Hiroshima University Research and Technology Guide

2014 Version

Creating Innovation

HIROSHIMA UNIVERSITY

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Environment/ Energy

Commercialization of Sediment Microbial Fuel Cells beyond Photovoltaic Power Generation

Keywords Sediment Power Generation, Recycle Sediment

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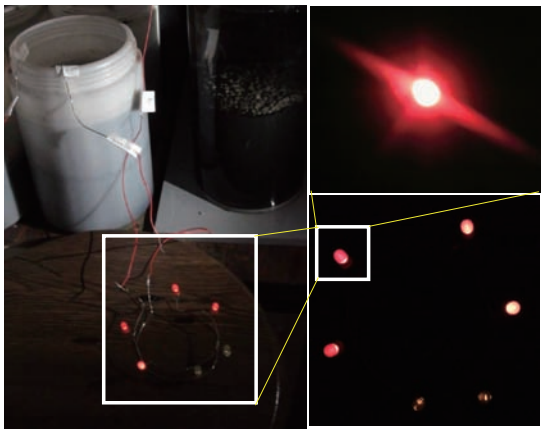
Field Civil Engineering, Hydraulic Engineering

Outline

Background

It has been known for many years that the remediation of sediment is facilitated under energy recovery by sediment microbial fuel cells (SMFC). To date, we have developed technologies to achieve an efficient energy recovery, and to enhance the remediation.

Currently, many investigations have been increasingly conducted in order to commercialize SMFC. However, realworld application of SMFC is limited because of its low power density level, especially, there is no application of SMFC without energy storage system in the field where environmental perturbation is intensive.



Research Summary

There are two projects: ① is the development of Sediment Power Generation Technology (SPGT) using SMFC, and ② is the commercialization of Sediment Remediation Technology (SRT).

The purpose of ② is to efficiently readily remediate the sediment rather than energy recovery. It was found that the remediation of sediment deposited on riverbanks is facilitated under energy recovery by applying SRT (just inserting pencil type of SRT), in the case of low power density.

Result

① Technologies have been developed to recover energy efficiently, and to improve the transfer performance of hydrogen ion. As a result, it is possible to commercialize SMFC with low power density.

② LED was first lighted by stacking SMFC without using energy storage system. Particularly, based on the research results of ① (type of electrode, ion transfer method), the method to recover energy (0.4V, 50mA) from unit SMFC was established. Further, the technology to maintain the power (at least 50mA, 2V) for lighting LED over the long term was also established.

For Application

Amounts of electric energy and the remediation of sediment will be investigated to commercialize SMFC. We aim to transfer these technologies to Asian developing countries where sewage and waste disposal systems are insufficient.

Competitive Advantages

Development of an energy recovery (electric current) system to activate the microbial environment of sludge deposited in the areas which are affected by several natural and anthropogenic phenomena, and a power generation-remediation system for the efficient detoxification of sludge.

Patent/Journal/Award

Patent Application No. JP 2011–21108
Title: Sediment Microbial Fuel Cells and Microbial Power Generation Systems

URL http://www.civil-hu.jp/coast/

Environment/ Energy

High Precision Isotopic Measurements of Sm and Gd for Monitoring of Environmental Neutron

Keywords Isotope, Mass Spectrometry, Micro-beam Analysis

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Field Earth and Planetary Science, Environmental Science

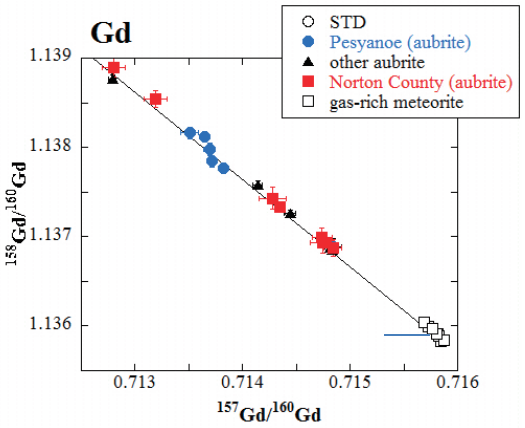
Outline

Background

Isotopic shifts of Sm and Gd is a good indicator as a neutron monitor, because some of their isotopes ^{149}Sm, ^{155}Gd and ^{157}Gd easily react with neutrons.

Research Summary

Most of extra-terretrial materials interact with high-energy cosmic rays. As the result of the interaction, istopic compositions of some elements in the materials vary because of nuclear reactions. In this study, isotopic shifts of Sm and Gd due to neutron capture reactions have been applied to understand the cosmic-ray irradiation records of the planetary materials.



Three-isotope plot of Gd: Gd isotopic data of neutron-irradiated meteorites due to cosmic-ray irradiation show significant differences of that of standard materials (STD).

Result

High precision isotopic measurements less than 0.001 % of reproducibility can be performed on Sm and Gd in natural samples. This technique is available to detect neutron fluence of 10^{14} n cm^{-2} in natural environmental samples. In addition, the efficiency for chemcal separation of Sm and Gd from natural samples were also developed.

For Application

This technique is availably used as a monitoring system for neutron-irradiated materials.

Competitive Advantages

The analytical precision in this study is 4 to 5 times better those tat from the conventional techniques.

Patent/Journal/Award

H. Hidaka and S. Yoneda (2007) Geochimica et Cosmochimica Acta, 71, 1074–1086, H. Hidaka et al. (2012) Astrophysical Journal, 746, 132(1–8)

URL

Environment/ Energy

Innovative Measurement of Kuroshio Effect to Seto Inland Sea Environments

Keywords Underwater Sound, Measurement, Velocity, Temperature, Environment, Long-term Variation, Seto Inland Sea, Kuroshio

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Field Fphysical Oceanography, Ocean Environment, Coastal Acoustic Tomography

Outline

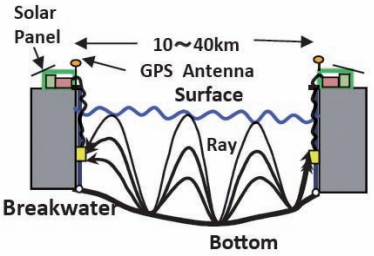
Background

Water in the Seto Inland Sea exchanges with Pacific water through the rapid tide (Kyucho) in the Bungo Channel. This situation causes less polluted environments even under a semi-enclosed sea condition. Until now long-term environmental measurements over a wide region were impossible in the Seto Inland Sea because of heavy shipping and fisheries. Thus the widely spreading effect of the Kuroshio to the inland sea environment is not yet clarified in spite of its importance.

Observational line

Research Summary

The coastal acoustic tomography system (CATS) is set up on both sides of the Bungo Channel and Akinada, located at the inlet of the inland sea and its central part, respectively. The reciprocal sound transmission is performed between the pair of CATSs. The Kuroshio effect to the inland sea environment is clarified by measuring accurately the temporal variation of current and temperature.



Coastal Acoustic Tomography System

Result

In the 2011 Akinada Experiment, the eastward cross-line volume was estimated to be 9,000m3/s. According to this volume, the inland sea water can be exchanged with Pacific water in about 3 years. This is an important finding for the inland sea environment even if more and longer and experiments are required.

For Application

CATS is already patented. The products are sold by the Aqua Environmental Monitoring Limited Liability Partnership company. This technology is expected to be used widely in environmental assessment

Competitive Advantages

CATS is a unique technology to make the long-term measurement of coastal sea environments possible. No competitive technologies exist.

Patent/Journal/Award

Acoustical Science and Engineering, 33(1), 45–51, 2012.

Journal of Oceanography, 67, 173–182, doi 10.1007/s 10872–011–0016–5, 2011.

Patent No.3612434: Acoustic tomography information collector

March 2014: 54th Sato Research Medal, Acoustical Soceity of Japan

URL

Environment/ Energy

Ocean Coast Environmental Survey Technique using Ocean Acoustic Tomography

Keywords Coastal Ocean Acoustic Tomography,Sensing of Ocean ,Snapshot,Tide Flow Field,Variation of Environment

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Field Fphysical Oceanography, Ocean Environment, Coastal Acoustic Tomography

Outline

Research Summary

Acoustic tomography is a recently developed technique used for ocean measurement obtaining three dimensional snapshots of an ocean field consisting of water temperature and water velocity distribution within a very short period by means of sound transmitted in the water at very high speed. Until now, it was rather difficult to obtain the measurement and search of the coastal sea tide of the entire target ocean area continuously for longer period because in Japan the navigation of ships and the operation of fishing boats have priority.

In order to cope with this difficult situation, our laboratory focused on this coastal ocean acoustic tomography technique and developed a practical system consisting of many acoustic sources coupled with a method to analyze the data from this system. Now, it is possible to obtain precise measurements of changing water flow fields in the Kanmon Strait, Tokyo Bay, and Hiroshima Bay areas, once thought to be very difficult to measure. This technique makes it possible to measure water flow in a three dimensional field making it possible to estimate the frequent red tide phenomena in the coastal ocean area and search for environmental assessments.

For Application

1) Joint research and technical instruction are recommended for using this method (system and data analysis) for a wide range of coastal sea environmental research projects.
2) Presentation of knowledge, search, consulting, and technical instruction is available.
3) Joint research using this technique is desired.

Competitive Advantages

1) Remote sensing of coastal sea tide distribution using coastal infrastructure (wharf, breakwaters)
2) Precise acoustic transmission time measurement using GPS
3) Transmission and receiving of M series signals-a kind of quasi-random signal against the background noise.

Patent/Journal/Award

URL

Environment/ Energy

R & D of Nitrogen-based Nanocomposite Materials for Hydrogen Storage

Keywords Hydrogen Storage, Nanocomposite Materials, Ammonia Borane, Ammonia

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Outline

Background

Fuel cell vehicles (FCV) feature 35–70 MPa hydrogen storage tanks (inner volume: 156–171 L) and the tank size of the vehicles is large compared to those of gasoline vehicles. Ammonia borane (NH_3BH_3) and Ammonia (NH_3) has emerged as attractive candidates because of their high percentage of hydrogen (20–18 mass%). It is expected that lightweigt and compact hydrogen storage system can be developed using the nitrogen-based hydrides.

Research Summary

However, their high working temperature and the slow reaction rate limit the practical application of the nitrogen-based hydrides. Those properties can be improved by the use of nanocomposite materials (Fig. 2). The nanocomposite materials encompass a catalyst and composite chemical hydrides at the nanometer scale.

In this study, we will review our experimental results on hydrogen storage properties and characterization of hydride-magnesium amide (MH-$Mg(NH_2)_2$), hydride-ammonia borane (MH-NH_3BH_3) and hydrideammonia (MH-NH_3) systems.

Result

(1) We have developed Li-Mg-N-H ($8LiH-3Mg(NH_2)_2$) system which absorbed and desorbed 5.8 mass% of H_2 at 150°C.
(2) $NaH-NH_3BH_3$ composite material desorbed 11 mass% of hydrogen below 90°C without emission of NH_3 and foaming.
(3) $LiH-NH_3$ system desorbed 6 mass% of H_2 at room temperature.
(4) H_2 and N_2 were generated by the decomposition of $NaNH_2$ at 400°C.

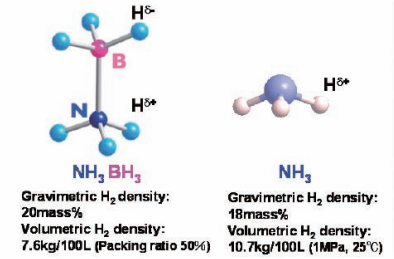

Fig. 1. Structure of ammonia borane and ammonia

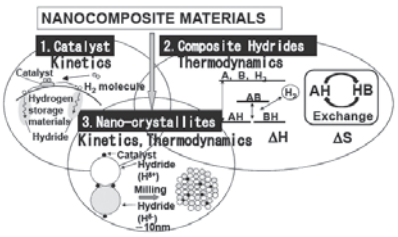

Fig. 2. Design concept of nanocomposite materials for hydrogen storage
(ΔH: enthalpy difference, ΔS: entropy difference, AH, BH: hydride, The size of the hydrides: 10-100nm)

For Application

Industry: Energy industry, Chemical industry, Automobile industry Application: Energy storage and delivery, Challenge: Reversibility at room temperature.

Competitive Advantages

(1) The volumetric H_2 densities of nitrogen-based composite materials having protide (hydride) ($H^{\delta-}$)[LiH, NaH] and proton ($H^{\delta+}$) [$Mg(NH_2)_2$, NH_3BH_3, NH_3] provide 0.9–1.4 times of compressed hydrogen at 70 MPa (3.9kgH_2/100L).
(2) NH_3 shows promise for the application of H_2 energy carrier because the cost of H_2 in NH_3 is below 1/4 of the supply cost of H_2.

Patent/Journal/Award

Patent: Unexamined Publication JP2010–265138, JP2009–215103
Journal: Y. Kojima et al., J. Mater. Res., 24, 2185 (2009), H. Yamamoto et al., Int. J. Hydrogen Energy 34, 9760 (2009), H. Miyaoka et al., Int. J. Hydrogen Energy 36, 8217 (2011), Y. Kojima, Materials Science Forum, 654–656, 2935 (2010),S. Yamaguchi et al., Extended Abstract, JCREN (2013).
Award: 2007: Highly Cited Researcher (ISI HighlyCited.com), 2009: Presidential Awards (Hiroshima University), 2012, International Steering Committee of the International Symposia on Metal-Hydrogen Systems, CERTIFICATE OF APPRECIATION

URL http://home.hiroshima-u.ac.jp/hydrogen/

Environment/ Energy

Study of Thermochemical Hydrogen Production at Low-temperature

Keywords Hydrogen, Hydrogen Production, Nonequilibrium Process

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Field Material Engineering, Physics

Outline

Background

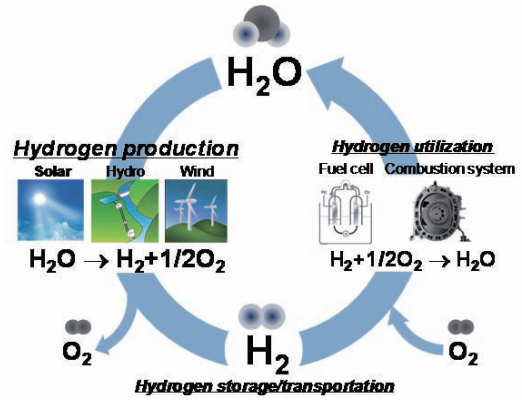
Current hydrogen production method is mainly steam reforming of hydrocarbons. Regarding sustainability, hydrogen should be ideally produced from H_2O without utilization of fossil fuels. However, in the case of current techniques on hydrogen production via water-splitting, more than 800°C is necessary, suggesting that heat sources are limited.

Research Summary

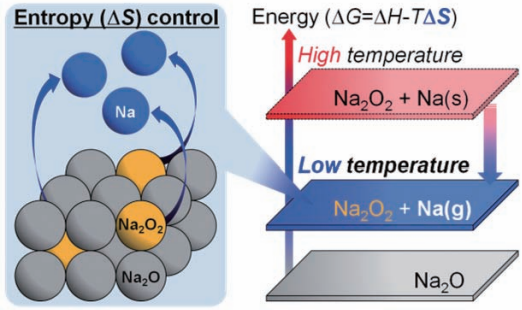
So far, promising hydrogen systems have been sorted by using thermodynamic database. On the other hand, in this work, we tried to control the chemical reactions from material science point of view to reduce the operating temperature of hydrogen generation. Particularly, the reaction system including alkali metals, which have low melting points, were systematically investigated under nonequilibrium conditions.

Result

From the calculation by using database, it is expected that more than 2000°C is required to generate hydrogen for all the alkali metal systems. However, the experimental results indicated that the hydrogen production can be operated below 500°C by using nonequilibrium techniques. The temperature was lower than those of the current hydrogen production techniques. Among them, the sodium Na system experimentally showed the lowest operating temperature, 400°C.



Sustainable energy system by using hydrogen



Schematic image of temperature control by nonequilibrium process

For Application

The hydrogen production technique proposed in this work can be operated below 500°C. Thus, renewable energy such as solar heat and unused energy such as exhaust heat from factory can be available. As a future work, we would like to try establishing the bench scale type for practical application.

Competitive Advantages

The current thermochemical hydrogen production via water-splitting requires more than 800°C. On the other hand, in the case of the alkali metal system proposed in this work, the hydrogen can be produced below 500°C by using nonequilibrium process. Its low operating temperature is recognized as advantage point for the practical use.

Patent/Journal/Award

Journal: Hiroki Miyaoka, Takayuki Ichikawa, Naoya Nakamura and Yoshitsugu Kojima, International Journal of Hydrogen Energy 37, 17709 (2012)

Patent: Hydrogen Production System, Japanese Patent, Application No.2013–039251

URL ISSD HP http://www.hiroshima-u.ac.jp/rcsd/ Labo HP http://h2.hiroshima-u.ac.jp/

Environment/ Energy

Development of Energy Harvesting Technology using Flexible Power Generation Device

Keywords Piezoelectric material, Vibration energy, Ocean energy, Wind energy

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Outline

Background

In recent years, increase in demand for energy and global warming have become international concerns. It is urgent to increase the use of renewable energy for solving these problems. Current technical developments of renewable energy are mainly the wind power generation and the photovoltaic power generation.

Research Summary

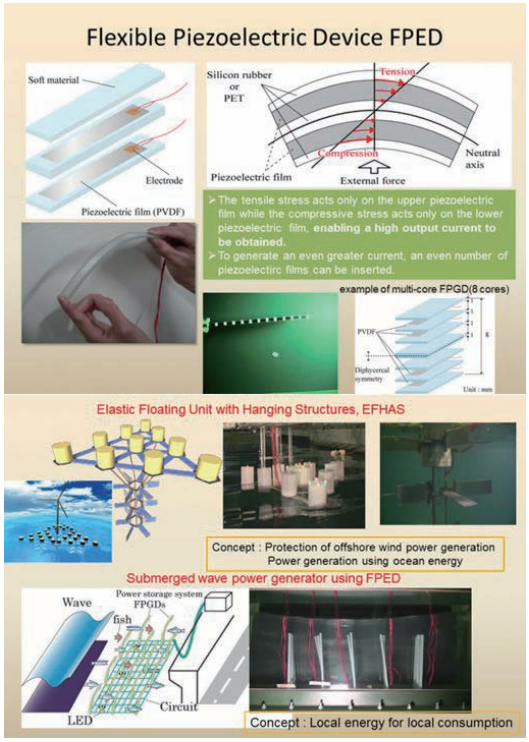
The authors have proposed the energy harvester named flexible piezoelectric device (FPED). The FPED essentially consists of the piezoelectric film and the soft materials such as the silicone rubber. Compared to the familiar energy harvester using the PZT and metal materials, the FPED can achieve a low natural frequency from 1 Hz to 10 Hz. So, it is expected that the FPED is suitable for harvesting not only vibration energy but also ocean energy and wind energy.

Result

The right figure shows the composition, the principle of power generation, and the marine structures using the FPED. You can find the related articles about those on the internet.

For Application

Companies with interests in the energy harvesting technologies are welcome.



Co-researchers

Yoshikazu TANAKA (Graduate school of engineering, Assistant professor)

Competitive Advantages

The features of FPED are as follows: the FPED is flexible and can achieve low natural frequencies, the turbine generator is not needed, the FPGD have no directivity toward the external load, and the compositions of FPGD such as thickness, materials and number of lamination can be customized based on the installation condition.

Patent/Journal/Award

Yoshikazu Tanaka, Yoshikazu Michinaka and Hidemi Mutsuda, An experimental study of a submerged power generator that uses flexible power generation devices, Journal of the Japan Society of Applied Electromagnetics and Mechanics, Vol. 20, No. 2, pp.541–546, June 2012.
ICPEE 2012 (2012 International Conference on Power and Energy Engineering), EXCELLENT ORAL PRESENTATION AWARD, Wind Energy Harvesting Using Flexible Piezoelectric Device, Hidemi Mutsuda.
Five Patents accepted.

URL

Fruid dynamics for vehicle and environmental system Labo. http://naoe.hiroshima-u.ac.jp/2koza/index_j.html
System safety Labo. http://naoe.hiroshima-u.ac.jp/6koza/index_j.html

Environment/ Energy

Migration, Decontamination of Radioactive Cesium and the Emergence Mechanism of Contaminated Rice

Keywords Environmental Radioactivity, FDNPP Accident

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Field Inorganic Chemistry, Environmental Chemistry

Outline

Background

We have studied the environmental radioactivity. Artificial radioisotopes were emitted after FDNPP accident. It is important to reveal the migration of these radionuclides in the environment.

Research Summary

- We have analyzed the migration pathway of radioactive cesium and strontium by using reported results.
- We have studied the decontamination of radioactive cesium from contaminated soils.
- We have studied the emergence mechanism of contaminated rice.

Result

Results were reported at Japanese Society of Radiation Safety Management.

For Application

This study will comtribute to the radiation disaster recovery.

Competitive Advantages

This becomes comprehensive approach to the radiation disaster recovery.

URL Radiation Reaction Chemistry, Hiroshima Univ. http://home.hiroshima-u.ac.jp/radichem/

Study of Chemistry Using Mössbauer Spectroscopy

Environment/ Energy

Keywords Mössbauer Spectroscopy, Spin-crossover

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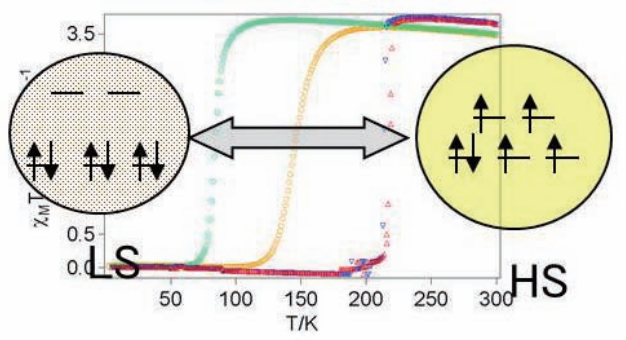
Field Inorganic Chemistry, Environmental Chemistry

Outline

Background

Radiation and radionuclide are used in a variety of fields. Mössbauer spectroscopy using g-ray is a powerful tool to investigate materials. From the spectra, physical and chemical information is extracted.



Research Summary

We investigated the relation of mixed-valence state, spin-crossover phenomenon with their crystal structure.

Result

We revealed that the symmetry around the mixed-valence monocation affects the valence detrapping in the mixed-valence state. We succeeded in the construction of a variety of assembled structures and the appearance of the spin-crossover phenomenon.

For Application

We believe that the mixed-valence compounds and spin-crossover complexes have an important role in the development of new materials.

Competitive Advantages

Mössbauer spectroscopy is a powerful tool to investigate the electronic state of iron atoms nondestructively.

Patent/Journal/Award

Inorg. Chem., Dalton Trans., BCSJ, Chem. Lett., etc.

URL http://home.hiroshima-u.ac.jp/radichem/

Environment/ Energy

Eco-biotechnology for Recovery of Energy and Resources from Wastewaters

Keywords Environmental Purification, Recovery, Resources, Energy, Eco-biotechnology

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Field Environmental Technology, Microbiology

Outline

Background

Water environmental protection technologies are accompanied with requirements of energy and cost. Environmental businesses, however, will come up in wastewater treatments, if high-value-added products such as energy and resources are produced from wastewaters.

Research Summary

Down-flow hanging sponge (DHS) reactor, which has been developed as cost-effective and energy-saving wastewater treatments for developing countries, has a great potential to easily cultivate micro-organisms, which can be hardly cultivated. The new environmental technology using DHS reactor would be expected to apply to decompose strong greenhouse gases such as methane and nitrous oxide, produce electric energy from organic wastewaters, recovery phosphate rare metals from liquids. This technology is based on eco-biotechnology, which is combined with microbial ecology and biotechnology, and is developed to solve some environmental problems in my research.

Phosphate recovery pilot-plant installed in Higashihiroshima municipal sewage treatment center to investigate performance

Result

The developing environmental technologies are as follows:

- Recovery of rare metals from wastewaters and sea water using functions of manganese oxidizing bacteria
- Recovery of concentrated phosphate from wastewaters and sea water using polyphosphate accumulating bacteria
- Production of biodegradable plastic, PHA from wastewaters
- Discovery and application of new microbes simultaneously decomposing greenhouse gases, methane and nitrous oxide
- New nitrification process under low pH

For Application

Regarding the phosphate recovery, a pilot plant of the proposing system is installed in a municipal sewage treatment site and the performance has been investigated using the actual sewage. The other technologies are in the basic research to step toward the practical use.

Competitive Advantages

Innovative environmental technologies will be provided by using DHS reactor, which is able to retain concentrated microbes, and by eco-biotechnology.

