and the nucleus pulposus in a disc are not understood enough. In this paper, a method of the estimation of local elastic modulus in a disc was represented. Namely, the indentation behavior of the thin specimens was examined with polyurethane elastomer which was selected as a model material of a human disc. Therefore, the compressive elastic modulus could be estimated from the values of the initial thickness, the indentation load and the strain measured by the indentation test. As a result, the distribution of local elastic modulus in a lumbar disc was confirmed from the indentation test with a thin sheet sliced from cadaveric lumbar disc (L3/4).

40th Annual Meeting of Orthopaedic Research Society
New Orleans, USA, 21-24
February, 1994

A Cineradiographic Study on the Deformation of Lumbar Discs during Flexion and Extension of the Trunk

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The human lumbar spine is often susceptible to the mobility owing to more load to sustain and more mobility than other spinal regions. To reveal the deformation behavior of the normal lumbar discs (L3/4, L4/5 and L5/S1), the lumbar spines of eight healthy volunteers were examined during flexion and extension using cineradiography. The disc deformation could be evaluated with the displacement of the superior corners of the disc, which were measured with respect to the upper surface of the adjacent lower vertebra. As a result, during flexion, the deformation of the lumbar disc increased rapidly after a certain delay from the start of the trunk motion and reached the maximum value before the finish of the trunk motion. It was also confirmed that time lags were present between the onsets of the disc deformation. Namely, each disc deformed not simultaneously but stepwise from the upper to the lower level with time lags during flexion.

1994 SEM Spring Conference
on Experimental Mechanics
Baltimore, USA, 6-8 June.
1994

Structural Effect on Cyclic Loading Response of Human Lumbar Spine

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The purpose of this study is to investigate the cyclic loading response of L4-5 functional spinal unit (FSU) in the lumbar spine as well as to confirm the structural effect of the posterior elements and the nucleus pulposus on the mechanical properties of the FSU. The experiments were carried out by means of cyclic compression-tension, cyclic torsion and cyclic forward-backward bending tests. Cadaveric specimens used in this test were intact FSU, a disc body unit (DBU) removing the posterior elements from FSU, and DBU removing the nucleus pulposus which is located the central portion of a disc. As a result, the slope of every load-displacement curves of the FSU increased with load. This nonlinearity implies that the stiffness of FSU is not constant over the range of physiologic loads. The relationship between the stiffness and the load could be expressed with a linear function under every cyclic loading. The every loading stiffness was lower than the unloading one. The stiffness was higher than the tensile stiffness under loading and unloading. The existence of the posterior elements and the nucleus pulposus reduced the stiffness of intact FSU under compression and tension loading, but increased under torsion and backward bending.

4th International Conference
on Residual Stresses
Baltimore, USA, 8-10 June.
1994

Measurement Method of the Stress Distribution along a Depth by Polychromatic X-ray

Jun-ichi SHIBANO, Takayoshi UKAI, Shigeru TADANO
Department of Mechanical Engineering II, Hokkaido University

In recent studies, the possible use of polychromatic mixed X-rays of different wavelengths has been proposed for another type of residual stress measurement. This paper presents a new polychromatic X-ray method for residual stress measurement. Since the relationship between the diffracted beam peak of the polychromatic X-ray and the strain along the depth direction could be confirmed from the tests by steel plates, the residual stress with the steep gradient

along the depth direction in a subsurface layer was estimated by means of the formulas derived from this relation. The specimen having known stress distribution was measured to inspect practical effect of this method. Therefore, it could be confirmed that a stress distribution along the depth direction in a subsurface layer could be evaluated by this method.

Asia-Pacific Vibration Conference '93
Kitakyushu, Japan, Nov. 14-18, 1993

Large Amplitude Vibration of Thick Shallow Shells

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and A. W. LEISSA

Department of Engineering Mechanics, The Ohio State University, Columbus,
Ohio, U. S. A.

The object of this paper is to study the effect of thickness and curvature upon the large amplitude vibration of shallow shells. For this purpose, the nonlinear governing equations for thick shallow shells which have principle curvatures and rectangular planform are derived by Hamilton's principle using first order shear deformation theory. Applying Galerkin's procedure and eliminating variables except transverse displacement, the governing equations are reduced to an elliptic ordinary differential equation in time. The period of vibration for the shell is calculated by integrating the equation using a Gauss-Legendre integration method. The present method is applied to a shallow shell which has a rectangular boundary supported by shear diaphragms and natural frequencies for the shell have been obtained numerically.

Asia-Pacific Vibration Conference '93
Kitakyushu, Japan, Nov. 14-18, 1993

Free Vibration of Spinning Cross-Ply Circular Cylindrical Shells

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Department of Mechanical Engineering II,
Hokkaido University, Sapporo, Japan

An analysis is presented for the free vibration of spinning cross-ply laminated circular cylindrical shells. 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 considering the second order terms of deflections. The variables are expressed as summation of the quasi-static components, which are independent of time, and of the dynamic ones. The deformed state under steady rotation is determined numerically from the quasi-static equations, and the dynamic equations of the vibration are solved by using the transfer matrix method. The method is applied to spinning shells, and the effects of the spinning velocity, lamination parameters and edge conditions of the shell on the free vibration are studied.

Forth International Symposium
on Plasticity and Its
Current Applications,
Baltimore, U. S. A.
July 23-24, 1993

**Viscoplastic Behavior of Type 304 Stainless Steel Subjected
to Uniaxial and Biaxial Ratchetting**

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Hokkaido University, Sapporo, 060, Japan

In this paper, uniaxial ratchetting, biaxial ratchetting and creep tests were carried out at room temperature and at 550°C using Type 304 stainless steel. As a result, it is clear that uniaxial ratchetting behavior is caused by the viscosity of Type 304 stainless steel, and that biaxial ratchetting behavior is caused by both the viscosity of the material and nonproportionality of the loading path.

Asian Pacific Conference on
Fracture and Strength '93,
Tsuchiura, Japan, July 26-
28, 1993

**Characteristic Behavior of CFRP $[\pm 45^\circ]_4$ Subjected to Cyclic Tension-
Compression Loading and Ratchetting**

K. SASAKI* and H. ISHIKAWA*

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Fiber reinforced composite materials are widely used in the several structures. Many researches on fatigue failure, damage and crack for composite material have been made in recent years. However, inelastic behavior of composite materials subjected to loading whose direction is different from that of the fiber's one has not been investigated in detail. In this paper, cyclic loadings under the several conditions were carried out to investigate the inelastic behavior of a composite material using the laminated graphite/epoxy specimen. The specimens had the angle of 45 degree of fiber measured from the axial direction of the specimen. As a result, it was found that the fiber reinforced composite material subjected to cyclic loading had characteristic inelastic deformation.

6th International Congress on
Tribology, Budapest, Hun-
gary, August 30-September
2, 1993

**Tribological Properties and An Analysis of Deformation
of Steel Coated with Ceramics**

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**Fuchu Works, Toshiba Co., Tokyo, Japan

***Department of Mechanical Engineering II,
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Evaluating the bondability, anti-corrosiveness, anti-friction and anti-wear characteristics under various conditions revealed the fundamental properties of various ceramic coatings. Meanwhile, in order to investigate the effect of ceramic coating, we analyzed their elastic-plastic deformations under rolling-sliding contacts using the finite element method. The effect of thickness of the coated layer on the mechanical behavior of the substrate is discussed also. Based on the findings from the fundamental tests, we applied ceramic coatings to the slidable parts in the operating mechanism of a current-switching vacuum breaker under non-lubricated conditions.

ASME 1993 WAM Symposium on Parameter Estimation for Modern Constitutive Equations, New Orleans U.S.A., November 23-December 3, 1993

Determination of Material Properties in Hybrid Constitutive Model

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This paper treats a constitutive model of plastically deformed metal, where kinematic back stress with the memorization of nonproportional preloading and the plastic deformation induced anisotropy are incorporated. This model employs one surface, i. e. the yield surface, and the modified Ramberg-Osgood stress-strain relation to describe the nonlinearity or the roundness of the stress-strain curve, which make the model easy to be implemented in a computer program for the inhomogeneous problems of actual structures. Material properties are determined by a few kinds of the simple material tests.

Second Asia-Pacific Symposium on Advances in Engineering Plasticity and Its Application, Beijing, China, June 29-July 2, 1994

Constitutive Equation for Cyclic Viscoplasticity Considering Memorization of Back Stress

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Hokkaido University, Sapporo, 060, Japan

This paper treats a constitutive model for the viscoplastic deformation and the deformation due to nonproportional loading, where both isotropic flow stress and kinematic back stress with the memorization of nonproportional preloading and the plastic deformation induced anisotropy are incorporated. This model employs one surface, i. e. the yield surface, and the modified Ramberg-Osgood stress-strain relation to describe the nonlinearity or the roundness of the stress-strain curve. Material properties are determined by a few simple material tests. The computer simulation based on this model is verified to be adequate to describe the essential features of the viscous deformation and the nonproportional cyclic straining.

The 4th Int. Symp. Therm.
Engng. & Sci. Cold Regions,
Hanover, NH, USA, Sept.
28-Oct. 1, 1993

**Freezing Characteristics of Water Flow in a Horizontal Cooled Tube
with the Separated Region**

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An experimental study was conducted to determine the effect of flow separation on the freezing characteristics of a turbulent water tube flow. The flow separation was induced by an orifice situated at the inlet of an uniformly cooled circular tube. The degree of flow separation was varied by employing orifices of various hole diameters. Three kinds of tubes with 29.0 mm, 41.5 mm, and 62.9 mm in diameter were adopted. The Reynolds number and the cooling temperature ratio, respectively, ranged from 3.9×10^3 to 4.5×10^4 and from 2.3 to 30.5. The measurements showed that the flow separation exerted a marked influence both on the local ice-formation characteristics and on the transient pressure-loss behavior.

The 4th Int. Symp. Therm.
Engng. & Sci. Cold Regions,
Hanover, NH, USA, Sept.
28-Oct. 1, 1993

Some Topics on Melting Heat Transfer Problems

S. FUKUSAKO and M. YAMADA
Department of Mechanical Engineering Hokkaido University,
Sapporo 060, Japan

Recent some results in the understanding of melting heat transfer in the ice blocks and the liquid ice layers are presented. Attention is devoted to the melting of the ice blocks immersed in a saline water and the liquid ice layers saturated by an aqueous binary solution. The discussion is mainly focused on the morphological studies of the melting phenomena. The emphasis in the paper is on the fundamental mechanism of melting heat transfer in the ice blocks and the liquid ice layers.

The 3rd World Conf. on E.
H. F. T., Honolulu, U. S. A.,
Oct. 31-Nov. 5, 1993

**DIRECT-CONTACT HEAT-TRANSFER CHARACTERISTICS
FROM A LIQUID ICE LAYER**

M. YAMADA, S. FUKUSAKO, and A. HORIBE
Department of Mechanical Engineering Hokkaido University,
Sapporo 060, Japan

An experimental study has been performed to investigate the direct-contact heat-transfer characteristics between air and liquid ice. The effects of concentration of solution, inlet-air temperature, height of liquid-ice bed, and the flow rate of inlet-air on the heat-removal performances were extensively examined. The results revealed that the flow rate of inlet-air exerted considerable effects on the direct-contact heat-transfer characteristics, and that there might be an optimum condition of the flow rate of air for total removed heat. The average heat removal rate were favorably correlated by the flow rate of inlet-air and the temperature difference between inlet-air and equilibrium freezing temperature of initial concentration of solution.

The 6th AIAA/ASME
Therm. and Heat Transfer
Conf., Colorado Springs,
USA, June 20-23, 1994

**Melting Characteristics of a Horizontal Ice Cylinder Immersed in
Saline Water : Effect of Liquid Depth to Saline Water Surface**

S. FUKUSAKO, M. YAMADA, A. HORIBE, and C. WATANABE
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Sapporo 060, Japan

Melting of a horizontal, circular ice cylinder immersed in quiescent saline water has been investigated experimentally to determine the effect of initial liquid depth from the top of the ice cylinder to the saline water surface. Emphasis was placed on interpreting the heat transfer mechanisms which control solid-liquid interface position. The measurements were carried out for saline water of 3.5 wt% salinity with ambient temperatures ranging from 1.8 to 19.8°C. Flow visualization was employed to study the transient flow patterns and corresponding solid-liquid interface positions. Local heat transfer coefficients at the solid-liquid surface were determined and found to be complicated functions of time and imposed thermal conditions as well as position.

The 12th Sympo. on Thermo-
physical Properties, Color-
ado, U. S. A., June 19-24,
1994

Surface Tension of Low-Temperature Aqueous Solution

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Sapporo 060, Japan

Measurements of surface tension of aqueous binary solutions have been carried out to determine the effects of both temperature and concentration of solution on the surface tension. The aqueous solutions of sodium chloride, propylene glycol, and ethylene glycol were adopted as testing liquids. Differential capillary rise method for the measurement and Sugden's revise method for the data revision were employed, respectively. Measurement results showed that the surface tension of both ethylene glycol solution and propylene glycol solution increased as the concentration of solution decreases, while for sodium chloride solution the surface tension increased monotonically as the concentration increases. The relationship between the surface tension of liquids and temperature was found to be almost linear for the temperature range from 20°C to just above the freezing temperature. The correlation equations for surface tension of three kinds of aqueous binary solutions were favorably determined as a function of temperature and concentration of solution.

43rd General Assembly of
CIRP Edinburgh, Scotland,
U. K., August 22-28, 1993

Automation of Polishing Process for a Cavity Surface on Dies and Molds by Using an Expert System

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T. SASAKI, Ikegami Mold Engineering Co., Ltd./Japan
Received on January 14, 1993

SUMMARY :

In order to establish an automatic manufacturing system for dies and molds, a surface finishing technology for free form surface must primarily be developed, because the cavity surface is still finished by handiwork of a skill machinist. In this paper, the knowledge of skilled machinists for mold polishing operation was acquired, and an expert system to design the polishing process was established. This system was confirmed to be useful for schedule and determination of the polishing process, and it was verified that performance of this system was similar to expert performance of mold machinist.

The 6th International Conference on Fusion Reactor Materials, September 27-October 1, 1993, Stresa, ITALY

Mechanical Property Changes in Neutron Irradiated Fe-Cr and Fe-Mn Alloys, and Their Defect Structures Irradiated in FFTF/MOTA and JMTR

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The mechanical property change and defect structures were investigated on Fe-Cr and Fe-Mn alloys irradiated in the JMTR and the FFTF. Dislocation loop density increases much larger with Manganese levels than Chromium levels in irradiation in the JMTR, while in the FFTF, dislocation density of the Fe-Cr alloys is much larger than in the Fe-Mn alloys. This reverse trend is due to the saturation in the development of dislocation loops. The Fe-0.1 and 0.4%Cr with dislocation density much lower than that of 2%Cr, and that of the Fe-0.1 and 0.4%Mn much lower than that of 2%Mn showed the increment in yield strength almost the same as that of the Fe-2%Cr and rather larger than that of the Fe-2%Mn, respectively, in the JMTR. Yield strength increase without significant variation in strain hardening exponent is observed in the Fe-0.1%Cr and Fe-0.1%Mn irradiated in the FFTF and very small voids are observed in the Fe-0.1%Mn irradiated in the JMTR.

11th Power System Computation Conference, Avignon, France, August 30-September 3, 1993

Dynamic Preventive Control Strategies for Enhancing the Transient Stability of Multi-machine Power Systems

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This paper discusses dynamic preventive control strategies for enhancing the transient stability of multi-machine power systems. The transient stability assessment for detailed models of generators is implemented quickly by two security indices derived from the conventional

Transient Energy Function (TEF) method and the Pattern Recognition (PR) method. The former index uses the excess kinetic energy that the post-contingency network can not absorb, and the advantage of being easy to understand in physical meaning. The latter index uses the distance between a discriminant function and a feature vector in a two-dimensional feature plane constructed by the asynchronous kinetic energy and the transmission power margin. The preventive control problem is formulated as a constrained non-linear programming problem and minimizes these indices and the operating cost. The optimal solution is obtained quickly by considering only severe contingencies during the optimization process. An illustrative example of a simple system is given, and both methods are compared in detail.

11th Power System Computation Conference, Avignon, France, August 30- September 3, 1993

Preventive Control Based on Non-linear Optimization Considering Voltage Instability in Power Systems

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This paper presents a preventive control method for avoiding the static voltage instability in power systems. The static voltage instability occurs when the power demand exceeds the tip of the P-V curve; therefore, a realistic load flow solution does not exist. The authors have developed the complex-valued NR load flow method which has the advantage of being able to obtain a complex-valued solution without diverging even under such conditions. In addition, since the absolute values of the extended imaginary parts for this solution increase monotonously as power demand increases, we can assess a degree of the voltage instability by the sum of the squares of the extended imaginary parts. The desirable preventive control strategies can be obtained by minimizing this index considering the operating constraints. Also, this paper discusses successive control method for avoiding the voltage collapse during the load demand continues to increase, and it is clarified that the extension of the preventive control is valid from the viewpoint of on-line operation. Numerical examples for various model systems demonstrate the effectiveness of the proposed method.

1st Japan-Korea Joint Symp.
on Electrical Eng., Sapporo,
Japan, February 6-8, 1994

Security Assessment and Preventive Control Strategy in Power Systems

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An interconnected electric power system is frequently subjected to disturbances such as transmission line outage, generation loss and load shedding. To ensure power system security, it is necessary to simulate contingencies in advances, assess the results and take preventive control measures if the system state is insecure. This entire process is called security assessment and preventive control, and can be divided into two categories: steady-state and dynamic-state. The former deals with adequacy of generator and transmission capacity to meet load demand in the post-contingency steady state. The latter treats the dynamic response of the system following disturbances (issues concerning angle and voltage stability). This paper presents indices for assessing the security to each state quantitatively. The desirable preventive control is determined by minimizing these indices with respect to control variables while satisfying several constraints and coordinating with economic load dispatching.

1st Japan-Korea Joint Symp.
on Electrical Eng., Sapporo,
Japan, February 6-8, 1994

The Application of Fuzzy Theory to Thermal Generating Unit Maintenance Scheduling in Power Systems

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Thermal power station unit maintenance scheduling has to be determined carefully taking into account reliability and economy. Conventionally, scheduling is based on the deterministic (crisp) equalization of the supply reserve capacity for the maintenance period while considering multi-year constraints. However, most external factors which influence load and reserve capacity contain a degree of uncertainty or fuzziness. Therefore, appropriate representation of these elements is desirable. This paper presents a new approach which applies Fuzzy theory to express the inherent uncertainty elements of the scheduling problem and is also based on equalization, however, equalization of an averaged reserve capacity value containing the degree of uncertainty is achieved by the application of membership functions. The proposed performance is compared with that of a conventional deterministic method.

The 5th European Conference of Power Electronics and Applications, September 13-16, 1993, Brighton, UNITED KINGDOM

Modelling and Control of Sinusoidal PWM Rectifiers

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PWM rectifiers are promising because they can supply DC power while keeping a sinusoidal AC current with unity in the fundamental power factor. There are two types, a voltage-fed rectifier and a current-fed rectifier. The former is required to simultaneously control both the fundamental power factor and DC voltage, while the latter does so for both the fundamental power factor and DC current.

State feedback control is essentially suited for multi-input and multi-output systems such as those. Here a discrete-time optimal regulator is applied to their control because it provides a microprocessor-based robust feedback system without steady-state errors in response to a step reference and/or disturbance change. To obtain a mathematical model, only the fundamental component of the rectifier switching function is considered. The obtained nonlinear equations are linearized and then modified in the form that the regulator requires. Finally, the regulator is implemented using a digital-signal-processor. Experimental results demonstrate the validity.

The 5th European Conference of Power Electronics and Applications, September 13-16, 1993, Brighton, UNITED KINGDOM

Control Method and Characteristics of Active Power Filters

Shoji FUKUDA and Takayoshi ENDOH
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This paper describes a control method with a combined filter system employing a current source converter and a high pass filter which senses load current, source current and line voltage to create the reference signals for an active filter. The transfer function of the active filter is identified and is used for the control system design. It is shown that the source current feedback is most effective to suppress the harmonic-enlarging effects due to the parallel resonance and the harmonic current generated by source harmonic voltages. A small setup controlled by a digital-signal-processor was built, and the validity of the proposed method was

demonstrated by experimental results.

IEEE Industry Applications
Society Annual Meeting,
October 2-8, 1993, Toronto,
Canada

Introduction of the Harmonic Distortion Determining Factor and Its Application to Evaluating Real Time PWM Inverters

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Frequency spectra of inverter output currents are one of the important factors to evaluate PWM methods. These spectra are, however, influenced not only by the PWM method itself but by the operating conditions of the inverter such as the switching frequency or load parameters. The harmonic distortion determining factor (HDDF) is considered to be a common quality index that represents the intrinsic spectral property of individual PWM methods. As it has a close relation to RMS values of the harmonic current or torque ripples of driven motors and, further, it is almost independent of the operating conditions, HDDF is quite useful for evaluating PWM methods. In this paper four typical analog PWM methods and four digital PWM methods are compared and evaluated based on HDDF values.

