



Title	Abstracts & Titles, No. 153-157
Citation	Memoirs of the Faculty of Engineering, Hokkaido University, 18(2), 137-169
Issue Date	1991
Doc URL	http://hdl.handle.net/2115/38043
Type	bulletin (other)
File Information	18(2)_137-170.pdf



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Abstracts & Titles, No. 153~157

BULLETIN

OF THE

FACULTY OF ENGINEERING

HOKKAIDO UNIVERSITY

NOTICE

IN COMMEMORATION OF THE THIRTY ANNIVERSARY
OF DEPARTMENT OF ELECTRONIC ENGINEERING

No. 153

Nov. 1990

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Properties of Forward Phase Conjugation by Nearly Degenerate Four Wave Mixing with Boxcar Type Phase-Matching

Teruhito MISHIMA, Tsugumu HON-MA* and Shinji SASADE**

(Received August 31, 1990)

Abstract

Coupled wave equations are derived and solved for analyzing properties of forward phase conjugation by nearly degenerate four wave mixing with boxcar type phase-matching. The properties are discussed in conjunction with incident angles, polarization directions of the waves and frequency detuning.

Optical Transfer Properties of Parametric Image Upconverter III – Diffraction Effect of Medium Aperture –

Atsushi OKAMOTO and Teruhito MISHIMA

(Received August 31, 1990)

Abstract

Optical transfer properties of two-photon-pumped parametric image upconverter are analyzed with consideration to the finite aperture of a nonlinear optical medium. The sum-frequency response is derived in case where an infrared plane wave is incident on the nonlinear optical medium with a finite aperture and with a finite thickness. It is shown that the spatial frequency resolution of the image upconverter is limited by the diffraction effect of the finite aperture and that the spatial frequency bandwidth is restricted by the phase matching condition due to the finite medium thickness. It is also shown that the number of the resolution elements is proportional to the square of the aperture size and is inversely proportional to the infrared wavelength and the medium thickness.

Acceptance Angles of Upconverter by Multi-Wave Mixing

Kojiro KOYANAGI, Atushi OKAMOTO and Teruhito MISHIMA

(Received August 31, 1990)

Abstract

This paper presents a theoretical study of the acceptance angles of upconverters by optical multi-wave mixing which are classified under forward sum and difference mixing and backward sum and difference mixing. It is found that broad acceptance angles are obtained in upconverter by backward multi-wave difference mixing.

Studies on a Solar Power Satellite at Hokkaido University

Kiyohiko ITOH, Yasutaka OGAWA and Manabu OHMIYA

(Received August 31, 1990)

Abstract

In this paper, we describe studies on a Solar Power Satellite (SPS) which have been carried out at Hokkaido University from 1981. The SPS transforms sunlight energy into electric energy using a huge solar array on a geostationary orbit, and transmits the energy down to the earth by a 2.45GHz microwave. On the earth, we receive the microwave using a "Rectenna" (Rectifying Antenna), and supply commercial electric power. The SPS provides one of the promising solutions to energy shortage and environmental pollution problems.

At Hokkaido University, we proposed a circular microstrip antenna for transmission and reception of the microwave power. The circular microstrip antenna does not resonate at integer multiple frequencies of a dominant frequency (2.45GHz). Higher harmonics which interfere with radio communication systems are reduced by the circular microstrip antenna. Then, we can construct simple antenna systems because we do not need additional bandpass filters to prevent unwanted radiation.

In this paper, we present a detailed description of the circular microstrip antenna for energy transmission and reception. Also, we describe the effect of the SPS on the communication system and biological environment.

Howells-Applebaum Adaptive Superresolution Array for Accelerated Scanning

Manabu OHMIYA, Yasutaka OGAWA and Kiyohiko ITOH

(Received August 31, 1990)

Abstract

A new approach is described which provides an accelerated scanning rate for a Howells-Applebaum adaptive superresolution array (H-A SRA). Analytical considerations clarify the causes of performance degradation of the H-A SRA at a high scanning rate. Then a suitable steering signal and implementation of an H-A weight control loop (H-A loop) for accelerated scanning are proposed. Furthermore, the weight solution determined by this method is shown to coincide approximately with the optimum Wiener one under some specific signal conditions and antenna parameters. Computer simulations show that the proposed H-A SRA gives a much better scanning performance than the conventional array. The new system is readily implemented by improving the circuit inserting the steering signal in the H-A loop. Therefore, the approach is very effective.

Fast Separation of Bi-Level Images and Halftone Images

Osamu ABIKO, Tomoaki SHIRAKAWA, Hideo KITAJIMA and Yoshihiko OGAWA

(Received August 31, 1990)

Abstract

In this paper, a new image separation algorithm for bi-level images superimposed on halftone images is proposed. A computer simulation indicates that it can separate such images correctly. The algorithm divides the input-image into micro-blocks and uses the difference of the block-density to separate each image. Since it needs only three vertical blocks, it is possible to separate such bi-level images very rapidly. These techniques are expected to be applied to facsimiles.