Patent/Journal/Award

Patent 2009–044797, 2011–048070

URL http://www.civil-hu.jp/sanitary/

Environment/ Energy

Development of Novel Fluorescent Dyes for Dye-sensitized Solar Cells

Keywords Fluorescent Dyes, Dye-sensitized Solar Cells, Photovoltaic Performance, Photosensitizers, Color Materials

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Field Basic Chemistry, Applied Chemistry, Materials Chemistry

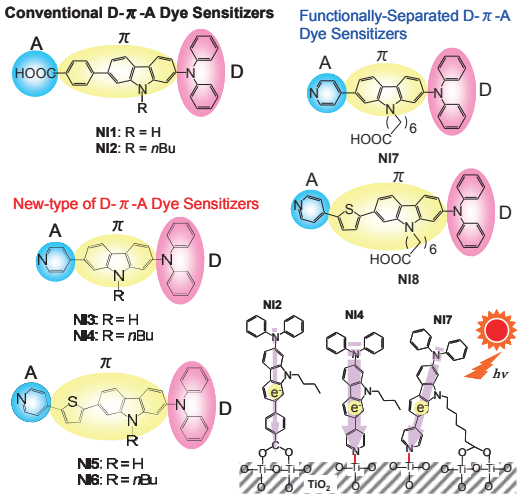
Outline

Background

Dye-sensitized solar cells (DSSCs) based on organic dyes adsorbed on nanocrystalline TiO_2 electrode which emerged as a new generation of sustainable photovoltaic devices, have received considerable attention because of high incident solar light-to-electricity conversion efficiency and low cost of production. To achieve a breakthrough in development of DSSCs, an epoch-making molecular design of organic dye capable of controlling not only the photophysical and electrochemical properties of the dyes themselves but also the molecular orientation and arrangement of dyes on the TiO_2 surface is required.

Research Summary

As a new type of D-π-A dye sensitizers for DSSCs, we have designed and synthesized D-π-A fluorescent dyes with a pyridine ring as electron-withdrawing-injecting anchoring group. The short-circuit photocurrent density (J_{sc}) and solar energy-to-electricity conversion yield (η (%)) values of DSSCs based on a new type of D-π-A dye sensitizers are greater than those of the conventional D-π-A dyes with a carboxyl group as the electron-withdrawing anchoring group.



Result

It was demonstrated that the formation of coordinate bonds between the pyridine ring of a new type of D-π-A fluorescent dyes and the Lewis acid sites of the TiO_2 surface leads to efficient electron injection owing to the good electron communication between them, rather than the formation of a bidentate bridging linkage between the conventional D-π-A dyes and the Bronsted acid sites of the TiO_2 surface.

For Application

To further improve the photovoltaic performance of DSSCs based on a new type of D-π-A fluorescent dyes, an enhancement of dye loading on the TiO_2 film is essential. One way of achieving increase in the adsorption amounts of the D-π-A dye sensitizers is to prepare TiO_2 nanoparticles having many Lewis acid sites.

Competitive Advantages

The development of new type of D-π-A fluorescent dyes with pyridine ring indicated the pyridine rings of the new type of D-π-A dye sensitizers that form a coordinate bond with the Lewis acid site of a TiO_2 surface are promising candidates as not only electron-withdrawing anchoring group but also electron-injecting group, rather than the carboxyl groups of the conventional D-π-A dye sensitizers that form a bidentate bridging linkage with the Brønsted acid sites of the TiO_2 surface.

Patent/Journal/Award

Patent application No. JP 2011–001709/ *Angew. Chem. Int. Ed.*, **2011**, *50*, 7429–7433/ 1) Research Incentive Award in Electric Technology Research Foundation of Chugoku, 2) Nissan Chemical Industries, Ltd. Award in Synthetic Organic Chemistry, Japan, 3) Award for Yang Scientists in Industry-Academia Collaboration Program of Hiroshima University, 4) Young Scholar Lectures of the Chemical Society of Japan, 5) Honor for University Scientists in Hiroshima Bank, Ltd., 6) Academic Incentive Award in the UBE Foundation, 7) Incentive Award in Electro-Organic Chemistry, 8) Incentive Award in Chugoku-Shikoku branch of the Society of Synthetic Organic Chemistry, Japan, 9) Best Lecture Award in Japan Society of Colour Material, 10) DIC Award in Synthetic Organic Chemistry, Japan.

URL http://home.hiroshima-u.ac.jp/orgmtrls/Ohshita_Group/Ohshita_Group-Home.html

Environment/ Energy

Dissolved Iron Dynamics and Iron Uptake by Phytoplankton

Keywords Iron, Aquatic Ecosystem, Iron Specification

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Field Water Environmental Engineering

Outline

Background

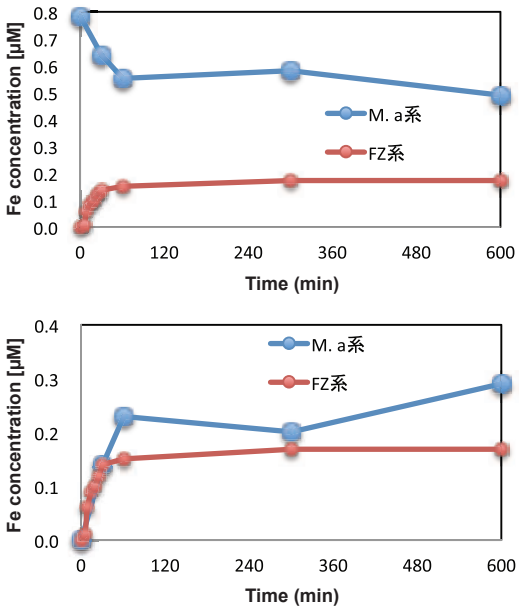
Iron is one of the essential elements for living organisms, and iron uptake is influenced by the oxidative states of metals or the binding states with organic matters. Microorganisms naturally grow when the Fe^{2+} concentration is very low. Other possible paths of iron uptake are the direct uptake of other forms of iron, or equilibrium shifts due to the dissolution and reduction of different iron complexes to the Fe^{2+}. It is not sufficient only to investigate Fe^{2+} concentrations when we consider the bioavailability of Fe^{2+}.

Research Summary

Iron was speculated to be uptaken by the phytoplankton with the equilibrium shift to Fe^{2+} from other iron forms. In order to verify this speculation, the rate of uptake of iron by *Microcystis aeruginosa* was compared with the rate of equilibrium shift to Fe^{2+}.

Result

The rate of uptake of iron by M. aeruginosa exceeded that of equilibrium shift to Fe^{2+}, suggesting that the iron uptake by phytoplankton is not limited by Fe^{2+} equilibrium shift, and they would have the ability to uptake other iron form.



The upper graph shows the rate of total iron decrease by M. aeruginosa (blue) and the rate of Fe^{2+} generation (measured by FZ (ferrozine), which is cobined to Fe^{2+} selectively), and the lower graph shows the blue line which is shifted to the rate of iron uptaken (blue).

For Application

Supply of iron into the coastal sea area is one promising technology for the restoration of the ecosystem. In this study, the new standpoint of iron speciation to the marine living thing bioavailability is demonstrated.

Competitive Advantages

In this study, the rate of uptake was DIRECTLY compared to that of equilibrium shift.

Patent/Journal/Award

Kento Hirota, Noriatsu Ozaki, Tomonori Kindaichi, Akiyoshi Ohashi: Comparison of Dissolution Kinetics of Fe^{2+} from Various Ferric Specie in River Water and Sewage Effluents. The 4th IWA-ASPIRE Conference & Exhibition, 2–6 OC, 2011, 20–1–5

URL

Environment/ Energy

Research on the Increase of Plant Biomass

Keywords Plant, Gene, Genetic Modification, Cell Wall

Nobukazu TANAKA

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Title Professor

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Field Basic Biology, Biological Science, Boundary Agriculture

Outline

Background

There is really a call for genetic modified plants which have a high activity of carbon dioxide fixation and increased biomass in a low-carbon society.

Research Summary

Although secondary cell wall of plant woody cells is the largest biomass on land, the accumulation mechanism is poorly understood. Recent studies reported that arabinogalactan proteins (AGPs) play a key role in the mechanism. However, the existence of vast amount of sugar chains on AGP disturbs our molecular analyses. We formulated a hypothesis that a monosaccharide composition of the sugar chains is involved in the AGP function, and are carrying out a study into a relationship between monosaccharide composition and phenotype using genetic modified plants.

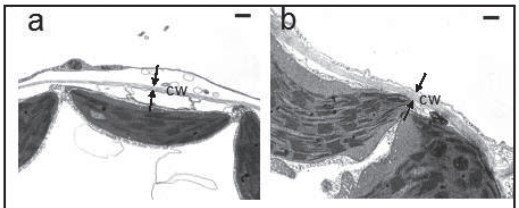

Fig. Cell wall observed by TEM
(a, control plant; b, hUGT1-transgenic plant;
cw and arrows, cell wall; bar: 0.5 μm)

Table. Dry weight and total cell wall polymer

	Mean value ± SD (mg/g FW)	
	control	*hUGT1*
Dry weight	45.6 ± 0.6	133.2 ± 7.1 [a]
Total cell wall polymer	10.5 ± 1.8	82.1 ± 5.4 [a]

[a]P<0.01

Result

We found that genetic modified plants over-expressing a human UDP-galactose transporter gene (hUGT1) displayed an increased cell wall thickness, and their AGPs were hyper-galactosylated. These results indicated that the monosaccharide composition of AGP is involved in the cell wall thickness.

For Application

Industry: fuel industry, paper manufactures, chemical industry, crop and plant modification institute Application: bioethanol production, material of paper Challenge: removal of lignin Requests for industry: proposal of an ideal plant species to fit in our technology

Competitive Advantages

There are little reports that an increase of cell wall thickness was found on genetic modified plants transformed by genes responsible for cell wall biosynthesis such as cellulose synthase up to the present. Our technology is broadly applicable to many plant species for increase of biomass by thickening of the cell wall.

Patent/Journal/Award

Khalil et al., The impact of the overexpression of human UDP-galactose transporter gene hUGT1 in tobacco plants. J. Biosci. Bioeng., 109, 159–169 (2010).

URL http://home.hiroshima-u.ac.jp/ntana/index.htm

Environment/ Energy

Heat Transfer Analysis of Gas Hydrate Re-gasification

Keywords Natural Gas Transportation, Gas Hydrate, Gasification, Heat Transfer

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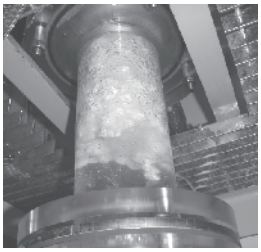
Field Naval Architecture and Ocean Engineering

Outline

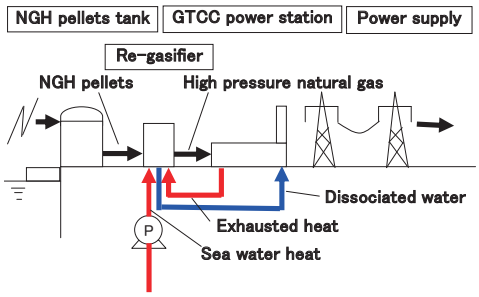
Background

New storage and ocean transportation system of natural gas using the gas hydrate has been studied and developed. It is necessary to achieve more compact and more efficient re-gasification system, and to develop a predicting method for the hydrate dissociation rate from the point of view of the plant design.



Research Summary

Re-gasification test of methane hydrate was executed by means of a bench plant, in order to grasp the influence of flow rate of water on the heat transfer of the packed bed of hydrates with dissociating phenomena. In addition, the dissociation characteristics were investigated numerically.



Result

Comparison of re-gasification test results and numerical calculations was made to verify an analytical model. It was found that the heat transfer performance of re-gasification cylinder was approximately characterized by unsteady incompressible water flow model.

For Application

These results will contribute to the design of more compact and more efficient gas hydrate re-gasification systems, and improvement in the economy of natural gas ocean transportation chain for many of the small and medium-sized gas fields in the east and south Asia.

Competitive Advantages

Re-gasification test of methane hydrates was performed at high pressure of 5.0MPa to develop an efficient re-gasification system and numerical model with hydrate phase change was verified.

Patent/Journal/Award

Proceedings of the 7th International Conference on Gas Hydrates (ICGH 2011)

URL http://naoe.hiroshima-u.ac.jp/3koza/index_j.html

Environment/ Energy

Application of Granulated Coal Ash to Remediate Organically Enriched Sediments

Keywords Coal Ash, Sediment, Remediation, Hydrogen Sulfide

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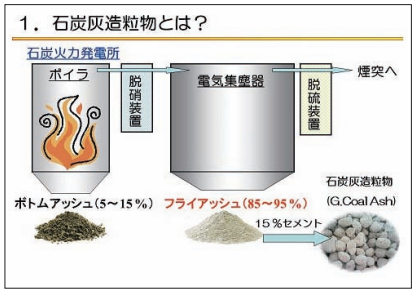
Field Aquatic Environmental Science, Aquatic Ecology

Outline

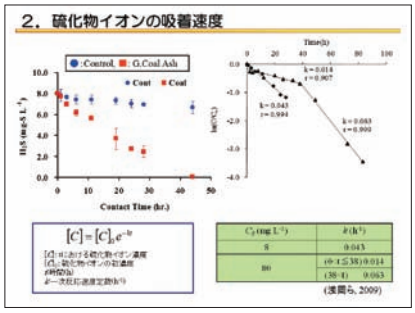
Background

Sediments at the mouth of river and coastal area, sometimes, are enriched with organic matter. Sulfate reduction occur in such conditions and as a result, hydogen sulfide is produced, which is highly toxic to living things. Coal fly ash is produced more than 10 million tons per year in Japan. It would match to the concept of the Law if the coal ash can be utilizable to remediate organically enriched sediments.



Research Summary

We elucidated by lab experiments and field experiments that granulated coal ash is very effective to reduce hydrogen sulfide. The mechanisms is both adsorption and oxidation.



Result

We elucidated by lab experiments and field experiments that granulated coal ash is very effective to reduce hydrogen sulfide. The mechanisms is both adsorption and oxidation.

For Application

The techniques have been already applied to several limited areas along the coast of Japan. We hope this technology will be applied in much more larger scale.

Co-researchers

Dr. Satoshi Asaoka

Competitive Advantages

The technique we developed is advantageous compared to some conventional techniques. For example, sand covering is consume natural sand. Instead, coal ash is a recyled material. In the case for dredging sediments, it would be annoying thing to find the damping site of the dredged sediments.

Patent/Journal/Award

1. Asaoka, S., T. Yamamoto, I. Yoshioka and H. Tanaka: Remediation of coastal marine sediments using granulated coal ash. J. Hazad. Mat., 172, 92–98 (2009.12).
2. Asaoka, S. and T. Yamamoto: Characteristics of phosphate adsorption onto granulated coal ash in seawater. Mar. Poll. Bull., 60, 1188–1192 (2010.8).
3. Asaoka, S., S. Hayakawa, K. H. Kim, K.Takeda, M. Katayama and T. Yamamoto: Combined adsorption and oxidation mechanisms of hydrogen sulfide on granulated coal ash. J. Coll. Interface Sci., 377, 284–290 (2012.4).
4. Yamamoto, T., K. Harada, K. H. Kim, S. Asaoka and I. Yoshioka: Suppression of phosphate release from coastal sediments using granulated coal ash. Estuar. Coast. Shelf Sci. 116, 41–49 (2013.2).

URL

Environment/ Energy

Practical Application of Regional Environment Simulator (RES)

Keywords Atmosphere-vegetation Land Surface-ocean Coupled Model, Regional Environment

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Title Professor

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Field Environmental Impact Assessment (Environmental Studies)

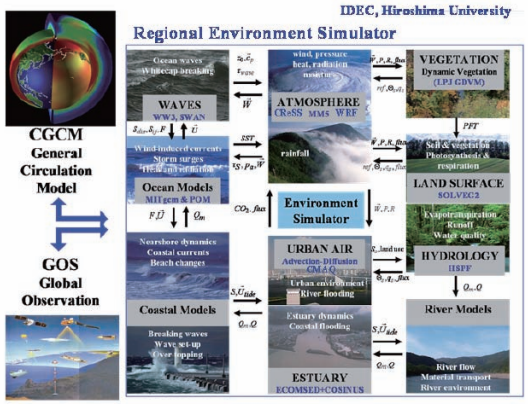
Outline

Background

After coupling of atmosphere and ocean models in early 1990s, a future climate change on a global scale can be predicted. In the field of computational Earth Science, various types of numerical models have been created and opened to the public by many institutions and researchers. We are now able to establish our own simulator for regional environmental impact assessment.

Research Summary

As shown in the right figure, the configuration of RES consists of three parts of estuaries-coastal ocean, atmosphere-land surface, and atmosphere-ocean. Major model elements underlying are numerical models used by many research institutions and researchers. A meteorological model: WRF, ocean model: MITgcm or POM, wave model: WW3 or SWAN, land surface model: SOLVEG2, runoff hydrology model: HSPF. According to the problems to be solved, the dynamic vegetation model, estuaries-rivers model, and coastal models are combined with major elements.RES provides a tool for education and research foundation of international environmental cooperation studies and environmental impact assessment. RES also contributes to collaboration research with consulting firms to promote application practices of environmental assessment and disaster predictions.



Regional Environment Simulator (RES)

Coupled numerical model system of Dynamic vegetation and vegetation land surface, ocean, waves, estuaries, rivers and coastal and urban atmosphere, and hydrological analysis

Result

Education & Research: Basic teaching materials and research tool for environmental impact assessment have been established in the field of international environmental cooperation studies.

Applications in practice: A civil and environmental consultant has validated the applicability of RES in the fields of disaster prevention and environmental impact assessment in the coastal ocean.

For Application

Application to an environmental consultancy.

Competitive Advantages

RES can clarify the interaction between environmental factors as the well as the numerical analysis of environmental feedback. This outcome also provides a basic environmental information for adaptation measures to global climate changes.

Patent/Journal/Award

(1) Global Environmental Technical Award in 2008 by the Japan Society of Civil Engineers (JSCE), 2008.

(2) JGEE Award 2010 (Journal of Global Environment Engineering Award in 2010 by the Japan Society of Civil Engineers) “Modification of Fire Module in LPJ-DGVM for Application in Tropical Area: A Case Study of West Kalimantan”, Journal of Global Environment Engineering (JGEE), Vol.15, 2010.

URL http://prc.hiroshima-u.ac.jp/project/works.php?project_id=42&works_id=19&pageMode=works

Ⅲ

Design and Manufacturing

Design and Manufacturing

A Study on Stall Delay by Wavy Leading Edge

Keywords Wing, Lift, Separation, Wavy Leading Edge, Stall

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Field Fluid Engineering, Naval Architecture and Ocean Engineering

Outline

Background

Stall caused by flow separation is an undesirable phenomenon for wings of fluid machinery because of a decrease of lift force and an increase of drag force. Stall control is an important technique for flow separation problems on wings.

Research Summary

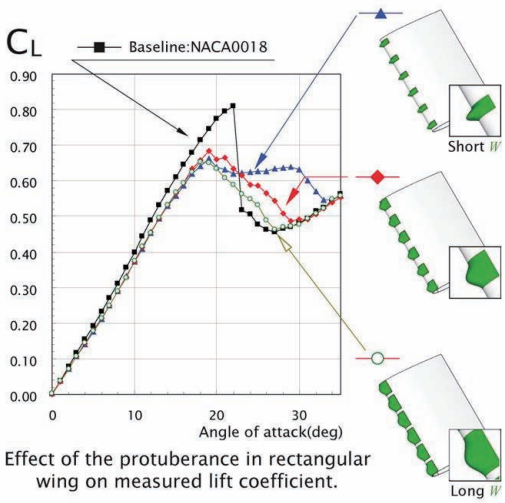
There was an interesting report on a wavy leading edge of humpback's flipper which inspired a possibility to delay stall, however the mechanism remained unclear. The present study reveals the mechanism of delaying stall by wavy leading edge.

Result

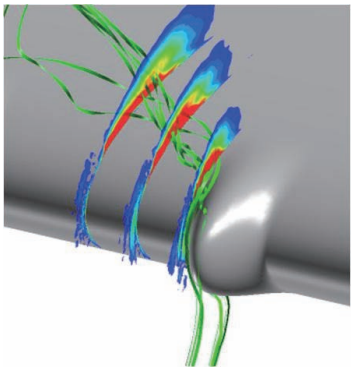
The mechanism of delaying stall by wavy leading edge was revealed. The effects of various protuberances were evaluated on rectangular wing and the effective configuration of wavy leading edge for stall delay was discussed.

For Application

The application to lifting bodies, such as wings and a rudder, is expectable.



Effect of the protuberance in rectangular wing on measured lift coefficient.



Competitive Advantages

Flow mechanism of streamwise vortices around a wavy leading edge was revealed.

Patent/Journal/Award

Numerical Simulation around Rectangular Wings with Wavy Leading Edge: H. Arai, Y. Doi, T. Nakashima, H. Mutsuda, J. of the Japan Society of Naval Architects and Ocean Engineers, Vol.12, pp.34–41, 2010 (Inui award)

URL

Design and Manufacturing

Design, Planning and Control of Manufacturing Systems

Keywords Manufacturing Systems, Production Planning, Production Control, Production Scheduling

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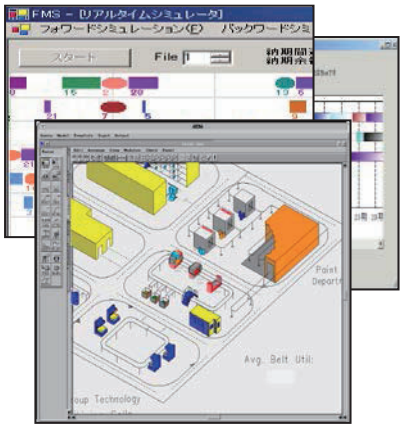
Field Mechanical Engineering, Electric/Electronic Engineering

Outline

Background

In the current competitive environment, effective design, planning and control of manufacturing systems including global supply chain has become a necessity for survival in the market place.



Research Summary

- Minimization of lead-times by integrating production planning and scheduling
- Meeting due-dates using capacity adjustment
- Minimization of setup time
- Effective lot-splitting
- Optimization of scheduling using meta-heuristics such as genetic algorithm, Estimation of Distribution Algorithm

Result

Effectiveness of the proposed methods has been confirmed by numerical experiments using practical data.

For Application

Machining and assembly industry

Competitive Advantages

Efficient planning and scheduling in a reasonable amount of time.

Patent/Journal/Award

Academic achievement award (The Japan Society of Mechanical Engineers)

URL http://home.hiroshima-u.ac.jp/mecdes/

Development of New High-efficiency Internal-combustion Engines by Utilizing Pulse-detonation Technology

Keywords Internal-combustion Engine, Detonation, Turbine Engine, Power Generation, Aircraft Propulsion

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Title Professor

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Field Aerospace Engineering

Outline

Background

Detonation is a combustion mode whose burning temperature is higher than conventional isobaric combustion. Therefore, the entropy increase in detonation is smaller than that in isobaric combustion. And hence, it is well known that theoretical thermal efficiency of internal-combustion engines utilizing detonations is higher than conventional internal-combustion engines utilizing isobaric combustion. Based on such theoretical analysis, we are devoting ourselves to development of a pulse-detonation turbine engine.

Research Summary

We are investigating the reasons why the experimental thermal efficiency is lower than the theoretical thermal efficiency, and making them smaller. Furthermore, we are developing technologies for the self-sustained operation of a pulse-detonation turbine engine where no external air supplier is used.

Result

So far, we clarified the energy balance in a pulse-detonation turbine engine. The results showed that the minimization of heat loss and the maximization of turbine isentropic efficiency were especially important. Furthermore, we developed new technologies by which air-flow rate can be minimized for the self-sustained operation of a pulse-detonation turbine engine.

For Application

We propose joint researches on applications of our technologies.

We want to make a joint research with a company having turbine technologies.

Competitive Advantages

The pulse-detonation combustion chamber can be operated at dramatically higher frequencies than ever.

Patent/Journal/Award

URL

Design and Manufacturing

Development of Joint Design Support System

Keywords Joint Design, Welding Design, Optimization, Knowledge Management

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Field Naval Architects and Ocean Engineering

Outline

Background

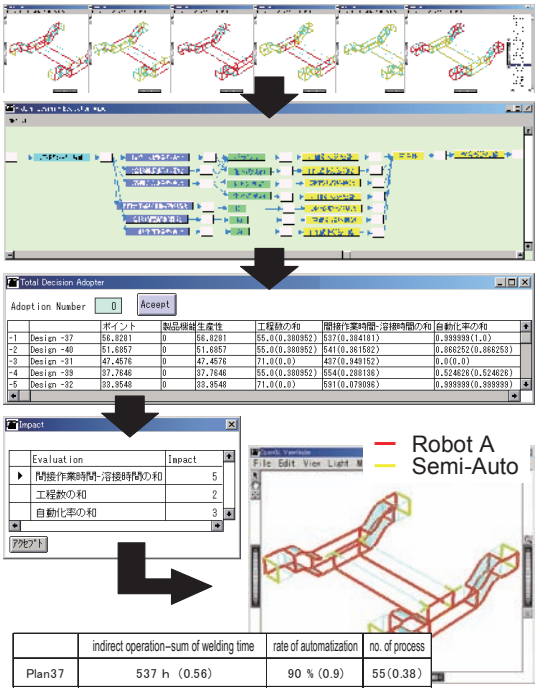
Many conventional welding studies aim to improve element technologies of welding. However, “System Oriented Thinking” has been paid strong attention to in recent years. Therefore, systematization and the informationalization of the welding is necessary.