The First Japan-Korea Joint
Symposium on Electrical
Engineering, "Applied Elec-
tromagnetics, Power Systems
and Controls", February 6-8,
1994, Sapporo, Japan

Highly precise control for electrical machine with periodic disturbances — DC motor speed control system based on optimal repetitive control —

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When motor has periodic disturbances, such as a compressor, rotor speed changes periodically and cannot be controlled constantly by using PI controller. However, if such a control system is constructed considering periodicity, motor speed can be controlled constantly on the load condition mentioned above and such control designing method is called repetitive control. But the method lacks clearness so as to decide control gains.

In this paper, new state equations named ERROR SYSTEM is derived with due regard to

periodicity of disturbances, and the optimal regulator technique is applied for the controlled object. And then a new control designing method, optimal repetitive control is introduced. The proposed control strategy is applied for DC moto speed control system with periodic disturbance.

Finally, it is shown that the proposed method is available for eliminating the fluctuation of rotational speed.

The Forth International
Workshop on Algorithmic
Learning Theory, November
8-10, 1993, Chofu, JAPAN

Generalized Unification as Background Knowledge in Learning Logic Programs

Akihiro YAMAMOTO

Department of Electrical Engineering, Hokkaido University, Sapporo, JAPAN

In this paper we investigate the roles of generalized unification as background knowledge in learning logic programs. Our framework of learning is PAC-learning. We treat logic programs in which function symbols and recursions appear. We generalize the hereditary programs, which Miyano et. al have defined to investigate the learnability of elementary formal systems, by introducing generalized unification as the background knowledge of the learning algorithm. As a consequence, we succeed to revise Miyano's algorithm so that it treats another class of logic programs. Our algorithm is superior to the algorithm given by Dzeroski et. al in the point that it uses no queries on target predicates. We also define the size of a sample S not as the number of atoms in S , but as the number of symbols in S . This becomes possible because the evaluation of destructors in generalized unification corresponds to the use of back ground predicates in Dzeroski's algorithm.

The Forth European-Japanese
Seminar on Information
Modelling and Knowledge
Bases, May 31-June 3, 1994,
Kista, SWEDEN

Programming by First Order Formulas for Object and Relation Definition

Akihiro YAMAMOTO

Department of Electrical Engineering, Hokkaido University Sapporo, JAPAN

In this paper we introduce a class of first order formulas, called FOD's (Formulas for Object Definition). It is a super class of definite clauses and subclass of extended goals introduced by Fribourg. We show extended goals act as programs whose execution is Skolemization and SLD-resolution. Then we introduce various classes of FOD's to represent reflexive axioms, tuples of relational databases, and proofs of definite programs.

World Conference on Educa-
tional Multimedia and
Hypermedia June 25-30,
1994, Vancouver, CANADA

From Augmentation Media to Meme Media

Yuzuru TANAKA

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Computers as meta media are now evolving from augmentation media vehicles to meme media vehicles. While an augmentation media system provides a seamlessly integrated environment of various tools and documents, meme media system provides further functions to edit and distribute tools and documents. Documents and tools on meme media can easily replicate themselves, recombine themselves, and are naturally selected by their environment, namely the society of their authors and users. Their accumulation in their users' community will form a meme pool, which will bring rapid evolution of documents and tools. The IntelligentPad architecture provides a standard framework called a pad that works as a meme medium. When applied to microworlds, it will bring more flexibility to the environments, and more opportunities of creative thinking to their users.

The Forth European-Japanese
Seminar on Information
Modelling and Knowledge
Bases, May 31-June 3, 1994,
Kista, SWEDEN

From Augmentation Media to Meme Media : IntelligentPad and the World-Wide Repository of Pads

Yuzuru TANAKA

Department of Electrical Engineering, Hokkaido University, Sapporo, JAPAN

Computers as meta media are now evolving from augmentation media vehicles to meme media vehicles. While an augmentation media system provides a seamlessly integrated environment of various tools and documents, meme media system provides further functions to edit and distribute tools and documents. The accumulation of documents and tools in the society will form a meme pool, which will bring their rapid cultural evolution. The IntelligentPad architecture provides a standard framework called a pad that works as a meme medium, while WWW and Mosaic respectively provides a world-wide pad repository and its browser to form an open market of pads in the Internet.

Progress in Electromagnetic
Research Symposium
(PIERS), Pasadena, USA,
July 12-16, 1993

A Finite Element Analysis of Waveguide Loaded Cavities

H. IGARASHI, Y. SUGAWARA and T. HONMA

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The electromagnetic fields and resonant frequencies in closed cavity resonators have been analyzed by various numerical methods. This paper describes a novel approach for analysis of electromagnetic fields in a cavity coupling to an external waveguide. In our method, the electromagnetic field in the cavity and waveguide region near the cavity is analyzed by finite element method. The effect of the infinitely long waveguide on the field is taken into account in the absorbing boundary condition at the end of the waveguide region. The present method gives the resonant frequency and the external Q of a waveguide loaded cavity by solving a standard eigenvalue problem.

Second International Workshop on EMF and Related Effects on Blankets of Fusion Plasma Torus Tokai, Japan, Sept. 15-17, 1993

Experimental and Numerical Analyses for Effects of Ferromagnetic Material

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In strong and fluctuating magnetic field of a fusion reactor, ferromagnetic material receives magnetic body force as a result of magnetization. Experimental and numerical studies are explained to evaluate effects of ferromagnetic material. The magnetic torque for a ferromagnetic beam plate are analyzed for a ferromagnetic first wall. Iron loss and mechanical vibrations are also investigated for a ferromagnetic thin plate.

The Ninth International Congress on Advances in Non-Impact Printing Technologies (Japan Hardcopy '93) Yokohama, Japan, October 4-8, 1993

Numerical Approach for the Design of Electrophotography Corona Device

T. NAKAMURA*, S. SAKAI*, O. YASHIMA*, H. IGARASHI and T. HONMA

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Electrophotographic copying machines and laser printing machines are commonly used in offices nowadays. In recent years, much effort and attention have been paid on developing color reproducing machines, which can produce high resolution printing image. A corona device plays an important role in electrophotographic process. This paper presents a computer-based analysis and design system for the corona device.

Sixth Int. Symp. on Super-
conductivity Hiroshima,
Japan Oct. 26-29, 1993

**Numerical Analysis of Levitation Force of HTSC by Using
Critical State Model and Frozen Field Model**

M. TSUCHIMOTO, H. TAKEUCHI, T. KOJIMA and T. HONMA
Department of Electrical Engineering, Faculty of Engineering,
Hokkaido University, Sapporo, Japan

Levitation force between permanent magnets and a high T_c superconductor is analyzed numerically based on the critical state model. Size and gap of the magnets are examined to obtain the large levitation force in a partial model of a flywheel. Horizontal restoring force is evaluated by using the frozen field model, which is from an assumption that flux is frozen to the HTSC by the strong pinning force.

The Ninth Conference on the
Computation of Electromag-
netic Fields (COMPUMAG),
Miami, USA Oct. 31-Nov. 4,
1993

**An Analysis of Electromagnetic Waves by a Complementary
Finite Element Method**

H. IGARASHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper describes an analysis of electromagnetic waves in a waveguide using the finite element method based on the complementary variational principle. The vector Helmholtz equation is represented in dual forms, in which the solenoidal and irrotational transverse fields are chosen to be unknowns, and they are approximated by the edge and facet elements, respectively. The dual representations are then shown to provide the lower bounds of the eigenfrequencies of a waveguide, with the aid of the complementary variational principle.

The Ninth Conference on the
Computation of Electroma-
gnetic Fields (COMPUMAG),
Miami, USA Oct. 31-Nov. 4,
1993

Large Scale Wake-fields Calculation Using Kirchhoff's Integral Equation

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This paper presents three dimensional time dependent Boundary Element Analysis for wake fields in a particle accelerator cavity. In particular, large scale problems (or complex shape boundary problems) are treated here. Generally speaking, time dependent problems require fewer storage memories than static or steady state problems for same numerical model, when the Finite Difference Method or the Finite Element Method is applied. This paper points out that the same aspect exists in Boundary Element Method and shows analysis of wake field accelerator as an example of large scale problems.

Fourth International TEAM
Workshop Miami, USA Nov.
5-6, 1993

An FE Analysis of a Waveguide Loaded Cavity TEAM Problem 18

H. IGARASHI, Y. SUGAWARA and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper gives a simple numerical method based on the finite element method for the analysis of electromagnetic fields in a waveguide loaded cavity (TEAM problem 18). In the present method, the external Q is obtained by solving a second order proper equation with a damping term, which can be reduced to a linear one. It is shown that the present method provides accurate Q values for wide range of the coupling.

First Pan-Pacific Conference
on Computational Engineering (PCCE), Nov. 1-5, 1993,
Seoul Korea

Numerical Analysis of ECT on a Crack near a Rivet hole

M. TSUCHIMOTO, A. FUKAYA and T. HONMA
Department of Electrical Engineering, Faculty of Engineering,
Hokkaido University, Sapporo, Japan

Eddy current problem to recognize a crack on the edge of a rivet hole is analyzed numerically. Vertical field is induced by the disturbance of the sheet eddy current on a thin plate. The vertical field is evaluated for a visualization technique with magneto optics. A vague image of a crack is improved by cancellation of signals of the rivet hole in the numerical analysis.

First Pan-Pacific Conference
on Computational Engineering (PCCE), Nov. 1-5, 1993,
Seoul Korea

An Equilibrium Analysis of Helically Symmetric MHD Plasmas

M. YOSHIDA, H. IGARASHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

The magnetohydrodynamic (MHD) equilibria in the stellarators, which are one of the nuclear fusion machines based on magnetic confinement, can be approximated as being helically symmetric. This approximation permits us to analyze the equilibrium and stability of the MHD plasma in two dimensions. Moreover, when the MHD plasma is described by the surface current model, its equilibrium can be analyzed by solving the Laplace equation for the magnetic scalar potential. Since the equilibria must be calculated for a number of different plasma geometries in the design of nuclear machines, the boundary integral equation method, which needs only the discretization of the boundaries of the plasma, seems suitable for the analysis of them.

In this paper, first, we solve the helically symmetric Laplace equation in the plasma region using the boundary integral equation method and find the magnetic field in the region.

First Pan-Pacific Conference
on Computational Engineer-
ing (PCCE), Nov. 1-5, 1993,
Seoul Korea

**A Computation of Electromagnetic Fields in a Waveguide
Loaded Cavity Using Finite Element Method**

Y. SUGAWARA, H. IGARASHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

The electromagnetic fields and resonant frequencies in closed cavity resonators have been analyzed by various numerical methods. However, there are few methods by which waveguide loaded cavities are effectively analyzed. This paper gives a simple numerical method based on the finite element method for the analysis of electromagnetic fields in a cavity coupling to an external waveguide. In the present method, the external Q is obtained by solving a second order proper equation with a damping term, which can be reduced to a linear one. It is shown that the present method provides accurate Q values for wide range of the coupling.

Eighth International Confer-
ence on Boundary Element
Technology (BETECH 93)
Vilamoura, Portugal Nov.,
9-11, 1993

A Boundary Element Analysis of Magnetic Fields Near Surfaces

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Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper describes a boundary element method for accurate computation of magnetic fields near surfaces of magnetic materials. The present method, which includes two different approaches, is based on the regularization of the quasi singularity in the kernel. The numerical results show that the present method gives accurate magnetic fields near the surface of a magnetic material of a rectangular cross section.

The Second Japanese-Czech-Slovak Joint Seminar on Applied Electromagnetics in Materials Kyoto, Japan, Jan. 19-21, 1994

R-Functions for Magnetic Field in a Toroidal MHD Plasma

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Since an analysis of magnetohydrodynamic (MHD) equilibrium of magnetically confined plasmas plays a crucial role in design of nuclear fusion machines, it requires an accurate and effective computational method. The paper deals with determination of electromagnetic field in balanced MHD plasma. An approximation by R-functions method is introduced for static linear field. Comparison of the results with analytical solution yields error estimation of R-functions method.

The Second Japanese-Czech-Slovak Joint Seminar on Applied Electromagnetics in Materials Kyoto, Japan, Jan. 19-21, 1994

Numerical Stability fo Velocity Fluctuation in a Particle Trajectory Estimation from Far Electromagnetic Fields

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Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

Authors have discussed particle trajectory estimation method from far electromagnetic fields. This method can not estimate time evolution of the particle trajectory, but "the shape" of a particle trajectory. Accordingly, two trajectories, which have different velocities, are estimated as same shape by this method. This paper discusses numerical stability for the particle velocity fluctuation and shows that this method is stable for the velocity fluctuation.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

**Regularization Technique of Quasi-singularity in BEM Analysis
of the Modified Helmholtz Equation**

H. IGARASHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper deals with a regularized formula for boundary element analyses of the modified Helmholtz equation. The quasi-singularity in the kernel, which impedes accurate computations of fields near a boundary, is regularized with the aid of the fundamental solution to the Laplace equation. The present formula is shown to effectively improve the accuracy in computation of an eddy current field.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

Recent Advances in Computational Electromagnetics

T. HONMA
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Hokkaido University, Sapporo, Japan

In this paper, we discuss three examples of the application of computational electromagnetics: BEM (Boundary Element Method) analysis of a corotron, estimation of the critical mass in levitation melting process, and a finite difference analysis of MPD (magnetoplasma-dynamic) thruster are discussed. It is found that the above engineering problems can be effectively solved by coupled approaching methodology with high-performance computer.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

**A Method for Computation of External Q of
Electromagnetic Cavities**

Y. SUGAWARA, H. IGARASHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper gives a simple numerical method based on the finite element method for the analysis of external Q values of a cavity coupling to an external waveguide. In the present method, the external Q is obtained by solving a second order proper equation, with a damping term, which can be reduced to a linear one.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

**A BEM Analysis of a Helically Symmetric MHD Equilibrium
with an Elliptic Cross Section**

M. YOSHIDA, H. IGARASHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper deals with a boundary element analysis of a helically symmetric equilibrium of the magnetohydrodynamic (MHD) plasma with an elliptic cross section, using the sharp boundary model. The solutions obtained by the present method are shown to be in good agreement with those by the analytic method based on the scyllac expansion.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

**An Analysis of Magnetic Fields around a Magnetic Roller
for Electrophotography**

T. NODA, H. IGARASHI and T. HONMA
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Hokkaido University, Sapporo, Japan

This paper describes a numerical analysis of magnetic fields and forces around a magnetic roller for electrophotography. The radial components of the magnetic field experimentally measured are used as the boundary condition to numerically compute the fields around the roller, using the discrete Fourier transform. It is revealed that the position of peaks of the radial component of the magnetic fields does not always coincide with those of the magnetic forces acting on toner particles.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

**An Analysis of the Wake Field Accelerator Using
the Boundary Element Method**

M. OHTSUKA, H. KAWAGUCHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper discusses an analysis of wake field accelerator using the Boundary Element Method (BEM). Then, the BEM analysis is based on Kirchhoff's integral equation to simulate transient electromagnetic phenomena. Using the BEM, one can generate numerical model easily, even if accelerator has complex shape.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

Consideration on Radiation Field Structure from FEL

H. KAWAGUCHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper discusses fine structures of radiation field from the Free Electron Laser (FEL) using numerical calculation. The discussion is done considering the Liénard-Wiechert potentials. One can find that the radiation fields have quite different radiation field structures from ordinal dipole radiation fields.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

Simulation of a Two Dimensional MPD Thruster

K. SASAKI, H. KAWAGUCHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper describes a quasi-steady two-dimensional analysis of an MPD (magnetoplasma-dynamic) thruster. To obtain self-consistent solutions, the Euler equation and magnetic field equation are numerically solved using the finite difference method.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

**Numerical Analysis of Levitation Force of HTSC for Combination
of Permanent Magnets**

H. TAKEUCHI, M. TSUCHIMOTO and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

Levitation force between permanent magnets and a high T_c superconductor is analyzed numerically based on the critical state model. Size and combination of the magnets are examined to obtain the large levitation force. There are the size of the magnets and the magnetic field configuration to obtain the maximum levitation force for a given size of the HTSC. Obtained results will be useful to design the flywheel system with HTSC.

The First Japan-Korea Joint
Symposium on Electrical
Engineering Sapporo, Japan,
Feb. 6-8, 1994

**Evaluation of Levitation Force of HTSC Based on a
Critical State Model and a Frozen Field Model**

M. TSUCHIMOTO, T. KOJIMA, and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

Vertical levitation force and horizontal restoring force between permanent magnets and a high T_c superconductor is analyzed numerically based on the critical state model and a frozen field model. Constitutive relation between shielding current and electric field is discussed in the two models.

Ninth International Conference on Boundary Element Technology (BETECH), Orlando, USA, March 16-18, 1994

Numerical Simulation of Electromagnetic Levitation Melting Process Considering Temperature Dependence

H. KAWAGUCHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper discusses determination of a metal shape in electromagnetic levitation melting process considering temperature dependencies. In this process, the surface tension plays an important role for determination of the metal shape. From this point of view, an estimation method of the temperature and the temperature dependence of the surface tension are considered.

Ninth International Conference on Boundary Element Technology (BETECH), Orlando, USA, March 16-18, 1994

BEM Analysis of Transient Electromagnetic Fields Based on Vector Potentials

H. KAWAGUCHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

Authors have discussed BEM analysis of transient electromagnetic fields which are produced by relativistic charged particles. The velocity of the particle, however, was 90 percents of the light velocity, $\beta (=v/c)=0.9$, at most, because of numerical difficulties of relativistic electromagnetic fields. This paper discusses these difficulties using wake fields in an accelerator cavity as an example of transient electromagnetic fields.

1994 Int. Workshop on
Superconductivity Kyoto,
Japan, June 6-9, 1994

Evaluation of Total Shielding Current of a Bulk HTSC

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Total shielding current of a bulk high T_c superconductor (HTSC) is evaluated from induced voltage of a Rogowski coil when a cylindrical magnet is moved to the HTSC. Experimental results show that dynamic levitation force is explained by the flux flow-creep theory. Numerical results with the critical state model are compared to discuss the dynamic levitation force.

The International Symposium on Advanced Computational and Design Techniques in Applied Electromagnetic Systems (ISEM-Seoul), Seoul, Korea, June 22-24, 1994

Numerical Estimation of Bootstrap Current in Tokamaks under Different Approximations

H. IGARASHI, M. YOSHIDA and T. HONMA

Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

This paper describes an analysis of the bootstrap current in a tokamak plasma with a semi-fixed boundary. The bootstrap current is computed using four different viscosity estimations based on the banana, simple rational, Hirshman's rational approximations and velocity space partitioning. It is revealed that the former two methods overestimate the bootstrap currents especially for high q values while Hirshman's rational approximation gives the results consistent with those by the velocity space partitioning.

The International Symposium on Advanced Computational and Design Techniques in Applied Electromagnetic Systems (ISEM-Seoul), Seoul, Korea, June 22-24, 1994

**Consideration on Acceleration Mechanism of
Two Dimensional MPD Thruster**

K. SASAKI, Y. HIKITA, H. KAWAGUCHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

The authors have been developing a numerical simulation method for Magnetoplasmadynamic (MPD) thruster. The simulation method consists of two parts, compressive fluid analysis and electromagnetic fields analysis. The fluid phenomena are analyzed by the Total Variation Diminishing (TVD) scheme and Successive Over-Relaxation (SOR) method is applied for the electromagnetic fields analysis. It has been already shown that the numerical simulation method is valid for estimation of the propulsion force and current pass distribution. This paper considers thruster shape dependencies on the propulsion force, using the numerical simulation method. Especially, we consider two typical thrusters, Flare and Converge-Diverge type thrusters and discuss their acceleration mechanism.

The International Symposium on Advanced Computational and Design Techniques in Applied Electromagnetic Systems (ISEM-Seoul), Seoul, Korea, June 22-24, 1994

**Numerical Analysis of Radiation Field Structure
from Free Electron Laser**

J. MATSUOKA, H. KAWAGUCHI and T. HONMA
Department of Electrical Engineering, Faculty of Engineering
Hokkaido University, Sapporo, Japan

In this paper, fine structure of radiation fields from FEL are considered using numerical calculation. The consideration is based on the Liénard-Wiechert potentials. And then, we treat the FEL system with planar wiggler. From the consideration, one can find that frequency distribution of the radiation fields depend on observation point strongly.

The International Symposium on Advanced Computational and Design Techniques in Applied Electromagnetic Systems (ISEM-Seoul), Seoul, Korea, June 22-24, 1994

Evaluation of Levitation Force of HTSC by a Frozen Field Model

M. TSUCHIMOTO, T. KOJIMA and T. HONMA
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Vertical levitation force and horizontal restoring force between a permanent magnet and a high T_c superconductor are analyzed numerically by using a frozen field model. The frozen field model is under the assumption that flux is frozen in the HTSC by the strong pinning force. Total body force is produced by an unbalance of Maxwell stress. Constitutive relation between shielding current and electric field is discussed in two models.