Discrete Kalman Filter for Range Compression in SAR Image Processing

Yasuyuki UCHIYAMA, Tomoaki SHIRAKAWA,
Hideo KITAJIMA and Yoshihiko OGAWA

(Received August 31, 1990)

Abstract

Range compression is conventionally implemented by a matched filter in image processing for a synthetic aperture radar. This paper proposes a kalman filter for iteratively processing the data in the time domain. An SAR received signal model is modified to yield a recursive estimator for range compression. Computer simulation indicates the proposed method that has an advantage over the conventional method.

High Quality Image Reconstruction for Synthetic-Aperture Radar

Tomoaki SHIRAKAWA, Yasuyuki UCHIYAMA
Hideo KITAJIMA and Yoshihiko OGAWA

(Received August 31, 1990)

Abstract

In this paper, a new image reconstructing algorithm for synthetic-aperture radar(SAR) is proposed. This method is based on filtering and yields reconstructed images of higher resolution than the conventional methods. The result of computer simulation is included to show the effectiveness of the proposed method.

Windows for Pre-Emphasis and De-Emphasis for Block Coding of Images

Hideo KITAJIMA*, Tetsuo SHIMONO**, Tomoaki SHIRAKAWA*,
and Yoshihiko OGAWA*

(Received August 31, 1990)

Abstract

This paper proposes the use of a signal domain window to suppress blockiness that occasionally degrades the reconstruction of a block-coded signal. Effects of a window and its inverse window on signal-to-noise ratios, and required bit rates are analyzed. A likely window is also given. New quantization error measures are also introduced to augment the conventional Euclidean norm for vectors.

English-Japanese Machine Translation System Emphasized on User-Interface

Takashi SAWAMURA, Yoshikazu MIYANAGA, Koji TOCHINAI

(Received August 31, 1990)

Abstract

We develop an English-Japanese Machine Translation system emphasized on a User-Interface, which frequently communicates with users and performs translation in cooperation with users. Users can obtain high quality versions by using the system integrated processes of pre-editing, registration of words into dictionary, translation and post-editing, which are separated in conventional MT systems. And this system acts like "interpreter" because it interpretes input words in a sentence successively.

Effectiveness of a Compact ARMA Lattice Filter in a Speech Coding System

Makoto HIROSHIGE, Yoshikazu MIYANAGA and Koji TOCHINAI

(Received August 31, 1990)

Abstract

In this report, a new speech coding method using a compact ARMA lattice filter is proposed. This report mainly discusses some differences between the proposed method and a conventional coding method using PARCOR. In comparison, spectrum parameters and residual error signals are quantized at the same bit rate. First, we compared their performances of parameter coding without sophisticated coding schemes for residual signals. Next, we applied a CELP coding method to a compact ARMA lattice coding system. The results of experiments show that the proposed method is superior to the conventional method in the segmental S/N ratio and in audible experiments of synthesized speech, especially, when the lattice parameters are quantized at low bit-rate.

The Measurement of Molecular Wobbling Motion in LB Films Using a Time-Resolved Fluorescence Depolarization Method

Naohito KIMURA, Ruriko TSUNETA, Tsunehisa ARAISO,

Toshio ISHII and Kōichi MUKASA

(Received August 31, 1990)

Abstract

Langmuir-Blodgett (LB) films have the advantages of well-ordered structure, and have been investigated to develop functional molecular devices. Because molecules wobble thermally, we employed a "time-resolved fluorescence depolarization method" in order to characterize the LB films dynamically. We assumed a model which described the oriented molecules in wobbling motion on a substrate, and evaluated the LB films with three layers of stearic acid including 1,6-diphenyl-1,3,5-hexatriene as a fluorescence probe.

In the experimental results (1) the orientation angle was about 13° , (2) the wobbling angle was $7\sim 8^\circ$ and (3) the wobbling angle was independent of the temperature below 35°C .

Observation of Magnetic Domain Structure by MFM-SEM

Jiro NAGAO, Masahiro IIZUKA, Sunao OKITSU,
Hiroshi ADACHI and Koichi MUKASA

(Received August 31, 1990)

Abstract

A magnetic force microscope (MFM) is a very useful tool for observation of fine magnetic structure with high resolution and without special sample treatment. However it has some problems to be overcome. The cantilever of MFM was designed on the basis of the theoretical analysis which considered these problems. A scanning tunneling microscope (STM) was used for the detection of the cantilever deflection resulting from the magnetic force. Tip-induced domain configuration and wall motion were observed by scanning electron microscope (SEM) when a sharp Fe wire tip was approaching a sample.

Deep Level Transient Spectroscopy of 50 keV Fe-Ion Implanted GaAs

Masafumi TANIWAKI, Hideto KOIDE,
Hiroyuki YOSHIDA and Yoshihiko HAYASHI

(Received August 31, 1990)

Abstract

The annealing process of 50 keV-Fe⁺ implanted GaAs was studied by DLTS. Eight trapping states were detected and identified. Fe had strong interactions with the implantation-induced point defects. A new trapping state appeared by annealing at 400°C, and the trapping states by point defects increased simultaneously. This means that the created Fe-related structure increases the number of point defects trapping states. The structure probably causes the amorphization of heavily Fe⁺-implanted GaAs at 400°C.