Research Summary

In this paper, boundary of joint design is considered to start from the division of the structure and ends at deciding detailed information to execute the welding operation. In order to realize this, the scenario for multistep optimization of joint information is proposed.

Result

Process model of joint and welding design is defined based on the process analysis of the welding and the joint design. Moreover, information processing methods are proposed to support the generation, analysis and evaluation of the design plans.



	indirect operation-sum of welding time	rate of automatization	no. of process
Plan37	537 h (0.56)	90 % (0.9)	55(0.38)

For Application

Optimization of joint of welding products and knowledge management of welding design is expected.

Competitive Advantages

Many conventional welding studies aim to improve element technologies of welding. Here, systematization and the informationalization of the welding is examined in this study.

Patent/Journal/Award

Study on Generation Methodology of Welding Operation Information in Manufacturing System, Quarterly Journal of the Japan Welding Society, 17–4, (1999), pp.508–518.

Implementation of the Joint Design Supporting System based on the Demand Analysis and the Design Process Analysis, Quarterly Journal of the Japan Welding Society, 25–2, (2007), pp.286–297.

Definitions of Data Models and Data Processing Functions for the Joint Design Supporting System, Quarterly Journal of the Japan WeldingSociety, 25–2, (2007), pp.298–308.

Best Paper Award of the Japan Welding Society

URL

Design and Manufacturing

Development of Corrosion/Environment Monitoring System with Two-electrode Cell

Keywords Chemical Plants, Plant Maintenance, Two-electrode Cell, Corrosion, Environment, Monitoring

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Title Associate Professor

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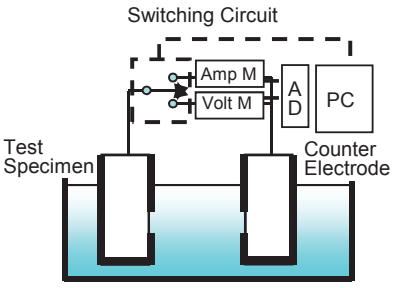
Field Materials Engineering, Chemical Plant materials, Chemical Engineering, Corrosion Engineering

Outline

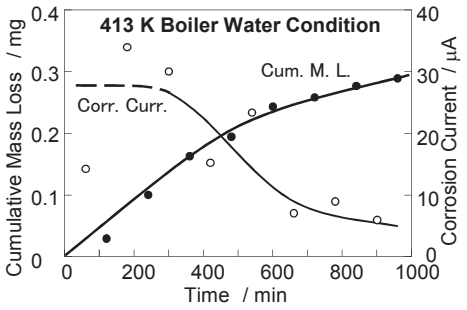
Background

Deterioration of metallic components of nuclear power and chemical industry plants is caused by attacks of wear and corrosion. The corrosion/environment monitoring is required for preventing plant disasters. Ordinary impedance methods etc. are still inadequate in its handling and cost performance.



Research Summary

A corrosion monitoring system with two-electrode cell test circuit was proposed in this study. The advantages of this system are easy handling, simple instrument and cost performance, as compared with the ordinary corrosion monitoring. The system can estimate corrosion rates of metallic materials obtained from polarization resistances in potential and current behavior under a very short polarization condition.



Result

Corrosion test results of carbon steel under a higher temperature and pressure boiler water condition (140°C, 0.7 MPa) were coincided with corrosion current results estimated by this system and sustain an application of this system to the corrosion monitoring.

For Application

This system will be one of the best technologies in plant maintenance, control and detection of plant environments. The improvement of this system should be done in the near future, in order to apply to actual plant and process control system.

Competitive Advantages

The advantages of this system are easy handling, simple instrument and cost performance, as compared with the ordinary corrosion monitoring.

Patent/Journal/Award

Patent: P2009–276161A, P2010–087096A

Journal: Y. Isomoto and T. Sato, Zairyo-to-Kankyo (JSCE), 59 (7) 265–271 (2010).

Y. Isomoto and N. Okamoto, Proc. of JSCE Materials and Environment 2010, D202, 441 (2010).

URL http://home.hiroshima-u.ac.jp/mm1/

Design and Manufacturing

FEM Stress Analysis and Strength Evaluation of Adhesive Joints under Static and Impact Loadings

Keywords Static/Impact Loading, Adhesive, Interface Stress Distribution, Singular Stress, Strength, Weight Reduction, Finite Element Method

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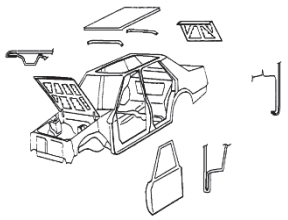
Field Mechanical, Electric/Electronic, Physics, Material

Outline

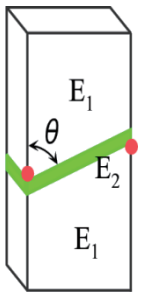
Background

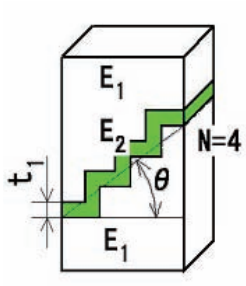
Instead of the conventional mechanical joints, adhesive joints have been widely used in various industries for weight reduction. Therefore, it is necessary to investigate the characteristics of adhesive joints under static and impact loadings.



Research Summary

The interface stress distribution and changes in the interface stress distributions in adhesive joints under static and impact loadings are analyzed using FEM calculations. The effects of some factors such as Young's modulus ratio between the adherends, the adhesive adhesive Young's modulus and thickness on the magnitude of the singular stresses occured at the edges of the interfaces are examined. Based on the results, methods how to increase the joint strength are proposed. Under impact loadings, the strain rate dependency is taken account in the FEM calculations.





Result

To increase the joint strength, it is found that the Young's modulus of the adhesive must be increased and the adhesive thickness must be decreased. Under the impact loadings, the characteristics of the adhesive joints are opposite to those of the joints under static loadings. It can be concluded that the stress characteristics must be taken into account in the reliable design of adhesive joints.

For Application

The conditions for the static design and impact design of automobiles and airplanes are elucidated. In addition, these results will contribute to weight reduction in automobiles and airplanes

Co-researchers

Hiroko NAKANO, Yasuhisa SEKIGUCHI, Yuya OMIYA

Competitive Advantages

The strain rate dependency is taken into account in the FEM calculations. The strain rate dependency was measured in the experiments. The finding are that the characteristics of the adhesive joints under impact load are opposite to those of the joints under static load.

Patent/Journal/Award

Hiroko Nakano, Yuya Omiya, Yasuhisa Sekiguchi & Toshiyuki Sawa, Three-dimensional FEM stress analysis and strength prediction of scarf adhesive joints with similar adherends subjected to static tensile loadings, IJAA Vol. 54, Oct. 2014
Hiroko Nakano, Yasuhisa Sekiguchi & Toshiyuki Sawa, FEM stress analysis and strength prediction of scarf adhesive joints under static bending moments, IJAA Vol. 44, July 2014

URL http://home.hiroshima-u.ac.jp/mml/

Design and Manufacturing

FEM Stress Analysis and the Sealing Performance Evaluation in Bolted Flange Connections with Ring Joint Gasket

Keywords Ring Joint Gasket, Bolted Flange Connections, FEM

Toshiyuki SAWA

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Title Professor (Special Appointment)
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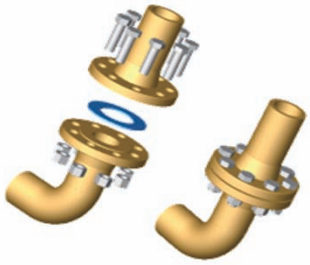
Field Mechanical, Electric/Electronic, Physics, Material

Outline

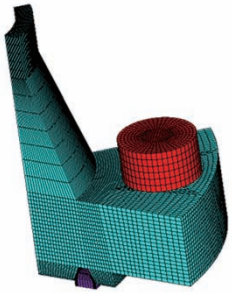
Background

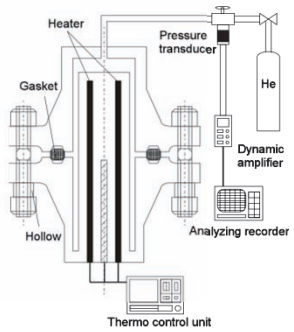
Bolted Flange Connections with Ring Joint Gaskets have been used under higher temperature and higher pressure conditions. Assembly procedures and bolt tightening methods of the connection with ring joint gaskets have been done empirically. Therefore, It is important to determine optimal assembly procedures and tightening methods..



Research Summary

In this study, the leakage tests for bolted flange connections with a ring joint gasket are conducted for obtaining the sealing performance of the connections. In addition, using the 3-D FEM stress calculations, the gasket contact stress distributions for the connections are analyzed. Using these results, the characteristic of the connections with ring joint gaskets is examined.





Result

The ring joint gasket contacts with the flange groove completely when the plastic deformation occurs at the gasket surface. Consequently, the sealing performance of the connection with the gasket is improved significantly.

For Application

Using the obtained available results on this study, optimal tightening methods and bolt preload for the connection with the ring joint gasket can be established.

Co-researchers

Yasuhisa SEKIGUCHI, Yuya OMIYA

Competitive Advantages

No research has focused on the characteristics of metal-metal contact for the bolted flange connections with metal ring gasket has been conducted. In this study, the characteristic of the ring joint gasket based on careful study of metalmetal contact has been clarified.

Patent/Journal/Award

K. Tenma, T. Kikuchi, T. Sawa, K. Horiuchi, Evaluation of Sealing Performance and FEM Calculations in Bolted Flange Connections With Ring Joint Gasket Subjected to Internal Pressure, PVP2011, ASME, 2010PVP Medal Award

URL http://home.hiroshima-u.ac.jp/mml/

Design and Manufacturing

FEM Stress Analysis of Bearing Surfaces and Stress Evaluation in Bolted Joints

Keywords Contact Stress, Bolted Joint, Reduction in Bolt Preload, Permanent Set

Toshiyuki SAWA

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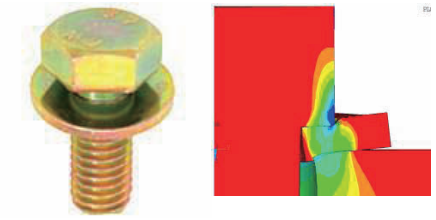
Field Mechanical, Electric/Electronic, Physics, Material

Outline

Background

As the bolt strength increases, the bolt preload increases. The permanent set at the gearing surfaces occurs due to a higher bolt preload. A reasonable bolt design method is proposed that takes the reduction of the bolt preload into account.

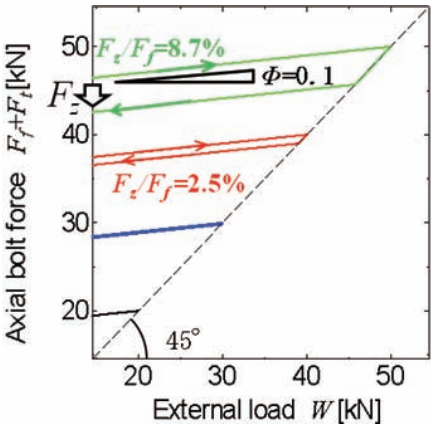


Research Summary

The elasto-plastic deformation at the bearing surfaces in a bolted joint was analyzed using FEM calculations. The deformation was also examined when an external load was applied to the joint. The development of the permanent set was analyzed and the reduction of the bolt load due to the permanent set was estimated. This study proposes a method for determining the optimal bolt preload.

Result

The result shows that the higher bolt preload could keep the higher bolt load when the external load was applied. It was also found that the effect of plain washers specified in JIS was smaller on the reduction of the bolt preload. It suggested that the thicker plain washer improves joining. The effect of plain washer thickness to permanent set was also studied.



For Application

Further research is needed for bolted joints under higher temperature. The effect of creep under higher temperature must be examined. The proposed method could be useful in designing automotive components.

Co-researchers

Yasuhisa SEKIGUCHI, Yuya OMIYA

Competitive Advantages

The proposed method for determining the bolt preload is valuable for practical design of bolted joints.

Patent/Journal/Award

Toshiyuki Sawa, Yuya Omiya & Kengo Kuwaki, FEM Contact Stress Analysis at the Bearing Surfaces in Bolted Joints With Washer Under Tensile Loadings, PVP2013–97830 , ASME

URL

Design and Manufacturing

Stress Analysis and Sealing Evaluation of Bolted Flanged Connections in Pressure Vessels

Keywords Pressure Equipments, Pressure Vessel, Bolted Flange Connections, Sealing Performance, Leakage

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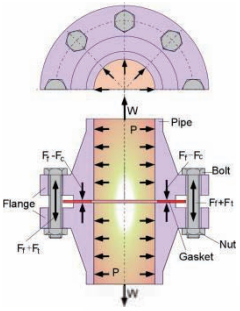
Field Mechanical, Electric/Electronic, Physics, Material

Outline

Background

A tiny invisible leakage from the gasket interface in bolted flanged connections is always occurring. Recently, from reliable design and environmental standpoints, a rational design method taking into account the tiny leakage is needed.



Research Summary

Actual bolted flange connections in piping lines are subjected to internal pressure as well as bending moments. In addition, bolt preloads may vary. Thus, the effects of the external bending moments and the variance in bolt preloads on the gasket stress distributions and the sealing performance should be examined from a reliable design standpoint. Using the obtained gasket stress distribution in bolted flanged connection, a method for estimating the amount of leakages is proposed.

Result

It was found that the effect of the variance in the bolt preloads were substantial on the gasket stress distribution and the sealing performance. Furthermore, the assembling efficiency for the bolted flanged connection was proposed taking into account the variance in the bolt preloads.

For Application

This research will contribute to the establishment of a reliable pipe flange and bolt preload design method taking into account the external load to the pipe line system in the chemical plant and electrical power plant.

Co-researchers

Yasuhisa SEKIGUCHI, Yuya OMIYA

Competitive Advantages

This research shows the relationship between the bolt preload and tiny leakage form the gasket interfaces. The findings of this study will contribute to a more reliable flange connection design method taking tiny leakage into considersation.

Patent/Journal/Award

K. Horiuchi, Y. Takagi & T. Sawa, FEM Stress Analysis and the Sealing Performance Evaluation of Pipe Flange Connections Subjected to External Bending Moments and Internal Pressure, PVP2011–57524, ASME

URL

Design and Manufacturing

Polymer Processing Using Supercritical Fluids

Keywords Supercritical Fluid, High Pressure Gas, Plasticizing Effect, Foaming

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Field Process Engineering, Physical Properties, Process System

Outline

Background

It is desired to realize the polymer processes which are safe, environmentally benign, eliminating the use of toxic organic solvents or fluorinated gases, and precisely controlling physical properties, morphology, and functions of products.

Research Summary

Supercritical fluids (SCFs) (high pressure gases above its critical temperature) dissolve in polymers about 10wt% and change the polymer properties widely as function of temperature and pressure. In our laboratory we are measuring the solubility and diffusivity of SCFs in various polymers, investigating the reduction of viscosity and glass-transition temperature of SCF-containing polymers, and applying the above phenomena to microfoaming and micronizing of polymers.

Result

1) Zero-shear viscosities of polystyrene can be reduced about one order of magnitude when several % of supercritical carbon dioxide ($scCO_2$) is dissolved in it. (Fig. 1) 2) Polycarbonate is crystallized up to 20% in several hours in the presence of $scCO_2$. 3) Foam polymers with about 10μm bubbles can be produced when dissolved $scCO_2$ or nitrogen are rapidly released. (Fig. 2) 4) Poly(ethylene glycol) can be micronized through a nozzle with an assistance of $scCO_2$.

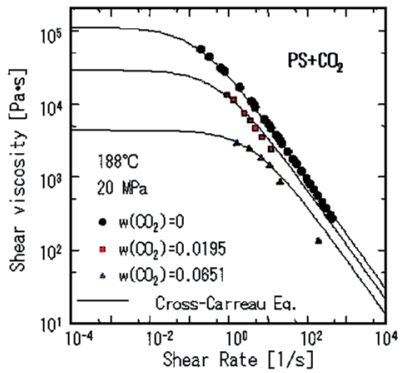

Fig. 1 Shear viscosity of CO_2+PS

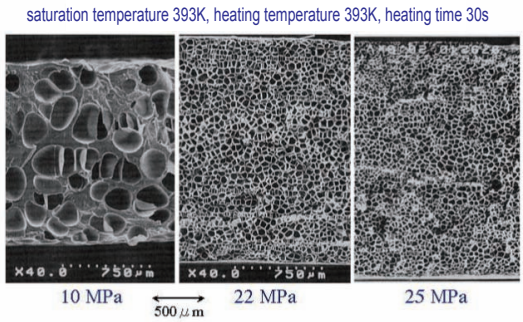

Fig. 2 Foaming of polystyrene using N_2.

For Application

Application of SCFs to polymer production and processing has widely been examined; for examples, removal of low molecular weight substances, fractionation, addition of functional materials, dyeing, plasticization in injection and extrusion molding, foaming, crystallization, surface modification, and micronization.

Competitive Advantages

Since properties of SCF-containing polymers can be varied with pressure, the morphology and function of polymer products can be controlled with pressure as a key operational variable. Moreover, carbon dioxide is non-toxic and inflammable, even if it is remained in the polymer products.

Patent/Journal/Award

See our website.

URL http://home.hiroshima-u.ac.jp/highpres/

Grey-box Modeling Based on Subspace Identification Methods

Keywords Subspace Identification Methods, Grey-box Modeling, Control Systems Design

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Title Associate Professor

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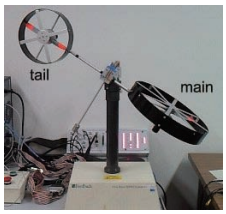
Field Control Engineering, Electric/Electronic

Outline

Background

Accurate mathematical models are required for designing control systems. White-box modeling based on the first principles and black-box modeling based on experimental data are two major approaches. Subspace identification methods are basically black-box modeling.



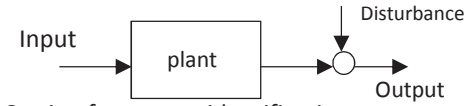
Twin Rotor MIMO system

$$\dot{x}(t) = Ax(t) + Bu(t)$$
$$y(t) = Cx(t) + Du(t)$$

Linear dynamical model for control systems design

Research Summary

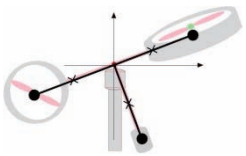
In this research, we develop theory for grey-box modeling, based on subspace identification methods and white-box models.



Setting for system identification (black-box modeling)

Result

We have derived grey-box models for a twin rotor MIMO system and a pendulum system.



Components of Twin Rotor MIMO system (for white-box modeling)

For Application

We expect that our procedure can be applicable to mechanical and electrical systems for control systems design. We need more researches on effective grey-box modeling of the systems that have large uncertainties in white-box models.

Competitive Advantages

We have accurate parameter dependent models using the prior knowledge on white-box models.

Patent/Journal/Award

Journal paper: SICE Journal of Control, Measurement and System Integration (2011)

Conference paper: IFAC World Congress (2011), SYSID (2012)

URL

Design and Manufacturing

The Intercausal Relationship regarding Students' Learning Activity in a Design Study

Keywords Manufacturing Class, Design, Thinking, Sketching

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Title Associate Professor

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Field Technology Education

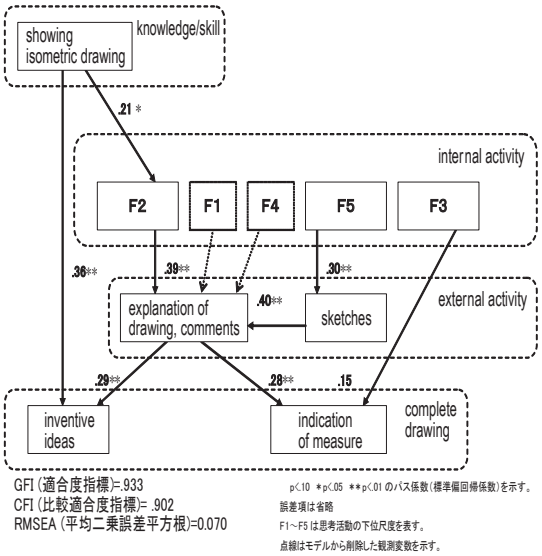
Outline

Background

The purpose of this study is to examine the intercausal relationship regarding students' learning activity in a design study.

Research Summary

Learning activity factors extracted from 113 students' design study were basic knowledge and skills required for 'isometric drawing method', 'thinking' due to internal activity, 'sketching' and 'comment on sketching' relevant to external activity, and 'details indication of measure' and 'inventive idea' observed from final drawing. These date were examined by using a covariance structure analysis.



Result

We found that 'isometric drawing method' affected the thinking factors 'examination of use condition' and 'inventive idea' of designed articles. The thinking factors of 'examination of use condition' and 'examination of the added value' influenced the exterior learning activity of 'sketching' and 'comment on sketching'. It was clarified that thinking of 'production and use stage' and activity of 'comment on sketching' contributed to qualitative improvement of design activity.

For Application

Competitive Advantages

Patent/Journal/Award

Encouraging prize: Japanese Society of Technology Education (2010)

URL http://home.hiroshima-u.ac.jp/cyata/

Material Modeling, Numerical Simulation and Optimum Process Design for Metal Forming

Keywords Elasto-plasticity, Material Modeling, Metal Forming, Optimization Problems in Metal Forming

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Field Mechanical Engineering, Material Engineering

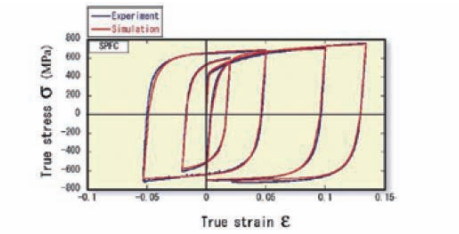
Outline

Background

For development of new forming technologies for materials with high performance but with difficulty in forming, such as high strength steel sheets, magnesium alloys etc., (1) material testing to determine the mechanical properties, (2) modeling of material behavior of elasto-plasticity for numerical simulations, and (3) optimum process design are required.

Research Summary

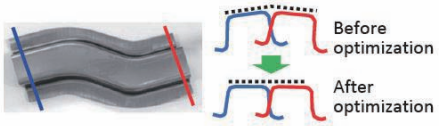
Mechanical behaviors of sheet metal, such as cyclic plasticity, yield locus and forming limit curve, are investigated by original testing equipments. Material models, which can describe these mechanical behaviors correctly, are developed and material parameters for the models are identified. The developed material models are used for FE simulation of metal forming process. Furthermore, optimization of metal forming process based on FE simulation and numerical optimization technique, and development of incremental sheet forming method with local heating are also carried out.



Expression of cyclic plasticity by Y-U model

(a) Experiment (b) Y-U model (c) Conventional model

Springback prediction in draw bending of high strength steel sheet by Y-U model and conventional model



Compensation of torsional springback for S-rail product of high strength steel sheet by optimization of draw bead

Result

Yoshida-Uemori kinematic hardening model (Y-U model), which can precisely describe cyclic plasticity of metals, was proposed. FE simulation using Y-U model is capable of predicting springback of high strength steel sheets in stamping process, which was difficult to predict with conventional material model. In addition, springback and wrinkle of high strength steel sheet products are successfully suppressed by optimizing stamping process based on FE simulation. It is also possible to design the optimum forming process in consideration of variation in material properties or forming conditions.

For Application

Material testing, material parameters identification, prediction of defects such as springback, wrinkle and fracture in sheet stamping, and optimization of metal forming process for metal forming industries, especially sheet stamping industries.

Competitive Advantages

Y-U model is included in several FE commercial codes, such as PAM-STAMP, LS-DYNA, etc. A software for material parameter identification of Y-U model, MatPara, is developed and commercially available.

Patent/Journal/Award

F. Yoshida & T. Uemori: International Journal of Plasticity, 18 (2002), 661–686.

URL http://home.hiroshima-u.ac.jp/eplabo/ http://www.cem-inst.com/

Design and Manufacturing

High Performance Dry-cyclone with Movable Cut Size

Keywords Powder Technology, Classification, Standard Particle, Numerical Simulation

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Title Professor

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Field Particle Classification, Cyclone Separator, Centrifugal Separation

Outline

Background

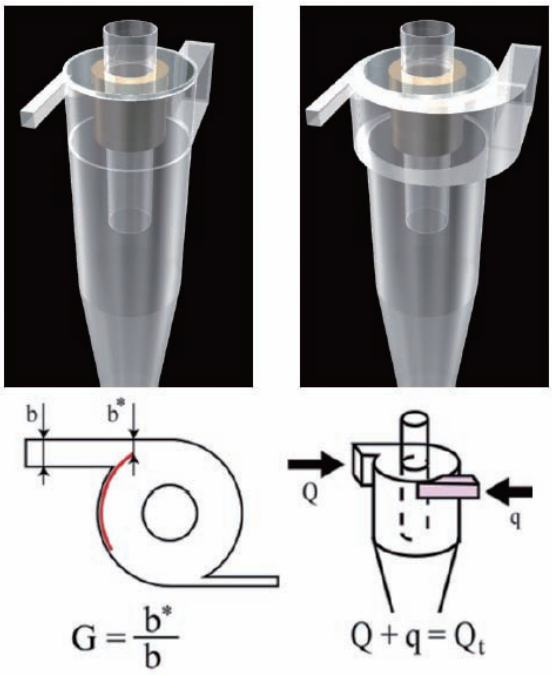
Particle classification means to separate large and small particles based on cut size. Our laboratory developed the highperformance dry-cyclone of movable cut size with simple operation.