The 9th Int. Conf. on Ternary and Multinary Compounds, Yokohama, Japan, August 8-12, 1993

DILUTED MAGNETIC III-V SEMICONDUCTORS AND ITS TRANSPORT PROPERTIES

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A new class of diluted magnetic semiconductor (DMS) based on III-V compounds and its transport properties are reviewed. The new DMS, (In, Mn)As, has been grown by low temperature molecular beam epitaxy to overcome the low solubility limit of Mn in InAs. Typical growth temperature range in which uniform alloy can be obtained was from 200 to 300°C. At 200°C, all thick films were n-type, whereas at 300°C they were p-type. Films exhibiting n-type conduction were all paramagnetic with the Mn-Mn interaction being antiferromagnetic. Magnetotransport properties of p-type films revealed the magnetic properties of the films via anomalous Hall effect, which is proportional to the magnetization of the film. Especially striking was the appearance of hysteresis in the magnetic field dependence of the Hall resistivity at low temperature, which showed the presence of ferromagnetic order. The ferromagnetic order was accompanied by paramagnetic response and large negative magnetoresistance extending to

high magnetic fields. The coexistence of remanent magnetization and unsaturated spins (partial ferromagnetic order; asperomagnetism), and the large negative magnetoresistance can be explained by the formation of large unsaturated bound magnetic polarons with partially aligned canted spins. The absence of such ferromagnetic order in n-type samples is a strong evidence that the ferromagnetic Mn-Mn interaction is hole-induced. The ferromagnetic order observed in the (In, Mn)As based heterojunctions is also discussed.

International Conference on
Solid State Devices and
Materials, Nippon Con-
vention Center, Makuhari
Messe, Chiba, Japan, August
29-September 1, 1993

Fabrication of InGaAs Wires by Preferential Molecular Beam Epitaxy Growth on Corrugated InP Substrate

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Fabrication technology of InGaAs wire structures by preferential molecular beam epitaxy growth on corrugated InP substrate was successfully developed for the first time. Growth was made on the substrates having V-grooves with (211) A or (111) A facets and wires were made in nonquantum regime. The effects of the growth conditions on the cross-sectional structure and photoluminescence (PL) properties were clarified. Wires grown on (111) A facets showed better structural and PL properties than those on (211) A facets. Insertion of an InGaAs low-temperature (LT) buffer layer was found to greatly improve the band-edge PL intensity. Under optimum conditions, the wire exhibited an intense PL emission with a narrow peak width at an energy position of InGaAs lattice-matched to InP. A defect-related emission is also observed and discussed.

International Conference on
Solid State Devices and
Materials, Nippon Conven-
tion Center, Makuhari
Messe, Chiba, Japan, August
29-September 1, 1993

**Fabrication and Characterisation of Direct Schottky Contacts to
Two-Dimensional Electron Gas in GaAs/AlGaAs Quantum Wells**

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Pt Schottky contacts to the edge of a two-dimensional electron gas in a GaAs/AlGaAs system have been manufactured using a newly developed *in-situ* etching and electroplating technology. The electroplating takes place selectively on the edge of the quantum well. It is shown that the *in-situ* etching prior to deposition leads to more uniform electroplating due to the removal of native oxides. $I-V$ and $C-V$ measurements have been made in order to compare the diodes with conventional Schottky diodes. It can be shown that the capacitance shows functionally the relationship predicted by theory, which demonstrates that we have manufactured a contact to a 2-dimensional electron gas. $I-V$ measurements at low temperatures reveal parallel ohmic conductance. It is shown qualitatively that tunneling through the extremely thin barrier plays an important role in the current conduction, which explains the high ideality factor and the low apparent barrier height compared to bulk Schottky diodes.

International Conference on
Solid State Devices and
Materials, Nippon Con-
vention Center, Makuhari
Messe, Chiba, Japan, August
29-September 1, 1993

**Formation of Oxide-Free Nearly Ideal Pt/GaAs Schottky Barriers
by Novel *In Situ* Photopulse — Assisted Electrochemical Process**

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An oxide-free Pt/GaAs Schottky barrier was fabricated by a novel *in situ* photopulse-assisted electrochemical process. Nearly ideal thermionic emission characteristics of a high barrier height ϕ_{Bn} of 1.07 eV and an ideality factor of $n=1.05$, were observed over a range of 7 orders of magnitude of electric current. The results of atomic force microscopy (AFM), X-ray photoemission spectroscopy (XPS) and deep level transient spectroscopy (DLTS) measurements indicated that the novel electrochemical process produces a smooth and oxide-free interface and prevents formation of process-induced damage. It produces firm Fermi level pinning which was previously possible only by ultrahigh-vacuum (UHV) processes.

International Conference on
Solid State Devices and
Materials, Nippon Con-
vention Center, Makuhari
Messe, Chiba, Japan, August
29-September 1, 1993

**Mechanism of Multiatomic Step Formation during Metalorganic Chemical
Vapor deposition Growth of GaAs on (001) Vicinal Surface Studied
by Atomic Force Microscopy**

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The detailed behavior and mechanism of multiatomic step formation processes during metalorganic chemical vapor deposition (MOCVD) of GaAs on vicinal surfaces are systematically investigated using an atomic force microscope (AFM). Under the low growth rate condition, the step flow growth mode with regular stripe is obtained, and the final terrace width is almost independent of the substrate misorientation angle. The result suggests that the barrier height difference for surface migrating Ga atoms between the terrace site and the step site is small, and the final terrace width is mainly determined by a migration length. Three-dimensional nucleation and growth mode with irregular steps are also obtained under the high growth rate condition. However, as the AsH₃ partial pressure increases, irregular steps are no longer observed. For these results, we discuss the multiatomic step formation mechanism.

International Conference on
Solid State Devices and
Materials, Nippon Con-
vention Center, Makuhari
Messe, Chiba, Japan, August
29-September 1, 1993

**Novel Step Height Reduction Phenomenon during Alkyl-Desorption
Limited Atomic Layer Epitaxial Growth on Vicinal Substrate**

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New atomically controlled epitaxial growth, called alkyl-desorption-limited epitaxial (ADLE) growth, is studied on (001) exactly oriented and vicinal GaAs substrates. In ADLE

growth, the growth rate is limited by the desorption rate of alkyl from organometals rather than by saturation of alkyl adsorption. First, the proposed ADLE growth mechanism is quantitatively confirmed by comparing a new theory of growth based on the alkyl-desorption rate equations with the experimental growth data taken on (001) exactly oriented substrates. Next, the behavior of multi-atomic steps on vicinal substrates is studied using an atomic force microscope (AFM). It is found that the multi-atomic-step heights are reduced during ADLE growth. This new phenomenon is explained by the ADLE growth mechanism.

International Conference on
Solid State Devices and
Materials, Nippon Con-
vention Center, Makuhari
Messe, Chiba, Japan, August
29-September 1, 1993

Behavior of Growth Rate in Gas Source Molecular Beam Epitaxial Growth on InP Using Phosphine

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Effects of phosphorus pressure on the growth mechanism and the quality of the grown layers in gas source molecular beam epitaxial (MBE) growth of InP on (001) substrate are investigated. It is found that normal growth process with the growth rate limited by indium flux intensity takes place only in a very narrow range of phosphorus supply. Outside this range, the growth rate depends also on phosphorus pressure. A significant decrease in growth rate under high phosphorus pressure is demonstrated to be due to oversaturation of the substrate surface by excess phosphorus. High phosphorus pressure deteriorates both the electrical and optical properties as well as the crystalline quality of the epitaxial layers. Incorporation of excessive phosphorus is shown to be responsible for deterioration, indicating that control of phosphorus pressure is very important for successful MBE growth of InP.

International Conference on
Solid State Devices and
Materials, Nippon Con-
vention Center, Makuhari
Messe, Chiba, Japan, August
29-September 1, 1993

**Process Induced Defects in InP Produced by Chemical Vapor Deposition
of Surface Passivation Dielectrics**

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Near-surface defects of InP produced during three different chemical vapor deposition (CVD) processes were systematically characterized by capacitance-voltage ($C-V$) and deep level transient spectroscopy (DLTS) techniques. Deposition of plasma-enhanced CVD (PECVD) phosphosilicate glass (PSG) and SiO_2 films produced the same bulk level, lying at 0.35 eV below the conduction band edge, near the surface region of InP. Such a level was absent in the samples prepared by the photo CVD process. In addition, the photo CVD process gave a lower density of interface states than the PECVD process. The origin of the bulk trap and the energy- and space-distributed nature of interface states are discussed.

The Twentieth International
Symposium on Gallium Ar-
senide and Related Com-
pounds, Freiburg, Germany,
August 29-September 2, 1993

**A novel *in-situ* characterization method of quantum structures
by excitation power dependence of photoluminescence**

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ABSTRACT: Excitation power dependence of photoluminescence from AlGaAs/GaAs quantum wells is analyzed both theoretically and experimentally. It is shown that the recombina-

tion processes at the sample surface and the quantum structure interfaces, which have not been considered previously, can cause marked non-linearity. Extending the recently proposed photoluminescence surface state spectroscopy, PLS³, technique, state distributions at quantum well interfaces are determined in an in-situ, contactless and non-destructive fashion. Growth interruption is shown to produce high density of interface states and lower the PL efficiency.

The 3rd IUMRS Int. Conf.
on Advanced Materials,
Tokyo, Japan, August 31-
September 4, 1993

INTER-SUBBAND POPULATION INVERSION IN TUNNELING HETEROSTRUCTURES

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Population inversion between the subbands in the same band (intraband, inter-subband population inversion) is shown to be possible within accessible material parameters utilizing heterostructures that act as an energy filter for carriers. Two possible structures are examined; one utilizing the unique band line-up of type-II polytype heterostructures and the other using the energy filtering of triple barrier resonant tunneling heterostructures.

The type-II heterostructure consists of an AlInAs emitter/AlSb barrier/InAs active layer/AlSb barrier/GaSb collector structure. It is designed in such a way that (1) the emitter can emit electrons only to the first excited subband of the InAs active layer, and (2) the GaSb collector can collect electrons only from the ground subband of the InAs layer, to efficiently inject and extract electrons into the excited subband and out of the ground subband. (1) is possible by choosing the AlInAs composition so that the emitter conduction band becomes energetically higher than that of the ground subband of InAs. (2) is possible because of the peculiar broken band line-up between InAs and GaSb. Since the valence band of GaSb is higher than the conduction band of InAs, the first excited subband of InAs can be positioned in the band gap of GaSb while keeping the ground subband of InAs in the "window" between the InAs conduction band and the GaSb valence band, thus allowing carriers to flow only from the InAs ground subband to GaSb. In order to achieve population inversion, injection and extraction of carriers have to be much faster than the intersubband relaxation time, which is dominated by the optical phonon scattering and is of the order of ps. This requirement is shown to be satisfied by keeping the thickness of the AlSb barriers less than 20 Å, which is well within the controllable range of the modern crystal growth techniques. Discussion of the triple barrier structure will also be presented.

The First International Symposium on Control of Semiconductor Interfaces Karuizawa, Japan, November 8-12, 1993

Barrier Height Control and Current Transport in GaAs and InP Schottky Diodes Having An Ultrathin Silicon Interface Control Layer (Invited)

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The present status of the effort to control the Schottky barrier height (SBH) at M-S interfaces of GaAs and InP using an ultrathin Si interface control layer (Si ICL) is discussed.

It is shown that, by inserting ultrathin Si ICL having a thickness of 10 Å, SBH can be changed in a precisely controllable fashion over 300-400 meV without blocking thermionic current transport.

The First International Symposium on Control of Semiconductor Interfaces Karuizawa, Japan, November 8-12, 1993

Effects of Interface States on C-V Profile Characterization of Semiconductor-Semiconductor Interfaces of GaAs and Related Alloys

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Capacitance-voltage ($C-V$) profiling routinely used in the compound semiconductor technology, ignores existence of interface states. This paper clarifies theoretically and experimentally the effects of interface states on the apparent $C-V$ carrier profiles. The equilibrium $C-V$ carrier profiles were calculated by a rigorous computer simulation program and fitted to experimental curves obtained on GaAs regrowth interfaces and continuously grown selectively doped two dimensional electron gas interfaces. $C-V$ anomaly at GaAs regrowth interface is shown to be due to formation of U-shaped interface states which produced an additional depletion/accumulation profile, extending over a distance much larger than the Debye length. A temperature dependent analysis on peak height and peak width of $C-V$ profiles is shown to be a powerful means to find whether the observed $C-V$ profile peak is due truly to free electrons or artifact caused by charge/discharge of interface states.

The First International Symposium on Control of Semiconductor Interfaces Karuizawa, Japan, November 8-12, 1993

Application of Silicon Interface Control Layer Technique to Fabrication of InGaAs Metal-Insulator-Semiconductor FETs

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Previously proposed interface control technique using an ultra-thin MBE Si interface control layer (Si ICL) was applied to air-exposed InGaAs surfaces by introducing an HF surface treatment. A depletion type photo-CVD SiO₂/Si ICL/InGaAs MISFET was fabricated to demonstrate the applicability of the modified process. After optimum annealing of the MISFET, effective electron mobility of 3850cm²/Vs was achieved. The instability of drain current was also reduced below 5% at t=10⁴s. The result indicates that the HF surface treatment is useful for the fabrication of InGaAs MISFET.

The First International Symposium on Control of Semiconductor Interfaces Karuizawa, Japan, November 8-12, 1993

In-situ Characterization of AlGaAs/GaAs Quantum Well Interfaces by Photoluminescence Surface State Spectroscopy

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In-situ characterization of AlGaAs/GaAs quantum well (QW) interfaces is shown to be possible with the use of the recently proposed photoluminescence (PL) surface state spectroscopy technique (PLS³). PLS³ theory is extended to deal with PL from buried QWs. Experimentally, AlGaAs/GaAs QWs were grown by MBE and characterized by the new technique. The theory gives a procedure to determine density distributions of interface and surface states. It is shown that both states are generally U-shaped and that the regrowth process induces the interface states, even if the sample is kept in UHV chamber.

A Workshop on Two-Dimensional Semiconductor Research Using Synchrotron Radiation : 2D (SR)² Tsukuba, Japan Nov. 15-16, 1993

**SURFACE AND INTERFACE RELATED KEY ISSUES
FOR SEMICONDUCTOR ELECTRONICS (invited)**

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The semiconductor electronics has made a tremendous progress in these 40-50 years, and this will continue into the 21st century. Technologically, the dominant trend has always been miniaturization or scale-down of device feature sizes. This trend will continue and is expected to bring us production-level realization of structures with the feature size of about 100 nm at the end of this century.

Continuous reduction of the device dimensions into the nanometer range leads to the following two consequences. One is that properties of surfaces and interfaces become more and more dominant over the bulk properties of the device structure. The other is that, at some points, all the physical phenomena related to device operation inevitably go into the quantum regime.

The purpose of this paper is to review and identify the key research issues related to surfaces and interfaces for future semiconductor electronics in the nanometer regime, where active contributions from the SR community are cordially invited.

The topics to be discussed include the following :

- (1) Surface and interface related issues in the present-day silicon and compound semiconductor devices and integrated circuits.
- (2) Understanding of correlation between atomic-scale structure and electronic behavior of surface and interface for removal of Fermi level pinning and artificial control of electronic properties for present devices and future nano-devices.
- (3) Formation of defect-free atomic-scale and atomically controlled microstructures for future nanoelectronics and *in-situ* dynamic monitoring and control of fabrication process.

The future of semiconductor microelectronics seems to depend critically on how well one manages the above issues related to surfaces and interfaces, being irrespective of whether one tries to stick to the present "classical" device concept to its scaling limit, or envisages novel "quantum" electronics based on mesoscopic devices or single electron devices.

21st Conference on the
Physics and Chemistry of
Semiconductor Interfaces,
Mohonk, New York, January
24-28, 1994

A novel *in situ* electrochemical technology for formation of oxide- and defect-free Schottky contact to GaAs and related low-dimensional structures

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The Pt/GaAs Schottky interfaces with excellent qualities were fabricated by a novel *in situ* electrochemical etching and plating technology using the electrical and photo pulses. The etched GaAs surface was very smooth, and no oxidized and disordered layer was produced at the interface. This technology also prevents formation of process-induced near-surface defect levels of GaAs. The Pt/GaAs diodes exhibited nearly ideal thermionic emission characteristics with a barrier height larger than 1.0 eV and an ideality factor lower than 1.05. Selective deposition of Schottky barriers to the edge of two-dimensional electron gas in a GaAs/AlGaAs quantum well structure was truly achieved by this process, which is confirmed by the agreement of the experimental $C-V$ results with theoretical predictions, as well as the results of the electron beam-induced current measurements.

21st Conference on the
Physics and Chemistry of
Semiconductor Interfaces,
Mohonk, New York, January
24-28, 1994

Atomic Arrangements on GaAs Surface in HCl Solution Studied by Atomic Force Microscopy and X-ray Photoelectron Spectroscopy

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The macroscopic electronic behavior and atomic arrangements of the GaAs surfaces immersed in HCl solution were studied by surface current transport (SCT), band-edge photoluminescence (PL), atomic force microscopy (AFM), and x-ray photoelectron spectroscopy.

copy (XPS). SCT measurements indicated reduction of the surface band bending on immersion into HCl solution for both *n*- and *p*-type materials. A remarkable increase of the band-edge PL intensity was also observed. In the AFM image taken in HCl solution, the (001) surface showed an array of atoms along $[110]$ and $[\bar{1}10]$ direction with the spacing of 4.1 Å, indicating presence of a (1×1) structure. Similarly, (1×1) images with threefold symmetry were observed on the (111) *A* and (111) *B* surfaces. The XPS analysis of the GaAs surfaces after immersion into HCl solution detected a monolayer level presence of gallium chloride. These results indicate that bond termination on the GaAs surface by adsorption of Cl atoms to surface Ga atoms realizes a nonstrained regular (1×1) passivation structure which removes surface states from the band-gap region.

The International Conference
on Advanced Microelectronic
Devices and Processing Sen-
dai International Center, Sen-
dai, Japan, March 3-5, 1994

In-Situ Characterization and Controlled Formation of Interfaces for Compound Semiconductor Quantum Structures

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Quantum structures will be used in devices of next-generation electronics. Their fabrication seems to require an entirely UHV-based integrated fabrication/characterization system to achieve atomic-scale perfection of interfaces. This paper reviews the techniques of *in-situ* characterization and controlled formation of III-V compound semiconductor interfaces recently developed at Research Center for Interface Quantum Electronics for use in such a system. The topics discussed include (1) *in-situ* process characterization technique based on photoluminescence, (2) an interface formation technique by selective MBE growth for mixed alloy quantum wires and (3) an interface control technique utilizing an ultrathin MBE Si interface control layer for insulator-semiconductor, metal-semiconductor and semiconductor-semiconductor interfaces.

The International Conference
on Advanced Microelectronic
Devices and Processing Sen-
dai International Center, Sen-
dai, Japan, March 3-5, 1994

**A Novel *In-Situ* Electrochemical Process for Defect-Free Schottky Barriers
on GaAs and Its Application to Quantum Structure Contacts**

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The defect- and oxide-free Schottky contact to GaAs were fabricated by a novel *in-situ* electrochemical etching and plating process. The Pt/GaAs Schottky barriers exhibited excellent electrical characteristics with a barrier height larger than 1.0eV and an ideality factor lower than 1.05. This process also prevents formation of process-induced damage near surface region of GaAs. Selective deposition of Schottky contacts to the edge of a two-dimensional electron gas (2DEG) in a quantum well structures were truly achieved by this process, which is confirmed by the agreement of the experimental C-V results with theoretical predictions.

The International Conference
on Advanced Microelectronic
Devices and Processing Sen-
dai International Center, Sen-
dai, Japan, March 3-5, 1994

**Surface Morphology of Metalorganic Chemical Vapor Deposition
Grown GaAs Studied by Atomic Force Microscopy**

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The detailed behavior and mechanism of multiatomic step formation processes during metalorganic chemical vapor deposition (MOCVD) of GaAs on vicinal surfaces are systemat-

ically investigated using an atomic force microscope (AFM). Under the low growth rate condition, the step flow growth mode with regular stripe is obtained, and the final terrace width is almost independent of the substrate misorientation angle. The result suggests that the barrier height difference for surface migrating Ga atoms between the terrace site and the step site is small, and the final terrace width is mainly determined by a migration length. Three-dimensional nucleation and growth mode with irregular steps are also obtained under the high growth rate condition. However, as the AsH₃ partial pressure increases, irregular steps are no longer observed. For these results, we discuss the multiautomic step formation mechanism.

Sixth International Conference Indium Phosphide and Related Materials Fess Parkers' Red Lion Resort, Santa Barbara, California, U. S. A., March 27-31, 1994

OPTIMIZATION OF INTERFACE CONTROL LAYER FOR InP SCHOTTKY BARRIERS

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Introduction

As compared with GaAs, the Schottky barriers on InP are generally not well behaved with low n-type Schottky barrier heights (SBH) and lack of reproducibility. Various approaches including use of special interfacial oxides have been tried to enhance SBH. However, many of such diodes suffer poor current transport characteristics, showing large leakage currents and low breakdown voltages. The values of Richardson constant A^{**} seems also to require attention according to a recent report (1). Therefore, not only SBH, but also the overall current transport including forward currents and reverse leakage currents should be optimized.

The purpose of this paper is to attempt to control the SBH of the InP Schottky barrier by inserting a suitable interface control layer (ICL) (2). For this purpose, various oxide ICLs formed by chemical etching, photochemical oxidation and laser induced oxidation, and a semiconductor ICL utilizing an MBE grown ultrathin Si layer (2), were investigated. It is shown that the oxide ICL can enhance SBH to 0.7eV for n-InP but with poor controllability of SBH. It was also found that Richardson constant A^{**} is anomalously small and that reverse leakage current is large. On the other hand, Si ICL was found to be capable of controlling SBH in the range of 0-0.55eV systematically by suitable doping into ICL, maintaining nearly ideal thermionic current transport.