^{151}Eu Mössbauer Analysis of $\text{Ba}_2\text{EuCu}_3\text{O}_7$

Tatsuya MURAKI, Masafumi TANIWAKI and Ken-ichi SHIRAMINE

(Received August 31, 1990)

Abstract

The lattice vibration and electronic state of Eu in aligned high- T_c superconductor $\text{Ba}_2\text{EuCu}_3\text{O}_y$ was studied by ^{151}Eu Mössbauer spectroscopy. The lattice vibration was estimated by three methods. The mean square displacement of Eu along c-axis is larger than that of the displacement perpendicular to c-axis. An anomaly was observed in the ^{151}Eu isomer shift at $T > T_c$.

On the Structure Model of Liquid Water

Kazuo TOKIWANO

(Received August 31, 1990)

Abstract

The behavior of structure functions of liquid water is interpreted using a class of mixture models. Here water is treated as an equilibrium mixture of tetrahedral hydrogen-bonded pentamers and non-hydrogen-bonded monomers. Theoretical calculations of partial structure functions for the model are compared with molecular dynamic simulations and neutron diffraction data. The implications of the structure model to theoretical understanding of liquid water are discussed.

An Design System for Optical Integrated Circuits : OPTICS

Masanori KOSHIBA, Hiroshi SAITOH and Masashi EGUCHI

(Received August 31, 1990)

Abstract

A computer-aided-analysis system, OPTICS (OPTical Integrated Circuit design System), is described for the analysis and design of optical waveguides for optical integrated circuits. The system is composed of pre- and post-processing and waveguide-solver packages. The pre-processor is used to define guide geometries, index profiles, operating wavelengths, and boundary conditions—all interactively, and is linked to a computer aided mesh generation. The waveguide solver in which the scalar finite-element method is used provides effective refractive indices and field distributions. The results are displayed by the post-processor to give a physical picture. To show the validity and usefulness of this system, rib waveguides are investigated in detail.

Cerenkov Radiation of Frequency-Doubled Light from Leaky Waveguides

Kazuya HAYATA* and Masanori KOSHIBA*

(Received August 31, 1990)

Abstract

A new scheme for activating Cerenkov radiation of frequency-doubled light, which takes advantage of leaky waveguides, is proposed and simulated numerically. The underlying concept of this scheme is based on a possibility of increasing overlap between the fundamental (driving) and the frequency-doubled (driven) field profiles along the transverse direction. A preliminary investigation is made on the frequency doubling of infrared coherent radiation using a bent planar waveguide. Numerical results for the generated harmonic power as a function of the interaction length are shown, taking the radius of curvature of the bend as a parameter. Also displayed are the evolutionary plots of interacting fields, by which the effect of the bend on the field profile is visually understood.

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**A Study on the Method for Counting the Cell Number of *Thiobacillus ferrooxidans* in a Mixed Culture with *Thiobacillus thiooxidans*.
—by Selective Culture Using a Membrane Filter—**

Takakatsu TAKAMORI, Keiko SASAKI,
Masami TSUNEKAWA and Tsuyoshi HIRAJIMA

(Received October 29, 1990)

Abstract

A method to estimate the cell number of *T. ferrooxidans* in a mixed cell of *T. ferrooxidans* and *T. thiooxidans* by means of the selective colony formation on a membrane filter was studied. It required 10 to 15 days for the formation of colonies. It was possible to count colony numbers when the colony formed from 1 ml of the sample is under 10^3 . Using this method, it was clarified that the cell number of highly active *T. ferrooxidans* existing in the leachate of bacterial leaching or culture solution can be estimated.

**Flotation Characteristics of Rare Earth and
Other Salt-type Minerals with Some New Collectors.
—Flotation of Bastnaesite, Monazite, Fluorite, Barite and Calcite—**

Masami TSUNEKAWA, Manabu KANEMOTO,
Takakatsu TAKAMORI and Tsuyoshi HIRAJIMA

(Received October 29, 1990)

Abstract

Flotation tests of bastnaesite, monazite, fluorite, barite and calcite were carried out using n-oleoylsarcosine (OLSA), sodium octadecylsulfosuccinamate (SOSS) and n-tallow-1,3-diaminopropane dioleate (TDO) as collectors. The effects of collector concentration and pH on the flotation recovery were investigated. The flotation behavior of each mineral was discussed with regards to the reactions between ions of the collectors and constituent ions of the minerals, and the hydrolysis of these ions. The separation of rare earth minerals from each other or from the other salt-type minerals was performed by flotation with TDO. The feasibility of selective flotation of the above mentioned minerals with OLSA and SOSS was also suggested.