Research Summary

Conventional dry-cyclones are difficult to change the cut size and to separate sub-micron particles. However, the new type cyclone developed in our laboratory can separate sub-micron particles with movable cut size. Research of new cyclone with low energy consumption is also developed.

Result

By use of the additional jet air and inlet guide plate shown in the figure, cut size about 0.5μm is confirmed experimentally.



Developed dry-cyclone with movable cut size

For Application

It is difficult to reach the cut size to sub-micron range by use of conventional forced type particle separator. The new cyclone is simple in construction and easy to change the cut size in sub-micron range.

Co-researchers

Prof Kunihiro Fukui

Competitive Advantages

It is difficult to reach the cut size to sub-micron range by use of conventional forced type particle separator. The new cyclone is simple in construction and easy to change the cut size in sub-micron range.

Patent/Journal/Award

Yoshida, H. et al Advanced Powder Technology, 23, 185–190 (2012)

Yoshida, H. et al Powder Technology, 219, 29–36 (2012)

URL http://home.hiroshima-u.ac.jp/powder/

Ⅳ

Material/Device

Material/Device

The Quantitive Grasp Method and its System for Symmetry-breaking

Keywords Symmetry-breaking, Periodic Structure, Nano-technology, Block-diagonalization Method, Symmetry

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Title Assistant Professor

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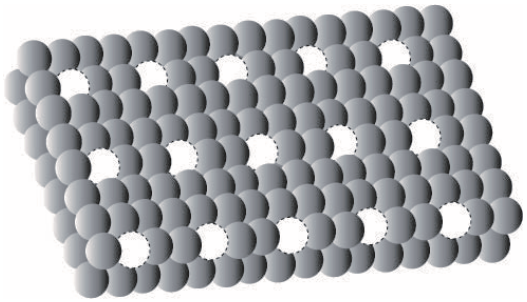
Field Applied Mechanics/ Structural Analysis (Fundamental Engineering)

Outline

Background

In the lattice structure (including nano- & micro-structure and the colloidal particle arranged regularly) of a uniform substance, etc., when accompanied by imperfection in the structure, it is hard to quantify as to how many lattice defects exist. Especially for the periodic defectiveness, human recognition is limited to very small flexibility of lattice structure, it is already impossible with the level of flexibility in an actual problem that one is going to analyze.



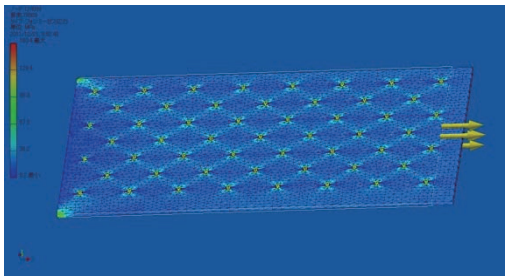
Multi-particle lattice arrangement with periodic defective particles.

Research Summary

In new material development, where the atomic structure and particles (including nano- and micro-structure) are arranged regularly in the material composition, the disturbance of arrangement and qualitative change are in many cases accompanied by physically important and essential transformation of phenomenon. I propose a method of systematical quantification and systemization.

Result

- Collapse can be predicted from the hierarchical level of the symmetry, for substances with various composition and their various pattern changes of symmetry-breaking.
- Suggest index-level and prediction for new material development.
- The kind and level of the symmetry which has periodic symmetrical structure can be checked, and the hidden symmetry can be found easily.



The symmetry breaking analysis and the modification state of a sheet of having a target hound's-tooth check hole.

For Application

- Field of the exotic material research and development
- Light material device, the quality control field of a sensor material (periodic crystal arrangement and its structure)

Competitive Advantages

- Development of an exotic material (prediction and analysis of the detailed action of material which shines by stress).
- Collapse prediction of material which has a detailed structure periodically.
- As a means of quality control engineering of material.

Patent/Journal/Award

Japanese Patent Pending. This research result was derived from "Challenging Exploratory Research" of Grants-in-Aid for Scientific Research in JSPS.

URL

Material/Device

Manufacturing Process Development of Al_3Ni Intermetallic Compound Reinforced Al Composite by using Ni Celmet

Keywords Metal Matrix Composites, Functional Materials, Metal Physical Properties

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Field Materials Engineering, Process Engineering

Outline

Background

The manufacturing of intermetallic compound reinforced composite has many problems in production cost, quality and performance.

Since the conventional manufacturing methods have a limit in improving those problems, a new process method which solves the above problems is required.

Research Summary

It is not possible to produce ceramic particle reinforced composite using the infiltration method. It becomes possible by producing the intermetallic compound by a reaction with aluminum after infiltrating Al molten alloy with nickel celmet.

In order to produce highly productive intermetallic compound reinforced composite with sufficient casting, this study applied the molten reaction principle to the low-pressure infiltration method.

The molten reaction type low-pressure infiltration method as a new simple manufacturing method has been developed.

Result

The intermetallic compounds of the reaction of porous nickel with Al alloy produced by molten reaction type low-pressure infiltration method. Fine and granular Al_3Ni was distributed in the matrix at the temperature, 973K the aspect ratio of (ratio of length/width). Al_3Ni phase was observed. Most of Al_3Ni has the aspect ratio (1~3) of powdery shape.

For Application

It may be used for a broad range of purposes, such as piston ring parts of diesel engines and brake discs of automobiles.

Competitive Advantages

For producing a composite, there are many problems such as production cost, quality, performance, etc. In order to solve these problems, production with control of the dispersion, high density, low cost and complicated shape is attained by using the molten reaction type low-pressure infiltration method.

Patent/Journal/Award

Y. B. Choi, The 8th Korea-Japan Joint Symposium on Composite Materials

URL http://home.hiroshima-u.ac.jp/zaishitu/index.html

Material/Device

Synthesis of Calcium Phosphate Hydrogel from Waste Incineration Fly Ash and Bone Powder

Keywords Waste Incineration Fly Ash, Bone Powder, Calcium Phosphate Glass, Calcium Phosphate Hydrogel, Fast Proton Conductor, Fuel Cell

Kunihiro FUKUI

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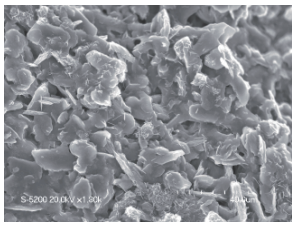
Field Process Engineering, Material Engineering, Recycle Engineering

Outline

Background

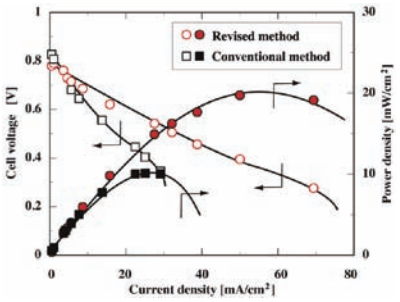
In Japan, over 7 million tons of waste incineration fly ash generated by garbage incineration plants is discharged every year, and this amount has been increasing. The main component of waste incineration ash is Ca. Over 4 million tons of chicken bone is also discharged per year as industrial wastes in Japan. Chicken bone consists of Ca and P. A large portion of these industrial wastes are reclaimed from the sea. Thus, there is a need to rapidly develop new effective ways of reusing these industrial wastes.



SEM image of calcium phosphate hydrogel

Research Summary

Waste incineration fly ash and bone powder could be successfully recycled into calcium phosphate hydrogel, a type of fast proton conductor. It was found that the conductivity of the hydrogel from bone powder is almost equal to that from calcium carbonate reagent, which is higher than that from incineration fly ash. However, the difference of the conductivity among them can be hardly observed above 100 °C.



Performance of the fuel cell having the calcium phosphate hydrogel membrane from incineration ash

Result

The performance of fuel cells having the hydrogel membrane obtained from all raw materials increases with the cell temperature, and the fuel cell containing the hydrogel membrane from incineration fly ash has the highest dependence of the fuel cell performance. For this reason, the difference in the cell performance among them can be hardly observed above 120 °C.

For Application

Since calcium phosphate hydrogel is cheaper and shows a higher proton conductivity and greater heatresistance than perfluorosulfonic polymers such as Nafion, it is thought to be one of the candidates for the electrolyte of fuel cells.

Competitive Advantages

As this hydrogel can be also applied to electric double-layer capacitors, and hydrogen sensors, the demand for it is expected to increase in future.

Patent/Journal/Award

Japanese Patent Unexamined Publication No. 2008–016273 (K. Fukui, T. Yamamoto, H. Yoshida)

Fukui, K., N. Arimitsu, K. Jikihara, T. Yamamoto and H. Yoshida “Performance of fuel cell using calcium phosphate hydrogel membrane prepared from waste incineration ash and chicken bone powder” Journal of Hazardous Materials, 168, 1617–1621 (2009)

URL http://home.hiroshima-u.ac.jp/greenpro/index.html

Material/Device

Synthesis of Functional Material Powder by Microwave Heated Fluidized Bed Solid-phase Reactor

Keywords Microwave, Solid-phase Reaction, Fluidized Bed, Functional Material, Nano

Kunihiro FUKUI

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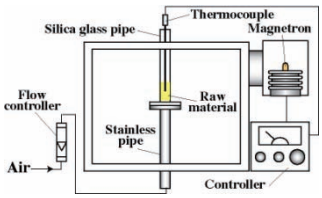
Field Process Engineering, Material Engineering, Recycle Engineering

Outline

Background

The solid-phase reaction is a method that a product powder is acquired from several types of raw material powders by mixing and heating these raw material powders at a high temperature. This method is widely used for synthesis of ceramic powders and so on. Unfortunately, this method requires both a long reaction time and an enormous amount of energy to maintain a high temperature. In this work, we propose the novel synthesis method with microwave heating.

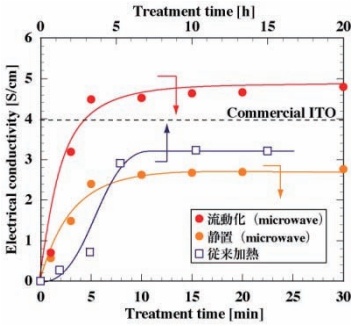


Fluidized solid-phase reactor with microwave heating

Research Summary

The microwave heating could reduce the treatment time necessary for the completion of the solid-phase reaction by 1/30 and that microwave heating also decreased the amount of ITO produced, since the powder layer of the raw material was heated unevenly and had an uneven temperature distribution that the center of the layer had much higher temperature than the periphery.

Therefore, a microwave heated fluidized bed reactor was proposed in order to diminish the uneven progress of the ITO synthesis reaction.



Relationship between conductivity of obtained ITO and treatment time

Result

The electric conductivity of the powder obtained with the proposed reactor was higher than that of the commercially supplied ITO powder. Though the output of the microwave irradiation kept constant, the attained temperature depended on the packing fraction of the raw material powder layer in the reactor.

For Application

This novel method, the microwave heated fluidized bed solid-phase reactor, is most suitable for the functional materials from the raw materials which have relatively high absorption ability for the microwave. For example, Carbon, NiO, ZnO, CuO and so on.

Competitive Advantages

Since this novel method, the microwave heated fluidized bed solid-phase reactor, can reduce the treatment time remarkably, and raise the yields of the product, we can reduce the energy consumption and the cost.

Patent/Journal/Award

Japanese Patent Unexamined Publication No.2011–246305 (K. Fukui, T. Yamamoto, H. Yoshida)
Fukui, K., K. Kanayama, M. Katoh, T. Yamamoto, H. Yoshida “Synthesis of indium tin oxide powder by solid-phase reaction with microwave heating,” Advanced Powder Technology, 20(5), 488–492 (2009)

URL http://home.hiroshima-u.ac.jp/greenpro/index.html

Material/Device

Development of New Method for Microfabrication of Polyimide using High Pressure Carbon Dioxide

Keywords Polyamic Acid, Polyimide, Microfabrication, Supercritical Carbon Dioxide

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Title Assistant Professor

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Field Process Engineering, Material Science

Outline

Background

Exixting methods for polyimide processing has some disadvantages for microfabrication from the view point of the permeability of precursor and processing time.

The objective of this study is to develop a new microfabrication method for polyimide using supercritical carbon dioxide.

Research Summary

As a first step, the solubilities of 4,4'-diaminodiphenyl ether (ODA) and pyromellitic dianhydride (PMDA), which are representative monomers of polyimide, in supercritical carbon dioxide were measured.

Moreover, the relationship between the molecular weight of polyamic acid which is an intermediate of polyimide and polymerization condition was investigated.

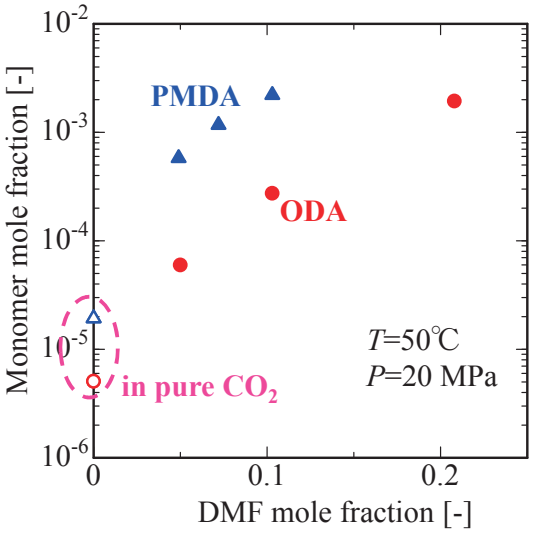

Fig. Solubilities for ODA and PMDA in $scCO_2$ with DMF at 50℃ and 20 MPa.

Result

As for the solubilities of monomers, it was found that addition of a little amount of N,N-dimethylformamide could enhance the monomer solubilities dramatically. Moreover, the molecular weight of polyamic acid increased with increasing monomer concentrations, and it achieved more than 2×10^4 g/mol by using appropriate monomer concentrations.

For Application

Insulating layers of the devices for electronics and communications can be made in 3-dimensional microscopic space. Moreover, fine particles of polyimide can be manufactured with only a little amount of organic solvent.

Competitive Advantages

Supercritical carbon dioxide has better permeability compared with organic solvents, and this technique can deliver more monomers than compared with the deposition polymerization. Therefore, this method has great advantages for fabrication of polyimide thin films and embedding polyimide in the narrow gaps on a high-aspect ratio surface.

Patent/Journal/Award

About solubility measurement; M. Haruki, N. Fukui, F. Kobayashi, S. Kihara, S. Takishima, Ind. Eng. Chem. Res., 50 (2011) 11942–11949.

About polymerization in $scCO_2$; M. Haruki, Y. Hasegawa, N. Fukui, S. Kihara, S. Takishima, Production of polyamic acid in supercritical carbon dioxide with N,N-dimethylformamide, J. Appl. Polym. Sci., 131 (2014) app.39878.

URL http://home.hiroshima-u.ac.jp/highpres/

Material/Device

Development of Novel π-conjugated Materials for the High-Performance Organic Electronic Devices

Keywords Organic Devices, Oligothiophenes

Ichiro IMAE

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Title Associate Professor

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Field Materials Chemistry, Applied Chemistry, Basic Chemistry

Outline

Background

For the purpose of developing a novel organic π-conjugated systems, I have designed the novel family of oligothiophenes containing 3, 4-ethylenedioxythiophene (EDOT) unit (see Figure), and apply them to organic electronic devices such as organic field effect transistor, organic thin film solar cells, and dye-sensitized solar cells, as flexible and printable devices.

Research Summary

In this research, I focused on the 3,4-ethylenedioxythiophene (EDOT) unit which can work for the stabilization of charged state of oligothiophenes and the extension of the effective π-electron conjugation length.

However, there are no report to obtain the pure EDOT-containing oligothiophenes which have over 5 units of thiophene rings, because the difficulty of the synthetic method.

Result

On the preparation of some compounds, purification processes are strongly affecting the efficiency to obtain them. In this work, I adopted the starting materials and reagents which easily make the isolation of the objective compounds from by-products.

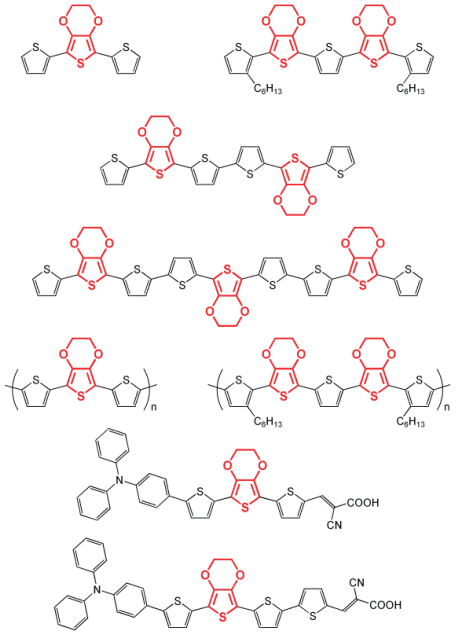


Figure: EDOT-containing oligothiophenes

The oxidized states of EDOT-containing oligothiophenes were found to be stabilized well, and showed remarkable red-shift of absorption bands.

For Application

I have been studying the application of EDOT-containing oligothiophene themselves to the organic semiconductor materials for the field effect transistors. Also, I am trying to synthesize some derivatives containing oligothiophenes for the donor unit of π-conjugated polymers for plastic solar cells and π-bridge unit of donor-π-acceptor type dye-sensitized solar cells, I hope that companies related with organic electronics will co-work with me.

Competitive Advantages

Organic electronic devices such as field effect transistors and plastic solar cells are generally flexible, light and able to fabricate the large-area devices with low costs. In these points, they are superior to the inorganic-based devices.

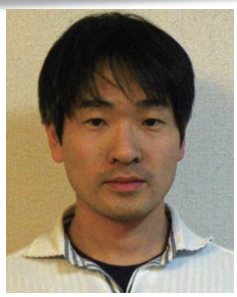
Patent/Journal/Award

- I. Imae et al., Electrosynthesis and charge-transport properties of poly(3', 4'-ethylenedioxy-2, 2': 5', 2"-terthiophene), Mater. Chem. Phys., 131, 752 (2012).
- Award for Encouragement of Research in Polymer Science "Synthesis of Conjugated Oligomers with Well-defined Structures and Their Application to Photo- and Electroactive Materials" (2005, the Society of Polymer Science, Japan)

URL http://home.hiroshima-u.ac.jp/imae/

Material/Device

Improvement of the Effective Thermal Conductivity Using CNT



Keywords Single-walled Carbon Nanotube, Packed Bed, Nano Material

Shuhei INOUE

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Title Associate Professor

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Field Thermal Engineering

Outline

Background

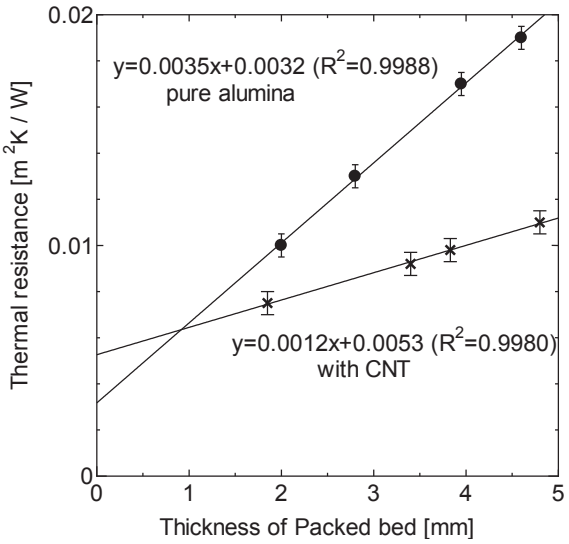
Low heat conduction in the packed bed is one of the most important issues for realizing the fuel cell car society. At the moment, it cannot comply with the practical demand of refilling rate for hydrogen.

Research Summary

In this study, I focus on two themes; one is to develop the technique to synthesize single-walled carbon nanotube, which possesses outstanding thermal conductivity, on the metal hydride, and the other is to confirm the effectiveness for CNT use.

Result

I succeeded in synthesizing single-walled carbon nanotubes on the metal hydride, and confirmed its effectiveness.



For Application

In the next stage, I have to develop the ways of synthesizing better CNT and controlling the filling rate. I hope the industry to cooperate in these practical researches.

Competitive Advantages

Conventional techniques to enhance the effective thermal conductivity of the packed bed system include two main faults. One is to reduce the net volume of the vessel, and the other is the efficiency is not enough because the contact thermal resistance is still large.

Patent/Journal/Award

Patent Application No. JP 2010–132052

S. Inoue & Y. Matsumura, J. Hydrogen Energy, 37, 1836 (2012).

URL http://home.hiroshima-u.ac.jp/~hpthermo/

Material/Device

Forming of Conducting Nanowires through Plasma Discharge

Keywords Plasma Process, Nano-wire

Masahiko KATO

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Title Associate Professor

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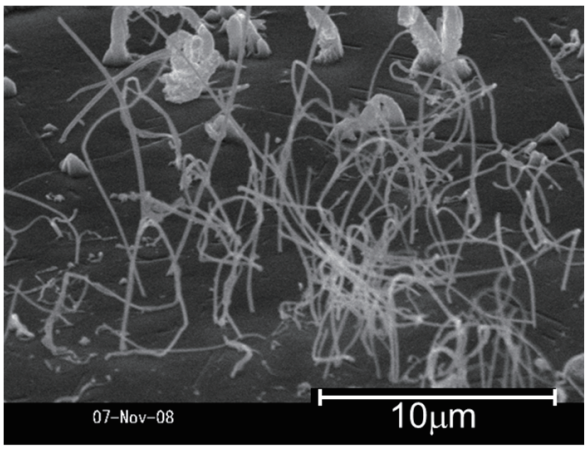
Field Mechanical Engineering, Material Engineering, Structual・functional Material

Outline

Background

Recently, materials with a fine surface structure at nanometer level are paid attention to as the mechanical, electrical chemical properties are prominently improved. However, the processing cost is extremely high.



Research Summary

To obtain nano-wires on steel surface, specimens were plasma discharged using R.F. power source at reduced pressures. Optimization of discharging condition and clarification of formation mechanism was carried out.

Result

Nano-wires with a diameter less than 1μm and a length ranging from 10 to 100μm were obtained as is shown in the picture. The nano-wire consisted of CrC, and showed electrical conductivity.

For Application

Possible application: Heatsink, Cold emitter, Catalyst support, under-layer for coating, Surface of rolling

Competitive Advantages

Manufacturing cost is much lower than that using microfabrication technique, and adhesive strength is extremely high.

Patent/Journal/Award

patent application 2012–26002 (Formation of nano-wires on metal surface, metallic material with nano-wire)

URL http://home.hiroshima-u.ac.jp/zaikyou/

Material/Device

Development of Polymer and Organic/ Inorganic-nanoparticle Composite Materials

Keywords Polymer Nanocomposites, Nanoparticle Dispersion, Supercritical Fluids

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Field Polymer Rheology, Chemical Engineering, Polymer Material Processing

Outline

Background

Polymeric materials with novel highly functions would be developed by well-dispersed and fine-structured single nanometer cluster of inorganic or organic-nanoparticles. However, the fundamental process on nanoparticle dispersion has not been established especially as a environmentally friendly process, and the expected effects of nanoclusters on polymer nanocomposites have not been achieved in general because of difficulty of nano-scale dispersion.

Research Summary

We have develop a highly efficient mixing process combined with the superior properties of the supercritical fluids; the plasticization of polymeric materials and the rapid sorption by high diffusivity. The effects of supercritical fluid make it possible to mix polymer/nanoparticles system at lower temperature than the conventional mixing and simultaneously to introduce nanoparticles into entangled polymer matrix without using organic solvents.

Result

The Figure shows the result of general-purpose polystyrene /Cu complex nanocomposite material produced by newly developed mixer under 12 MPa CO_2 at 150°C. Dispersion of Cu complex clusters has been achieved in single-nanometer-scale, that may be controlled by the correlation length of the entanglement. The nanocomposite shows that the zeroshear viscosity of nanocomposite is reduced by about 1/10 and the dielectric constant is 1.2 times higher than the neat polymer, in spite of as low as approximately 0.01 volume fraction of particles. However, the glass transition temperature does not change very much. These properties may come from the effect of nanoscale particles dispersion in linear polymeric matrix.