Sixth International Conference Indium Phosphide and Related Materials Fess Parkers' Red Lion Resort, Santa Barbara, California, U. S. A., March 27-31, 1994

Behavior of InP Growth by Gas Source Molecular Beam Epitaxy on Singular and Vicinal Substrates

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Introduction

Based on the vast data concerning molecular beam epitaxial (MBE) growth of GaAs, it is usually assumed that the growth rate in III-V MBE is limited by supply of the group-III flux as long as sufficient group-V flux is provided. It is also assumed that the growth rate can be calibrated by the period of reflection high-energy electron diffraction (RHEED) oscillation. Presently, these two basic assumptions form the basis of the standard procedure for predetermination of the growth rate in MBE growth of III-V compounds and their related heterostructures (1) and quantum wells (2).

The purpose of this paper is to clarify the behavior of the growth rate during gas source MBE growth of InP on singular and vicinal substrates. RHEED oscillations during growths with various growth conditions were investigated and compared with the real growth rates obtained from direct measurements of the layer thicknesses. Furthermore, effects of both growth conditions and substrate misorientation on the layers' properties were examined by Hall effect measurements and photoluminescence (PL) measurements. It is shown that the above two assumptions based on GaAs MBE experiences are not necessarily true in gas source MBE growth of InP. Namely, the growth rate shows a marked dependence on phosphorus pressure, and the RHEED oscillation is very sensitive to the substrate misorientation. It is also shown that use of the vicinal substrates has significant effects on incorporation process of the adatoms into the grown layers.

Surfaces and Interfaces in
Mesoscopic Devices, Keau-
hou-Kona, Hawaii, April 24-
29, 1994

Si-interlayer Based Interface Control Technology for Compound Semiconductor Mesoscopic Structures

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In mesoscopic structures, potential differences at surfaces and interfaces are directly utilized as the boundary conditions for electron wavefunctions. Thus, requirements for the "electronic perfection" of surfaces and interfaces are much more stringent than in the present-day devices. However, in compound semiconductor technology, reasonably well controlled interfaces can only be obtained by continuous growth of very similar materials like GaAs and AlAs. Interface formation between dissimilar materials to obtain larger potential differences, or interface formation through crystal regrowth, thin film deposition, electron and ion beam processes and dry etching *etc.* results in formation of surface or interface states which cause Fermi level pinning and strongly interact with mesoscopic behavior of electrons. For example, the reported voltage control of quantum wires by a side gate suggests involvement of surface states, indicating that the side-gating phenomenon, which is a long standing issue in GaAs LSIs, may also become a problem in planar integration of mesoscopic structures. Thus, control of interface by suitable means is a key issue for success of mesoscopic devices and their planar integration.

The purpose of the present paper is to present and discuss a novel Si-interlayer based interface control technology which is being developed at our Research Center for successful control of various interfaces of compound semiconductor mesoscopic structures. In this approach, an ultrathin Si interface control layer (Si ICL) is inserted at the interface in order (1) to establish an ordered atom arrangements at the interface so as to remove interface states and (2) to control the interface potential by built-in dipoles in the Si ICL. Main points are listed below.

(1) Various sample structures having Si ICLs were formed using a UHV-based total system where MBE, GSMBE, CVD, ECR, EB/FIB, PL, XPS/UPS and STM chambers were connected by a UHV-transfer chamber. Si ICL was grown by MBE, using a Si K-cell. Such a system without air exposure during processing was found to allow formation of structures with the interface "atomic" profiles monitored and controlled to a monolayer-level. A novel PL surface state spectroscopy was also developed for *in-situ* monitoring of the "electronic" properties of surface and interfaces during formation of Si ICLs and related quantum structures.

(2) Insertion of Si ICL of 10 Å at the insulator-semiconductor interfaces of GaAs and InGaAs greatly reduced interface state density and removed Fermi level pinning. Direct application of Si ICL to InGaAs wire structures formed by selective epitaxy greatly increased the intensity of PL emission from wires as compared with those without Si ICL. Strong interaction between

surface states and near-surface AlGaAs/GaAs and InGaAs/GaAs quantum wells, recently observed by our group was very much suppressed by the Si ICL technique. Application of Si ICL to the surface of semi-insulating GaAs substrate reduced surface-related leakage current and increased surface breakdown field strength which is related to the side-gating threshold.

(3) Insertion of Si ICL of 10 Å with suitable doping at metal-semiconductor interfaces of GaAs and InP was found to allow control of Schottky barrier heights over 300–400 meV by doping-induced dipoles with retaining nearly ideal thermoionic current transport. This opens up a possibility of a large-amplitude potential modulation for mesoscopic structures. Application of such a technique to modification of heterojunction band line-up is also discussed.

3rd Int. Symp. on Atomic
Layer Epitaxy and Related
Surface Processes, Sendai,
Japan, May 25-27, 1994

Kinetics and Mechanism of Atomic Layer Epitaxy of GaAs using Trimethylgallium

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Abstract

Since the first demonstration of atomic layer epitaxy (ALE) of GaAs using trimethylgallium (TMGa), extensive studies on the nature of the self-limiting process have been conducted by a number of research groups. The understanding of the self-limiting process is, however, far from complete. At present, there are three widely known models for the self-limiting process, which are 1) Site-blocking model, 2) Selective adsorption model, and 3) Flux balance model. The latter two are based on the fast (<1 s) desorption time constant of CH₃ from GaAs after TMGa exposure, measured by surface science techniques. On the other hand, in order for the first model to be valid, a long time constant is needed. Using *in situ* Auger spectroscopy on GaAs surfaces exposed to TMGa in vacuum, we found that, at the temperature range where ALE of GaAs takes place, C signal from the surface decays after TMGa exposure with a time constant of the order of 100 s to a constant level. The constant C signal showed no sign of decay in 10 min. On the basis of the presence of long time constant (100 s), the consistency of various rate equations including those proposed in literature with the wide range of reported CH₃ desorption rates and with the ALE growth results has been examined. It is shown that the adsorption inhibition model can explain the coexistence of the fast and slow processes in CH₃ desorption and most of other experimental results consistently. The origin of the remaining discrepancies will also be discussed.

18th Workshop on Compound
Semiconductor Devices and
Integrated Circuits May 29-
June 1, 1994

**Low-Damage Fabrication Technologies of Nanostructures
for Devices in Quantum Regime**

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It is expected that all the microelectronic devices go into quantum mechanical regime at the turn of the century as a result of continued scaling-down of device dimensions. Intensive efforts are now being made at present to establish new technologies to realize quantum structures including quantum wells, wire and dots that may become basic building blocks of next generation nanoelectronics. In quantum regime, motions of electrons are far more delicate and sensitive to defects as compared with the average classical motions of electrons in the present-day devices. Particularly, defects at surfaces and interfaces play far more important roles in nanostructures. Thus, the key issue is how to realize defect-free structures with well-controlled surfaces and interfaces.

The purpose of this paper is to present and discuss the present status of the development of low-damage fabrication technologies of nanostructures. A brief overview of various approaches of nanostructure fabrication is given at first. Then, specific approaches that are currently pursued at the Research Center for Interface Quantum Electronics are presented and discussed.

The topics include (1) GaAs/InGaAs quantum structure formation by selective MBE and selective MOVPE growth on masked and patterned substrates, (2) interface control in quantum structures and (3) in-situ electrochemical process for direct Schottky contact formation to quantum well and its applications.

The Third IEEE Conference
on Fuzzy Systems IEEE
World Congress on Compu-
tational Intelligence, June
26-29, 1994, Orlando U. S. A.

**Soundness and Completeness Theorems between the
Dempster-Shafer Theory and Logic of Belief**

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Modelling of belief is one of most important issues in intelligent systems. Two approaches are found: one is a logical approach using modal logic; the other is a numerical approach such as Bayesian theory and Dempster-Shafer theory of evidence. The former is mainly concerned with logical inference methodology with belief, while the latter is mainly concerned with belief formation using methods of updating such as conditional probability and the Dempster's rule of combination. Since two approaches are complementary to each other, if they were unified, a more effective method of dealing with belief is obtained.

Here presented is a basis for unifying modal-logical and Dempster-Shafer-theory-based approaches by means of proving soundness and completeness theorems of several systems of modal logic with respect to classes of belief-function-based and plausibility-function-based models newly defined here. Thus it makes possible to introduce a concept of belief formation based on aggregation of evidence into a modal-logical approach to belief, to decide rules of inference which are valid under available uncertain evidence, and to introduce a concept of knowledge acquisition from a logical point of view into a belief formation method in the Dempster-Shafer theory.

The Fifth International
Fuzzy Systems Association
World Congress, July 4-9,
1994, Seoul, Korea

Doxastic Document Retrieval

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Here presented is a theory of doxastic document retrieval formulated by Dempster-Shafer-measure-based models for doxastic modal logic. Weights of keywords for documents are identified with bodies of evidence in the sense of the Dempster-Shafer theory, and binary indexing is modelled using a doxastic modal operator based on plausibility function induced by the weights. It makes possible to interpret the retrieval process as being carried out based on belief of an indexer. Non-monotonic reasoning is introduced to treat the difference between pertinence and relevance in doxastic retrieval.

Asian Conference on Com-
puter Vision, Osaka, Japan,
November 23-25, 1993

Dynamic Reconfiguration of Active Net Structure

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Active net is a deformable model which utilizes the network analogy of a physical region. The algorithm detects the contour of a target object by minimizing the energy defined for the sample points of the network. The original algorithm uses fixed network topology to extract the target. In this paper, we introduce the network reconfiguration mechanism such as tearing and division to realize multiple object detection and complex object detection. The introduced algorithm dynamically unlinks the arcs of the network when their strain value exceeds predefined threshold level. In the method, we propose a new image energy which improve the position sensitivity of edge without increasing computation cost. Experimental results for images taken from video camera show the validity of our approach.

IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Seattle, USA, June 21-23, 1994

Qualitative Image Analysis of Group Behaviour

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The analysis of group behaviour in a scene is a difficult task, because a group is not a physical entity, both the group and elements are meaningful for analysis, and the meaning of temporal aspect of group activity is hard to analyze. In this paper, qualitative analysis of group behaviour is proposed. Our method is basically a multi-scale region analysis of group image. After an input image is filtered at different scales, players close to each other in a certain distance are gradually fused into several regions resulting a hierarchical representation group members. The hierarchical description sequence of a group region is then interpreted from temporal aspect. We adopt a qualitative approach as dynamic relation analysis method. Dynamics of group behaviour is classified by its topological transition of group regions. Occlusions are also detected with transition rules. In the paper we apply the method to a soccer game image sequence. First we show how each member can be detected and classified from a color image. Then we introduce a qualitative static group description based on multi-scale image analysis. Next we describe a qualitative analysis of group dynamics.

1993 Joint Technical Conference on Circuits/Systems, Nara Japan July 26-28 1993

A Postprocessing of HANGUL Recognitions Using Dictionary Lookup

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In this paper we present a postprocessing of on-line Korean character (Hangul) recognition using dictionary lookup method. Multiway tree is generally used as a data structure for the dictionary, but the tree consumes a lot of memory space in storing the unused link field. Therefore we propose a modified multiway tree (MMT) based on the linguistic properties of Hangul character. Experimental results show that MMT has less number of node without sacrificing search time, and is more acceptable data structure for the postprocessing of Hangul recognitions.

International Conference on
Neural Network Applica-
tions to Signal Processing
Singapore, August 17-20,
1993

A Neural Network Classification/Recognition of Script Signals

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In this paper, a neural network model for classifying or recognizing script signals (such as handwritten characters, digits, Chinese characters) is proposed. The involved preprocessing techniques, neural network architecture, working algorithm and learning algorithm are stated, and the experimental results on the handwritten digit recognition and the handwritten Chinese character classification are also given.

The architecture of the neural network in the model is a three layer feedforward network. The working and learning algorithms are derived from the basic error backpropagation algorithm for the special network architecture. The preprocessor is designed to make the neural network to have adaptability to script's shift in position and change in size.

1994 Joint Technical Confer-
ence on Circuits/Systems,
Computers and Communica-
tions Kongju, Korea July 11-
13, 1994

Experiment on The Transmission of Medical Video Image Data Using A Japanese Communications Satellite

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An experiment to transmit medical treatment image, such as ultrasonic cardiac images and X-ray CT images, was done by using a Japanese communications satellite (JC-SAT). An

experimental earth station of VSAT with an antenna of 1.8 diameter was constructed in the laboratory of university to conduct the transmission experiment. The experiment was done in turn-back transmission where the same earth station was used and images of good quality were received. Rebuilding three-dimensional (3-D) CT image and constructing 3-D models after receiving image data were conducted in order to transmit 3-D medical images and model data by communications satellite.

21st International Symposium
on Acoustical Imaging, Mar
28-30 Laguna beach, USA

3-D Motion Image Reconstruction Using Volume Rendering Technique from Ultrasound Echographic Images

Tsuyoshi YAMAMOTO, Taisei MIKAMI*, Junichi TERANISHI*,
Akira KITABATAKE* and Yoshinao AOKI**

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In this paper, we propose a technique to visualize live heart motion from multiple longitudinal images obtained by the step-wise rotation of transesophageal echocardiographic images. Images appeared on monitor are once recorded on a VCR tape and then digitized using video sampler for each timing of cardiac cycles.

Photo-realistic shaded animation were created by using volume ray-tracing technique. Operator can change visualization parameters such as viewing position, illumination condition, surface colors and so on. To reduce artifacts, we introduce a space variant filter kernel for the noise reduction filter. Animation sequence of live heart visualization will be shown.

1993 International Geoscience
and Remote Sensing Sympo-
sium, Tokyo, Japan, August
18-21 1993

Detection of A Straight Metal Tube By Snow Search Radar

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In this paper we discuss a detection method of a straight metal tube buried in snow using snow search radar. The snow search radar is a three-dimensional imaging radar system for searching any objects buried in snow with a few meters of accumulation. The resolution with respect to the distance direction is determined by the sweeping range of the microwave. However, we can detect the change of distance less than the resolution if the target object has a fixed slope. We selected the straight metal tube as a target object. Then the reconstructed image of a metal tube is described a few parameters with accuracy. The results are obtained by processing with simulated and actual data.

1994 International Conference
on Acoustics, Speech & Sig-
nal Processing, Adelaid, Aus-
tralia April 19-22, 1994

Sign Language Image Processing for Intelligent Communication by A Communications Satellite

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A method to transmit sign language images by an intelligent communication is proposed. In this method text data is transmitted to synthesize sign language images at the receiving end. Dictionaries for coding and decoding sign language images are developed, and a stick figure model is adopted to draw the sign language images using Computer Graphics (CG). Joint angles are given, and bending fingers and arms are described by the connecting vectors. Based on the evaluation of the synthesized sign language images evaluated by handicapped persons, surface and solid models are used to display 3-D sign language images, and an animation with controlled hand motion speed is synthesized to improve understandings of communication by

sign language. An experiment using a Japanese communications satellite was conducted to verify the effectiveness of the proposed communication method.

The 12th International Conference on Thermoelectrics, December 9-11, 1993, Yokohama, JAPAN

Seebeck Coefficient and Contact-Conductance of PbTe-Metal Junctions

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N. SASA, K. MUKASA and Y. OGAWA

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The Seebeck coefficient and the electric contact-conductance of PbTe-metal junction were measured as a function of the work function of metals. The apparent Seebeck coefficient increases with increasing the work function from 3.63eV (Zn) to 4.5eV (Cr), and decreases with the work function exceeding 4.5eV. The electric conductance continuously increases with the work function. These thermoelectric properties are explained by the change of the energy band structure of the PbTe-metal junction, which is caused by the change of the work function of metals. The Seebeck coefficient critically changes when the contact barrier type varies from the Schottky-type to the ohmic type. The contacting conductance dependence on the work function also indicates that the barrier type changes. These experimental results suggest that the proper selection of electrode metals is important in designing the thermoelectric device.

The 12th International Conference on Thermoelectrics, Desember 9-11, 1993, Yokohama, JAPAN

Tunneling spectroscopy study on thermoelectric materials

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A PbTe thin film was evaluated by means of Electron Tunneling Spectroscopy (ETS) as a thermoelectric semiconductors. The energy band gap of the PbTe thin film analyzed by ETS was 0.15eV (4.2K) and 0.18eV (77K). It was also found that the Fermi level is located at 0.064eV and 0.085eV at 4.2K and 77K, respectively. Since the Seebeck coefficient is determined from the Fermi energy level, ETS is useful to evaluate the Seebeck coefficient of thermoelectric semiconductors. The Seebeck coefficient of PbTe at 300K obtained by ETS analyze at 77K and the simple calculation was 0.29mV/K , which agrees to the general Seebeck coefficient at room temperature of 0.30mV/K .

The 12th International Conference on Thermoelectrics, Desember 9-11, 1993, Yokohama, JAPAN

Computer-based analysis of the thermoelectric cooling device

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Thermoelectric characteristics of a thermoelectric cooling device are evaluated with the Boltzmann's transport equation and the first law of thermodynamics. Solving a differential equation that describes thermal distribution in a thermoelement, we simulated the cooling ability of the device. The calculation is also applied to designing the device and its system. The result shows that the thermal resistance influences the thermal flow density at cooled side and

also influences its coefficient of performance (COP). A conventional bulk thermoelectric cooling device has high thermal resistance at its cooled and heated side, and a thin film device has a large thermal flow density at the cooled side. The analysis reveals the fact that the cooling system which consists of thin film devices is a new candidate for a high cooling performance system.

The 12th International Conference on Thermoelectrics, Desember 9-11, 1993, Yokohama, JAPAN

Thermoelectric properties and structure of Bi_2Te_3 -based thin films

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Thermoelectric Bi_2Te_3 -based thin films were investigated by means of the Seebeck coefficient measurement, the electric conductivity measurement and the X-ray diffraction. In a high vacuum belljar, $\text{Bi}_2\text{Te}_{2.8}\text{Ce}_{0.2}$ pressed pellets were dropped into a heated crucible to be evaporated flashingly, and the thin film was formed on a glass substrate. Its thickness was controlled by the number of the pellets. The substrate temperature affects its electric conductivity and Seebeck coefficient. The substrate annealing also influences these factors. At low substrate temperature, the power factor of an annealed sample is 1.5 times as large as that of an as-deposited sample. The power factors of these samples are nearly the same at higher substrate temperature ($>350^\circ\text{C}$). X-ray diffraction patterns show that films deposited at the substrate temperature of 75°C has the stoichiometric composition of Bi_2Te_3 , and at the higher substrate temperature or after the annealing the crystallographic characteristic is changed.

The 40th International Field
Emission Symposium, August
2-6, 1993, Nagoya, JAPAN

Spin polarization of field emitted electrons from transition metals.

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Y. HORI
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For characterizing surface spin states of a tip used in spin polarized scanning tunneling microscopy (SP-STM) experiments, it is useful to measure the spin polarization of field emitted (FE) electrons from the tip. We designed a field emission microscope (FEM) with spin resolution. A custommade Mott polarimeter operated at 40 kV was used as an electron spin analyzer. The Mott polarimeter was calibrated by spin polarized electrons photo-emitted from negative electron affinity treated GaAs. Selection of an appropriate crystallographic orientation, at which electrons to be analyzed are extracted, is available with a 3 rings positioner. A Ni tip was used as a test sample tip. A clean tip surface was obtained via field-evaporation. Observing the FEM pattern on the fluorescent screen, it is confirmed that the electrons can be extracted along [001] and [103] direction.

1994 IEEE Instrumentation
and Measurement Technol-
ogy Conference, May 10-12,
1994, Hamamatsu, JAPAN

Magnetic Force Microscope (MFM) Imaging with Electrodeposited Tips

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Since the magnetic force microscope (MFM) imaging is influenced by magnetic properties of a tip apex, it is important to define the properties and to characterize the tip-sample interac-

tion. To compare MFM images taken with various kinds of tips gives the fundamental information about the properties and the interactions. We made electrodeposited MFM tips of FeNi, Co and FeCo and observed S-MIG recording heads and longitudinal recorded media as the standard samples with these tips. The MFM imaging also depends upon the thickness of coated films over the tip. We also studied the images with three different types of FeCo tips (20 nm, 300 nm and 2μ in thickness). The result of this study is that the Co tip gives a well-contrasted and unsaturated image of the recording head, and that FeCo is enough sensitive to observe recorded bits on the longitudinal medium.

XXIVth General Assembly of
the International Union of
Radio Science, Aug. 25-Sept.
2, 1993, Kyoto, JAPAN

Review of the Finite Element Method for Microwave and Optical Waveguide Analyses

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This paper presents a review of the finite element method for the analysis of microwave and optical waveguiding problems. It discusses different types of finite element formulations, placing emphasis on the finite element method using full vector electric or magnetic field. Techniques to avoid spurious solutions are also introduced.