Study on Numerical Analysis of Radiation Heat Transfer by a Method of Analytic Theory of Numbers

Yunshan WANG, Xuchang XU,
Kazuhiko KUDO and Hiroshi TANIGUCHI

(Received October 30, 1990)

Abstract

A new method is developed to shorten the computation time and to increase the accuracy of radiation heat transfer analysis by Monte Carlo method. The method utilizes a number mesh derived by analytic theory of numbers which replaces the random numbers used in the Monte Carlo method. In the present study, at first the principle of the method of analytical theory of numbers is explained when it is used to obtain the value of multiple integrals. This is followed by a review of previous methods to solve radiation heat transfer by using the method of analytical theory of numbers. Then, a new method is proposed. As each set of the number mesh derived by analytical theory of numbers has its own distribution rule, it cannot be used freely as a substitute of the random numbers in the Monte Carlo calculation. Hence, by comparing the results with the one obtained by the Monte Carlo method using a large number of random numbers, an appropriate set of number mesh is sought. By using the finally obtained set of number mesh, the computation time is shown to be shortened by 20 percent.

Ice-Accretion Characteristics in a Cold Air Stream with Spraying Seawater

Akihiko HORIBE and Shoichiro FUKUSAKO

(Received October 24 1990)

Abstract

An experimental study was performed to investigate the characteristics of marine icing on a horizontal circular cylinder immersed in a cold air stream with spraying sea-water droplets. The experiments were carried out under a variety of conditions encompassing air velocity, air temperature, droplet diameter, droplet temperature, and liquid content. The formation of the ice layer formed on the cylinder were extensively observed. It was found that the morphology of the ice accretion depended mainly on both the air velocity and droplet

diameter, while the surface features of the ice layer varied markedly with both the droplet diameter and the droplet temperature. The salt-content distribution and crystal system within the ice layer formed on the cylinder were qualitatively determined.

Rate Expression of Citric Acid Formation by *Asp. Niger* -Surface Culture-

Akihiko SAKURAI, Hiroshi IMAI and Tetsuo EJIRI

(Received October 24 1990)

Abstract

The citric acid formation rate expressions were compared between the Luedeking-Piret type and the Contois type in the case of surface culture using *Aspergillus niger* Yang No. 2. The batch cultivation time course was simulated rather well by the Luedeking-Piret type equation. The critical biofilm surface density below which the equation was applicable was experimentally determined to be 40 mg/cm².

The biofilm at the interface between the liquid and air enhanced the oxygen transfer from the air to the liquid.

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An Uniform Flow Formula for the Partially Full Flow in a Circular Pipe

Naoyuki FUNAMIZU, Seiichi YAMASHITA and Tetsuo TAKAKUWA

(Received December 21, 1990)

Abstract

Sanitary sewage and storm water collection systems are designed and analyzed on the basis of the relation between the water depth and the mean flow velocity of a circular pipe. It is well known that this relation calculated by the Manning formula does not agree with the actual relation. Thus, a new uniform flow formula was developed on the basis of the Ven Te Chow's experimental results.

The new formula has the following advantages over the Manning formula:

- (a) it provides a better expression of the flow characteristics in a circular pipe than the Manning formula, and
- (b) the applicable pipe roughness range of this formula is wider than the Manning formula.

Computer Simulation of a Stress-Strain Curve with a Serrated Flow

Yoshisato KIMURA** and Tetsuo MOHRI*

(Received December 26, 1990)

Abstract

A serrated plastic flow is observed on a stress-strain curve in almost all metallic materials. Computer simulation is proposed as one of helpful method for the study of such a serrated flow. As an initial basis of the simulation, calculation of the stress-strain curve for homogeneous deformation is performed. And by adding sinusoidal modulation to the average dislocation velocity of the homogeneous deformation, serrated flow on a stress-strain curve is obtained.

Theoretical Calculation of a Phase Diagram for InP-InSb Pseudo-Binary Alloy

K. NAKAMURA¹⁾, T. MOHRI¹⁾ and T. ITO²⁾

(Received December 26, 1990)

Abstract

We demonstrate the theoretically calculated phase diagram for InP-InSb pseudo-binary system both in the bulk and in the thin film. The bulk phase diagram is calculated based on two schemes, nonempirical and semiempirical methods. The phase diagram for a thin film is, as an initial attempt, evaluated by adding an elastic energy term to the conventional semiempirical method. The elastic constraints from the substrate significantly affects the topology of the phase boundary.

On the Inhibiting Materials Against Electrodeposition of Gallium in Bayer Liquor

Takeshi TOYODA, Masayuki SHIOBARA,

Takeshi SASAKI and Tatsuo ISHIKAWA

(Received December 27, 1990)

Abstract

In order to identify the materials inhibiting electrodeposition of gallium in Bayer liquor, the electrolysis with gallium electrode was carried out in alkaline sodium aluminate solutions with additives of co-existing materials in Bayer liquor, and the dependency of current efficiency on the quantity of the additives was investigated.