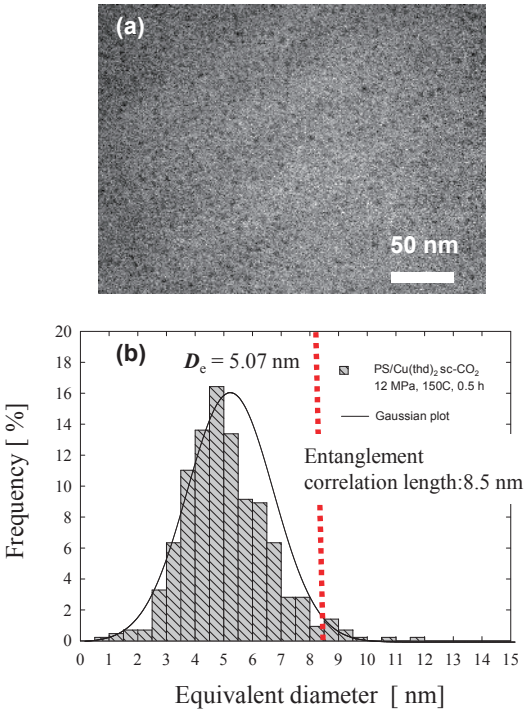

Figure. TEM images of polystyrene /Cu complex compounds (a) and equivalent circle diameter distribution of the cluster of Cu complex (b).

For Application

- Development of master batch of polymeric compounds.
- Fine-kneading required under low temperatures and non-organic solvent.
- Single nano-scale metal clusters dispersion into polymeric material aiming at developing a conductive polymer and high index polymer, etc.

Competitive Advantages

To the conventional method, there are the in-situ polymerization method using a large amount of organic solvent and the meltmixing method using specialized surfactant and high shear flows that causes thermal degradation of polymers. Our method has advantage of no-organic solvent and low temperature process and more can achieve the well-dispersed single-nanometer particles into polymer.

Patent/Journal/Award

Shin-ichi Kihara, Masaaki Okamoto, Ai Nagira, Masashi Haruki, and Shigeki Takishima, “Development of Polymer/Nanoparticle composite Materials Using High Pressure Fluids”, Asian Joint Conference on Advanced Polymer Processing, 2011/9/4–8, Huanghai Hotel, Tsingtau, China

URL http://home.hiroshima-u.ac.jp/highpres/

Material/Device

Early Breast Cancer Detection Using Ultra-wideband Impulse Radio

Keywords Electron Devices, Integrated Circuits, Electronic Materials

Takamaro KIKKAWA

Department Research Institute for Nanodevice and Bio Systems

Title Professor

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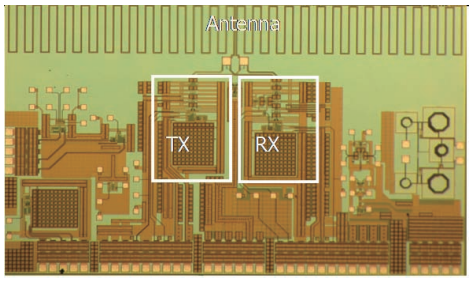
Field Electrical and Electronic Engineering

Outline

Background

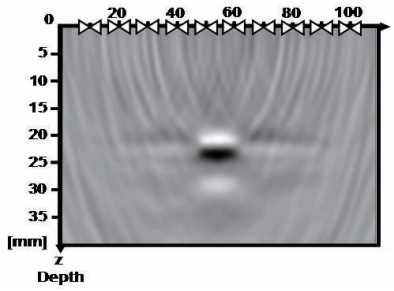
Issues of medical engineering in early breast cancer diagnostics are X-ray radiation and painful X-ray mammography. Issue of high data rate communication among electrical equipments and devices are the limitation of the communication bandwidth. In order to solve these issues, ultra-wideband impulse radio communication technologies are applied to the new fields in terms of impulse radar emitted into bodies and integrated antennas on semiconductors for near field transmission.



CMOS integrated circuits with on-chip antenna

Research Summary

Researches on ultra-wideband CMOS integrated circuits and antenna propagation for early breast cancer detection and inter-chip signal transmission are conducted. Technologies are silicon on-chip antenna, CMOS-UWB generator, UWB transmitter, UWB receiver, UWB amplifier and high-speed digital signal processing as well as UWB antenna array and switching matrix circuits.



Confocal imaging of breast cancer phantom

Result

We have developed ultra-wideband CMOS integrated circuits having silicon on-chip antenna for the first time. Using this technology, we have developed CMOS integrated circuits and antenna array for early breast cancer detection system.

For Application

Looking for industrial partners who are interested in early breast cancer detection system, electrical devices, health care devices and medical equipments.

Competitive Advantages

Competitive advantages of thi s research are integrated technologies of non-invasive imaging system for early breast cancer detection by use of CMOS integrated circuits, ultra-wideband micro antenna array, confocal imaging algrism, and impulse radio radar system radiating 1/1000 of conventional mobile phones.

Patent/Journal/Award

Patent: JP2008–241834/ Journal: T. Kikkawa, P. K. Saha, N. Sasaki, and K. Kimoto, IEEE Journal of Solid-State Circuits, Vol. 43, No. 5, May 2008, pp.1303–1312./

Award: The Japan Society of Applied Physics 2000 Best Paper Award. 2008 The Japan Society of Applied Physics Regional Achievement Award. Fellow, Institute of Electrical and Electronics Engineers, Inc., USA. Fellow, Japan Society of Applied Physics, Japan

URL http://www.rnbs.hiroshima-u.ac.jp/kikkawalab/

Material/Device

Design and Development of Pb-free Solder Alloys for High Temperature Applications

Keywords Alloy Design, Pb-free Solder, Property Estimation, Electron Theory

Kazuhiro MATSUGI

Department Graduate School of Engineering

Title Professor

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Field Environment, Energy, Manufacturing Process, Material

Outline

Background

Pb-free solder alloys for high temperature application, have never been developed successfully. The alloy design of high performance alloys such as Ni, Ti, Al based alloys have been carried out on the basis of the electron theory. This theory may be applied to design of Pb-free solder alloys.

Research Summary

2-1) Determination of alloy system and composition: Zn alloys have low cost and similar melting points to Pb alloys. Zn alloys are alloy-designed theoretically.

2-2) Measurement of melting point and tensile properties:

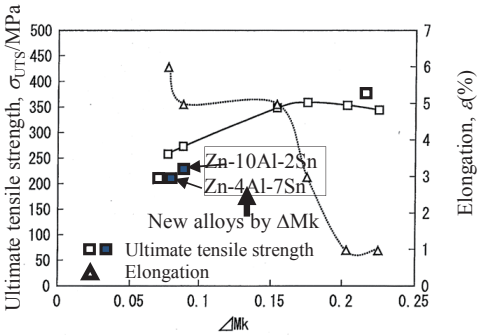

Fig.1 Relation between ΔMk and UTS, elongation.

Result

Contoll of tensile properties by parameters obtained from electron theory: ΔMk (s orbital energy level, R. Ninomiya, Doctor thesis, Mechanical properties and alloy design of Mg and Zn alloys, Toyohashi University Technology, 1995) was used for prediction of tensile properties. Figure 1 shows the relation between UTS and elongation of Zn-10Al-0.02Mg-0~13.5Cu alloys. Alloy design has to be carried out for optimization of both UTS and elongation in specified region of ΔMk more than 0.07. Two alloys of Zn-Al-Sn are obtained on the basis of this specified region. These alloys show UTS more than 200 Mpa and elongation of 5%.

For Application

This research contains the ①necessity, ②importance, ③emergency and ④originality.

Competitive Advantages

This approach for alloy design showing the rapidity and accuracy has never been reported in the world.

Patent/Journal/Award

patent application 2011-069511 (Determination method for composition of Zn alloys for high temperature applications and their appliacyions)

URL

Material/Device

Chemical Engineering Approach for Material Synthesis on the Use of Rare Metal

Keywords Raremetal, Nano/Fine Particle, Phosphor, Magnetic, Catalyst Materials Metal-bio Technology, Recycle

Takashi OGI

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Title Assistant Professor

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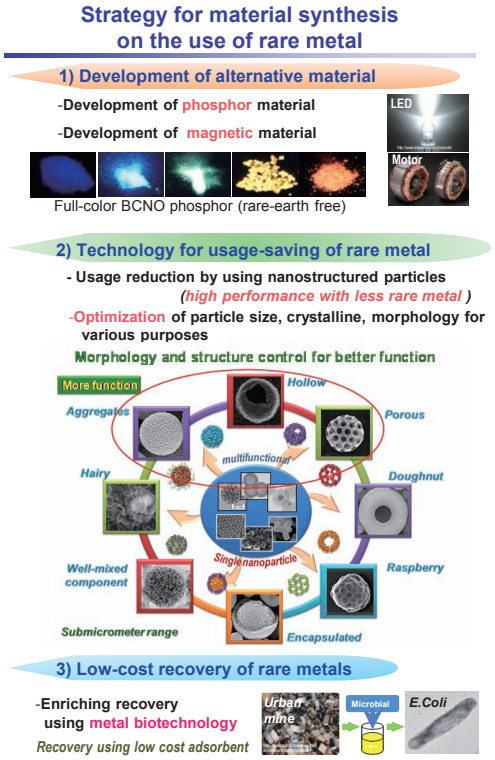
Field Chemical Engineering

Outline

Background

Optimization of the use of rare metal has increasingly captured the attention of researchers for decades. The exploration of several strategies, which relate to find alternative materials (rare metal free materials), to minimize/reduce the use of rare metal, and to recover the rare metal itself, has become a great quest for large field of applications, especially facing with the limitation of resources.



Research Summary

1) Developments in the synthesis of rare metal-free material new phosphor / magnetic materials.
2) Techniques to optimize the use of rare metal based on particle nanotechnology.
   Elaboration of the particle processing of several morphologies (sphere, encapsulated, porous, and hollow) in terms of the selection of material types,
3) Recovering techniques to rare metal using bio-mineralization and bio-sorption

Result

- Rare-earth free BCNO phosphor (quantum efficiency= over 70%
- Hollow porous carbon materials and their application to fuel cell
- Pt supported WO_3 nanoparticle and their photocatalytic activity
- Structure control of fine particle used for phosphor and catalyst
- Recovery of tungsten using microbe (*E. coli*)

For Application

- Field of materials processing related to rare metal compound
- Field of particle technology for the advanced function materials
- Field of recovery of rare metal from the aqueous solution

Competitive Advantages

Due to the method outlined here can be broadly applied to the optimization of various types of functional materials, especially related to rare metal compound, we believe that this study contributes new information to the field of chemical, material, environmental, and medical engineering.

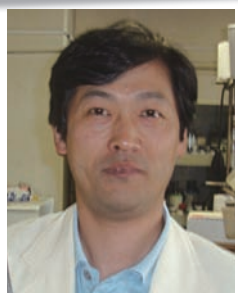
Patent/Journal/Award

42 papers, 22 Japanese reviews, and 5 awards (Please accesses to the following website.)

URL http://home.hiroshima-u.ac.jp/aerosol/ http://home.hiroshima-u.ac.jp/~ogit/index.html/

Material/Device

Organic Thin Film Solar-cell Materials



Keywords Solar Cells, Energy

Joji OHSHITA

Department Graduate School of Engineering
Title Professor
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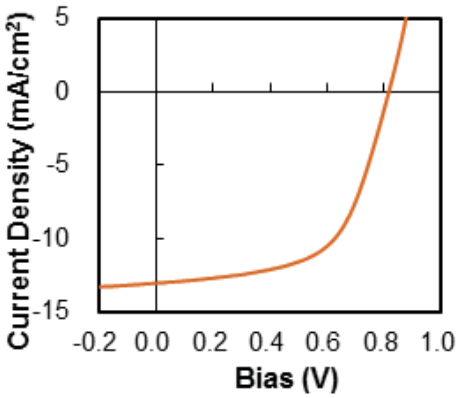
Field Organic Materials Chemistry

Outline

Background

The bulk heterojunction type polymer solar cell (BHJ-PSC) is of current interest because of its potential applications to low-cost, lightweight, and flexible modules. In this system, microphase-separated organic layers consisting of an electron-donating host polymer and an electron-accepting guest compound, such as PCBM derivatives, operate as the active components. Donor-acceptor (D-A) type polymers are extensively studied as the host.

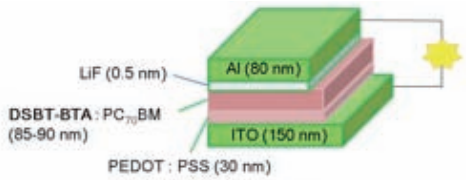


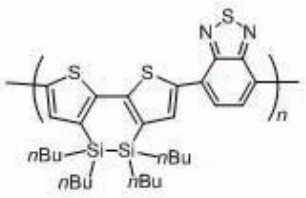
Research Summary

Silicon- and germanium-bridged bithiophenes were synthesized as the building blocks of the host polymers for BHJ-PSC.

Result

Polymers composed of the silicon-and germanium-bridged bithiophene were prepared and applied to BHJ-PSC. A maximal power conversion efficiency over 6 % was achieved.





pDSBT-BTA

For Application

Colaboration with industries is possible.

Competitive Advantages

The polymers may provide high open-circuit voltage.

Patent/Journal/Award

J. Ohshita, Y.-M. Hwang, T. Mizumo, H. Yoshida, Y. Ooyama, Y. Hariam, Y. Kunugi, Organometallics, 2011, 30, 3233.
J. Ohshita, M. Nakashima, D. Tanaka, Y. Morihara, H. Fueno, K. Tanaka, Polym. Chem. 2014, 5, 346.

URL http://home.hiroshima-u.ac.jp/orgmtrls/Ohshita_Group/Ohshita_Group-Home.html

Material/Device

Nanoparticle Synthesis, Dispersion and Functionalization for Industrial Applications

Keywords Nanotechnology, Material Science, Heat-transfer Engineering, Fine Particle Engineering, Chemical Engineering

Kikuo OKUYAMA

Department Graduate School of Engineering

Title Professor (Special Appointment)

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Field Process Engineering

Outline

Background

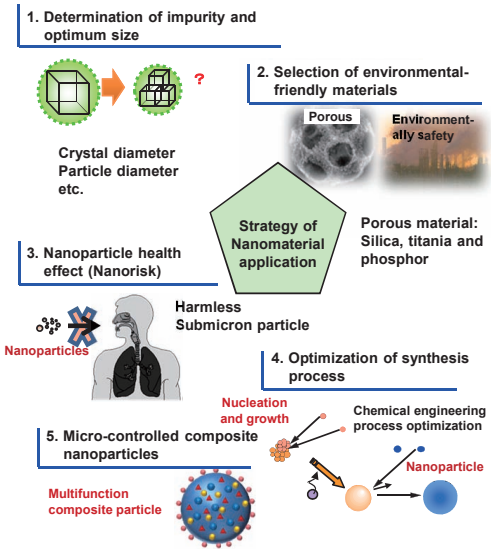
Various nanoparticle materials (with diameters less than about 100nm) are now under industrial application as electronic, optical, magnetic, cosmetic, drug materials and so on. The uses of these nanoparticles are expected to increase in the future from the viewpoint of energy conservation and the saving resource. However, since these nanoparticles are hard to handle compared to micron-sized particles, handling technology as well as nanoparticle synthesis methods become very important..

Research Summary

In the application of nanoparticle material, five strategies are under research;

(1) Determination of effect of impurity, outer size and crystal size on the function of nanoparticles.
(2) Development of new synthesis method for nanomaterial related to environment and energy related application.
(3) Self-organization method for avoiding the health effect(Nano-risk), and multi-structuralization of nanoparticles for better function.
(4) Optimization of synthesis process, nanoparticle dispersion by beads mill and surface modification for functionalization.
(5) Synthesis of controlled composite, porous, hollow and dense particles.

Moreover, nanoparticle measurement method , ion generation and nano-fiber synthesis are under research.



Result

- New aerosol and colloid synthesis methods are developed.
- Generation of ions by electrospray for the air purification.(ion-induced nucleation)
- Nano-fiber synthesis by electro-spinning for air filter application.
- Dispersion and coating of nanoparticles for thin film preparation.
- Self-organization of nanoparticles for various morphology particles.

For Application

Nanoparticles are key material in Nanotechnology, and are widely used in the field from engineering to medicine. Use of nanoparticles is expected to save energy and cost and expected to be widely available. However, nanoparticles are difficult to handle and handling technology as dispersion, coating, drying and so on becomes very important.

Competitive Advantages

From 2001 to 2006, “Nanoparticles Synthesis and Their Functionalization Technology” Project in NEDO’ nanotechnology program was conduced as joint research with 12 companies. Through this project, current status of nanoparticle synthesis, dispersion and functionalization technology was examined from the point of view of industrial application. Our researches on nanoparticle synthesis, dispersion and functionalization technology are well-known in the world.

Patent/Journal/Award

Many patents and about 400 SCI research papers were reported. From many awards, 2002 Fuchs Memorial Awards from the Aerosol Research Assembly and 2009 Society Award from the Society of Chemical Engineers, Japan, are representative.

URL http://home.hiroshima-u.ac.jp/aerosol/ Researcher ID in Web. of Science is F-6092-2010.

Material/Device

Development of Fluorescence PET (Photo-Induced Electron Transfer) Sensor for Water

Keywords Fluorescent Dyes, Water Detection, Sensors, Photo-induced Electron Transfer (PET), Zwitterionic Structure

Yousuke OOYAMA

Department Graduate School of Engineering

Title Associate Professor

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Field Basic Chemistry, Applied Chemistry, Materials Chemistry

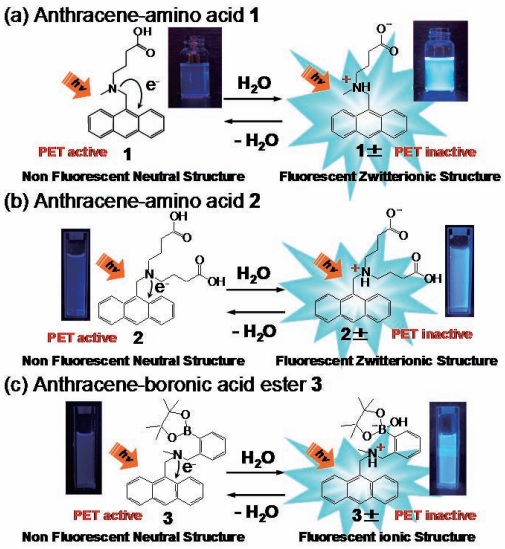
Outline

Background

Sensing water in organic solvents is of a practical importance as well as of a keen interest in fundamental analytical chemistry. Water sensors based on fluorescence measurements have been developed so far. In most of these fluorescence water sensors, however, the fluorescence intensity decreases with an increase of water in organic solvents and this feature makes them difficult to detect a trace amount of water. Thus, a new detection principle is required for improving sensitivities of fluorescence water sensors.

Research Summary

We have designed and synthesized anthracene-amino acids **1** and **2**, and anthracene-boronic acid ester **3** to develop a new class of fluorescence PET (photo-induced electron transfer) sensors for detection of water in organic solvents. An enhancement in fluorescence is observed with increasing water content in various organic solvents, which is attributable to the suppression of PET by the formation of fluorescent ionic structure by the intramolecular proton transfer of the carboxyl proton to the amino group for **1** and **2** and hydrolysis for **3**.



Result

The detection and quantitation limits of anthracene-boronic acid ester **3** are, respectively, 0.2 and 0.7 wt% for 1,4-dioxane, 0.2 and 0.5 wt% for THF, 0.04 and 0.1 wt% for acetonitrile and 0.04 and 0.1 wt% for ethanol. The fluorophore-boronic acid ester system is one of the most promising classes of fluorescence PET sensors for detection of a trace amount of water.

For Application

Further studies on development of the polymer film containing fluorescence PET sensor for detection of water in organic solvents and in the atmosphere are required.

Competitive Advantages

In most of conventional fluorescence water sensors, however, the fluorescence intensity decreases with an increase of water in organic solvents and this feature makes them difficult to detect a trace amount of water. On the other hand, In our fluorescence PET sensors, the addition of water to organic solvents containing the fluorescence PET sensors cause the formation of fluorescent ionic structure; the fluorescence enhancement of the PET sensors with the increase of water content is attributable to suppression of PET due to the formation of fluorescent ionic structure.

Patent/Journal/Award

1) Application No. JP 2009–249485, 2) JP2011–063291/ *Chem. Commun.*, **2011**, *47*, 4448–4450/ 1) Research Incentive Award in Electric Technology Research Foundation of Chugoku, 2) Nissan Chemical Industries, Ltd. Award in Synthetic Organic Chemistry, Japan, 3) Award for Yang Scientists in Industry-Academia Collaboration Program of Hiroshima University, 4) Young Scholar Lectures of the Chemical Society of Japan, 5) Honor for University Scientists in Hiroshima Bank, Ltd., 6) Academic Incentive Award in the UBE Foundation, 7) Incentive Award in Electro-Organic Chemistry, 8) Incentive Award in Chugoku-Shikoku branch of the Society of Synthetic Organic Chemistry, Japan, 9) Best Lecture Award in Japan Society of Colour Material, 10) DIC Award in Synthetic Organic Chemistry, Japan.

URL http://home.hiroshima-u.ac.jp/orgmtrls/Ohshita_Group/Ohshita_Group-Home.html

Material/Device

Mechanofluorochromism of D-π-A Fluorescent Dyes

Keywords D-π-A Fluorescent Dyes, Solid-state Fluorescence, Mechanofluorochromism, Rewritable Photoimaging and Electroluminescence Devices, Color Materials

Yousuke OOYAMA

Department Graduate School of Engineering

Title Associate Professor

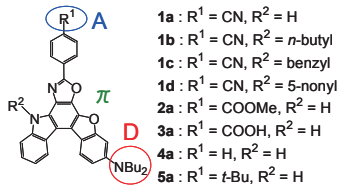
E-mail yooyama@hiroshima-u.ac.jp

Field Basic Chemistry, Applied Chemistry, Materials Chemistry

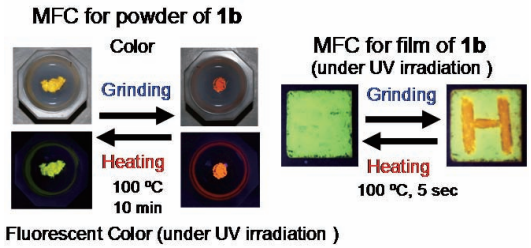
Outline

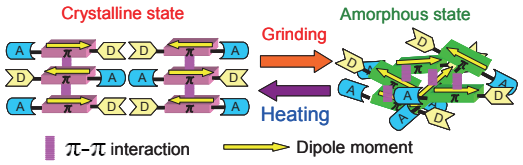
Background

Mechanofluorochromism (MFC) found recently denotes a change in fluorescent color induced by mechanical stress to organic crystal, being accompanied by a reversion to the original fluorescent color by heating or exposure to solvent vapor. Although it has received an increasing interest both in the fundamental research field of solid state photochemistry and in the applied field of optoelectronic devices, the number of organic fluorescent dyes exhibiting the MFC is still limited and the mechanism is a matter which requires intensive debates.



Heteropolycyclic D–π–A fluorescent dyes





Proposed mechanisms of MFC observed with heteropolycyclic D–π–A fluorescent dyes

Research Summary

We have found that newly developed heteropolycyclic donor-acceptor π-conjugated (D-π-A) fluorescent dyes with strong electron-withdrawing substituents as acceptor show MFC i.e., grinding of as-recrystallized dyes induces a fluorescent color change with an enhanced fluorescence quantum yield and the fluorescent color is recovered by heating or exposure to solvent vapor.

Result

We have demonstrated that the MFC is attributed to a reversible switching between crystalline and amorphous states with changes of dipole-dipole interaction and intermolecular π-π interaction by changes of the densities of the solids before and after grinding.

For Application

We believe that these mechanofluorochromic dyes can be a promising class of organic fluorescent dyes for rewritable photoimaging and electroluminescence devices.

Competitive Advantages

We propose that the most important point for developing MFC dyes is to design D-π-A fluorescent dye molecules with large dipole moments and thus strong D-π-A characters, which are controlled by tuning the electron-donating ability of D, electron-accepting ability of A, steric size of a substituent, and D-π-A system.

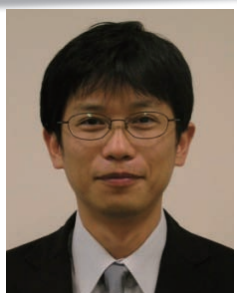
Patent/Journal/Award

1) *Eur. J. Org. Chem.*, **2009**, *31*, 5321–5326 (Cover Picture of Issue 31, 2009), 2) *J. Mater. Chem.*, **2011**, *21*, 8372–8380 / 1) Research Incentive Award in Electric Technology Research Foundation of Chugoku, 2) Nissan Chemical Industries, Ltd. Award in Synthetic Organic Chemistry, Japan, 3) Award for Yang Scientists in Industry-Academia Collaboration Program of Hiroshima University, 4) Young Scholar Lectures of the Chemical Society of Japan, 5) Honor for University Scientists in Hiroshima Bank, Ltd., 6) Academic Incentive Award in the UBE Foundation, 7) Incentive Award in Electro-Organic Chemistry, 8) Incentive Award in Chugoku-Shikoku branch of the Society of Synthetic Organic Chemistry, Japan, 9) Best Lecture Award in Japan Society of Colour Material, 10) DIC Award in Synthetic Organic Chemistry, Japan.