The Fourth Sino-Japanese
Joint Meeting on Optical
Fiber Science and Electro-
magnetic Theory, Oct. 7-10,
1993, Xi'an, CHINA

Numerical Analysis of Nonreciprocal Phase Characteristics of Magneto-optic Channel Waveguides

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Sapporo, Japan

An effective numerical solution method, which is more accurate and can be applied to various magneto-optic channel waveguides, is developed. This approach is based on the finite element method and the scalar-wave approximation. A simple and efficient iterative method is

proposed for solving a nonlinear eigenvalue equation derived from the scalar finite element approach. The validity and usefulness of this method are confirmed by analyzing magneto-optic rib-type and ridge-type waveguides.

1993 Prague Meeting on Macromolecules. Fluorinated Monomers and Polymers, July 19-22, 1993, Prague, Czechoslovakia

PREPARATION AND REACTIONS OF FLUORINATED ALKOXYAZINES AND DIAZINES

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Alkoxyazines and diazines (alkoxy-pyridines and alkoxy-pyrimidines) were readily prepared in good yields by the reaction of fluoropyridines and fluoropyrimidines with alcohols, including fluorine-containing ones, in the presence of NaH using aprotic solvents such as DMSO-Ether and DMSO. Fluoropyridine or pyrimidines showed higher reactivity toward alcohols to afford alkoxy-pyridines or pyrimidines than the other halogenated azines or diazines such as chloro, bromo and iodopyridines.

Some reactions of fluorine-containing alkoxyazines thus prepared are also described.

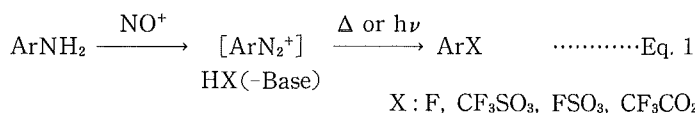
The 3rd Tohwa International Symposium. Synthetic and Mechanistic Hydrocarbon Chemistry, December 6-9, 1993, Fukuoka, Japan

DEAMINATIVE FLUORINE-CONTAINING FUNCTIONALIZATION OF AMINOARENES.

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Deaminative fluorine-containing functionalization of ArNH_2 (including heterocyclic) in fluorine-containing acids HX ($\text{H}:\text{F}$, CF_3SO_3 , FSO_3 , CF_3CO_2) can be illustrated to be an initial formation of arenediazonium species $[\text{ArN}_2^+]$ (diazotization stage) and its subsequent thermal or photochemical decomposition (dediazonation stage) in situ to produce fluorine-containing

functionalized arenes [ArX] as shown in Eq. 1.



The yields of ArX are, however, greatly influenced by a substituent on the aromatic nucleus, and undesirable products such as tarry matter are at times formed to render it difficult to apply this method satisfactorily. In this report, firstly we would like to elucidate the primary factors for selective formation of ArF using HF (-base) solution and then describe the facile preparation of ArX by deaminative fluorine-containing functionalization of ArNH₂ using HX (-base).

The 3rd Tohwa International Symposium. Synthetic and Mechanistic Hydrocarbon Chemistry, December 6-9, 1993, Fukuoka, Japan

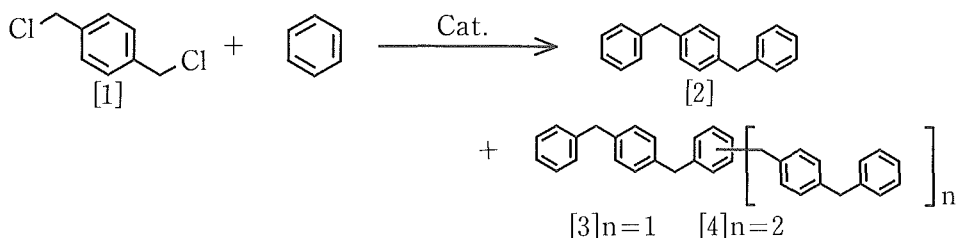
ZnCl₂-POLAR SOLVENT SYSTEM AS A USEFUL CATALYST IN THE FRIEDEL-CRAFTS BENZYLATION

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There are few useful preparative procedures for the synthesis of 1,4-dibenzylbenzene [2]. The Friedel-Crafts reaction of benzene with 1,4-bis-(chloromethyl) benzene [1] catalyzed by AlCl₃ and FeCl₃ gives the desired [2] in low yield in both cases. Thus diphenylmethane and other undefined products are mainly formed by the transalkylation and other reactions of [2], respectively. Recently, the preparation of [2] was reported in the reaction of benzene with 1,4-(bisbromomethyl) benzene using AlCl₃-CH₃NO₂ as a catalyst. However, the yield of [2] was 50-60%, and oligomers such as [3] and [4] were also produced in that reaction system with excess benzene to [1] ratio. In the present paper, we report that a ZnCl₂-polar solvent catalyst is very effective for obtaining the product [2] in higher yield compared with AlCl₃ or AlCl₃-CH₃NO₂.



The 3rd Tohwa International Symposium. Synthetic and Mechanistic Hydrocarbon Chemistry, December 6-9, 1993, Fukuoka, Japan

REACTION OF CARBOCATIONS DERIVED FROM CYCLOALKANES WITH CARBON MONOXIDE AND WATER IN THE PRESENCE OF HF-SbF₅

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Alkanes are well known to react with carbon monoxide and water readily in superacid under atmospheric pressure and give carboxylic acids. In this report, we shall discuss the reaction, initiated by the ionization of σ -bonds in cycloalkanes with five to eight membered ring having five (C₅-) to eight (C₈-) number of carbon atoms, followed by trapping with carbon monoxide and quenching with water to give carboxylic acids. Our discussion will be based on the detailed analysis of the composition and isomer distribution of the products.

The Eighth International Meeting on Boron Chemistry, Knoxville, USA, July 11-15, 1993.

Synthesis of Functionalized Allylic and Benzylic Boronates *via* Palladium-Catalyzed Cross-Coupling Reaction of (Dialkoxyboryl) methylzinc Reagents with Organic halides

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Although allylic boron compounds have proven to be exceptionally useful in the diastereoselective functionalization of carbonyl compounds, very little information is available for the intramolecular reaction and their stereochemical behaviors. Also, the reaction of benzylic boron compounds has been virtually unknown chemistry. We reported here the new synthesis of functionalized allylic or benzylic boronates by the cross-coupling reaction of the Knochel's borylmethyl zinc reagent with 1-alkenyl or aryl halides. The potential versatility of the present coupling reaction was demonstrated by a first successful intramolecular allylboration of carbonyls to provide bicyclic and spirocyclic alcohols in high yields. Benzylic boronates having

an acyl group at the *ortho*-position readily underwent rearrangement to the boron enolate which acts as *o*-quinodimethane.

Eighth International Meeting
on Boron Chemistry, Knox-
ville, USA, July 11-15, 1993

**Regio- and Stereospecific Preparation of β -Alkylthio-1, 3, 2-benzodioxaboroles
by Nickel-Catalyzed Hydroboration of Thioalkynes with Catecholborane**

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In connection with our recent works on the synthetic application of vinylic boron compounds using palladium catalysts, we have studied the synthesis of thioalkenylboronates *via* the catalytic hydroboration of thioacetylenes with catecholborane. It has been reported that the hydroboration of thioacetylenes with several dialkylboranes gives high yields of vinylboranes with strong preference for the addition of the boron atom at the carbon adjacent to the alkylthio group. However, we have found that the catalytic hydroboration of thioacetylenes with catecholborane in the presence of Ni or Pd-catalysts allows a complete reversal of the regiochemical preference. The best catalysts proved to be bidentate phosphine complexes of nickel such as NiCl₂(dppe) and NiCl₂(ppp). The synthetic applications of the (β -thioalkyl) vinylboranes thus obtained to the palladium-catalyzed boron cross-coupling reaction with organic halides to provide stereodefined alkenyl sulfides was also reported.

Eighth International Meeting
on Boron Chemistry, Knox-
ville, USA, July 11-15, 1993

**Synthesis of Functionalized Ketones via Palladium-Catalyzed Carbonylative
Cross-Coupling Reaction Using Organoboron Compounds**

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The three component cross-coupling reaction of aryl-, 1-alkenyl-, and alkylboron compounds with carbon monoxide and organic halides including aryl, benzyl, and 1-alkenyl groups successfully proceeded in the presence of palladium-catalyst and base to provide unsymmetrical ketones in excellent yields. A competitive side reaction, coupling without CO insertion, could be easily avoided by the choice of an appropriate base even under 1 atm of CO. Alkyl halides

which are usually less reactive toward the Pd-catalyzed coupling reactions also smoothly carbonylated and coupled with 9-alkyl-9-BBN derivatives under photochemical conditions. Because of both mild reaction conditions and inertness of organoboranes toward various functional groups, the method was readily applicable for the synthesis of polyfunctionalized ketones.

Eighth International Meeting
on Boron Chemistry, Knoxville,
USA, July 11-15, 1993

1,4-Addition Reaction of Alkenyldihydroxyboranes to α, β -Unsaturated Ketones Induced by Cyanuric Fluoride

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Conjugate addition reaction of alkenyl metals to α, β -unsaturated ketones is one of the most efficient methods for the extension of carbon chains with functional groups. We found that some fluorinating reagents, such as DAST or NaF, can induce the conjugate addition of alkenyldihydroxyboranes to α, β -unsaturated ketones to give γ, δ -unsaturated ketones stereoselectively. Among the fluorinating reagents we tried, cyanuric fluoride activates most effectively alkenyldihydroxyboranes under mild conditions, and even acid sensitive unstable substrates, such as methyl vinyl ketone, the functionalized ketones, and the functionalized alkenylboranes, can be used in this 1,4-addition reaction.

21st International Conference
on Pulping and Papermaking
Technology June 23rd-24th,
1994. Seoul, Korea.

PREPARATION AND CHARACTERIZATION OF CHITIN SHEET FROM SQUID BONE

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ABSTRACT

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. β -Chitin from squid bone of *Loligo* pen, easily forms slurry when it was ground with water. This is responsible for the

loose crystalline structure and the high hydrophilicity of *Loligo* pen chitin. The hand-made chitin paper from *Loligo* pen shows a high bursting factor of 7.4 and breaking length of 6.9km, compared with those of α -chitin from crab shell, 1.0 and 3.0 km. The *Loligo* pen paper is obviously softer than that from crab shell as to rigidity or stiffness calculated from Young's modulus. Furthermore the higher permeability of moisture together with water regain, a strong affinity for blood protein such as fibrinogen, albumin or γ -globulin, and slow biodegradation by lysozyme were observed.

The 3rd IUMRS International
Conference on Advanced
Materials, August 31-September 4, 1993, Tokyo, Japan

Synthesis of Aluminum Nitride in Air by the Self-Combustion of Mechanically Activated Aluminum-Graphite Powders

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The powders of aluminum metal and natural graphite mixed in various molar ratios (Al/C=7/0-0/7) were ground in a planetary ball mill. When the mixtures thus activated mechanically were exposed to air, exothermic reactions spontaneously occurred in two successive steps, evolving red heat initially and then white heat. The main product was aluminum carbide in the first step and aluminum nitride as well as carbide in the second step. From the measurements of XPS spectra and the lattice constants, it was considered that aluminum nitride obtained is solid solution with the composition of $(Al_2OC)_{1-x}(AlN)_x$. The effect of mixing ratio of Al to C, grinding time and gas atmosphere on the formation of aluminum nitride are discussed.

2nd International Symposium
on Reliable Flow of Particulate Solids, August 23-25,
1993, Oslo, NORWAY

Segregation Mechanism of Particulate Solids and their Prevention

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G. Enstad, POSTEC Research, Porsgrunn, Norway

Whenever particulate materials move in various fields, the solids mixture will exhibit segregation to certain extent. As the most basic phenomenon the segregation under gravity alone

is frequently encountered in various industrial processes handling bulk solids, such as storage and supply, conveying, furnaces, moving beds etc. Here the fundamental mechanism of particle segregation was surveyed from general viewpoint.

Based on the mechanism of segregation, the ways of preventing segregation or sometimes utilizing segregation could be devised from the practical viewpoints. Some examples for industrial use are briefly introduced and the practical approach to solve the segregation problems was illustrated including a segregation tester, a computer program and the determination of segregation characteristics.

1993 International Symposium on Organic Reactions, Tainan, Taiwan, December 11-13, 1993

Stereoselective Synthesis of *trans*- and *cis*-2, 5-Disubstituted Pyrrolidines by Intramolecular Cyclization of 4-Alkenylamines

Masao TOKUDA, Hirotake FUJITA, Makoto NITTA, and Hiroshi SUGINOME
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A stereoselective synthesis of *trans*-*N*-alkyl-2, 5-disubstituted pyrrolidines by the aminyl radical cyclization of substituted 4-alkenylamines, as well as a stereoselective synthesis of *cis*-2, 5-disubstituted pyrrolidines by the anionic cyclization, is reported. Thus, *N*-chlorination of substituted 4-alkenylamines with NCS followed by the reaction with Bu₃SnH (1.0 equiv.)-AIBN (1.0 equiv.) in benzene under reflux gave neutral aminyl radicals, which underwent a facile cyclization to give exclusively *trans*-*N*-alkyl-2, 5-disubstituted pyrrolidines in 19-65% yields. This cyclization can be applied to a synthesis of *N*-unsubstituted *trans*-2, 5-disubstituted pyrrolidines by starting from *N*-benzyl 4-alkenylamines. A synthesis of bicyclic pyrrolidines can also be achieved by a tandem cyclization of *N*-allyl 4-alkenylamines. On the other hand, a treatment of substituted 4-alkenylamines with a catalytic amount of butyllithium at -78°C gave *cis*-*N*-alkyl-2, 5-disubstituted pyrrolidines stereoselectively.

185th Meeting of The
Electrochemical Society, San
Francisco, USA, May 22-27,
1994

**Synthesis of β , γ -Unsaturated Acides by Electrochemical Regioselective
Carboxylation of Allylic Halides and Its Transformation to
Unsaturated γ -Butyrolactones**

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Department of Chemical Process Engineering, Faculty of Engineering,
Hokkaido University, Sapporo 060, Japan

Electrochemical carboxylation of γ -substituted allylic halides in the presence of atmospheric carbon dioxide using a magnesium anode took place exclusively at the less highly substituted carbon terminus of the allylic groups to give the corresponding γ -substituted β , γ -unsaturated acids regioselectively. The β , γ -unsaturated acids thus obtained are inaccessible by conventional carboxylation using allylic organometallic compounds. Treatment of the β , γ -unsaturated acids with phenylselenenyl chloride gave γ -substituted β -phenylseleno- γ -butyrolactones, which could be converted into the corresponding γ -substituted α , β -unsaturated γ -butyrolactones in high yields.

Mini-Symposium on Organic
Chemistry, Wisconsin, U. S.
A., Aug. 1993

**Some Recent Discoveries on Photochemical Rearrangements
in Steroidal Systems**

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Sapporo 060, Japan

Steroids are excellent probes for finding new reaction processes and exploring various stereochemical aspects of molecular transformations. We briefly present some recent results concerning our study on photoinduced reactions of steroids. Three topics were discussed:

- a) A new rearrangement of alkoxyl radicals generated by the photolysis of steroidal alcohol hypiodites and its synthetic applications.
- b) New Photoinduced reactions of steroidal α , β -unsaturated cyclic ketone oximes.
- c) The conformational dependence of the photorearrangement of steroidal β , γ -unsaturated cyclic ketones.

1993 Gordon Research Conference on Free Radical Reactions, Plymouth, New Hampshire, U. S. A., July 26-30, 1993

Recent Progress in Synthetic Applications of Alkoxy Radicals

Hiroshi SUGINOME
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Sapporo 060, Japan

Recent progress concerning the application of radical reactions to organic synthesis was presented in terms of our own syntheses of a variety of complex molecules, including natural products, using selective reactions of alkoxy and nitrogen radicals as their key step.

Topical Meeting of the International Commission for Optics 4-8 April 1994, Kyoto, Japan

Optical Hough transform filter for parallel detection of plural element shapes

Kunihiko MORI and Ryoji OHBA
Hokkaido University, Sapporo, Japan

The Hough transform (HT) is one of useful means for detection of element shapes such as straight line or circle from a noisy image. To recognize a pattern consisted from several element shapes by use of the HT, we need as many HT as kinds of element shape to be detected, since every element shape has its own HT. It must be serially processed in a digital computer. A HT operation for an element shape can be regarded as an imaging system whose point spread function (PSF) is space variant, and it has been implemented optically by using a 2D array of computer-generated-holograms (CGHs) each of which reconstructs an image of corresponding PSF.

We will discuss in the present paper on optical implementation of a HT filter for parallel detecting plural element shapes. Parallel detection is optically carried out using one 2D array of CGHs each of which simultaneously reconstructs plural parameter domains, called expanded parameter domain, corresponding to element shapes. We will demonstrate a HT filter of CGHs for parallel detection of lines and circles. Each CGH of the filter is fabricated by the direct-binary-search algorithm, and completed HT filter has excellent performance both in quality of reconstructed image and in diffraction efficiency.

ISPRS Commission V Symposium Close Range Techniques and Machine Vision
1-4 March 1994, Melbourne, Australia

**From multiple occluding contours to polyhedral representation
for 3D objects**

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A new algorithm is proposed to determine the surface of a 3D object from its multiple projections. The objective surface is optimally determined as that of a polyhedral model optimized using a cost function which is defined as the largest normalized discrepant area between corresponding projections of both the object and the model. Starting with an initial tetrahedron, the model is iteratively deformed so as to decrease the cost function. The deformation process is performed by one of the two sub-processes: vertex location adjustment or the vertex number increment. The cost function is always re-evaluated at the end of a run for the vertex location adjustment. The location adjustment sub-process is carried on while the evaluated cost keeps decreasing, otherwise the process is switched to the vertex increment sub-process and a new vertex is added to the current model. The deformation process terminates when the number of vertices reaches a given number. An experiment performed on a real object is also described using 16 photographs taken from different directions.

16th Congress of the International Commission for Optics
9-13 August 1993, Budapest, Hungary

**Optical implementation of Hough transform filter for
parallel detection of two kinds of element shape**

Kunihiko MORI and Ryoji OHBA
Hokkaido University, Sapporo, Japan

Hough transform (HT) is one of useful means for detection of element shapes such as straight line or circle from a noisy image. We need as many HT as kind of element shapes to be detected since every element shape has its own HT. HT operation can be regarded as an imaging system whose point spread function (PSF) is space variant, and it is implemented optically by using a 2D array of computer-generated-holograms (CGHs) each of which reconstructs an image of corresponding PSF. We have successfully implemented an optical HT filter using a DBS-CGH, computer generated hologram fabricated by the direct-binary-search

algorithm.

We will discuss in the present paper on optical implementation of HT filter for parallel detecting two kinds of element shape. Two kinds of HT are optically implemented by a 2D array of DBS-CGHs which simultaneously reconstruct two PSFs corresponding to lines and circles. The novel matrix format, which is adopted to parameter domain in HT instead of conventional orthogonal coordinate system, enables highly flexible fabrication of HT filter by reducing constraints for reconstructed sample points of CGH. Completed HT filter has excellent performance both in quality of reconstructed image and in diffraction efficiency.

Experimental results will be also presented on feature extraction of alpha-numeric characters.

16th Congress of the International Commission for Optics
9-13 August 1993, Budapest,
Hungary

Frequency stabilization of a laser diode by photo-thermic feedback on active layer domain

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Frequency stabilization experiments are performed on a laser diode (LD) by focusing amplitude modulated light on its active domain. Most of reported frequency stabilization methods apply some electrical negative feedback schemes to both the temperature and drive current controls. Heat conduction has a rather large delay time due to the distance between LD chip and thermoelectric element. The delay time results in a large response time constant to the temperature control system and which can not work at the higher frequency range. A light beam, which is focused on the surface of a LD chip, makes a heatspot and changes the optical path length of the cavity directly. It is possible to control its frequency by changing the irradiating power according to the output of frequency discriminator. This method requires no thermoelectric element and it enables not only to reduce the size of LD head but also to accomplish high speed temperature control without any drive current modulation.

Sensors and their Applications VI, September 12-15, 1993, Manchester, UK

Machine Diagnosis by Acoustic Signal Processing

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It is the most remarkable feature that both the decrease in population of youth and tendency of their recruit minds to soft and service industries make a clear trend to reduced number for technicians or engineers in production industries. Those who want to be maintenance engineers are also decreasing rapidly today, so that divisions for maintenance in factories are keen to develop automated maintenance/diagnosis methods of machines. We have been working on developing acoustic diagnosis methods to detect possible defects of ball bearings in practical machines in oil refining plants. In the present paper, an experiment on machinery diagnosis performed on a pilot model of oil refinery equipment is described. A hand held data processor and specially designed sound collecting microphone used in the experiment are described as well as the idea and principle and basic experiment of the present diagnosis method.

Third Australasian Instrumentation and Measurement Conference, AIM-TEC '94, April 26-29, 1994, Adelaide, Australia

Instrumentation and Measurement Technologies in Large Complex Systems

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A strong demand for reduced manpower operation of a large system makes maintenance/diagnosis of the system to be automated. Intelligent sensor technology, integration of control/instrument stations are going to be adopted to reduce manpower in the real process. An example of such case is presented with a modernized refinery at first, then a definition of large and

complex systems is given and importance of the measurement and instrumentation problems in such a system is clarified. Recent trends for integrated control system, intelligent sensor system are also described together with roles of measurement and instrumentation in large complex systems.