Vanadium, silicon, and iron retarded the electrodeposition, but only in a much higher concentration range than those in Bayer liquor as treated by cooling. On the other hand, humic acid of 200 ppm, much lower than that in Bayer liquor, severely depressed electrodeposition. The results suggest that the humic compounds remaining in Bayer liquor under cooling treatments are mainly responsible for low current efficiency in gallium deposition.

The attempt to remove the humic compounds from Bayer liquor was conducted by pre-electrolysis followed by cooling treatments.

A considerable amount of humic compounds was taken away by those treatments, but the current efficiency of gallium deposition decreased. It is probably due to the dissolution of

gallium through some redox cycles caused by low molecular weight degradation products from humic compounds. The dissolution can also be accelerated by the concentration reduction of poisoning organic compounds.

Characteristics of Catalytic Combustion Using Butane Premixed Gas

Kenichi ITO, Osamu FUJITA and Hitoshi KUDOH

(Received December 26, 1990)

Abstract

Basic Characteristics of the catalytic combustion using butane premixed gas was investigated. The catalyst used was a platinum-loaded γ -Al₂O₃ monolith type. Special focus was on the thermal and emission characteristics for steady state and start-up operations, and degradation characteristics of the catalyst. Experimental parameters were strength of fuel, mixture velocity, catalyst length and the time after ignition.

The results showed that the stable combustion performed in a catalytic combustor and excellent emission characteristics were obtained over a wide range for steady state operation. Especially, NO_x and CO emission were much smaller than the regulation or allowable limits. Although, for the operation during start-up time the emission of CO and HC showed a higher value than steady state, they were also allowable from a practical aspect. Thermal degradation occurred when the operation temperature was over about 800 °C, and is a problem for a combustor design.

From these results, it was concluded that catalytic combustion has a promising potential to be a low emission and high performance combustor except for presence of a thermal degradation problem.

“Flameless” Combustion within Porous Radiant Burners Using Ceramic Fiber Mat as Burner Material

Kenichi ITO, Osamu FUJITA, Romeo M. BALINGCONGAN
and Kiyotaka YAMANE

(Received December 26, 1990)

Abstract

Experimental investigation of the combustion of premixed methane-air and propane-air in a ceramic fiber mat burner was conducted. The results revealed five distinct stages of combustion dependent on air ratio and mixture velocity exists. One of these is a stage where combustion is completed within the mat so that no flame is visible above the surface, and is called “flameless” combustion. The temperature profile, constant surface temperature map and profiles of the CO, CO₂ and NO_x concentrations above the surface were measured. It was found that the “flameless” stage offers promising application in the development of a clean, compact and highly efficient combustion technology. Porosity, thermal degradation and kind of fuel used affect the combustion characteristics of the burner.

Expansion of the Ability of the Neocognitron in Pattern Recognition

— Constructing a Highly Sensitive S-cell —

Yasuhiro HATAKEYAMA and Yukinori KAKAZU

(Received December 22, 1990)

Abstract

The purpose of this study is to improve the pattern recognition ability of the Neocognitron. Since, in the Neocognitron system, local feature detection (S-cell) seems to play an important role in pattern recognition, how to construct a highly sensitive S-cell is regarded as one of the major problems of improving the ability of pattern recognition of it. For this purpose, properties of the conventional S-cell are revealed by experimental analyses. From the results, the highly sensitive S-cell is proposed as the new one. The performance of feature detection of the proposed S-cell is compared with that of the conventional S-cell, which shows the effectiveness of the proposed one. The experimental results of recognizing patterns of arabic numerals show that the performance of the system which adopts the highly sensitive S-cell is better than that of the conventional S-cell.

Atomic Layer Epitaxy Growth of InAs and GaAs Thin Films and Fabrication of Quantum Wells and Barriers

Shu GOTO, Keiichi HIGUCHI and Hideki HASEGAWA

(Received January 4, 1991)

Abstract

Growth of InAs and GaAs epitaxial thin films by atomic layer epitaxy (ALE) in a vertical atmospheric pressure metalorganic vapor phase epitaxy (MOVPE) system is described. The electrical properties of the InAs thin films are excellent according to Hall effect and quantum Hall effect measurements. InAs/GaAs double-barrier structures using ALE films exhibited the occurrence of conductance minima, indicating resonant tunneling in spite of presence of the misfit dislocations.

The Behaviors of Irradiation Introduced Point Defects and Grain Boundary Segregation

Hu BENFU and Heishichiro TAKAHASHI

(Received December 27, 1990)

Abstract

The relative behavior of Fe-Cr-Mn alloys during electron irradiation is shown to be different from those observed in Fe-Cr-Ni and Fe-Cr-Mn with additional elements of W,V. The difference appears to be a consequence of the different diffusion behavior of nickel and manganese due to interaction between solute atoms and point defects. Especially, the interaction between manganese atom and vacancy in Fe-Cr-Mn is strong so that the migration energy becomes greater than in Fe-Cr-Ni alloy. This interaction causes the manganese solute depletion at grain boundary defects sink, while nickel solute segregates there. Also, due to the addition of W, and V into the Fe-Cr-Mn alloy a lot of small dislocation loops are nucleated and the growth of these loops is retarded as a consequence of the decreasing net flow of interstitial atoms toward the dislocation loops.