URL http://home.hiroshima-u.ac.jp/orgmtrls/Ohshita_Group/Ohshita_Group-Home.html

Material/Device

Preparation of New Metal Oxide Cluster and Application as Functional Materials



Keywords Catalysis, Negative Staining Reagent, Polyoxometalate

Masahiro SADAKANE

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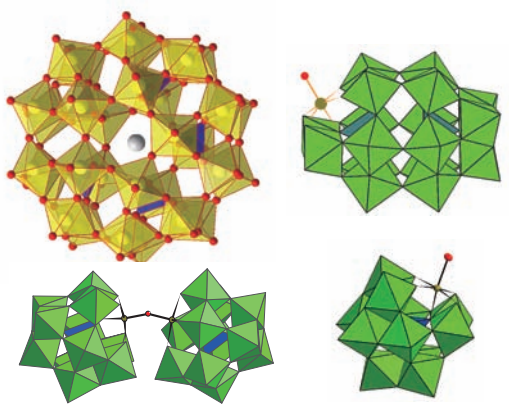
Field Chemistry, Inorganic Chemistry, Catalysis, Material

Outline

Background

Polyoxometalates are metal oxide clusters, and used as industrial catalysts and negative staining reagent for virus observation.



Research Summary

I am preparing new polyoxometalates and applying my new compounds as functional materials such as catalyst and negative staining reagent.

Result

I prepared new polyoxometalates, which show good catalytic activities and good negative staining feature.

For Application

Catalyst, TEM staining reagent.

Competitive Advantages

I can modify molecular structure of metal oxide clusters.

Patent/Journal/Award

BCSJ Award

URL http://home.hiroshima-u.ac.jp/sada/

Material/Device

Development of Zeolite Synthesis - Interzeolite Conversion

Keywords Inorganic Porous Materials, Zeolite, Catalyst

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Title Professor

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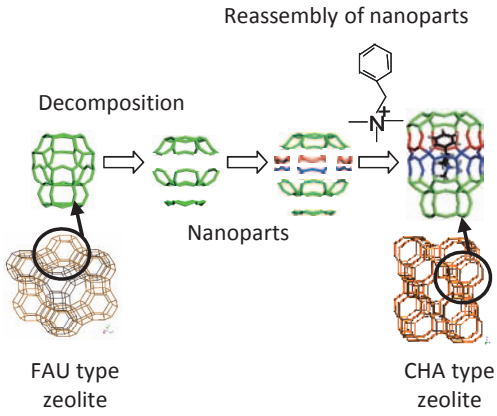
Field Catalyst and Chemical Process, Inorganic Industrial Materials

Outline

Background

Zeolites are microporous aluminosilicate minerals comprising Al, Si, and O, and they have been applied to various purposes such as water purification, as catalysts and laundry detergents, and in nuclear processing. Zeolites with unique properties such as solid acidity, large internal surfaces, molecular sieving and ion-exchange abilities are conventionally synthesized by the hydrothermal treatment of amorphous aluminosilicate gel as the starting material in the presence of organic and/or inorganic structure-directing agents.

Concept of interzeolite conversion process – "Lego" Zeolite Synthesis



Research Summary

We have investigated the hydrothermal conversion of one zeolite type into another (interzeolite conversion), assuming that locally ordered aluminosilicates (nanoparts) generated from the starting zeolite are precursor species for nucleation and crystal growth of another zeolite. Namely, the crystallization process of zeolite by interzeolite conversion would involve reassembly and evolution of the nanoparts. It is believed that the interzeolite conversion route is an alternative strategy for zeolite synthesis.

Result

We succeeded in synthesizing several types of zeolites, such as *BEA, RUT, CHA, LEV, MTN, and OFF type zeolites using FAU and *BEA type zeolites as the starting material. The interzeolite conversion method was applied to the preparation of CHA type zeolite membrane.The CHA type zeolite membrane prepared on the porous α-alumina tube demonstrated a high separation factor, α(H_2O/CH_3COOH), of ca. 2500 with a permeate flux of ca. 8 kg m^{-2} h^{-1}.

For Application

CHA type zeolite membrane synthesized by the interzeolite conversion method exhibits the high potential for the effective future application for use in the separation of water from acidic organic solvents, not limited to acetic acid.

Competitive Advantages

The use of FAU and *BEA type zeolites as a starting material for the preparation of other zeolites results in a crystallization rate that is superior to that achieved in the conventional synthesis using amorphous aluminosilicate gel as the starting material. This enhanced crystallization rate arises because the decomposition/dissolution of the starting zeolite generates nanoparts that assemble and evolve into another type of zeolite.

Patent/Journal/Award

・Catalysts & Catalysis, 53, 392–397 (2011).
・Patent Application No. JP 2012–052163.
・J. Jpn. Petrol. Inst., 56, 183–197 (2013).
・Zeolite, 31, 19–26 (2014).
・Award from Catalysis Society of Japan (2014).

URL http://home.hiroshima-u.ac.jp/catalche/

Material/Device

Preparation of Fine-structured Surfaces and Surface Contamination by Gasborne Nanosized Materials

Keywords Gas-phase Processing, Functional Material, Nanoparticle, Thin Film, Surface Contamination

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Field Process Engineering

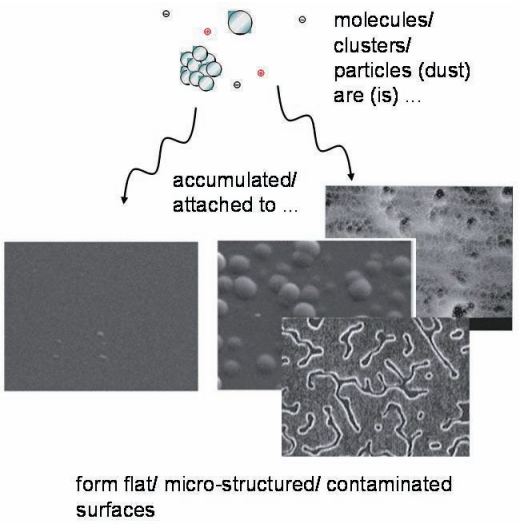
Outline

Background

Industrial process are desired that are capable of manufacturing functional thin films with a micro-engineered morphology and composition on solid walls. Besides, contamination and damage of solid walls by exposure to gasborne materials hinder manufacturing processes.

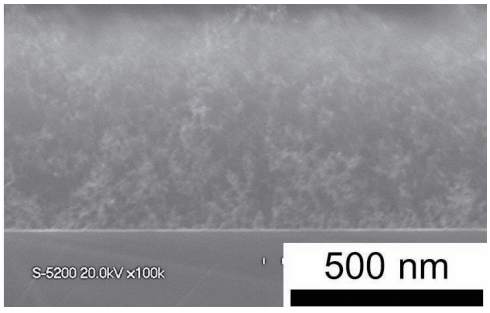
Research Summary

Thin films are fabricated with materials deposited on the wall surfaces by synthesizing and transporting nanosized materials in the gas phase with reaction and phase-transition fields such as high-temperature gas and plasma. In addition, the effects of attaching undesirable foreign materials to the surfaces are investigated.



Result

The conditions have been clarified under which dense films having a flat surface, or uniformly-structured porous films consisting of nanoparticles, can be fabricated. The possibilities of controlling the size and crystallinity of particles in the films have also been confirmed. Novel methods are being developed for fabricating composite thin films in which different materials coexist. Moreover, the elucidation of the mechanisms related to micro-contamination by particulate and molecular materials is also in progress as well as the development of the techniques for preventing the contamination.



For Application

The methods developed are considered to be applied to the manufacturing processes for surfaces having mechanical, optical or electrical functions or those with a high catalytic activity. The comprehension and control of the micro-contamination are expected to lead to efficient and resource- and energy-saving manufacturing processes.

Competitive Advantages

The methods developed for the thin films are gas-phase processes and are therefore advantageous in designing composition of the films and selecting manufacturing conditions. Since many industrial processes are involved in the contamination by gasborne nanomaterials, the knowledge and techniques obtained here will be widely applicable.

Patent/Journal/Award

URL http://www.chemeng.hiroshima-u.ac.jp/material/

Material/Device

Preparation and Properties of Stereocomplexes of Lactic Acid Copolymers Having High Heat-resistance and Impact Resistance

Keywords High Heat-resistance, Impact Resistance, Lactic Acid Copolymer, Stereo Complex

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Title Associate Professor

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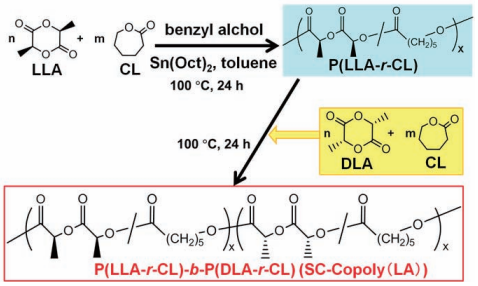
Field Polymer Chemistry, Material Chemistry, Material Engineering

Outline

Background

Poly (lactide), i.e., poly (lactic acid) (PLA) can be expected as an environment-friendly substitute material for conventional oil-based plastics. However, the melting point (T_m) of PLA is rather low compared with polyamides, and so PLA is not very heat-resistant. For increasing this T_m of PLA, the stereocomlex of poly [L-lactic acid (LA)] (PLLA) with poly (D-LA) (PDLA) has been prepared. The heat-resistance of the stereocomplex of PLA homopolymers (SC-PLA) has increased, but its brittleness could not be improved. Therefore, we have been aiming at preparing stereocomplexes of LA copolymers (SC-Copoly (LA)) having both high heat-resistance and impact resistance.

Scheme 1. One-pot Synthesis of SC-Copoly(LA-*r*-CL)



Research Summary

Conventionally, SC-PLA and SC-Copoly (LA) were prepared by dissolving and mixing of those polymers in solvent[1]. Here, we have tried to obtain SC-Copoly (LA) by one-pot synthesis (Scheme 1). The e-caprolactone (CL) monomer was used as elastomer. We have measured thermal and mechanical properties such as T_m and tensile strength. Further, the enzymatic degradation of these SC-Copoly (LA) was investigated.

Table 1. Thermal Properties of SC-Copoly(LA-*r*-CL)

Polymer	LA/CL (molar ratio) [a] Feed	LA/CL (molar ratio) [a] Observed	T_g [b] °C	T_m [c] °C	$-\Delta H_m$ [c] J/g
SC-Copoly①	90/10	91/9	37.8	201.8	39.9
SC-Copoly②	70/30	79/21	25.5	191.4	28.9
SC-Copoly③	50/50	54/46	-	162.8	14.0
P(LLA-*r*-CL)④	60/40	79/21	23.4	150.8	32.2
P(DLA-*r*-CL)⑤	70/30	78/22	29.9	156.8	32.7
Blend (④+⑤)	-	-	26.9	202.7 147.7	25.6 5.5
PLLA	100/0	100/0	40.3	178.2	57.2

[a]Determined by ^{1}H-NMR. [b]Determined by DSC in the 2nd heating. [c]Determined by DSC in the 1st heating.

Result

Thermal properties of obtained stereocomplexes of LA/CL copolymers [SC-Coply (LA-*r*-CL)] are shown in Table 1. The T_m of SC-Coply (LA-*r*-CL) ② is about 40°C higher than that of LA/CL copolymer ④ having almost the same LA/CL molar ratio. This result may show that we can obtain the SC-Coply (LA-*r*-CL) by one-pot synthesis. The X-ray diffraction (XRD) method also demonstrates the stereocomplex formation of SC-Coply (LA-*r*-CL). Furthermore, the mechanical properties shows that the values of elongation at break of SC-Coply ② and ③ are about ten times and hundred times greater respectively than that of PLLA, indicating that the elasticity, in other words, the impact resistance of SC-Coply (LA-*r*-CL) is much more improved compared with PLLA.

For Application

Industry/application: interior parts of automobile, housing of household appliances; challenge : shortening of reaction time, high-price of LA monomer; requests for industry : price down of LA, especially that of D-LA monomer.

Competitive Advantages

①Superiority in heat-resistance and impact resistance compared with PLLA, ②One-pot synthesis of stereocomplex of LA/CL copolymer

Patent/Journal/Award

patent: to be prepared / Journal: H. Shirahama, A. Ichimaru, C. Tsutsumi, Y. Nakayama, H. Yasuda, *J. Polym. Sci. Part A: Polym. Chem*. **2005**, 43, 438–454 / Award: NEDO Award of “1st Monozukuri Renkei Taisho (1st Manufacturing and Cooperation Award)” sponsored by The NIKKAN KOGYO SHIMBUN.

URL http://www.hiroshima-u.ac.jp/techrd/

Material/Device

Exploitation of New Functions of Materials by Using Multi-extreme Conditions

Keywords New function,Multi-extreme,Temperature,Pressure,Magnetic field

Takashi SUZUKI

Department Graduate School of Advanced Sciences of Matter

Title Professor

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Field Cryogenics, Condensed Matter Physics, Physical Acoustics, Superconductivity, Strongly-Correlated Electron, Multiferroics

Outline

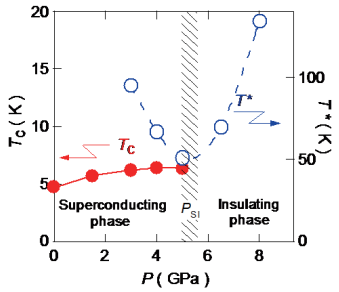
Background

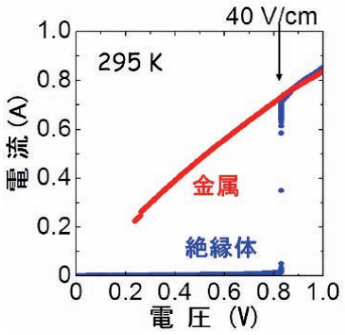
Research Summary

The properties of materials are those of electrons that constitute the materials. Electrons have electric charge in themselves and are magnets. The quantum-mechanical properties of electrons that contain full of new functions become obvious at low temperatures. On the other hand, materials respectively have their characteristic structures. Therefore, control of structure and electrical/magnetic properties of material, if possible, could be a shortcut to exploit new functions.

We are working hard to exploit new functions and clarify formation mechanisms of new functions in superconductors and materials of strongly-correlated electronic system, by controlling material parameters through skillful utilization of multi-extreme conditions such as ultra-low temperature of -273 degrees C or below, ultra-high pressure of 80,000 atmospheric pressure or higher and 140,000 gauss or higher and precisely measuring structures, conduction, thermodynamic properties, etc. of materials.

One of our typical results achieved recently is discovery of a material which transforms directly to an insulating material from the superconducting status when pressurized. This is the first example of inorganic 3D superconductor in the world.





Result

For Application

We are ready to participate in joint studies and offer contracted studies with enterprises and other organizations interested in this field.

Competitive Advantages

Patent/Journal/Award

Patent:

Takashi Suzuki US 8,338,821 B2 (25DEC2012)

"Pressure detection apparatus, Josephson device, and superconducting quantum interference device that include superconductor thin film that undergoes transition from superconductor to insulator by pressure"

Publication:

1) F. Nakamura, T. Suzuki, Y. Maeno et al., Scientific Report 3 (2013) 2536.

2) I. Ishii, T. Suzuki el al., Physical Review B87 (2013) 205106.

URL http://home.hiroshima-u.ac.jp/ltlab/index.html

Material/Device

Preparation of Submicron Size Spherical Porous Carbons and their Applications for Electrode Materials

Keywords Carbon Materials, Spherical Porous Carbon, Lithium Ion Battery Anode, Electric Double Layer Capacitor Electrode

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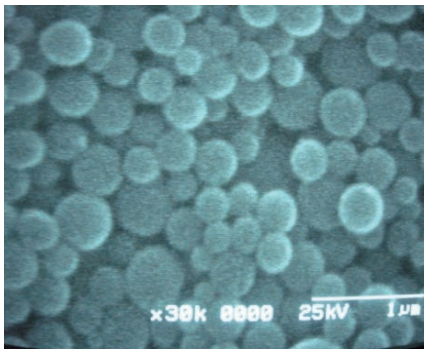
Field Functional Materials

Outline

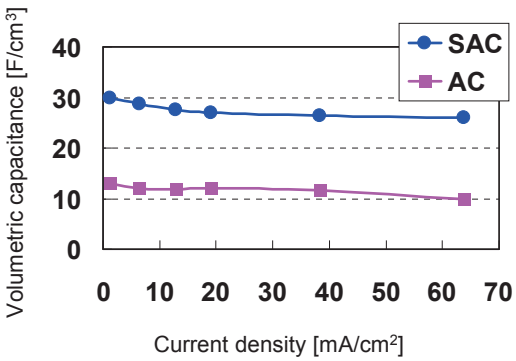
Background

Carbon materials have attracted much attention as electrode materials for electric storage devices such as electric double layer capacitor (EDLC) and lithium ion battery (LIB)
The improvements of electric storage characteristics such as energy density, power density, and cycle performance are still now required.



Research Summary

Submicron-size spherical particles of phenol-resin, which were prepared by the use of surfactants, were used as a source of carbon particles. The spherical phenol-resin particles were carbonized and then followed by steam activation. As a result, fine spherical porous carbons(SAC) were obtained. The electrode performances of the carbon particles obtained for electrodes of EDLC and LIB were investigated.



EDLC volumetric capacitance

Result

The EDLC volumetric capacitance of SAC(30 F/g) is much higher than that of traditional activated carbon powders (AC). For LIB, SAC exhibits satisfactorily stable cycle performance and has reversible capacity more than 700 mAh/g even after ten cycles.

For Application

Lithium ion secondary battery makers, Makers of electric double layer capacitor, Car industries

Competitive Advantages

Compared with commercially powdered carbons, the obtained spherical carbon particles exhibit extremely high capacity for LIB, high volumetric capacitance for EDLC, and good cycle performances.

Patent/Journal/Award

URL

Material/Device

Polymer Crystallization and Melting Kinetics

Keywords Polymer, Crystallization, Melting, Kinetics

Akihiko TODA

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Title Professor

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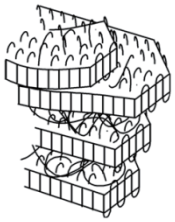
Field Polymer Physics

Outline

Background

Important role of structure control and thermal stability of crystalline polymeric materials



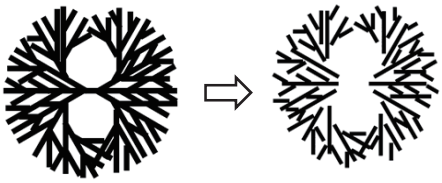
Crystalline-amorphous stacked layers in crystalline polymers

Research Summary

Studies starting from growth kinetics and morphology of polymer single crystals, the evolution mechanism of polymer spherulites, i.e. basic structure of all crystalline polymers. Melting kinetics of those structures analyzed in quantitative ways.

Result

Successful explanation of the evolution mechanism of polymer spherulites based on experimental observations. Unique approach to the melting kinetics studied by steady heating and temperature-modulation.



Melting of Polymer Spherulites

For Application

For polymer industry, the structure control and thermal analysis of crystalline polymeric materials.

Competitive Advantages

Various preparation and observation methods including multi-step temperature jump, growth under temperature gradient, etching. Unique thermal analysis.

Patent/Journal/Award

URL http://home.hiroshima-u.ac.jp/atoda/

Material/Device

Self-healing Coatings for Corrosion Inhibition

Keywords Self-healing, Coatings, Corrosion, Corrosion Inhibition, Steel, Light Metal

Akihiro YABUKI

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Title Associate Professor

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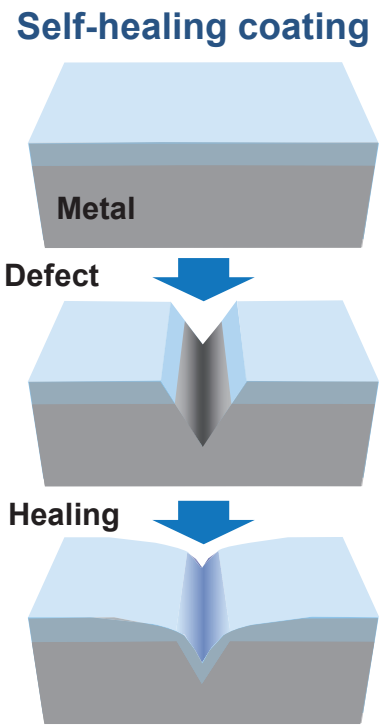
Field Material Chemistry, Material Engineering, Process Engineering

Outline

Background

Coatings have been widely applied as a surface treatment to prevent the corrosion of metallic materials. One of the most important characteristics required for the coatings is the ability to self-heal, so that the mechanically damaged surface is automatically repaired by a chemical component of the coating.



Research Summary

The corrosion inhibition properties of the coatings using various additives for metallic materials were investigated. Several types of coatings were prepared, and after using a knife to create a defect in the coating, the self-healing property of the coatings was evaluated based on electrochemical impedance measurements in corrosive solution.

Result

Self-healing corrosion protective coatings using polymer and metal powders, a fluoro-organic compound, casein as a pH-sensitive organic agent, and TiO_2 particle-polymer composite have been developed.

For Application

The key to the development of self-healing coatings is the ability to control both the storage and release of the added corrosion inhibitors.

Competitive Advantages

Environmental concerns have necessitated the reduction and discontinuation of chromate conversion coatings which have the repairing effect. The developed coatings are alternative technologies.

Patent/Journal/Award

Science and Technology Encouraging Award, Development of Self-healing Corrosion Protective Coatings, The Suga Weathering Technology Foundation Progress Award, Study of Erosion and Erosion-Corrosion, Japan Society of Corrosion Engineering

URL http://selfhealing.hiroshima-u.ac.jp/

V

Mechanical Engineering

Mechanical Engineering

Shear Force Sensor of Sheet Type Suitable for Friction Force Measurement

Keywords Frictional Force, Shearing Force, Sensor, Measurement, Bedsore, Walk Analysis

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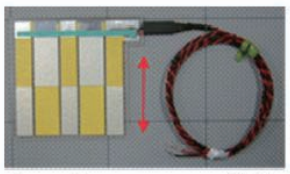
Department Graduate School of Engineering
Title Professor

E-mail fujimoto@naoe.hiroshima-u.ac.jp **Field** Sensor Engineering, Reliability Engineering, Fracture Mechanics

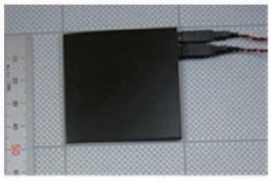
Outline

Background

The various kind of sensors were developed for pressure measurements, but there are very few which can measure the shear force (frictional force). If there is a sheet type shear force sensor, it is thought such a sensor may be useful in the welfare and the support technology of care, and for the human and animal movement analysis.



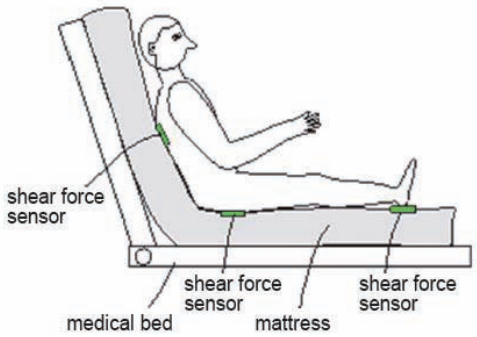
1 axis shear force sensor of 50mm square



2 axes shear force sensor of 50mm square

Research Summary

The sensor developed here is a sheet type sensor with about 3mm thick that can measure shear force working in the boundary surface, for example, at the interface between a body and a bed. The feature of the sensor is that the surface is flat so that there is little sense of incongruity when it touches the body. In addition, it is intended to measure not only the one-axis shear force but also the two-axis shear force. Also, it is necessary to be able to measure both static friction and succeeding dynamic slide friction.



Result

The right figure shows photographs of the sheet type shear force sensor of 1 axis (transparent) and 2 axes, and an application image in a medical bed. One-axis sensor is about 2mm thick and two-axis sensor is about 4mm thick. The shearing force acting on the sensor is converted into tension and compression force of the piezoelectric film, and causes an electric charge.

For Application

Fields of nursing care, robotics, clothing and bedding maker, ergonomics and the zoological study.

Competitive Advantages

The shearing force sensor similar to this study is not seen in a conventional technique. If sensor performance is recognized, it is thought to become a dominant technique.

Patent/Journal/Award

“Sheet type shear force sensor by the use of piezoelectric film”, Transactions of the Japan Society of Mechanical Engineers, under contribution.

URL http://www1.megaegg.ne.jp/~keisokusp/

Mechanical Engineering

Efficient Parametric Excitation Walking

Keywords Bipedal Robot, Parametric Excitation Walking

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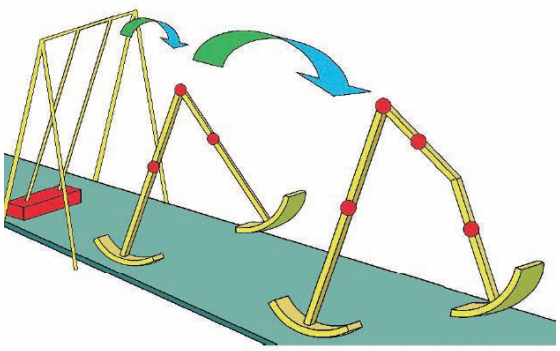
Field Mechanical, Electric/Electronic

Outline

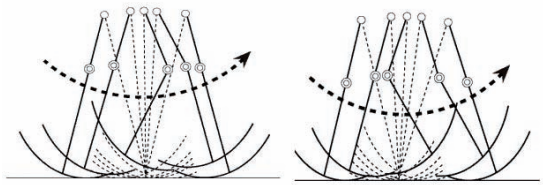
Background

Bipedal walking is one of the essential technologies for humanoid robots. To realize efficient gait, the principle of a children's swing, parametric excitation principle, was applied to a biped robot with a telescopic leg and a sustainable gait was realized.