Topical meeting of the International Commission for Optics 4-8 April 1994, Kyoto, Japan

Optimum Holographic Laserbeam Scanning

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An analytical method is presented to calculate for the optimum phase transfer function for an all holographic laser beam scanning system. Previous research on holographic laserbeam scanners was based on numerical optimization methods, which do not yield the optimum phase transfer function, but in general only a local extreme. An analytical approach has been proposed, but it does not comprehend a possible pre-aberration of the input beam.

15th International Conference on Amorphous Semiconductors (ICAS-15), September 6-10, 1993, Cambridge, United Kingdom

Ion-Conducting Amorphous Semiconductor Ag-As-S

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It is known that amorphous Ag-As-S with the Ag concentration larger than 15 atomic % is an Ag⁺ ionic conductor having $\sigma \geq 10^{-7}$ S/cm, but optically it is a semiconductor with $E_g \simeq 2$ eV. Hence, it may be interesting to investigate the interaction between the ions and photo-excited electronic carriers. I will report photoelectric effects and a *photoinduced chemical modification* phenomenon in amorphous Ag-As-S.

Photocurrent and photovoltage characteristics have been studied in melt-quenched $(As_2S_3)_x(Ag_2S)_{100-x}$ glasses with $x=15-35$. Under applied ac voltage (0.5Hz-10MHz), the glasses exhibit no bulk photoconduction. This negative feature is understandable, since the Ag⁺ ionic conductivity is greater by ~ 5 orders of magnitude than the electronic (hole) conductivity. By

contrast, photovoltage appears. This is because the measurement is performed under an open-circuit condition, and the photovoltage is sensitive to photo-carrier dynamics. However, the polarity of the voltage depends on electrode configurations and the magnitude decreases to zero under long exposure. These photovoltage characteristics suggest the existence of coupled ion-hole motions.

The coupled motion may cause a *photoinduced chemical modification* phenomenon. That is, when amorphous Ag-As-S is illuminated, Ag⁺ ions can gather to the illuminated region in response to photo-excited hole diffusion, and accordingly the composition may be modified. The expected phenomenon has been observed in films and melt-quenched glasses. For instance, in an Ag₂₅As₂₅S₅₀ film, illumination induces the Ag-composition modification of ~5 atomic %.

15th International Conference
on Amorphous Semiconduc-
tors (ICAS-15), September 6-
10, 1993, Cambridge, United
Kingdom

Time-of Flight Photocurrents in As₂Se₃ and Se under Bias Illumination

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It becomes evident that amorphous semiconductors are liable to change with light illumination. Presently a variety of photoinduced phenomena are known, but properties of materials *under* illumination have been studied less extensively. We have investigated hole-drift characteristics in As₂Se₃ and Se under illumination, which are known to exhibit respectively dispersive and nondispersive transports in the dark.

In As₂Se₃, the dark signal exhibits typical dispersive features, but it changes with illumination. That is, around 1 ms the photocurrent decreases rapidly and the transit time indicated by an arrow becomes longer. In contrast, the nondispersive transport in Se becomes featureless with illumination. The featureless signal, however, cannot be interpreted as a manifestation of dispersive transport, since the post-transit decay is not modified appreciably. Note that the relaxation-time constraint for time-of-flight measurements is still satisfied under illumination.

We may consider that these photoinduced changes are caused by two effects; one is an increase in trap density and the other is electric field perturbation by space charges. A numerical analysis shows that the former is dominant in As₂Se₃ and the latter in Se.

15th International Conference
on Amorphous Semiconduc-
tors (ICAS-15), September 6-
10, 1993, Cambridge, United
Kingdom

Mechanism of Photosurface Deposition

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It is known that Ag-rich Ag-As(Ge)-S glasses exhibit a so-called photosurface deposition (PSD) phenomenon, that is, photoinduced segregation of Ag particles to the glass surface. The phenomenon has been applied to direct positive patterning, but the mechanism of PSD is not elucidated yet. In detail, we do not know why illumination can induce the growth of Ag particles at illuminated surface. In order to reveal electric effects in PSD, we have carried out four experiments.

On the basis of the observations, the following scenario can be suggested as the mechanism of PSD: photo-excitation of electronhole pairs \rightarrow Ag⁺ diffusion toward illuminated surface \rightarrow segregation of negatively-charged Ag metallic particles on surface \rightarrow growth of the Ag particles.

9th International Conference
on Solid State Ionics, Sep-
tember 12-17, 1993, Hague,
Netherlands

Photo-Electro-Ionic Conduction in Ag-As-S Mixed-Conducting Glasses

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To understand the mechanisms of photoinduced phenomena and to reveal the nature of electroionic interaction in mixed ion-electron (hole) conductors, studies of photoeffects may be valuable. Hence, photoconductivity and photovoltage characteristics in Ag-As-S glasses have been investigated. It is known that the glass exhibits the ionic conductivity of $\sim 10^{-7}$ S/cm with the hole conductivity of $\sim 10^{-12}$ S/cm, but optically it is a semiconductor with the band-gap energy of ~ 2 eV.

AC photoconductivity in $(As_2S_3)_x(Ag_2S)_{100-x}$ glasses with $x=15-35$ contacted with Au, Al or Ag electrodes was measured in a frequency range 0.5 Hz - 10 MHz at temperatures of 250-350K. In all specimens, the ac conductivity increased with illumination.

However, the increases at lower and higher frequencies (than ~ 50 Hz in $AgAsS_2$ at 295K) show different features. Spectral and thermal measurements demonstrate that the increase at a higher frequency is caused by thermally-enhanced ionic conduction, and the low-frequency increase is due to photo-electro-ionic interaction at ion-depleted interfacial region.

In contrast, under illumination all the samples exhibited photo-electronic voltage. This is because voltage measurements are performed under an open-circuit condition and the photovoltage is sensitive to photoelectronic carrier dynamics. However, the polarity is dependent on electrode configurations and the voltage tends to decrease to zero under long exposure. These characteristics suggest the existence of coupled ion-hole motions.

OSA Topical Meeting on
Advances in Optical Imaging
and Photon Migration,
March 21-23, 1994, Orlando,
Florida, U. S. A.

Speckle Spectroscopy under Atmospheric Turbulence

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The application of the speckle interferometric technique to spectroscopic observation enables us to obtain the objective spectrum of a stellar object with high-spatial resolution under atmospheric turbulence. In our method, an object and its spectrum are reconstructed with high-spatial resolution from the speckle images and their dispersed specklegrams which are simultaneously recorded. The method is applied to observation of binary stars, of which spectra are hardly spatially separated by ordinary spectroscopic methods.

ICO Topical Meeting, Frontiers in Information Optics,
April 4-8, 1994, Kyoto

Phase Diversity Imaging through Atmospheric Turbulence

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A method of phase diversity imaging is applied to reconstruct an overly extended object from stellar speckle images. The reconstruction algorithm is based on the iterative blind deconvolution method and the Gerchberg-Saxton phase retrieval procedure. Computer simulations for reconstructing solar granulations are conducted. The simulation results exhibit the effectiveness of the phase diversity method for high-resolution solar imaging.

ICO Topical Meeting, Frontiers in Information Optics,
April 4-8, 1994, Kyoto

Parallel Blind Deconvolution Applied to Solar Image

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Two parallel blind deconvolution methods, each of which uses multiple frames or several images segmented from a single frame, are applied to solar images to reconstruct their fine structure. Influence of low-contrast intensity distribution on the solar images to the reconstruction is investigated with computer simulations. The methods are also applied to an observed solar image.

The Fourth International
Workshop on Ice Drilling
Technology, April 20-23,
1993, Tokyo

DRILLING FLUID FOR DOME F PROJECT IN ANTARCTICA

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At Dome F, one of the summits of the East Antarctic Ice Sheet, a very deep ice-coring operation is to be carried out by the Japanese Antarctic Research Expedition from 1995. Since it will take two years to complete the coring up to about 3000 m depth, the borehole should be filled with proper drilling fluid to prevent borehole closure during the operation. This paper is a report on our investigations for searching for the proper drilling fluid which can be used in the very cold environment at Dome F. Although the investigations are still in progress, three kinds of fluid were chosen as drilling fluid candidates. They are: 1) n-butyl acetate, 2) "IP-solvent" with densifier and 3) Silicone Oil. Their properties were investigated and compared in terms of density and viscosity, which are essential requirements for a drilling fluid. As a result, it was shown that n-butyl acetate and IP-solvent with densifier can be used as the drilling fluid. However, the use of n-butyl acetate is impossible without sufficient ventilation at the coring site or other action to dispose of its vapor. When the use of IP-solvent with densifier is considered, the choice of proper densifier is also a problem.

The Fourth International
Workshop on Ice Drilling
Technology, April 20-23,
1993, Tokyo

**BRITTLE ZONE AND AIR-HYDRATE FORMATION IN
POLAR ICE SHEETS**

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Microscopic observations of air bubbles and air-hydrate crystals included in the Vostok ice cores, Antarctica, revealed that badly fractured ices were observed in the ice cores having high concentration of air bubbles. They also showed that the transformation of air bubbles to air-hydrate crystals reduced the chance of ice core fracture. In this paper, we suggest a fracture model of an ice core including air bubbles to discuss the depth dependence of ice core brittleness.

The Fourth International
Workshop on Ice Drilling
Technology, April 20-23,
1993, Tokyo

OPTIMIZED STORAGE CONDITION OF DEEP ICE CORESAMPLES FROM THE VIEWPOINT OF AIR-HYDRATE ANALYSIS

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Experimental data on the dissociation rate of air-hydrate crystals in Vostok cores, Antarctica, and Dye-3 cores, Greenland, during their long term storage revealed that dissociation of the crystals affected the volume expansion of deep ice cores. The temperature dependence of the dissociation rate of the air-hydrate crystals determines the optimized storage temperature and the time period for both the transportation of ice cores and their long storage plans. The results also suggest that deep ice cores should be stored in the shape of bulk samples to prevent the from dissociating, including the air-hydrate crystals.

1993 International Geoscience
and Remote Sensing Sympo-
sium (IGARSS '93), August
18-21, 1993, Tokyo

THE MEASUREMENT ON THE DIELECTRIC PROPERTIES OF ICE AT HF, VHF AND MICROWAVE FREQUENCIES

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The dielectric properties of ice Ih (hexagonal ice) were measured at HF, VHF and micro-wave frequencies using several methods appropriate for each frequency range. C-axis orientation dependence of the complex permittivity was particularly investigated because the dielectric anisotropy of the media determines the polarization state of the electromagnetic waves propagating in it and because it can cause the radio-echo internal reflections in the polar ice

sheets. It was confirmed that the difference between the real part of the permittivity parallel to the *c*-axis and perpendicular to the *c*-axis is almost the same at HF and at microwave frequency. In addition, it was confirmed that the anisotropy of the loss tangent was about 20% at -22°C at HF, i. e. at frequencies characterized by the high frequency tail of the Debye relaxation spectrum. This value is well explained mainly by the anisotropy in the dispersion strength and partly by the anisotropy in the relaxation time of Debye dispersion. In addition, these facts suggests this ratio hold over frequencies up to microwave where the absorption of the lattice vibration becomes dominant.

Fifth International Symposium
on Antarctic Glaciology, Sep-
tember 5-10, 1993, Cambridge,
United Kingdom

**Causes and nature of ice-sheet radio-echo internal reflections
estimated from the dielectric properties of ice**

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The causes and nature of ice-sheet radio-echo internal reflections at deep layers in polar ice sheets are discussed, based on the dielectric properties of ice that have been measured at microwave frequency and radio frequency. The reflection coefficients of electromagnetic waves in ice sheets due to two causes: the change in permittivity induced by changes in crystal-orientation fabrics with depth, and changes in conductivity induced by changes in acidity with depth, were derived respectively as a function of the frequency used in radar sounding and the temperature of ice, and both were compared quantitatively. It is shown that at single-plane boundaries the reflection coefficients due to the former cause are independent of frequency and temperature and that they are large enough to produce dominant internal reflections. In contrast, reflection coefficients due to the latter cause strongly depend on frequency and temperature. Since they are inversely proportional to the frequency, the latter cause can be dominant only when frequencies below about 60 MHz are used. Examination of previous observational data has suggested that not only changes in acidity but also changes in crystal-orientation fabrics exist at depths corresponding to the dates of earlier volcanic eruptions.

International Seminar on
Advanced Pulsed Neutron
Sources, PANS-II, June 14-
16, 1994, Dubna, RUSSIA

Neutronics of Coupled Solid Methane Moderator with Premoderator

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From a neutronic point of view solid methane is the best moderator material for a pulsed cold neutron source. However, this type of moderator cannot be used at intense neutron sources due to serious radiation damage. We have therefore developed a coupled liquid-hydrogen moderator with a hydrogenous premoderator at ambient temperature. For the solid methane moderator, the premoderators can be used to reduce the radiation damage. We have measured the neutronic performance of the coupled solid methane and liquid hydrogen moderators with premoderators using the pulsed neutron facility of the Hokkaido linac in order to compare the performances of these moderator systems. It was found that a solid methane moderator with a premoderator cannot exceed a coupled liquid-hydrogen moderator system in the cold neutron intensity.

International Seminar on
Advanced Pulsed Neutron
Sources, PANS-II, June 14
-16, 1994, Dubna, RUSSIA

Development of High-Efficiency Moderators for Pulsed Neutron Sources

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The present paper summarizes the recent progress in high-efficiency moderator development in Japan in connection with the KENS-II program (pulsed spallation neutron source program in Japan). Various moderators such as coupled liquid hydrogen moderator for cold neutron experiments, composite moderators for narrow pulses of thermal neutrons, extended moderators, overlap moderators, backscattering moderators, etc. were studied experimentally in order to realize a higher moderator efficiency. Various premoderators and target-moderator coupling configurations were also studied. We discuss methods for pulse tailoring.

Proceedings of the Fourth
International Topical Meet-
ing on Nuclear Thermal
Hydraulics, Operations and
Safety, Taipei, Taiwan,
April 5-8, 1994

HEAT TRANSFER CHARACTERISTICS OF ALKALI METALS FLOWING ACROSS TUBE BANKS

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For the purpose of getting heat transfer coefficients of alkali metals flowing across tube banks at an acceptable level, we propose to use an inviscid-irrotational flow model, which is based on our flow visualization experiment. We show that the heat transfer coefficients obtained for the condition where only the test rod is heated in tube banks considerably differ from those obtained for the condition where all the rods are heated, because of interference between thick thermal boundary layers of alkali metals. We also confirm that the analytical values obtained by this flow model are in a reasonable agreement with experimental values.

The 12th Global Scientific
Meeting of the Korean Scien-
tist and Engineers Seoul,
Korea, Aug, 9-12, 1993

ESTIMATION OF EFFECTIVE DOSE FOR EXTERNAL PHOTON EXPOSURE ACCORDING TO ICRP 1990 RECOMMENDATIONS —WITH EXPERIMENTAL AND SIMPLIFIED METHODS

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The ICRP substituted in its recent recommendations the effective dose equivalent with the effective dose with the change of values of the tissue weighting factors. To investigate the dose variations arising from external exposure and simply evaluate the organ and effective doses, TLDs measurements using an anthropomorphic phantom were carried out and an empirical expression as a function of organ depth was developed.

The angular dependence of effective dose is higher than for effective dose equivalent in the same radiation field. The approximation of organ and effective doses was deduced from the dose equivalent relationship with the penetration depths associated with the organs of interest.

Fourth International Conference on Cold Fusion, Laihaina, Maui, Hawaii, USA, December 6-9, 1993

Anomalous heat production from SrCeO₃ proton conductor during absorption-desorption process of deuterium by alternative electric field

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Abstract

A proton conductor yields anomalous excess heat by absorption desorption cycles in deuterium containing mixed gas. The conductor was kept at several hundred centigrade in D₂ mixed gas and was charged by cyclic voltage field of a hundred volt/cm across the sample. The heat production was observed spontaneously with the operation as a hundred W/cm² of sample surface.

21 st International Conference on Metallurgical Coatings and Thin Films, San Diego, USA, April 25-29, 1994

Properties of Silicon Nitride Films Prepared by Magnetron Sputtering

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Numerous silicon nitride films were prepared with using different target materials (Si₃N₄ or Si) and different discharge gases (Ar or N₂). In the case with Si₃N₄ target and Ar gas pressure (1Pa), the atomic ratio of film (N/Si) was stoichiometric, 1.33, even when the substrate temperature was largely changed. When Ar gas pressure increased from 1Pa to 7Pa, the nitrogen content increased while the deposition rate decreased. In the case with Si₃N₄ or Si target and N₂ gas, the nitrogen content increased while the deposition rate decreased with the increase of N₂ pressure. The change of deposition rate due to the pressure was investigated by using an optical emission spectroscopy.

It was found by XRD analysis that the crystallization occurred when the substrate temperature was higher than about 1173 K.

21 st International Conference on Metallurgical Coatings and Thin Films, San Diego, USA, April 25-29, 1994

Properties of Boron Coatings Used as Plasma Facing Material of Fusion Device

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K. YABE

Hokkaido National Industrial Research Institute, Japan

For the boron films made by a dc glow discharge for a mixture gas of diborane and helium, numerous surface properties were investigated and the characteristics of the boron film as a plasma facing material in fusion devices were evaluated. The capability for oxygen gettering was estimated as about 10^{21} O atoms/m². The gettered oxygen was observed in the surface with a depth less than about 30nm. The hydrogen concentration of the boron film made at RT was approximately 30%. The hydrogens in the film desorbed at about 573K, which is considerably smaller than that of graphite. These results directly indicate that the boron film coated on graphite wall can largely reduce the particle recycling, in addition to the reduction of an oxygen impurity level in the plasma.

It is also noted that the boron film absorbed both the oxygen and the carbon considerably, after the exposure to atmosphere.

11 th International Conference on Plasma Surface Interaction in Controlled Fusion Devices, Mito, Japan, May 23-27, 1994

High Heat Load Experiments for SiC and B₄C Coated Graphite

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The bulk boronized graphites with different boron concentrations and the SiC converted CFC were irradiated by an electron beam with the heat flux ranging from 2 to 6MW/m² for a time period up to 120s in ACT of NIFS. The surface temperature was observed to be as high

as 2600°C.

The boron content largely evaporated at the temperature higher than about 1700°C. The evaporation rate of boron was observed to rapidly increase both with boron concentration and surface temperature. After the boron evaporation, the evaporation of the carbon occurred at the temperature higher than 2000°C.

For the SiC converted CFC, the silicon largely evaporated at the temperature above 1500~1600°C.

The present results show that both the bulk boronized graphite and the SiC converted CFC should be used in the environment with relatively a low temperature, less than 1500~1700°C.

11 th International Confer-
ence on Plasma Surface
Interaction in Controlled
Fusion Devices, Mito, Japan,
May 23-27, 1994

Gas Desorption Properties of Carbon Fiber Composite/copper Brazed Material Used for a Divertor

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Gas desorption properties of carbon fiber composite (CFC)/oxygen free copper (OFHC) brazed material used for a divertor in fusion devices were investigated. Major desorbed gas species from every parts in this component were H₂O, CO, CO₂ and H₂. For the CFC sample, total amount of desorbed gases in the temperature range from RT to 1073K was (3~5) × 10²⁰ molecules/m². Total amount of gases desorbed from the OFHC was twice or three times larger than that of the CFC.

For the sample containing a brazed part, both CO and CO₂ were largely desorbed at low temperature region, and the desorption rate of H₂ increased at high temperature region. The gas desorption quantity of the brazed layer estimated to be two orders of magnitude larger than that of the CFC. Since a fraction of the brazed layer is very small, this contribution to the total desorption of the entire brazed material can be regarded as very small, only several percents.

11 th International Conference on Plasma Surface Interaction in Controlled Fusion Devices, Mito, Japan, May 23-27, 1994

Hydrogen Retention of B₄C Converted Graphite

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The hydrogen retention of B₄C converted graphite was investigated by using a technique of thermal desorption spectroscopy after hydrogen ion irradiation. The H₂ desorption peaks were appeared both at 350 and 700°C. The former peak was regarded as the detrapping from B-H bondings, and the latter from C-H bondings in the B₄C layer.

Compared with a case of the graphite, the hydrogen retention of the B₄C rapidly decreased with the temperature, since the detrapping of B-H bondings occurred around at 300°C. The total amount of trapped hydrogens in the B₄C was 1.5 times larger than that of the graphite. The activation energies of H₂ and CH₄ desorptions of B₄C were considerably smaller than those of the graphite.

The hydrogen retention of the B₄C was largely reduced by the He⁺ ion bombardment after the hydrogen ion irradiation.

11 th International Conference on Plasma Surface Interaction in Controlled Fusion Devices, Mito, Japan, May 23-27, 1994

Helium Retention of Nickel

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In a fusion reactor, in order to enhance the pumping efficiency for helium ash, the use of a metal such as nickel has been conceived because of its capability to selectively retain helium. In this study, the nickel was irradiated by He plasma, H₂ plasma or both by H₂ and He plasma in the He fluence of 4~5×10¹⁸ He/cm² and temperature from RT to 700°C. The

amount of trapped helium was examined by the thermal desorption spectroscopy (TDS) technique. No retained hydrogen observed for irradiation temperatures higher than 100°C. The total amount of helium retained as a function of irradiation temperature, had two peaks at 100~200°C and 500~600°C. It is suggested that the optimum temperature for the selective pumping of helium thus becomes 500~600°C, since the nickel may be used on the vacuum chamber where the temperature is higher than about 300°C.