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Effects of Undercooling and Cooling Rate on Primary Silicon Size of Hypereutectic Al-Si Alloys

Tatsuya OHMI, Yasuhiro TANAKA and Masayuki KUDOH
(Received March 26, 1991)

Abstract

In order to investigate the effects of undercooling and cooling rate on primary silicon size of hypereutectic Al-32mass%Si and Al-22mass%Si alloys, three cooling methods were used. One was that a melt-filled graphite crucible with a small diameter was air-cooled or immersed in a metal bath, the second was that the melt was cast into a wedge shaped copper mold, and third was that the melt was directly injected into a lead bath.

On the other hand, the relationship between the cooling rate (R) and degree of undercooling (ΔT_m) was estimated on the basis of classical nucleation theory. This result was combined with the experimental relation between ΔT_m and mean grain size of primary silicon (D) in order to examine the effect of R on D .

The obtained results are summarized as follows: (1) Primary silicon size (D) was reduced with increasing ΔT_m and an exponential relation between D and ΔT_m was obtained. (2) Mean grain size of primary silicon of Al-22mass%Si alloy was 0.7 times as large as that of Al-32mass%Si alloy for the same undercooling. (3) Predicated cooling rate are about 500K/s for Al-22mass%Si alloy and about 590K/s for Al-32mass%Si alloy to obtain the mean grain size of primary silicon of 10 μm that is proper size for practical use.

Calculation of Equilibrium Phase Diagram of Al-Ge-Si Ternary System

Mitsuhiro OHMIYA, Ken-ichi OHSASA, Tatsuya OHMI
and Masayuki KUDOH
(Received March 26, 1991)

Abstract

The equilibrium phase diagram of the Al-Ge-Si ternary system was calculated by the CALPHAD method. The sub-regular solution model was used to describe the Gibbs free energy of the ternary solution phases such as liquid, fcc and diamond solid solutions. The excess free energy of ternary solution phases were calculated from the interaction

parameters of the three binary systems which construct the ternary system. In order to confirm the validity of the calculated phase diagram, a thermal analysis of an Al-24.0% Ge-16.5%Si ternary alloy was carried out and the Ge content of primary crystals in the solidified alloy was measured by an electron probe micro analyzer. As a result, the obtained values of the temperature and the Ge content well agreed with the calculated ones. Furthermore, the solute redistribution under the conditions of the equilibrium and non-equilibrium solidification were analyzed, and relationship between the temperature and the fraction of solid of the ternary alloy was quantitatively estimated.

Calculations of Ignition Lags for Hydrogen-Air Mixtures by Chemical Kinetics

Noboru MIYAMOTO, Hideyuki OGAWA, and Kenji DOI
(Received March 30, 1991)

Abstract

Calculations of the oxidation process during ignition lags for hydrogen-air mixture combustion were carried out by chemical kinetics. The contribution of each elementary chemical reaction to the oxidation process was discussed to determine the dominant factors in autoignition. The calculated results of this simulation were compared with the experimental values obtained with shock tubes.

The results showed that the contribution of each elementary chemical reaction was realized and the oxidation process could be precisely and easily simulated with only six elementary chemical reactions. A dominant factor to estimate the autoignition was the OH radical concentration which abruptly increased at autoignition. The calculated results corresponded well with experimental values at higher initial gas temperature.

The flame temperature could also be calculated in this simulation. The equivalence ratio of 1.08 gave the highest flame temperature for hydrogen-air mixtures.

Study on a Dynamic Vibration Absorber Using Permanent Magnets

Satoru IGARASHI, Katsuhisa SHIBUKAWA,
Seiji NAKATANI and Hiromi SEKITO
(Received March 30, 1991)

Abstract

A new magnetic dynamic vibration absorber that has a function of tuning the natural frequencies to the various exciting frequencies by adjusting the distance between magnets is proposed. This is to suppress the vibration of machines effectively. The principle of this absorber is described, and effectiveness of a trial absorber using three rare-earth magnets and equipped with a driving and control unit is investigated through actual vibration experiments.

The following results are obtained: (1) When the amplitude of exciting force is small, the trial absorber shows a remarkable absorbing effect in the relatively low frequency region. (2) When the amplitude of exciting force is large, nonlinear jumping phenomenon is observed around certain frequencies and the amplitude of the primary system has a large peak in this region. (3) In any case, the amplitude of the primary system can be reduced to a low level by adjusting the distance of magnets by manual operation.

On the Velocity Field Measurement Based on Spatio-Temporal Image Derivative —Comparison of Gradient Method and Ando's Method—

Yasuhiro SUGANO, Katsuhisa SHIBUKAWA and Satoru IGARASHI
(Received March 30, 1991)

Abstract

In this report, we treat two methods used for velocity field measurement based on spatio-temporal image derivative: the gradient method proposed by Horn and Schunck, which is used most widely but is costly in computation, and a method proposed recently by Ando, which is based on a computationally efficient algorithm and has the evaluators to judge reliability of the results. We first compare algorithm of the two methods, and attempt introducing the evaluators for the reliability of the results to the gradient method

referring Ando's method.