Research Summary

The method based on parametric excitation principle is applied to a kneed biped robot. Only knee torque is used without the hip torque and a sustainable gait is realized. To improve efficiency of parametric excitation walking, inverse bending knee gait is proposed.



Forward bending Inverse bending

Result

It is shown that proper knee motion generates a sustainable gait without hip and ankle actuation. It is also shown that inverse bending knee walking is more efficient than forward bending knee walking.

For Application

These results will contribute gait generation for humanoid robots and gait assistance for aged and injured people.

Competitive Advantages

In general, biped robots bend a swing leg to avoid scuffing the ground. In this research, the motion of the swing leg is utilized to improve gait efficiency.

Patent/Journal/Award

Yuji Harata, Fumihiko Asano, Zhi-Wei Luo, Kouichi Taji, Yoji Uno, "Biped gait generation based on parametric excitation by knee-joint's actuation," ROBOTICA, Vol.27, issue 07, pp.1063–1073, 2009.
Yuji Harata, Fumihiko Asano, Kouichi Taji, Yoji Uno, "Ornithoid Gait Generation Based on Parametric Excitation," Robotics Society of Japan, Vol.27, No.5, pp.575–582, 2009 (in Japanese).

URL http://home.hiroshima-u.ac.jp/dynamics/

Mechanical Engineering

Vibration Control of Elastic Structures Utilizing Sloshing in Liquid Tanks

Keywords Mechanical Vibration, Liquid Sloshing, Passive Damper

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Field Mechanical Engineering, Mechanical Vibration and Control

Outline

Background

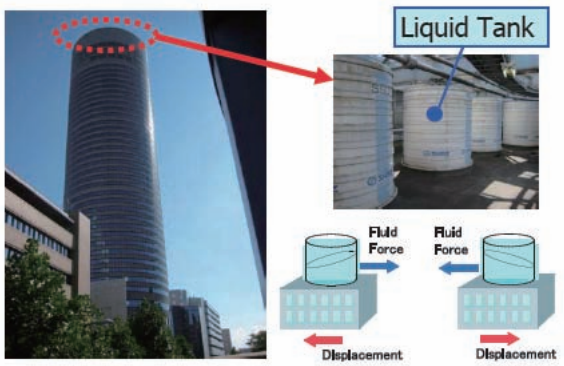
Tuned liquid dampers (TLDs) have been utilizing as control devices for mechanical and structural systems. Structure's vibrations are suppressed by sloshing in liquid tanks. However, the performance of TLDs has not been sufficiently investigated.

Research Summary

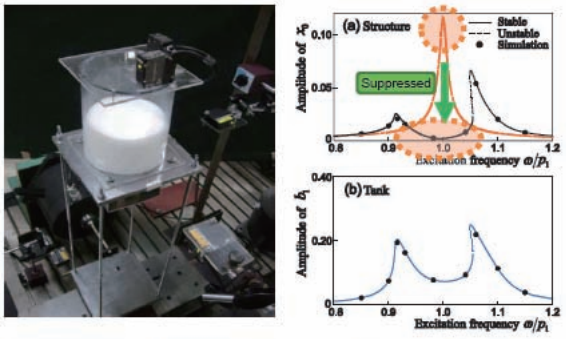
When liquid tanks move, the liquid free surfaces are stirred, and fluid forces act on the tank side walls. The nonlinear fluid force may be generated when the liquid elevation is high. In order to assess the performance of TLDs, the fluid force should be theoretically determined considering the nonlinearity of sloshing. The goal of this research is to give the design manual for manufacturing the optimal TLDs using rectangular, square and cylindrical tanks.

Result

The theoretical method to assess the performance of TLDs was achieved and facilitates the design of optimal TLDs. It is found from the theoretical and experimental results that TLDs are effective to both horizontal and vertical excitation.



Shin-Yokohama Prince Hotel　Mechanism of Control



Experimental Apparatus　Theoretical Results

For Application

- Vibration control of vibrations in High-rise flexible structures (high-rise buildings, towers, long span bridges)
- Theoretical analysis of sloshing dynamics in car fuel tanks
- Vibration analysis of sloshing in large liquid storage tanks
- Vibration analysis in sloshing in liquid transportation vehicles

Competitive Advantages

Although tuned mass dampers (TMDs) have been conventionally used as vibration control devices, TLDs have competitive advantages such as low cost, simple structure, maintenance free and convenient installation to the structure.

Patent/Journal/Award

The 2006 JSME Medal for Outstanding Paper, "Autoparametric Responses of an Elastic Structure Carrying a Cylindrical Tank (2nd Report, Influence of the Detuning Parameter)", awarded by the Japan Society of Mechanical Engineers, April 2007.

URL http://home.hiroshima-u.ac.jp/dynamics/

Mechanical Engineering

Hydrodynamic Force Characteristics on Maneuvering of Full Ship in Shallow Water

Keywords Full Ship, Maneuverability, Course Stability, Shallow Water Effect

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Field Naval Architecture and Ocean Engineering

Outline

Background

A large ship faces difficulties to access a port and canal due to the water's depth restriction where the ship maneuverability becomes much different from open sea. In view of safety, the shallow water effect on ship hydrodynamics should be understood. But there is not so much open-data so far.

Research Summary

Floor panels were set on platforms standing on the bottom of Hiroshima University towing tank and a series of maneuvering tests were conducted in shallow water, i.e. h/d=1.2 and 1.5 (h: water depth, d:ship draft). The 1/110 scaled-down KVLCC2 model, which is a modern standard 300K tanker ship with V-shaped frame-lines, was used as a studied ship.

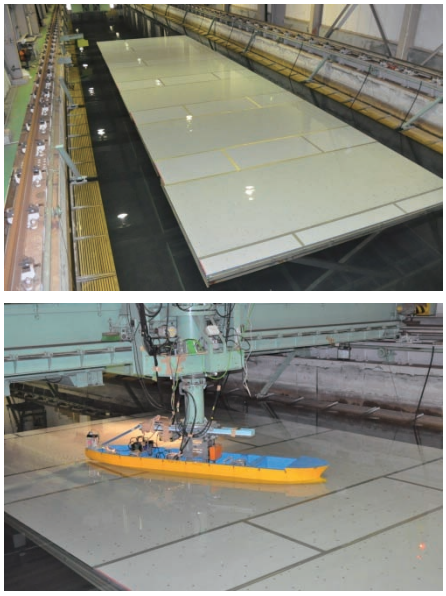

Figure: Experiment in shallow water (Hiroshima University towing tank)

Result

The influences of the shallow water effect on the interactions between main hull, rudder and propeller were investigated. They are essential for the maneuverability in shallow water. The course stability of KVLCC2 was also discussed based on the linear hydrodynamic derivatives, which seemed to improve constantly as the water depth becomes shallow, which is a different tendency from a conventional type of tanker ship (ESSO OSAKA).

For Application

A large full ship is normally difficult to operate so the helmsman would feel stressful especially when navigating in restricted water, e.g. port or canal. So in the stage of ship design, it is recommended that the maneuverability and course stability both in deep and shallow water should be predicted well according to these tank experiments.

Competitive Advantages

Since there are a few institutes where experiments can be conducted in shallow water, a lot of interests are still in ship hydrodynamics. The measured data in this study would be useful to understand the maneuverability and course stability for a modern VLCC and contribute to a safe navigation.

Patent/Journal/Award

URL

Mechanical Engineering

Load-sensitive Continuously Variable Transmission Using an Oblique Feed Screw

Keywords Continuously Variable Transmission, Feed Screw, Machinery

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Field Mechanical, Electric/Electronic

Outline

Background

If the reduction ratio of a driving mechanism is constant, it is difficult to improve performances of speed and force simultaneously. A continuously variable transmission is a solution to this problem.

Research Summary

We propose an oblique feed screw that can be used as a loadsensitive continuously variable transmission (CVT). This CVT consists of a feed screw, spring, and bearing, and it is remarkably simple and compact. Its reduction ratio changes automatically in response to the load.

Result

We developed remarkably simple CVT and weighs only 13.8 g. We have experimentally verified that it can exert a large force of more than 100 N, and that its reduction ratio can be increased from 20 to 45.

For Application

Suitable applications are driving mechanisms for a robot joint and a liner motion mechanism

Competitive Advantages

Compact, lightweight and simple

Patent/Journal/Award

Takeshi Takaki, Toru Yamasaki and Idaku Ishii: Load-sensitive continuously variable transmission using an oblique feed screw for parallel-jaw grippers, in Proc. 2011 Int. Symposium on Micro-Nano Mechatronics and Human Science, 2011.

URL http://www.robotics.hiroshima-u.ac.jp/

Mechanical Engineering

Fault-tolerant Controller Synthesis for a Mechanical System

Keywords Fault-tolerant, Feed Back Control, On-line Optimization, Mobile Robot

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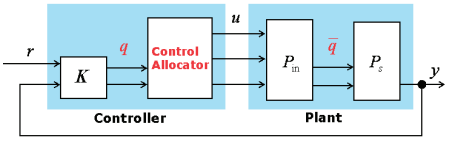
Field Control Engineering, Mechatronics

Outline

Background

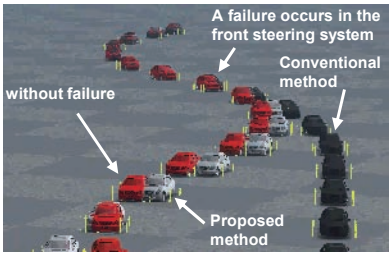
Recent mechanical systems are strongly required to be energy efficient in addition to high performance. To satisfy such requirements, the mechanical systems tend to be much more complex. In such systems, when one of components fails, the control performance of the entire system may be seriously deteriorated. Therefore, in particular, the mechanical system that has interactions with human must be designed to be robust against failures of the system.



$$\underset{u}{\text{minimize}} \quad \|\bar{q}-q\|_2^2$$
$$\text{subject to} \quad u_{i\min} \le u_i \le u_{i\max}, \quad i=1,2,\cdots,m$$

Research Summary

In order to synthesize a control system that is robust against actuator failures, the controlled object is usually designed to have redundant actuators. In such a system, even when one of the input channels fails, the system could continue to operate by utilizing the remaining input channels. To fully utilize the actuator redundancy, the control allocator that distributes the control signal calculated by the controller to each input channels appropriately must be inserted between the controlled object and the controller. The on-line based control allocator is known as one of the effective and practical devices for distributing the control signal. The advantage of this approach is that the design problem of the feedback controller and the control allocator can be separated, and hence the design problem of the control system becomes quite simple. In addition, since the control allocation is reduced to the convex quadratic programming, the on-line computational burden is relatively small. However, in the previous studies, it had been unclear whether the closed-loop stability can be assured when the actuator failure occurs. Thus, in this study, we have proposed a method to evaluate stability of the entire system with control allocator under actuator failure. Also, we have shown a design method of a controller that maintains control performance as much as possible.



Result

An analysis method to evaluate stability of the control system under actuator failure has been proposed. Based on this result, a design method of a control system that minimizes deterioration of the control performance under actuator failure has been proposed. The effectiveness of the proposed control method has been demonstrated by a numerical example of a yaw-rate control problem of a steer-by-wire vehicle.

For Application

Recently, the so-called by-wire systems have been introduced into automobiles in order to utilize active safety technologies. It can be expected that the proposed control method can be applied to such vehicles to enhance robustness of the control system against actuator failure. Similar control problems can also be seen in the areas of aircrafts and ships.

Competitive Advantages

The proposed control algorithm is reduced to a convex quadratic programming problem. Hence, its computational burden is relatively small. In addition, the control system can be realized as the output feedback. Moreover, the stability of the entire system is guaranteed.

Patent/Journal/Award

[1] N. Wada et al.: Model Predictive Tracking Control for a Linear System under Time-varying Input Constraints; International Journal of Robust and Nonlinear Control, to appear

[2] N. Wada et al.: Vehicle control with anti-failure performance based on time optimization, Proc. SICE Conference on Control Systems, 2012 (in Japanese)

URL http://home.hiroshima-u.ac.jp/~control/

Mechanical Engineering

Reinforcement Learning Approach for Cooperative Behavior Acquisition in Homogeneous Multi-robot Systems

Keywords Multi-robot System, Cooperation, Computational Intelligence, Reinforcement Learning

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Field Informatics, Mechanical Engineering, Electrical and Electronic Engineering

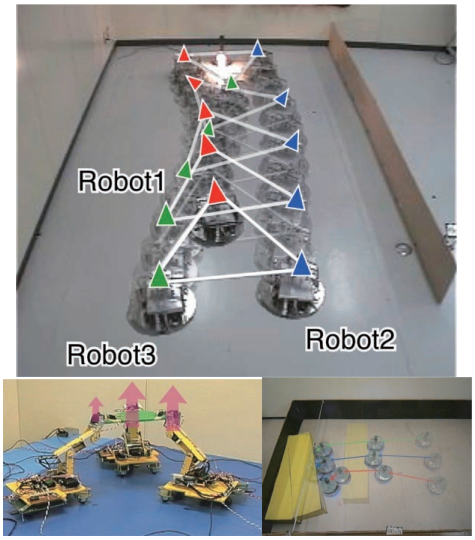
Outline

Background

Multi-robot systems (MRS) can be defined as a group of autonomous, interacting entities sharing a common environment, which they perceive with sensors and upon which they act with actuators. MRS have recently attracted considerable attention from roboticists as these offer the possibility of performing a task that a single robot cannot.

Research Summary

Reinforcement learning (RL) is one of the popular methods to autonomous robotics research and is available for solving the singlerobot tasks regardless of whether or not the robot knows the dynamics of the environment and the task. Together with the simplicity and generality of the implementation, this makes RL attractive also for MRS. However, several new challenges arise for RL in MRS. This is chiefly because traditional RL approaches are based on MDP/discretized state and action spaces. To overcome this problem, an RL technique was developed that has a mechanism for autonomous segmentation of continuous state and action spaces. Besides, our RL technique, termed BRL, has been extended for improving its robustness. A support vector machine is used for rule selection after a robot collects plenty of data by BRL.



Result

Throughout several multi-robot cooperation task, globally stable behavior was observed. It is found that the proposed RL can develop cooperative behavior in MRS from scratch and can adaptively coordinate rule parameters after an environmental change.

For Application

The performance of the proposed method is evaluated in homogeneous multi-robot systems. These results can contribute to human-robot cooperation.

Competitive Advantages

The focal point is giving an ability to acquire cooperative behavior through experience to each robot by autonomous role development and assignment. This provides a multi-robot system with the potential for versatility and system-level robustness.

Patent/Journal/Award

T. Yasuda, K. Araki, and K. Ohkura, “Improving the Robustness of Instance-Based Reinforcement Learning Robots by Metalearning”, Journal of Advanced Computational Intelligence and Intelligent Informatics, Vol.15, No.8, pp.1065–1072 (2011)

J. Sakanoue, T. Yasuda, and K. Ohkura, “Preservation and Application of Acquired Knowledge Using Instance-Based Reinforcement Learning for Multi-Robot Systems”, Journal of Advanced Computational Intelligence and Intelligent Informatics, Vol.15, No.8, pp.1109–1115 (2011)

T. Yasuda, S. Nomura, and K. Ohkura, “Self-Organized Task Allocation between Reinforcement Learning Robots and a Human Partner”, International Journal of Advancements in Computing Technology, Vol.4, No.22, pp.230–238 (2012)

URL http://www.ohk.hiroshima-u.ac.jp/~yasuda/index.html

VI

Civil Engineering/ Architecture

Civil Engineering/ Architecture

Modeling of Large-amplitude Seiches

Keywords Seiche, Harbor Resonance, Two-way Nested Model

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Field Physical Oceanography

Outline

Background

In some bays or harbors along the east coast of Kyushu or the coast of the San-in district in Japan, large-amplitude sea-level oscillations are sometimes observed in the subtidal frequency range. These are called seiches, and cause inundation of houses and stranding of small boats. Studies of numerical prediction of such seiches are needed but are not performed in Japan.

Research Summary

As a first step of developing a forecast model of seiches, a hindcast model of past seiches has been developed. As a recent example of seiches, the seiches in Nagasaki Bay and Youkaku Bay along the west coast of Kyushu from 24 to 25 February 2009 were targeted for modeling.

Result

The shallow-water equations are employed as model equations, which are solved numerically using finite-difference method. In order to resolve harbors enclosed by breakwaters, several model domains with different resolution are nested bidirectionally. A hindcast experiment of the seiches from 24 to 25 February 2009 was performed. The performance of the model was examined by comparing the modeled sea level with the observations.

For Application

Competitive Advantages

By using the fourfold nested model with the resolutions of 1 km, 250 m, 50 m and 10 m, the present mode can cover wide range of oceans from the East China Sea, where atmospheric pressure disturbances are generated and propagate, to the west coast of Kyushu, where seiches cause damage. In the inner-most model with the resolution of 10 m, eigenoscillations of harbors enclosed by breakwaters can be reproduced. Therefore realistic sea-level oscillations associated with large-amplitude seiches can be realized in the present model.

Patent/Journal/Award

URL

Civil Engineering/ Architecture

Research and Development of the Rapid Deployment Bridge mobile bridge® for Disaster Restoration

Keywords Disaster Restoration, Restoration and Revival, Disaster Prevention Engineering, Deployment Structure, Temporary Bridge

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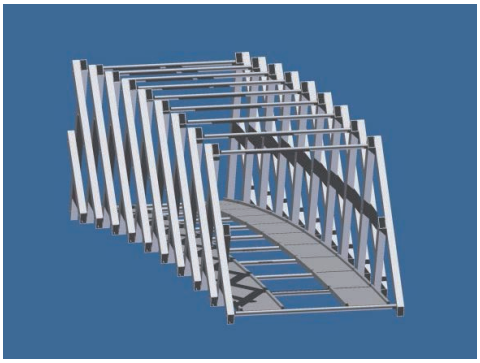
Field Applied Mechanics/ Structural Analysis (Fundamental Engineering,Sciences of Natural Disaster)

Outline

Background

Natural disasters occur frequently in Japan and abroad, and we often experience earthquakes, tsunami, and heavy rain (typhoon). To protect human lives, technical development of a new disaster prevention restoration system is indispensable. The basic technology of quick construction of a bridge has not been developed yet.



Research Summary

It is to advance component engineering of a “mobile bridge” based on a new structure concept as infrastructure to be used in a disaster. Research and development are under way of the movable temporary bridge “mobile bridge” which can be constructed and deployed quickly as one of the urgent measures to reduce “isolation of a village” in repeated disasters. It is a necessary restoration system which puts priority on short construction time for a country affected by natural disasters.

Result

The whole of the bridge can be folded up compactly and moved by air, marine, and land transportation. It can be applied flexibly even in the constrained area, under restricted construction conditions, such as mountain slope, with limited temporary assembly sites to secure. A trial production is in progress in a collaborative research project with several companies.

For Application

A larger prototype bridge is needed. Proposed technology can meet requirements for urgent response under risk management not to delay restoration work and goods transportation.

Competitive Advantages

It is the first form as a structure of bridges, and it is a logical and innovative structure. Can be offered for use upon deployment with short construction time.

Patent/Journal/Award

Patent application No. JP 2013–014747 (Jan. 29, 2013)

①Development of a prototype deployable bridge based on origami skill, Ichiro Ario, Masatoshi Nakazawa, Yoshikazu Tanaka, Izumi Tanikura, Syuichi Ono, Automation in Construction, 32, (2013) pp.104–111, http://dx.doi.org/10.1016/j.autcon.2013.01.012.

②Development of Prototype of Real-scaled MobilebridgeTM as a Smart Bridge for Dynamic Carriage Loadings, I. Ario, Y. Chikahiro, S. Matsumoto, Y. Tanaka, M. Nakazawa, S. Ono, Proc. of Dynamics, stability and control of flexible structure, (2013) CD.

③SMART, DEPLOYABLE SKELETAL STRUCTURES FOR SAFETY ENGINEERING, Piotr Pawlowski, Cezary Graczykowski, Jan Holnicki-Szulc, Ichiro Ario, Proc. of ECCOMAS Conference on Smart Structures and Materials (SMART2013), 6 (2013) CD

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http://www.hiroshima-u.ac.jp/news/show/id/17977, http://www.hiroshima-u.ac.jp/news/show/lang/en/id/1330

Civil Engineering/ Architecture

Shock Absorber System by Multi-folding Microstructures under Reused Condition

Keywords Impact Absorber, Folding, Impact Energy, Resistant Impact Force

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Field Applied Mechanics/ Structural Analysis (Fundamental Engineering)

Outline

Background

While in conventional shock absorbers the power and displacement mostly have linear relation, this HPV system, having the inflatable structure system which reduces shock speed, and pantograph truss which supports the main stiffness reaction by folding, can be used repeatedly, by making absorption of impact strength energy elastic.

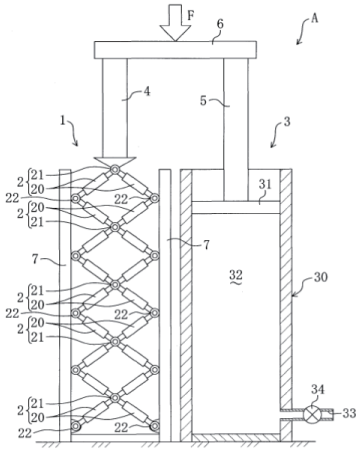
Impact crushing for everything.

Research Summary

The system I propose is the optimal performance impact-absorbing system (HPV) made of two pair systems; the variable rigidity type multi-folding micromicro structure (MFM) system which consists of the multilayer pantograph trusses with shock-proof nonlinear stability, and the damping system where the inflatable structure with membrane structure full of gas inside, and the gas discharged by a variable valve.

Result

- It can be used repeatedly any number of times within the limits of designed impact-load.
- Impact force can be mitigated/adjusted smoothly.
- According to the number of stages, it can vary impact strength.



Shock-absorber system subjects to impact loading.

For Application

- Improvement of safety of car body structure.
- Protector for crash of vessel against the supporting column of sea wind power generation facility.
- Impact-absorber of a helicopter, etc., at a collision, and device to reduce big impulse force.

Competitive Advantages

- Maintain active and improve safety in a impact zone
- Can be used repeatedly since it is not accompanied by plastic failure.
- Can be stored compactly and applied when a shock is expected.

Patent/Journal/Award

Patent Application No. JP 2008–021884. This is a research result derived from “Scientific Research (C)” of Grants-in-Aid for Scientific Research in JSPS from 2005 to 2007.

URL

Civil Engineering/ Architecture

A Study on the Architectural Planning on Children's Home

Keywords Facility Planning, Children's Home, Downsizing the Living Unit

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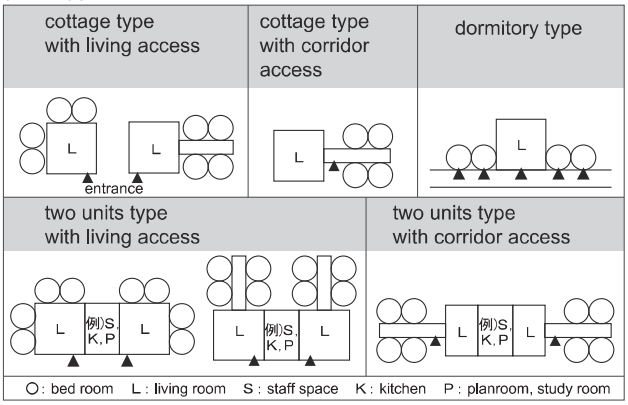
Field Architectural Planning

Outline

Background

The number of the children out of home care is increasing these days in Japan, and most of them are abused, suffer from family trouble or have some developmental disability. In order to support their physical and mental development, homely environment is important.

prototype of children's home



Research Summary

To examine the actual condition of downsizing the living unit in children's home, the questionnaire survey was conducted for 205 children's homes. Also, we conducted some field surveys on the cottage-type children's home to examine the relationship among space, communication, and the effectiveness of therapy.

Result

From the survey of the actual condition of downsizing the living unit in children's home, the prototype of the living unit plan is characterized. From the field surveys on the cottage-type residential center to examine the relationship among space, communication, and the effectiveness of therapy, it can be said that the characteristics (such as floor space, the number of children, and the organization of the space) contributed to a better condition for the milieu therapy.

For Application

To provide consultation on children's home construction or reconstruction project.

Competitive Advantages

To provide consultation on children's home construction or reconstruction project.