2 nd Japan-China Symposium on Material for Advanced Energy and Fission/Fusion Engineering, Tokyo, Japan, June 5-8, 1994

Plasma Surface Interaction Studies in Japan

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² National Institute for Fusion Science, Nagoya, JAPAN

In order to achieve a long burning time period in a fusion reactor, the interactions between the plasma facing materials and the fusion plasma have to be well controlled. Namely, the radiation loss due to impurities and deterioration of the energy confinement time due to fuel particle recyclings have to be suppressed, in addition to the requirement of heat removal based on a high heat flux component. Recently, in Japan, the plasma facing material/component has been very actively developed for ITER and Large Helical Device (LHD). In this review paper, we briefly introduce the following issues, (1) progress of plasma surface interactions in tokamaks and helical devices, (2) development of plasma facing materials, (3) divertor development, (4) boronization, (5) selective pumping of helium ash, (6) tritium retention, and (7) neutron damage of graphite plasma facing material.

The Third International Conference on Integral Methods in Science and Engineering '93 (IMSE '93), Sendai, Japan, Aug. 27-29, 1993

**A Deformable-Cell Method and Generalized Boundary Conditions
for the Numerical Analysis of Incompressible Fluids**

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A simple and intrinsic viewpoint to classify the methods for the numerical analysis of incompressible fluids is: whether the method is based on (I) differential-type hydrodynamic equations, or (II) integral-type laws of conservation. The present deformable-cell method belongs to (II), uses arbitrarily shaped and deformable cells according to uneven or movable boundaries, and is supposed to be applied to the problems such as free surface or density interface waves on uneven bottom, floating bodies, oscillating bodies in a flow, or flows around elastic wall as in vivo or in vitro etc. Among the integral-type laws of conservation to derive the equations for numerical analysis, the law of conservation of volume (LCV) is the most important, and the "boundary equation" for the systematic treatment of boundary conditions is derived from the LCV adjacent to the boundary. This method is reviewed here, and some examples analyzed numerically through it are shown.

The Fifth International Symposium on Computational Fluid Dynamics, Sendai, Japan, Aug. 31-Sep. 3, 1993

**Numerical Analysis of Magnetic Fluid with Interface
by a Deformable-Cell Method**

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Hokkaido University, Sapporo 060, Japan

A method for numerical analysis of incompressible fluids, which uses cells deformable in accordance with movable boundaries, is applied to a magnetic fluid with interface under a magnetic field. The similarity between the fluid analysis and the magnetic analysis, and the methods for incorporating the interaction between the fluid and the field are discussed. Numerical analysis was made on the motion of the free surface of the magnetic fluid under the magnetic field which changes gradually or periodically in time.

The Fifth International
Workshop on Low Tempera-
ture Detectors, July 29-
August 3, 1993, Berkeley,
USA

Monte Carlo Calculations of Quasidiffusion in Silicon

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Sapporo, Japan

Monte Carlo study of high-energy phonon propagation with elastic scattering and frequency down-conversion is reported. Experimentally observed exponential decay of phonon intensity at late arrival times is well reproduced. The phonon focusing is crucial for accounting for the overall shape of the observed phonon spectrum.

The 13th International Sym-
posium on Nonlinear Acous-
tics, Bergen, Norway, 28
June-2 July 1993

Strongly nonlinear waves radiated by a circular piston

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The propagation of nonlinear waves radiated into an ideal gas by a harmonically oscillating circular piston mounted in an infinite plane rigid wall is numerically studied, for the case that an acoustic Mach number $M=O(1)$, an acoustic Reynolds number $Re=1$, and the piston radius is comparable with a typical wavelength. The strongly nonlinear effect of $M=O(1)$ is elucidated on the propagation process of considerably diffracted waves in the near field, by solving the system of Euler equations with the upwind finite difference scheme. The result shows that in the near field there exists the interference of shocks and the waves distorted by the strong nonlinearity. The mean mass flow (acoustic streaming) is also analyzed, which forms a vortex ring like flow in front of the piston face. By the streaming, the gas near the piston is rarefied slowly.

The 4th International Symposium on Stratified Flows, Grenoble, France, June 29-July 2, 1994

Three Dimensionalization of the Stratified Mixing Layer

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2: Department of Engineering Science, Hokkaido University

We present a detailed analysis of the processes through which three dimensional motions arise in the free stratified mixing layer. Previously published Floquet analyses of the governing instabilities, both for stratified and unstratified flows, have suggested a wide range of mechanisms to be possible candidates for the origins of the streamwise vortex streaks that are observed to be precursory to fully developed turbulent flow. We employ very high resolution LES methods to reveal which of these candidate mechanisms is dominant.

The 4th International Symposium on Stratified Flows, Grenoble, France, June 29-July 2, 1994

Multiple Instability in a Laboratory Stratified Shear Layer

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and Morimasa OHTANI²

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We present observational evidence of the presence of a three layer density distribution, coupled with a sheared velocity profile, in the vicinity of a river mouth. We discuss the subsequent evolution of such multi-layer shear flows both theoretically and experimentally. Three distinct types of instability are observed in accordance with the predictions of linear theory. In the laboratory, we measure the density profile and the velocity profile (using a seven point laser doppler velocimeter) continuously, and so are able to identify the flow characteristics that obtain when the flow is unstable to each of the different instabilities. The most important parameter responsible for the selection of the particular type of instability is found to be the ratio R of the depth of the intermediate density layer to the depth over which the velocity varies, though any asymmetry in the flow (either in the velocity or density fields) also plays a role.

The 4th International Symposium on Stratified Flows, Grenoble, France, June 29–July 2, 1994

Secondary Instability and Three Dimensionalization in a Laboratory Accelerating Shear Layer with Varying Density Differences

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2: Department of Physics, University of Toronto

We investigate the processes by which an accelerating stratified shear flow undergoes the transition to turbulence in a sequence of experiments in a tilted tank. Using direct measurements of the velocity and density profiles we observe that the Richardson number at onset of Kelvin–Helmholtz type instability varies only slightly with the total density difference, or the Reynolds number, if this is sufficiently high. However, we observe that the mechanisms by which the flow undergoes breakdown are both complex and diverse, and suggest that the (non-dimensional) total density difference and/or the ratio of the depth of the shear layer to the total tank depth are important parameters in the determination of the dominant secondary structures.

The 4th International Symposium on Stratified Flows, Grenoble, France, June 29–July 2, 1994

STABILITY CRITERION OF A STRATIFIED TWO-LAYER SHEAR FLOW WITH HYPERBOLIC-TANGENT VELOCITY PROFILE

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Hachinohe Institute of Technology, Hachinohe 031, Japan

2: Department of Engineering Science, Hokkaido University,

Sapporo 060, Japan

We investigate the stability criteria of a two-layer shear flow on the basis of linear stability theory considering viscosity. The numerical calculation was made for $10 \leq Re \leq 2000$. The inclusion of viscosity effects enables the neutral curves derived by Holmboe and Hazel to be closed in the (α, Ri) plane; as a result there exists a critical Richardson number Ric , above which the flow is stable for all wavenumbers. The critical Richardson number is nearly constant for $20 < Re < 1000$, and the stability criterion can be represented as approximately $Ric = 1.4$. The parameter $\theta = (Ri/Re)^{1/3}$, which corresponds to the Keulegan number, is found to be approximately proportional to $Re^{-1/3}$. The results agree qualitatively with those of Ippen & Harleman's experiment for lower layer flow on slopes, and experimental results for upper layer

flow in an open channel also support the present numerical results. Applying the αRe expansion method of the asymptotic analysis, we obtained the results that Ric is approximately proportional to Re for small Re ; the stability criterion is represented by $\theta = const.$

1993 IEEE 11th International
Conference on Conduction
and Breakdown in Dielectric
Liquids, Baden- Dättwil,
Switzerland, July 19-23, 1993

Electron Emission from Silicone Oils and Hydrocarbons Induced by Vacuum-Ultraviolet Light

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Photo-induced electron emission from polydimethylsiloxanes, polymethylphenylsiloxanes, squalane, and squalene were measured. Absolute quantum yields and threshold energies were determined. The threshold energies for polydimethylsiloxanes are between 8.3eV and 8.4eV, for polymethylphenylsiloxanes between 7.3 and 7.7eV, for squalane 8.5eV, and for squalene 6.9eV, respectively.

Japan-USA Seminar on
Development and Environ-
mental Characteristics of
New Materials, Timberline
Lodge, Oregon, U. S. A.,
June 7-9, 1994

A QCM Study on Corrosion of Iron Thin Films in Neutral Aqueous Solutions

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A quartz crystal microbalance (QCM) technique is capable of detecting small mass changes in the range of $ng\ cm^{-2}$ from resonant frequency changes of quartz crystal. In this study, the QCM technique combined with electrochemical measurement was applied to minute corrosion of iron thin films in deaerated neutral solutions.

The iron thin film with a thickness of 200 nm was electroplated on the gold electrode of a quartz crystal. The mass changes of iron thin films during natural immersion or galvanostatic polarization in deaerated pH 6.48 borate solution, pH 6.42 borate solution with 10^{-2} M chloride ions, pH 6.0 borate solution with 0.5 M chloride ions, and pH 6.48 phosphate solution were measured as a function of time or potential to evaluate the iron dissolution rate or iron dissolution current. The corrosion rate of iron thin film at the natural immersion increased in the order of pH 6.48 phosphate > pH 6.0 borate with 0.5 M chloride ions > pH 6.42 borate with 10^{-2} M chloride ions > pH 6.48 borate solution.

The net current flowed through the external circuit during galvanostatic polarization near the corrosion potential was successfully separated into the iron dissolution current and hydrogen evolution current. The Tafel plots of the iron dissolution current and hydrogen evolution current were performed to evaluate the corrosion mechanism of iron thin film. The Tafel slopes of iron dissolution and hydrogen evolution thus obtained depended on the electrolyte solutions from which discussions were made on the corrosion mechanism.

The 12th International Corrosion Congress, Houston, Texas, U. S. A., September 19-24, 1993

In-Situ Gravimetry of Corrosion of Iron Thin Films Combined with Surface Analytical Techniques

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Faculty of Engineering, Hokkaido University, Sapporo, Japan

Corrosion and passivation of electroplated iron thin film in pH 6.48 boric acid-sodium borate solution were investigated by using the quartz crystal microbalance (QCM) technique combined with Auger electron spectroscopy (AES) for a better understanding of the corrosion of metal thin films. Moreover, the differences in corrosion behavior between iron thin films and bulk iron were examined.

The passivation potential of iron thin films was higher than that of bulk iron. Bulk iron was more easily passivated than iron thin films. No impurities were detected in iron thin film within the detection limit of AES. The differences in corrosion behavior between thin film and bulk, therefore, were attributed to a difference in structure.

The significant dissolution of iron preceded the formation of the passive film for passivation of iron thin films. The predominant process of passivation of iron thin films was the anodic deposition of ferrous ions once dissolved, which was supported by Auger results revealing the presence of significant amounts of boron in the passive film.

The anodic current of iron dissolution and cathodic current of hydrogen evolution could be separately obtained as a function of electrode potential from the mass change of iron thin films measured during galvanostatic polarization near the corrosion potential.

The 44th Meeting of International Society of Electrochemistry, Berlin, Germany, September 5-10, 1993.

Piezoelectric Detection of Underpotential Deposition of Silver on Gold Electrode

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A piezoelectric detection of surface stress change of solid electrode produced by an electromodulation is capable of monitoring sensitively interfacial phenomena of the electrode such as specific adsorption of electrolyte anions and underpotential deposition of metals.

In this study, the piezoelectric technique was applied to underpotential deposition of silver on gold electrode. A piezoelectric element made from ceramics was attached to one side of a polycrystalline gold foil and a small surface stress change of the electrode produced by a superimposed alternative voltage of 5mV at 230Hz was sensitively detected as electrical signals from the piezoelectric element by using a lock-in amplifier. The underpotential deposition of silver on gold was performed with a potentiodynamic method (10mV s^{-1}) in deaerated solution of $0.1\text{mol dm}^{-3}\text{Na}_2\text{SO}_4 + 10^{-3}\text{mol dm}^{-3}\text{H}_2\text{SO}_4 + 10^{-4}\text{mol dm}^{-3}\text{Ag}_2\text{SO}_4$.

The amplitude, $|A|$, and phase angle, ϕ , of piezoelectric signals changed depending on the adsorbed amount of silver in the potential range of 1.10V to 0.56V (SHE). Particularly, two characteristic potentials at which $|A|$ took minimum value and ϕ changed by about 180° , appeared in both anodic and cathodic potential sweep. It seems that these characteristic potentials are associated with sign reversal of surface charge and/or surface reconstruction due to underpotential deposition of silver. Discussion will be made on the interfacial process of silver adsorption.

JSME-ASME International
Conference on Power Engineering-93, September 12-16,
1993, Tokyo, JAPAN

Numerical Analysis of Radiative Heat Transfer in Boiler Furnaces with Multiple Division Walls

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Sapporo, Japan

The Radiative Heat Ray method (RHR) which has been developed by one of the authors is an effective method to evaluate radiative heat transfer phenomena in boiler furnaces. So far, the RHR method has only been applied to simple furnace geometries, while boiler furnaces

in thermal power plants have complicated shapes with deflection arches, division walls and hopper-shaped bases. Radiative heat transfer analysis of complicatedly shaped furnaces with several division walls is discussed in this paper. A simple numerical method of analysis is proposed, and the effect of the division walls on radiative heat transfer is discussed. Such special furnaces with several division walls are expected to reduce emissions of NO_x, CO₂ and other pollutant and greenhouse effect gases.

Fourth International
Symposium on Fire Safety
Science, June 13-17, 1994,
Ottawa, Canada

A STUDY ON POOL FLAME STRUCTURE USING THERMOGRAPHY

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Pool flames of heptane, kerosene, and crude oil in a 2.7m square tank were measured by thermography, storing thermal images as TV color images with 25,600 data points every 0.1 second. These apparent temperature images can be converted to irradiance by simple approximations. A series of data recorded continuously at 0.1 second intervals (70 images for one fuel) were analyzed statistically to obtain the distribution of mean radiance, standard deviation and coefficient of variation in the thermography image. The contours of mean radiance, standard deviation and coefficient of variation related to radiance were made, and the flame structure of pool flames are considered from a radiation point of view. Finally, the radiative characteristics of the continuous flame, intermittent, and plume regions, are established.

5th International Fuzzy Sys-
tems Association World Con-
gress Seoul, Korea, Jul. 4-9,
1993

On a multicriteria fuzzy clustering method

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In recent years, researches for 3-way data have become interested in data analysis by improving the technique of observing data and highly progress of the computer capacity. 3-way data is composed of objects, attributes and situations, that is, it is expressed by 3-dimensional

array, objects \times attributes \times situations. The clustering problem for such 3-way data can be regarded as a multicriteria optimization problem. In this optimization, the practical problem is to get a Pareto efficient solution. In a hard (non-fuzzy) clustering, there are some difficulties to find Pareto efficient clusters for the combinational optimization. But we show that fuzzy clustering has a merit to obtain Pareto efficient clusters. Using this property, the method of fuzzy clustering for 3-way data is offered.

The Fifth International Conference on Genetic Algorithms, Urbana-Champaign, IL, USA, July 17-21, 1993.

An Efficient Migration Scheme for Subpopulation-Based Asynchronously Parallel Genetic Algorithms

Masaharu MUNETOMO, Yoshiaki TAKAI and Yoshiharu SATO
Division of Information Engineering, Faculty of Engineering, Hokkaido University.

From a parallel processing point of view, reducing unnecessary communication among processors is essential to avoiding performance degradation. Researches on subpopulation-based parallel genetic algorithms (PGAs) presented so far, however, have not considered their detailed strategy for efficient communication among subpopulations: migrations are driven at constant intervals or fully random. In this paper, we present an efficient migration scheme for subpopulation-based asynchronously parallel GAs. The scheme we presented carefully observes fitness distribution of each subpopulation to decide when to exchange strings between two subpopulations.

49th Session of The International Statistical Institute
Firenze, Italy, Aug. 25-Sep. 2, 1993

Parameter-effect curvature and confidence region in nonlinear regression

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Sapporo 060, Japan

It has been discussed that the linear confidence region of the least square estimator $\hat{\theta}$ in the usual nonlinear regression model, $y=f(x; \theta)+\varepsilon$, is valid only if $f(x; \theta)$ is fairly flat in the neighborhood of $\hat{\theta}$. The nonlinearity of $f(x; \theta)$ is considered to be described in term of two curvatures, i. e. parameter-effect curvature and intrinsic curvature. In this paper we show

that the parameter-effect curvature can be vanished at the point $\hat{\theta}$ by the use of geodesic coordinate in the neighborhood of $\hat{\theta}$. The effect of this coordinate transformation is investigated by the numerical experiments.

4th Conference of the International Federation of Classification Societies,
Paris, France, August 31-
September 4, 1993

**A review of graphical methods in Japan
— from histogram to dynamic display —**

Masahiro MIZUTA

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Hokkaido University, Sapporo 060, Japan

We review graphical methods that are developed and/of improved in Japan. For example a decision of the bin-width on histogram with AIC, constellation graphical method, sampling method and a few methods with dynamic graphics are included. The computing environments for statistics in Japan are introduced in relation to these methods.

In addition to these, we also propose a new graphical method, *Dynamic scatterplot matrix*. This method is an extension of the scatterplot matrix with rotation.

The First IEEE Conference
on Evolutionary Computation
Orlando, FL, USA, June 27-
June 29, 1994.

**A Genetic Approach to Dynamic Load Balancing
in a Distributed Computing System**

Masaharu MUNETOMO, Yoshiaki TAKAI, and Yoshiharu SATO

Division of Information Engineering, Faculty of
Engineering, Hokkaido University.

This paper represents an efficient dynamic load balancing scheme based on a genetic algorithm (GA). A sender-initiated task migration algorithm continues to send unnecessary requests for a task migration while the system load is heavy, which yields inefficient inter-processor communication. In a GA-based load balancing scheme we propose, a subset of processors to which the requests are sent off is adaptively determined by a learning procedure to reduce unnecessary requests. The learning procedure consists of genetic operations applied to

a population of binary strings each of which stands for a list of destination processors of a migration request. From a view point of mean response time, we show the effectiveness of our approach through empirical investigations.

IXth Congress of International Society for Artificial Organs Amsterdam, The Netherlands July 4-8, 1993

Study of the cell contacting with material and affected by physical stimulations.

Toshiyuki SHIMOOKA, Kouji YAMADA, Ikuya NISHIMURA,
Shun MURABAYASHI and Toshio YUHTA
Faculty of Engineering, Hokkaido University, Japan

For the purpose of controlling the functions of cells by physical stimulations, effects of electrostatic field made by micro-patterned electrodes and magnetostatic field were investigated. L929 was cultured on the micro-patterned electrodes. Morphologic changes of L929 were restricted by the given electrostatic fields of 200 and 400mV. Platelets were cultured under the magnetostatic field made by neodymium magnet (0.3T). The elongation of pseudopodia was restrained by the magnetostatic field.

IFAC Symposium on Modeling and Control in Biomedical Systems Galveston, USA
March 27-30, 1994

A study of functions of the cardiovascular control loops during left ventricular bypass by computer simulation

Yoshinori MITAMURA, Eiji TAKAHASHI*, Yukinori SUZUKI**,
Toshiyuki SHIMOOKA[#] and Tomohisa MIKAMI
School of Engineering, Hokkaido Tokai University, Japan

* Faculty of Medicine, Yamagata University, Japan

** Muroran Institute of Technology, Japan

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Responses of the cardiovascular system during left ventricular bypass are quite interesting because an assist pump produces unusual hemodynamic conditions which otherwise can not be obtained. Two examples of the response are discussed. One is cardiac rhythm entrained by the assist pump and the other is hemodynamics during left ventricular bypass. The interac-

tions between cardiovascular control system and assist pump are analyzed using mathematical models.

24th General Assembly of the
International Union of Radio
Science, Kyoto, Japan, August
25-September 2, 1993

Assessment of ELF Electric Field Exposure on Human Body

Koichi SHIMIZU and Goro MATSUMOTO*

Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

* Dept. of Applied Electronics, Hokkaido Institute of Technology

In the study of biological effects of an ELF (extremely low frequency) electric field, an accurate assessment of field exposure on a human body is essential. Some techniques have been developed which evaluate the field exposure on a human body. They are a numerical analysis technique, an optical technique and two electric techniques. A newly developed technique enables us to measure the distribution of the current induced in a living biological body without the need for sacrificing and amputation. After the accuracy of this technique was confirmed, it was applied to the measurement with a living human subject under operating high power transmission lines. The result showed hot spots or regions with large current density in the neck and legs, particularly around the ankles.