Then we perform computer simulation for several synthetic image sequences to compare the computing time, accuracy and evaluation of reliability of the results of these methods. The results show that Ando's method has the advantages of high computational efficiency, high accuracy and having reasonable evaluators compared with the gradient method.

In both methods, meaningful results cannot be obtained for regions under overmuch velocity conditions. To solve the problem, we propose a simple algorithm in which velocities in such regions are computed from image with reduced resolvability by combining several pixels adjacent to the point in question. Computer simulation shows that for such regions meaningful results can be obtained by applying the proposed method.

A New Surface Passivation Method of InGaAs Using a Si Ultrathin Layer and Its Application

Eiji OHUE, Masamichi AKAZAWA, Satoshi KODAMA
and Hideki HASEGAWA
(Received March 29, 1991)

Abstract

A new method of passivating air-exposed InGaAs surfaces using an MBE-Si ultrathin layer is described.

HF treatment applied first, which reduces the Ga oxide and In oxide components of the native oxide, makes a As-rich surface. Then, an MBE-Si ultrathin interface control layer is deposited which reduces the As oxide component. Finally, a thick photo-CVD SiO₂ layer is deposited using an ArF excimer laser. A minimum interface state density of $4 \times 10^{11} \text{eV}^{-1} \text{cm}^{-2}$ is realized. An MISFET is fabricated using this surface passivation process and a maximum transconductance of $gm = 48.6 \text{mS/mm}$ is obtained for a gate length of $L = 6.5 \mu\text{m}$.

Characterization of InGaAs Surface by Photoluminescence

H. IWADATE, T. SAITOH, and H. HASEGAWA
(Received March 29, 1991)

Abstract

The band-edge photoluminescence (PL) intensity is known to be sensitive to the quality of the surface. It has been used for qualitative characterization of surface treatments for compound semiconductors. However, the PL intensity provides a rough measure of the effective surface recombination velocity S_{eff} , and there is no established theoretical qualitative relationship between the PL intensity and the surface state parameters. This report shows that the surface parameters, including the surface state density, fixed surface charge, band bending and effective surface recombination velocity, can be determined by comparing the measured dependence of the PL intensity on the intensity of the light with the calculated result using a rigorous computer simulation program. Using this method, the surface state parameters are obtained for sulfur treated InGaAs surface and passivated InGaAs surface using an ultrathin MBE-Si interface control layer.

An Operational Semantics of Cooperative Distributed Calculus

Yuuichi KAWAGUCHI and Eiichi MIYAMOTO
(Received March 29, 1991)

Abstract

This study was intended to provide a formal semantic analysis for the cooperative calculus by some processes in a distributed environment. The asynchronization is one of the characteristics of the distributed cooperative calculus, therefore, when some processes provide a cooperative effort on a distributed environment, communications are conducted with messages. This communication is basically asynchronous. So the means to treat it theoretically are required. And one more characteristic of distributed cooperative calculus is the time required by communication. This time is no smaller than the time which is required by a real calculation.

In this paper we extend R. Milner's process calculus CCS and construct a new process calculus which gives the formal semantics for cooperative distributed calculi with asynchronous communication that takes some time.

Optical Fourier Analysis of Image Formation by a Phase Conjugate Mirror

Atsushi OKAMOTO and Teruhito MISHIMA

(Received March 20, 1991)

Abstract

The optical transfer function and equation expressing the axial location of the image by PCM have been derived from the phase transfer characteristics of the function. In the non-degenerate operation with pure monochromatic waves, we show that the perfect conjugate replica can be obtained under the paraxial ray approximation. We also show that the transverse locations of the object and the image coincide but that the axial locations do not. The spreads of the axial location of the image owing to the temporal frequency bandwidth of a probe wave and the thickness of a nonlinear medium are discussed.

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Undrained Shear Characteristics of Lightly Overconsolidated Clay

Yoshiaki ODA and Toshiyuki MITACHI

(Received June 29, 1991)

Abstract

To investigate undrained shear characteristics of lightly overconsolidated clay, a series of consolidated undrained triaxial compression and extension tests were performed under isotropic and K_0 condition.

Based on the test results, the following conclusions were obtained.

- 1) Swelling indices in terms of vertical stress or mean principal stress versus logarithm of overconsolidation ratio can be approximated by two straight lines, and overconsolidation ratio at the intersection of the two lines is about 1.3.
- 2) K_0 -value during swelling can be well predicted using the above relationship.
- 3) The assumption that the undrained strength of lightly overconsolidated clay is equal to that of normally consolidated clay having the same void ratio is effective within the limit of overconsolidation ratio of less than 2 or 3. Within this limit, undrained shear strength and pore pressure coefficient at failure can be predicted fairly well by the equation formerly proposed by the second author.
- 4) The initial modulus of deformation normalized by consolidation pressure at the same axial strain increases with the overconsolidation ratio except for the K_0 -consolidated extension test.

Calculation of Lateral Deformation of Main Girders on the Erection of Concrete Composite Steel Plate Deck Bridges with Skew Angles

Toshiro HAYASHIKAWA

(Received June 29, 1991)

Abstract

An original procedure that calculates the lateral deformation of the main girders on the erection of concrete composite steel plate deck bridges with skew angles is presented. The displacement method is used in the static analysis to define the behavior of a thin wall cross section in combined bending, torsion, and warping deformations. The proposed method

calculates rationally and readily the lateral deformation of the main girders by using the torsional angles of the grillage beam bridges. A numerical example is given to illustrate the application of a new method developed here. The computed values agree approximately with experimental results of the actual bridges.

Analysis of the Initial Stage of Melt Mixing in the Duplex Casting Process with Top Pouring

Tatsuya OHMI, Yasuhiro TANAKA and Masayuki KUDOH

(Received June 25, 1991)

Abstract

In order to understand the initial stage of melt mixing in the Duplex Casting process with top pouring, the following problems were examined.

At first, water model experiments were carried out to obtain the information about the mixing flow, and the flow pattern resembling the impinging jet was observed. On the basis of this observation, a model was presented to explain the peculiar shape of the time-temperature curves obtained with the Duplex Casting process.

On the other hand, the rising rate of the meniscus in the mold and the falling speed of poured melt just above the meniscus during the second pouring were calculated using the Bernoulli equation.

The flow rate of the front of poured melt before impinging on the bottom of the mold was estimated from time-temperature curves and was in the range of 1.0 and 2.0 m/s. It is in the same order of falling speed of poured melt.

Furthermore, the cooling rate of poured melt in the free jet region was calculated as about 2200-3500 K/s.

Estimation of Fraction Solid for commercial Carbon Steel by the Seepage Method

Ken-ichi OHSASA, Tadayoshi TAKAHASHI and Masayuki KUDOH

(Received June 25, 1991)

Abstract

An artificial hole was made in the solid-liquid coexisting zone of a solidifying carbon steel and the interdendritic liquid flowed through the dendrites into the hole. After the end of the solidification, the specimen for chemical analysis was taken from the flowed portion in the hole by a lathe and the content of each element such as C, Si, Mn, P, S was determined. The hole was made at various temperatures in the solidification range of the carbon steel to obtain the relation between the temperature and the solute contents in the interdendritic liquid.

The fraction solid of the carbon steel when the hole was made was determined by comparing the measured solute contents in the hole and calculated ones obtained by numerical analysis which takes account of diffusion of each element in the solid. Furthermore, the lowering coefficient of solidification temperature of each element was estimated from the relation between the hole making temperature and the solute contents in the hole portion.

Free Vibration of a Cantilever Rectangular Plate with Varying Thickness

Katsuaki TANAKA, Gen YAMADA and Yukinori KOBAYASHI

(Received June 28, 1991)

Abstract

An analysis was presented for the free vibration of a cantilever rectangular plate with varying thickness by using the Ritz method. The transverse deflection of the plate was approximately expressed in series of the power function. Substituting the expression for the maximum kinetic and strain energies of the plate into Lagrange functional, the frequency equation was derived by the condition for a stationary value of the Lagrange functional. Eigenvalues and mode shapes of vibration were calculated numerically up to higher modes and the effects of the varying thickness on them were studied.

Complexity of Optimal Sequential Partitions of Graphs by Dynamic Programming

Taichi KAJI and Azuma OHUCHI

(Received June 24, 1991)

Abstract

Optimal sequential partitions of graphs is to find a minimum cost partition of the nodes of a graph into subsets of a given size, subjecting to the constraint that the sequence of the nodes may not be changed, that is, that the nodes in a subset must be of consecutive numbers.

For this problem, Kernighan discusses an algorithm using dynamic programming, in which computational amount of referencing to data is proportional to the number of edges in the graph.

But he does not indicate total complexity of the algorithm.

In this paper, we evaluate the total complexity from the both standpoints of theoretical and implementing level, then we compare it with the results of numerical computing.

The results reveal that the running times of the procedure depends on the number of nodes and block size, beside the number of edges.

A Study on Experimental Estimation of Dose Equivalents — Comparison of Measured and Theoretical Values —

Sangduk SA, Masakuni NARITA and Michio YOSIZAWA*

(Received June 20, 1991)

Abstract

This paper presents the experimental estimation of the conversion factors between dose equivalents and measured quantity, the air kerma in free air, for external photon radiations.

The measurements, in the irradiation geometry of anterior, superior and inferior, were made with the thermoluminescent dosimeters inside an anthropomorphic RANDO Phantom.

These measured values of conversion factors were compared with calculated ones by means of Monte-Carlo simulation method under the same irradiation conditions; both of them are in good agreement within a deviation of about 20%.