24th General Assembly of the
International Union of Radio
Science, Kyoto, Japan, August
25-September 2, 1993

Medical Telemetry using Mobile Satellite Communication

Koichi SHIMIZU and Katsuyuki YAMAMOTO

Dept. of Bioengineering, Hokkaido University

To provide paramedical care within moving vehicles, a telemedicine technique using mobile satellite communication is proposed. With this technique, the diagnosis from a specialist and the emergency care under his/her instructions would be available on the spot without unnecessary delay. First, fundamental transmission characteristics were measured in a fixed station. Then, experiments of medical data transmission were conducted with a navigating ship and an aircraft flying an international route. Through the experiments, the feasibility of this technique was verified. This technique has been applied to emergency vehicles on the ground, as well. The information of the patient can be transmitted to a hospital from a mov-

ing ambulance using an emergency radio system and mobile telephone system. The transmission experiments have been repeated in various conditions. We were able to obtain the average available time of the communication link of more than 95%.

3rd. International Conference
of the International Society
on Optics Within Life Sci-
ences, Tokyo, Japan, April
10-14, 1994

Trans-body Imaging of Physiological Functions with Light

Koich SHIMIZU, Mitsuhiro MOURI and Katsuyuki YAMAMOTO
Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

With the view toward the non-invasive imaging of biological functions with light, a fundamental study has been conducted. Using a near-infrared light, the transillumination images of a human hand, a mouse abdomen and a rat brain were obtained. The physiological changes such as local ischemia could be visualized in each of the transillumination images. With a rat brain, the change of the image was further investigated in various conditions. The physiological change of rat was made by changing the oxygen fraction of inhalation gas or by occluding the carotid artery to change the brain circulation. It was found that the changes in the brain blood volume and in the brain oxygenation state could be detected using multiple wavelengths of light. The wavelengths were an isosbestic point of hemoglobin (around 800nm), and shorter one (773nm) or longer one (819nm) than the isosbestic point. In this way, the spatial distribution of these changes could be visualized in the transillumination images of a brain. Through this study, the feasibility of optical trans-body imaging of physiological functions was verified.

3rd International Conference
of the International Society
on Optics Within Life Sci-
ences, Tokyo, Japan, April
10-14, 1994

Optical CT Imaging of Biological Body with CW Light

Masataka KITAMA, Koichi SHIMIZU and Katsuyuki YAMAMOTO
Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

With the progress of light sources and detectors, it has become possible to detect the light passed through a living body. The feasibility of an optical CT with a CW light was investigat-

ed. The strong scattering from tissues has been identified as a difficult problem to realize the CT imaging of a living body. A technique called "a scattering angle differential technique" has been newly developed to suppress the effect of scattering in the imaging through diffuse media. The effectiveness of this technique was confirmed in the analysis of the spatial resolution of imaging in diffuse media. The effectiveness was demonstrated in the CT imaging of a model phantom. However, it was found in experiments that this technique alone was not effective with a living mouse. The problem was found to be the reflection and the refraction at the air-tissue interface. Another technique called "a contact technique" was newly developed to overcome this problem. A measurement system was developed to use both techniques simultaneously. Using this system, the CT imaging of a mouse abdomen was attempted. Though the spatial resolution was poor, the existence of a liver and kidneys were recognized in the CT image of a living mouse.

1994 IEEE Instrumentation
and Measurement Technol-
ogy Conference, Hamamatsu,
Japan, May 10-12, 1994

**Noninvasive Measurement of Physiological Functions
in a Living Body by Transillumination**

Koichi SHIMIZU, Masataka KITAMA, Mitsuhiro MOURI
and Katsuyuki YAMAMOTO

Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

With the view toward the non-invasive imaging of biological functions with light, a fundamental study has been conducted. Using a near-infrared light, the transillumination images of the head of a rat were obtained. The change in the image was investigated, when the oxygen fraction of inhalation gas was changed and when the brain circulation was changed by occluding the carotid artery. It was found that the changes in the brain blood volume and in the brain oxygenation state can be detected using multiple wavelengths of light. Further, the spatial distribution of these changes can be visualized in the transillumination images of a brain. Through this study, the feasibility of optical trans-body imaging of physiological functions was verified.

1994 IEEE Instrumentation
and Measurement Technol-
ogy Conference, Hamamatsu,
Japan, May 10-12, 1994

Optical Biotelemetry in Moving Vehicles

Koichi SHIMIZU, Seiji MATSUDA, Takahiro MIYANAGA
and Katsuyuki YAMAMOTO
Dept. of Bioengineering, Fac. of Engineering,
Hokkaido University

For the improvement of the life-saving operation in an emergency medicine, a technique of the telemedicine using mobile communication was proposed. To obtain different kinds of physiological data from a patient in an ambulance, an optical biotelemetry technique was applied. Using an indirect light transmission, the wireless measurement became possible even in the moving car with the paramedical staff working actively. A test system was developed and its fundamental characteristics were measured. Through the experiments in a moving car, the feasibility of the proposed technique was verified.

1994 International Sympo-
sium on Electromagnetic
Compatibility, Sendai, Japan,
May 16-20, 1994

Threshold Evaluation of Electric Field Perception Using Optical Telemetry Technique

Masaji YAMASHITA*, Koichi SHIMIZU and Goro MATSUMOTO**
Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

* Dept. of Electrical Engineering, Hokkaido Institute of Technology

** Dept. of Applied Electronics, Hokkaido Institute of Technology

An optical telemetry technique was developed which enables us to evaluate physiological responses non-invasively without restraining the subject. The change in diameters of peripheral blood vessels is measured as the change in transmitted intensity of infra-red light across an ear auricle. The signal is transmitted to a remote place using infra-red light diffusely reflected from a ceiling and walls of a room. After the feasibility of this technique was verified with various stress-responses, it was applied to the study of biological effects of electromagnetic fields. A rabbit was exposed to a strong electric field, and the change in its peripheral circulation was detected with this technique. Different field strength were applied from 5kV/m-100kV/m. Both contraction and dilation of peripheral blood vessels were detected on the exposure to electric fields. The threshold level of the field strength to cause the response was analyzed.

1994 International Symposium on Electromagnetic Compatibility, Sendai, Japan, May 16-20, 1994

Measurement and Analysis of Human Perception-Threshold of Strong Electric Field

Hisae ODAGIRI*, Koichi SHIMIZU and Goro MATSUMOTO*
Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

* Dept. of Applied Electronics, Hokkaido Institute of Technology

For the study of the biological effects of ELF (Extremely Low Frequency) electric fields, the perception mechanism of ELF electric field was analyzed. When a human body is exposed to an electric field, the hair on the body surface moves due to the electric force exerted on the hair. A technique was developed to estimate the electric force exerted on a hair during the field exposure. After the experiments with model hair, the technique was applied to a body hair of a living human being. It was found that the force increased with field strength and relative humidity. A technique was developed to measure the threshold of the field perception. The cause of the individual difference of the perception-threshold was investigated. These results will provide the significant information for the safety standard of the field exposure.

1994 IEEE AP-S International Symposium and URSI Radio Science Meeting, Seattle, U. S. A., June 19-24, 1994

Optical Trans-body Imaging of Physiological Functions

Koichi SHIMIZU, Mitsuhiro MOURI
and Katsuyuki YAMAMOTO
Dept. of Bioengineering, Fac. of Engineering,
Hokkaido University

Attempts were made to visualize the functional change inside a living biological body using a transillumination technique. With a near-infrared light, the transillumination images of a human hand, a mouse abdomen and a rat brain were obtained. To examine the feasibility of functional imaging, a localized hypoxia was made in each of above body parts. One of a kidney was made hypoxic by stopping the renal circulation. It was visualized using transillumination images of multiple wavelengths of light. The physiological change of a rat brain was made by changing the oxygen fraction of inhalation gas or by occluding the carotid artery to change the brain circulation. It was found that the changes in the brain blood volume and in the brain oxygenation state could be detected noninvasively. In this way, the spatial distri-

bution of these changes could be visualized in the transillumination images of a living body. Through this study, the feasibility of optical trans-body imaging of physiological functions was verified.

1994 IEEE AP-S International Symposium and URSI Radio Science Meeting, Seattle, U. S. A., June 19-24, 1994

3D Analysis of Ion-Current Exposure on a Human Body

Koichi SHIMIZU, Masaji YAMASHITA* and Goro MATSUMOTO**
Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

* Dept. of Electrical Engineering, Hokkaido Institute of Technology

** Dept. of Applied Electronics, Hokkaido Institute of Technology

To study the biological effects of the ion-current commonly found under ultra-high voltage DC transmission lines, a technique was developed to evaluate the human exposure to the ion-current field. This technique is based on numerical analysis using the boundary element method. The difficulty of handling the space charge in the calculation was overcome by assuming a lumped source ion-current. This technique is applicable to a three dimensionally complex object such as a human body. In comparison with theoretical values, the accuracy of this technique was evaluated to be satisfactory for our purposes. It was then applied to a human body in an ion-current field. The distribution of the electric field along the body surface was obtained. It was found that the strength of the field concentration was significantly enhanced by the space charges. Further, the field exposure when a human body was charged by an ion-current was evaluated. This technique provides a useful tool for the study of biological effects and safety standards of ion-current field.

1994 IEEE AP-S International Symposium and URSI Radio Science Meeting, Seattle, U.S.A., June 19-24, 1994

Fundamental Study for CT Imaging of Biological Body with Light

Koichi SHIMIZU, Masataka KITAMA and Katsuyuki YAMAMOTO
Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

A fundamental study was conducted to examine the feasibility of an optical CT with a CW light. A technique called "a scattering angle differential technique" has been newly developed to suppress the effect of scattering in the imaging through diffuse random media. This tech-

nique uses the two detectors placed on and off the optical axis of a collimated beam of incident light. The scattered component in transmitted light is greatly reduced by subtracting the output of the off-axis detector from that of the on-axis detector. The effectiveness was confirmed in CT imaging of a model phantom. However, it was found in experiments that this technique alone was not effective with a living mouse. The problem was found to be the reflection and the refraction at the air-tissue interface. Another technique called "a contact technique" was newly developed to overcome this problem. A measurement system was developed to use both techniques simultaneously. Using this system, CT imaging of a mouse abdomen was attempted. Though the spatial resolution was poor, the existence of a liver and kidneys were recognized in the CT image of a living mouse.

1994 Japan-U. S. Seminar on
Electromagnetic Field Effects
Caused by High Voltage Sys-
tems, Sapporo, Japan, June
28-July 1, 1994

Evaluation of Biological Effects of ELF Electric Fields

Koichi SHIMIZU and Goro MATSUMOTO*

Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

*Dept. of Applied Electronics, Hokkaido Institute of Technology

The biological effects of ELF electric field were evaluated in animal experiments. New measurement techniques were developed which enabled us to evaluate the field exposure on a human body. A system was developed to realize the chronic exposure of an electric field on mice and cats. An optical telemetry technique was developed to measure the physiological response of an animal when it was exposed to an electric field. An ion-current shuttle box was developed to investigate the behavioral change of a rat when it was exposed to an ion-current as well as an electric field. In animal experiments, a mechanism of sensing the field was investigated. The cause of the seasonal change of field sensitivity was found. In cases of chronic exposure, suppression of growth was suspected. In shuttle box studies, an avoidance behavior from an ion-current was quantified. To find whether there are any adverse or beneficial effects of the field exposure on human being, further study is required to clarify the mechanisms of the biological effects.

1994 Japan-U. S. Seminar on
Electromagnetic Field Effects
Caused by High Voltage Sys-
tems, Sapporo, Japan, June
28-July 1, 1994

Analysis of the Field Exposure on the Animal Body in Ion-Current Field

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** Dept. of Applied Electronics, Hokkaido Institute of Technology

To study the biological effects of the ion-current commonly found under ultra-high voltage DC transmission lines, a technique was developed to evaluate the animal exposure to the ion-current field. This technique is based on numerical analysis using the boundary element method. The difficulty of handling the space charge in the calculation was overcome by assuming a lumped source ion-current. This technique is applicable to a three dimensionally complex object such as a human body. In comparison with theoretical values, the accuracy of this technique was evaluated to be satisfactory for our purposes. It was then applied to animal bodies in ion-current fields. The distribution of the electric field along the body surface was obtained. It was found that the strength of the field concentration was significantly enhanced by the space charges. This technique provides a useful tool for the study of biological effects and safety standards of ion-current fields.

1994 Japan-U. S. Seminar on
Electromagnetic Field Effects
Caused by High Voltage Sys-
tems, Sapporo, Japan, June
28-July 1, 1994

Fundamental Analysis of Human Perception of ELF Electric Field

Hisae ODAGIRI*, Koichi SHIMIZU and Goro MATSUMOTO*
Dept. of Bioengineering, Fac. of Engineering, Hokkaido University

*Dept. of Applied Electronics, Hokkaido Institute of Technology

For the study of the biological effects of ELF (Extremely Low Frequency) electric fields, the perception mechanism of ELF electric field was analyzed. When a human body is exposed to an electric field, the hair on the body surface moves due to the electric force exerted on the hair. It was shown that the force is approximately proportional to the dielectric constant of hair. The dielectric constant of hair was measured with different temperatures and humidities

of surrounding air. A technique was developed to estimate the electric force exerted on a hair during the field exposure. After the experiments with model hair, the technique was applied to a body hair of a living human being. It was found that the force increased with field strength and relative humidity. A technique was developed to measure the threshold of the field perception. The cause of the individual difference of the perception-threshold was investigated. These results will provide the significant information for the safety standard of the field exposure.

The 3rd Korea-Japan Joint
Conference on Totally Im-
plantable Artificial Heart &
Its Hemocompatibility, Seoul,
Korea, October 20-23, 1993

Two Approaches Toward A Totally Implantable Artificial Heart

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We have been developing two different types of totally implantable artificial hearts; a pulsatile motor-driven assist pump and an intra-cardiac axial flow pump. Each system has different advantages. The pulsatile pump maintains the circulation physiologically for a long period. On the other hand, the nonpulsatile pump has simple structure and small volume.

The motor-driven assist pump consists of a brushless DC motor driving a miniature ball screw, and a pusher-plate type blood pump.

The intra-cardiac axial flow pump is implanted at the heart valve position while preserving the myocardium. The axial pump consists of an impeller, a DC brushless motor, and a ferrofluidic seal. In vitro and in vivo tests show that the pulsatile motor-driven assist pump system has adequate hemodynamics performances, high actuator efficiency, and long-term durability. In vitro studies also indicate that the intra-cardiac axial flow pump is a feasible implantable artificial heart.

International Conference on
Advances in Materials and
Processing Technologies,
Aug. 27-27, 1993, Dublin,
IRELAND

Aluminum Nitride/Metal Composite Using Ultrafine Aluminum Particle and their Application for Joining

Koji ATARASHIYA
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Composite blocks of the system M-AIN were prepared by powder metallurgy. A raw material i.e. an ultrafine Al particle was prepared by means of arc-plasma processing. A mixture of an ultrafine Al particle and a metal powder was pressed in a steel die followed by sintering in flowing nitrogen. The composite blocks prepared by this method were characterized for structure, density, thermal expansion, microhardness and so on.

Mixtures of an ultrafine Al particle and a commercial coarse Al powder were pressed in a steel die. These green compacts were put on AIN plates followed by heating at 873 K in flowing nitrogen. Then joining of the AIN plate and the composite were completely accomplished. Chemical analysis of the material in the vicinity of the interlayer, which was carried out by means of EPMA, indicated that Al metal layer was formed along the interface. This Al metal layer maybe acted as a brazing material.

The 10th Japan-USA Joint
Technical Meeting on Coal
Liquefaction/Materials for
Coal Liquefaction, Toya,
Hokkaido, Japan, January
17-19, 1994

Estimation of Physical Properties of Hydrocarbons in a Coal-Derived Liquid by a Group Contribution Method

Masaaki SATOU and Yuzo SANADA
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A simple method of calculating the physical properties (boiling point, density and refractive index) of hydrocarbons in a coal derived liquid was developed using contribution of component groups to the property. Now, group analyses were performed by gas chromatography/mass spectroscopy (GC/MS) or a combination of ^1H -, ^{13}C - nuclear magnetic resonance (NMR) spectroscopies and elemental analysis. The component groups adopted in this study

are aromatic rings, naphthenic rings, aromatic conjunction carbons and aromatic inner carbons. The contributions of each component group to physical property were determined by regression analysis. The values obtained corresponded well, with the increments per component group, to the physical property of normal paraffin with the same total number of carbons. Thus, the calculated properties of hydrocarbon compound classes in a coal derived liquid showed good agreement with those observed.

7th International Conference
on Coal Science, September
12-17, 1993, Banff, Canada

**Noncovalent Interaction in Coal with Electron Acceptor
by means of EPR Power Saturation Technique.**

Haruo KUMAGAI¹⁾, Masahide SASAKI²⁾, Kazuo NAKAMURA³⁾,
Takaki OHKUBO¹⁾ and Yuzo SANADA¹⁾

- 1) Faculty of Engineering, Hokkaido University,
Sapporo 060, Japan
- 2) Government Industrial Development Laboratory, Hokkaido,
Sapporo 062, Japan
- 3) Fundamental Research Laboratories, Osaka Gas Co., Ltd.,
Osaka 554, Japan

The EPR power saturation for both original and electron acceptor doped coal has been measured to investigate the noncovalent interactions in coal. The EPR power saturation characteristics of high rank coal changed with iodine doping. The doped iodine which forms charge transfer complex with polyaromatics in coal results declining π - π interaction between polyaromatics. The results indicate that the π - π interaction plays important role for the macromolecular structure in high rank coal. For low rank coal no drastic change has been observed in EPR power saturation property. These results suggest that the contribution of π - π interaction for the formation of macromolecular structure in low rank coal is smaller than that in high rank coal.

7th International Conference
on Coal Science, September
12-17, 1993, Banff, Canada

Computer Simulation of the Conformation of Lignite with Water.

Haruo KUMAGAI¹⁾, Kazuo NAKAMURA²⁾, Masahide SASAKI³⁾,
Jo YONEDA¹⁾ and Yuzo SANADA¹⁾

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- 2) Fundamental Research Laboratories, Osaka Gas Co., Ltd.,
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Sapporo 062, Japan

Computer Aided Molecular Design (CAMD) technique has been applied to obtain the conformation and association of lignite molecule with water. The shape of lignite has changed from expanded shape to contracted one with decrease in the number of water molecule which surround the lignite molecule. The energy in lignite molecule has increased with increase in the number of water molecule. The total energy of lignite/water system, however, has decreased as a result of decreasing in hydrogen bond interaction energy between lignite and water. These results indicate that the conformation and energy level of lignite are strongly affected with the associated water molecules.

32nd Symposium on Engi-
neering Aspects of Magneto-
hydrodynamics Pittsburgh,
Pennsylvania June 27-30,
1994

Experimental Investigation on Tungsten/Copper-FGM Electrodes for a Coal-fired MHD Channel

Hideaki USAMI, Yoshiaki AOKI, Naoyuki KAYUKAWA, *Takayasu OKUO
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*Electrotechnical Laboratory, Tsukuba, 305 Japan

Abstract

We report on the experimental results of operating performance and wear of the tungsten/copper (W/Cu) -FGM (Functionally Gradient Material) electrode, which has the higher thermal conductivity than the mono-tungsten (W) electrode. The test was carried out under the

slagging condition in Hokkaido University Slagging-Electrode Test Facility. It was shown that the W/Cu-FGM electrode has higher durability than the mono-W electrode. It was also shown that the wear per coulomb of the electrodes for an MHD generator can be decreased by more than 22% by using the W/Cu-FGM electrode, in comparison with the mono-W electrode.

32nd Symposium on Engineering Aspects of Magneto-hydrodynamics Pittsburgh, Pennsylvania June 27-30, 1994

IMAGE PROCESSING FOR TEMPERATURE PROFILE OF MHD PLASMA JET

Hiroyuki OYAMA, Shigeo YATSU, Yoshiaki AOKI
and Naoyuki KAYUKAWA
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ABSTRACT

To determine the plasma temperature profile accurately is one of the basic requirements in the investigation of MHD plasma and the MHD generator performance. The light-polarization line-reversal method has been used so far, for measuring temperature, because of its high temporal resolutions. However this method only give an average value along the line of sight. In point of the specially local values, this method has the same limitation that the conventional emission-absorption technique has. It is difficult to measure the local plasma temperature. Here we propose a new method to overcome the above difficulty by using image processing method on computer. We measured the combustion plasma light emission intensity by VTR camera, and the local light emission intensity was obtained by the asymmetric Abel inversion. From reconstructed local light emission data, we calculated the local plasma temperature.

32nd Symposium on Engineering Aspects of Magnetohydrodynamics Pittsburgh, Pennsylvania June 27-30, 1994

**OPTIMAL Nb-Ti SUPERCONDUCTING MAGNET COIL DESIGN
FOR 200MWe COAL-FIRED MHD GENERATOR**

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ABSTRACT

We report on the effect of the cross-sectional shape of the magnet coil. The optimization of the cross-sectional shape of a magnet coil including an MHD channel is carried out for a 200 MWe coal fired Faraday type MHD generator. It is shown that the channel length can be shortened by more than 30% and the stored energy of the magnet coil can be reduced by about 60% by the optimization of the coil shape in comparison with the case of the crescent shaped coil producing a uniform magnetic field, where the enthalpy extraction is effectively kept unchanged. Also, for a stand alone commercial MHD/steam combined plant, it is estimated that the capital cost decreased by more than 8% and the cost of electricity can be reduced by about 3% by this coil shape optimization.