Patent/Journal/Award

MEANINGS OF SPACE OF COTTAGE-TYPE RESIDENTIAL CENTER IN MILIEU THERAPY FOR EMOTIONALLY DISTURBED CHILDREN, J.Archit. Plann, AIJ, No.582, 17–23, 2004

A STUDY ON THE CONDITION OF DOWNSIZING THE LIVING UNIT IN CHILDREN'S HOME, J.Archit. Plann, AIJ, Vol.77 No.671, 19–25, 2012

URL

Civil Engineering/ Architecture

Continuous Measurements of River Discharge by Acoustic Tomography

Keywords Stream Flow, Flood Event, Water Resource, Estuarine Flow

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Field Civil and Environmental Engineering

Outline

Background

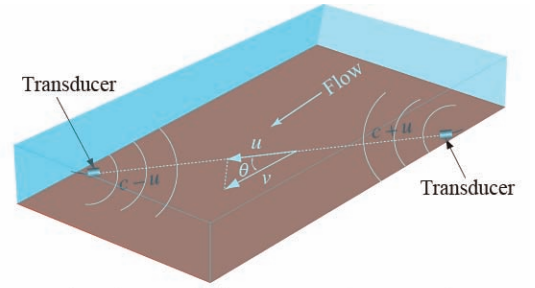
The acquisition of continuous measurements of river discharge is a high-priority issue for water resource management, and the real-time knowledge of river discharge is an environmental, social, and economic asset. Therefore, establishing a method and/or technology for quantifying discharge is of paramount importance.

Research Summary

The accurate estimation of river discharge is a difficult and laborintensive procedure; thus, a robust and efficient method of measurement is required. To improve discharge measurements, Fluvial Acoustic Tomography System (FATS) is proposed as an innovative method to continuously measure the cross-sectional average velocities and flow rate of rivers and estuaries.

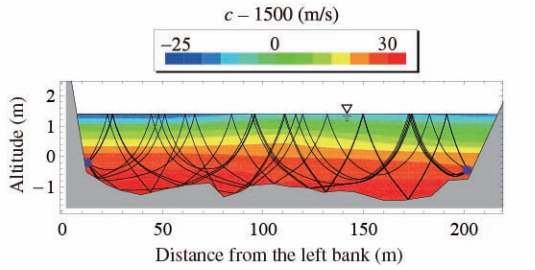
Result

The fluvial acoustic tomography system, characterized by the GPS precise clock system and the multipath was developed. Measurements of the cross-sectional average velocity and river discharge were carried out successfully in spite of the periodic intrusion of a salt wedge into the river. It is concluded that FATS is a prospective method for the continuous monitoring of river discharge.



$v = u / \cos\theta$ u : velocity component along ray path
v : velocity component in the direction of flow
c : sound speed in still water

Cross-sectional average velocity is deduced from multi ray paths that cover the cross section.



For Application

The FATS is a multi-sensor system for continuous in-situ observation of river discharge. This state-of-the-art sensor is capable of recording data in rough conditions like flood events, and even in tidal rivers with periodic intrusion of salt wedge. All these features distinguish the FATS from traditional sensors and their limitations. The FATS can estimate important characteristics (flow velocity, wave height and celerity) of Tsunami ascending rivers.

Competitive Advantages

The FATS is a reliable and accurate technique for the long-term measurement of river discharge, even in shallow, wide rivers or tidal estuaries with saltwater intrusions. Features & Benefits: Precise time measurements using GPS clock; High signal-to-noise ratio by M-sequence modulation of transmission signals; Accurate measurement of crosssectional average velocity by multi ray paths.

Patent/Journal/Award

Kawanisi, K., et al. (2012), Continuous measurements of flow rate in a shallow gravel-bed river by a new acoustic system, Water Resour. Res., 48(5), W05547, doi: 10.1029/2012WR012064.
Kawanisi, K., et al. (2010), Long-term measurement of stream flow and salinity in a tidal river by the use of the fluvial acoustic tomography system, J. Hydrol., 380(1–2), 74–81, doi:10.1016/j.jhydrol.2009.10.024.

URL http://home.hiroshima-u.ac.jp/kiyosi

Civil Engineering/ Architecture

History of British Architecture and Town Planning in 19th Century East Asia

Keywords British Architecture, Colonial Architecture, East Asia

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Field Architectural History

Outline

Background

British architecture and town planning occupy the most important role in the architectural modernization of Asian countries.

Research Summary

This research is concerned with British town planning of colonial cities and treaty concessions, industrial facilities, diplomatic buildings, mercantile buildings and biography of architect & civil engineers in 19th century East Asia.

English church, Shanghai by G.G. Scott

Result

Historic details of some important industrial, mercantile and diplomatic buildings have been clarified consulting to historical sources both in Japan and United Kingdom.

Empress Place building, Singapore

For Application

This research is thought to make some contributions in the conservation, renovation, restoration of historic buildings in Asian cities.

Competitive Advantages

This research stands on the global viewpoints crossing over the countries, making academic influences on the field of architectural history.

Patent/Journal/Award

Encouragement Award of AIJ

URL

Civil Engineering/ Architecture

The Study of Inhibiting Effect of Slude-zation in Tidal Flat by Ground-water Flow

Keywords Groundwater Flow, Estuarine River, Tidal Flat

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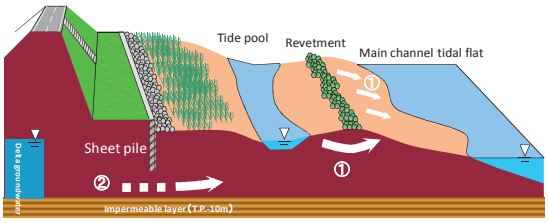
Field Civil Engineering

Outline

Background

With the decrease in recent natural tidal flat, the creation of the artificial tidal flat is carried out in many places in Japan. The developed tidal flats require not only stability of the topography but also control of sludge-zation, compensation of the habitation of the useful bivalve.



Groundwater flow formed around river structure (Groundwater flow occurred by water level difference with ①: tide pool, ②: delta groundwater (groundwater in inland area))

Research Summary

From observation results, we clarified that a groundwater flow is important for the formation of the tidal flat environment. It is thought that if the generation of groundwater flow is effective, highly functional tidal flat is formed. In this study, the influence of groundwater flow on the sludge-zation and habitation of the useful bivalve are evaluated for the purpose of developing a tidal flat creation technology considering the effect of the river structure.

Result

In a past study on Ota River, it was clarified that groundwater flow is caused by water level difference with ①: tide pool, ②: delta groundwater (groundwater in inland area). Each groundwater flow has some important roles for tidal flat formation, like improve water retentivity, supply organic matter, oxygen necessary for habitation of the benthos in the tidal flat, keep the ground loosely and degradation of water quality change (salt, water temperature) in the tidal flat at the time of the flood.

For Application

I clarified the importance of the groundwater flow and showed the need for consideration of a groundwater flow in developing land as an artificial tidal flat. It will be necessary in future to show structure and a shape, the height of the river structure and the relations of the groundwater flow (including the quality of the water and the speed) quantitatively.

Competitive Advantages

This study not only solves the ecosystemic formation defectiveness, a problem at the artificial tidal flat creation, but also clarifies the mechanism of sludge-zation in the tidal flat.

Patent/Journal/Award

URL http://www.civil-hu.jp/coast/

Civil Engineering/ Architecture

Numerical Simulation System for Optimization of Passive Control Devices of Building Structures

Keywords Building Structure, Base-isolation, Passive Vibration Control, Optimization, Finite-element Analysis

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Title Professor

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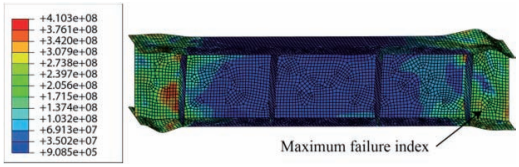
Field Mechanics of Building Structures

Outline

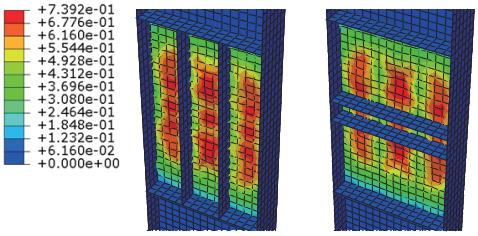
Background

In contrast to the total building structures, the performance of structural parts such as beams, columns, and devices for passive seismic control is defined under simple loading conditions, and those devices are mass-products. Therefore, we can utilize recent technologies of finite element analysis and optimization effectively to the design of devices. This way, most of physical tests can be replaced with numerical simulation.



Research Summary

We developed a prototype of numerical platform for optimizing the parameters of shape and stiffness of base-isolation and passive vibration control devices for maximizing its energy dissipation capacity. The performances of devices under cyclic loads are estimated using a high-precision finite element analysis. The right figures show optimization results of the locations and thicknesses of stiffeners of a link-beam of K-brace and a sheartype steel damper. As a result, the energy dissipation capacity has been drastically improved with practically acceptable computational cost.



Result

We demonstrate that the seismic responses of building structures are effectively reduced using the optimized devices. New types of innovative systems such as rocking system are also developed. This way, the seismic risk of building structures can be reduced utilizing the proposed numerical optimization system.

For Application

The proposed system can be used for optimization of devices for any type of structures including steel, RC, and timber structures. Therefore, collaborations with contractor company, housing industry, and design office are possible, with information and suggestion on requirements in practical design process.

Competitive Advantages

There is no numerical development system in building engineering utilizing sophisticated finite element analysis and optimization. By using this system, most of physical tests are not required and the cost and period of time for development of new devices can be drastically reduced.

Patent/Journal/Award

Ohsaki M, Nakajima T, Optimization of link member of eccentrically braced frames for maximum energy dissipation, J Constr Steel Res (2012), doi:10.1016/j.jcsr.2012.03.008

URL http://home.hiroshima-u.ac.jp/ohsaki/

Civil Engineering/ Architecture

History of Modern Architecture and Urbanism, and Theory on Contemporary Architectural Design

Keywords Architectural History, Urban History, Design, Modernism, Ideal City

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Field Architectural History and Design Theory

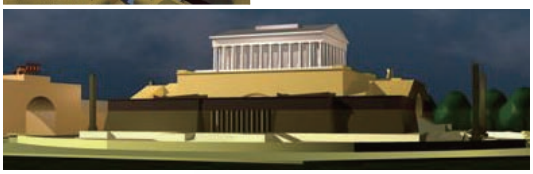
Outline

Background

As it has been a global subject as to what the model of sustainable urban and architectural environment is, a contemporary theory on architectural design theory needs to be developed, and the theoretical establishment from a viewpoint of urban and architectural history is especially searched for.

Research Summary

Analyzing and summarizing the global movement of contemporary urban and architectural design theory, problems are identified, each subject of research is presented, and analysis study is done. Especially the detailed research on the modern architecture and the urban formation process of Berlin as the birthplace of modernism architecture is performed, and the contemporary urban and architectural design is re-interpreted. Moreover, for the theory building about the formation history of sustainable city, comparative studies are performed on Japanese and European early modern city planning technique (ex.: Hiroshima castle town vs European sea port cities in the Age of Discovery, etc.). CG is utilized as a research means.



Result

Research results of architectural history, concerning the history of German modern architecture, on the design ideas of the architects such as Bruno Taut, Bauhaus-related Walter Gropius, and Mies van der Rohe, etc., and also concerning the German Neo-Classicism architecture.

For Application

Proposals are made on the contemporary orientation of the design method in a architectural design company.

Competitive Advantages

Concerning the urban and architectural design method on a practical level, the historical viewpoint which foresees the near future tends to be insufficient, our laboratory has been trying to catch the contemporary problems from a historical viewpoint and find out concrete guidelines through form analysis and design idea analysis.

Patent/Journal/Award

Book “Architecture Thought of 20th Century —From Cube to Chaos” (1998)
Prize of Architectural Institute of Japan (1999)

URL http://home.hiroshima-u.ac.jp/tsugi/index.html

Civil Engineering/ Architecture

Flow Visualization Technique for Natural Environment

Keywords PIV, Geometric Conversion

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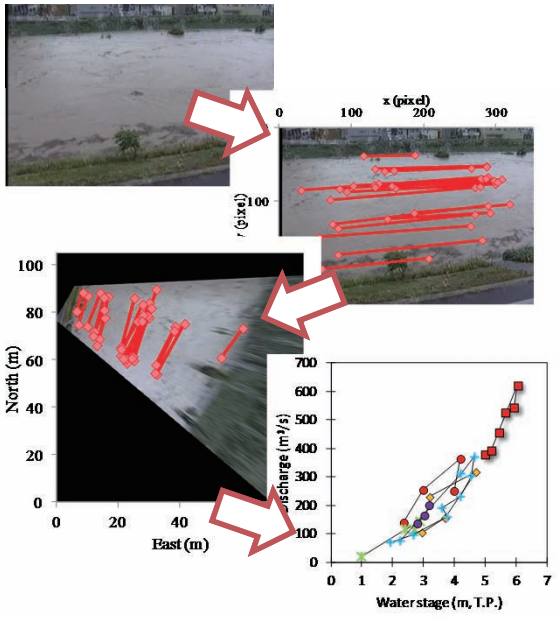
Field Civil Engineering, Social Safety System Science

Outline

Background

Natural environment changes in various time scales. The flooding in a river is one of environmental changes related to water resources management and natural disaster. The spatial scale of flooding flow is large so measuring the time-series change of the flow rate during the flooding has difficulties in instrumentation, expense, set up time and so on.



Research Summary

Measurement technique of the flow using the video images in natural environment was developed. Selection of camera, determination of a shooting angle, requirement for video storage format and system, geometric conversion and analysis of the measured result were comprehensively designed. As a result, stable and continuous measurement of flow in natural environment was achieved.

Result

The time change of a flood flow was measured in this research.

For Application

The developed method is applicable to not only the surface flow velocity of a river but observation of various flow in the natural environment.

Competitive Advantages

The visualization technique using the camera system has predominancy in small installation and operation costs, and high stability and accuracy of measurement, in comparison with other measurement technology.

Patent/Journal/Award

Tsubaki, R., Fujita, I. and Tsutsumi, S.: Measurement of the flood discharge of a small-sized river using an existing digital video recording system, Journal of Hydro-environment Research, Vol.5, Issue 4, pp.313–321, 2011.12.

URL http://www.civil-hu.jp/hyd/

Civil Engineering/ Architecture

Development of Real-time Risk Evaluation System of Individual Valleys and Slopes in Heavy Rain

Keywords Landslide Disaster, Disaster Prevention of Slope, Mud Flow, Heavy Rain

Takashi TSUCHIDA

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Field Geotechnical Engineering, Environmental Geotechnology

Outline

Background

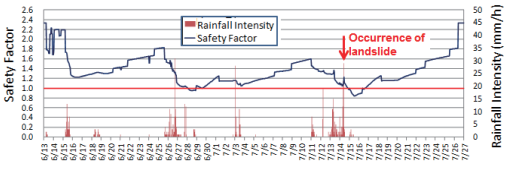
In Hiroshima Prefecture, there are a large number of sites dangerous for landslides in rainfall time, and the accurate risk assessment of these sites is an important problem. At present the prefectural land is divided into 350 unit areas of 5 kilometers square, and the criteria using the rainfall indexes are determined in each unit area on the basis of past records of disasters. In this system, the risk of individual valleys or natural slopes in each area cannot be determined.

Investigation of valley by volunteers

Research Summary

To achieve the real-time risk assessment of individual valleys using the geophysical and geotechnical data of sites, the following researches were carried out.

1) Proposal of practical method for investigating dangerous valleys which can be made by non-professionals, and the construction of system in which volunteers for disaster prevention can take part in the investigation of valleys.
2) Development of real-time risk assessment system, in which an analytical model for each valley is prepared and in the rainfall time, the safety factor for landslide of each valley is calculated and presented on a map on real-time basis.



Real-time calculation of safety factor application of actual landslide disaster in Fukutomi district

Result

The algorithm of real-time risk assessment system is completed. The system can be implemented. The trial investigation based on the proposed method was carried out by volunteers and some points for improvement were found.

For Application

The developed method can be implemented in the administrative works in landslide disaster prevention. In this method the participation of non-professionals to collect the geophysical and geotechnical data of sites is a key and the practice and improvement must be made on the investigation method.

Competitive Advantages

As there is no practical method for risk assessment of individual valley, the developed method is unique and better than the present system of the caution and evacuation against landslide disaster.

Patent/Journal/Award

Takashi Tsuchida, Athapaththu A.M.R.G., Seiji Kano, Kazuaki Suga: Estimation of in-situ shear strength parameters of weathered granitic (Masado) slopes using lightweight dynamic cone penetrometer, Soils and Foundations, Vol. 51 (2011), No. 3, 497–512.

URL

Civil Engineering/ Architecture

Citizen's Life Behavior Theory and Cross-Sector Urban Planning/Management

Keywords Citizen's Life Behavior, Urban Planning and Management, Transportation, Environment and Energy, Tourism, QOL

Junyi ZHANG

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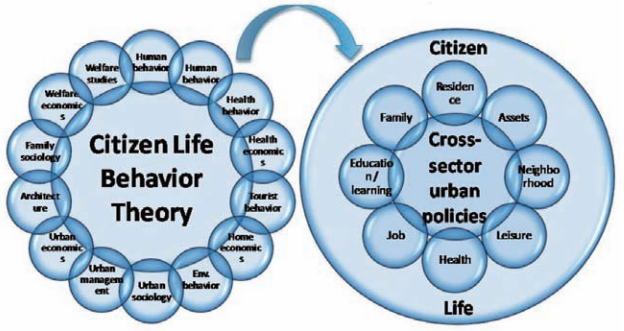
Field Civil Engineering

Outline

Background

It is recognized that cross-sector urban planning and management policies are required. To date, several types of theories have been developed to deal with a certain part of citizen life, such as travel behavior theory, life science, home economics, environmental behavior theory, health behavior theory, health economics, human life environment theory, and tourism behavior theory; however, no theory has been proposed to cover the whole citizen life in an integrated way.



Research Summary

(1) Integrated citizen's life behavior surveys: Participatory self-declaring survey, packaging survey contents and standardization, data fusion (combine existing and new surveys)

(2) Making full use of the above surveys, integrated behavioral model systems of citizen's life are developed to cover major citizen's life domains.

(3) Impact assessment systems of citizen's life for urban policy decisions are developed to deal with both quality of life and disexternalities of citizen's life.

(4) Cross-sector urban policies are proposed and evaluated focusing on low-carbon urban system design, mobility and social exclusion, urban tourism, promotion of healthy urban life, regeneration of central urban areas, and urban governance.

Result

QOL-oriented citizen's life behavior survey method is proposed to capture multi-dimensional citizen's lives. Integrated citizen's life behavior models are developed. And Cross-section policies are proposed.

For Application

Field works of urban planning and management are required.

Collaboration between government, firms and academia is important.

Governmental attitude is a key barrier. Effective citizen participation should be further promoted.

Competitive Advantages

Survey, analysis, forecasting and evaluation methods of citizen's life behavior are developed by making full use of the knowledge of citizen life related disciplines as well as social psychology, behavioral economics, experimental economics, complexity science, advanced econometrics, advanced survey and data fusion theory, etc.

Patent/Journal/Award

Best Paper Awards: 7, Outstanding Paper Awards: 3; Number of refereed papers: 238 (English: 185)

URL http://home.hiroshima-u.ac.jp/hitel/citi_qol_jp.html http://home.hiroshima-u.ac.jp/hitel/members/zhang.htmlhtml

VII

Computer Science, Information, Communication and System Engineering

Computer Science, Information, Communication and System Engineering

Spin Control of Multi-radicals

Keywords Multi-radicals, Electron Spin, Spin Multiplicity, Spin Switch

Manabu ABE

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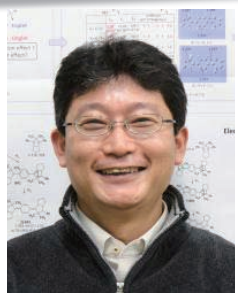
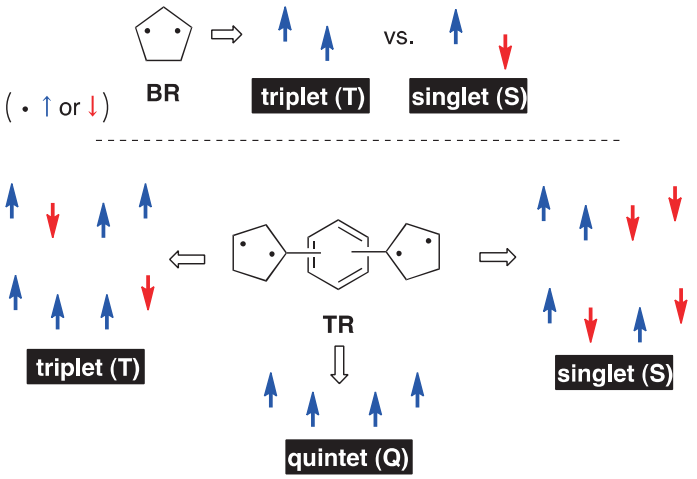
Field Basic Chemistry



Outline

Background

The direction of electron-spins plays an important role in molecular functions. Thus, new materials, new reactions, new function of molecules will be created by the control of spin-multiplicity in multi-radical species. In this study, the substituent and heteroatom effects on the ground state spin-multiplicity is actively investigated to produce new function of molecules. So far, the spin-control of biradicals (BR) and tetraradicals (TR) has been achieved by our research group in Hiroshima.



Research Summary

Result

For Application

Competitive Advantages

Memory materials, Spintronics

Patent/Journal/Award

Award: Nozoe memorial Award, Zimmer Award

URL

Computer Science, Information, Communication and System Engineering

Virtualization Methods with Mobility Support Functions for Multicast Communications

Keywords Mobile Network, Virtual Computer, Multicast Communication

Reiji AIBARA

Department Information Media Center
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Field Information Engineering

Outline

Background

Global live migration techniques migrate a virtual machine running on a computer to any other computer connected to the Internet, continue to execute processes on the virtual machine. The techniques already proposed are available for unicast communications.

Research Summary

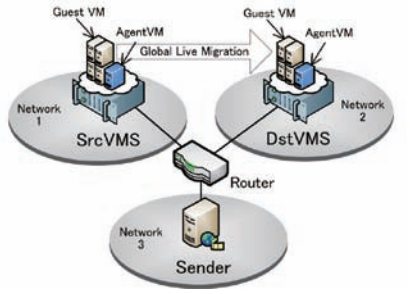
We have developed a new global live migration technology to reduce the interruption time for multicast communications not only for unicast. In addition, we considered the various security issues related to the migration of the virtual machine.

Result

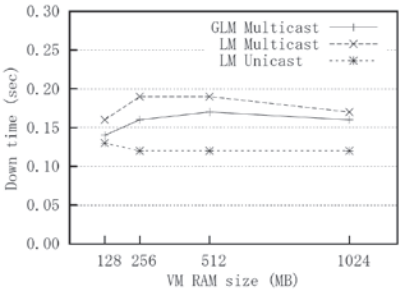
We designed fundamental methods for realizing the secure migration of virtual machines.

For Application

We may conduct joint research with companies that are interested in this field.



Set-up of global live migration experiment



Down time during global live migration and live migration

Co-researchers

Tohru KONDO, Seigo KISHIBA, Toshihiro OHIGASHI, Kouji NISHIMURA, Koichi TASHIMA

Competitive Advantages

Patent/Journal/Award

K. Kamada, T. KONDO, K. Nishimura, R. Aibara, Design and Evaluation of Global Live Migration with Mobility Support for IP Multicast, 12th IEEE/IPSJ International Symposium on Applications and the Internet (SAINT2012), 2012, pp.338–344, 10.1109/SAINT.2012.90.

Y. Ohishi, K. Maeda, T. Sahara, N. Hayashi, R. Aibara, Consideration of Network Selection Criteria on IP Mobility Communications Quality by Real-time Status and/or Statistical Information, Proc. 2013 IEEE 37th Annual Computer Software and Applications Conference Workshops, 2013, pp.569–574, 10.1109/COMPSACW.2013.76.

URL

Computer Science, Information, Communication and System Engineering

An Interactive System to Support "Learning by Problem-posing"

Keywords Learning Engineering, Education Engineering

Tsukasa HIRASHIMA

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Field Education Engineering

Outline

Background

It is known that posing a problem effectively deepens understanding on the problem itself. However, in order to perform it as a learning activity, diagnostics of the problem is made and the feedback based on the diagnostic results are indispensable. Those are realized via software in this study.

Research Summary

It is a large task involving load for learners to pose a problem. In this study, the following method is adopted, i.e., first, activity to pose a problem is divided into two phases, i.e., dividing into partialization phase and structure formulation phase. The structural formation is recognized as essential. Then parts of the problem are supplied to the learners and they try to make structural formation to pose a problem. Appropriate diagnostics can be performed with the software, as the constituent parts are already available. For learners, the only task is to recognize the constituent parts and the activity of posing a problem.

Result

The system made has been already used during 4 years in the lecture of mathematics in an elementary school. The learning effects have been obtained. It is also possible to perform the system in normal lecture using a media tablet.

For Application

The system has been used in practice and the learning effects have been obtained. The test was conducted in a certain elementary school with well prepared environment. From now, it is a task, as an agenda of realization, to expand it to general educational spots. Presently, an exercise using a media tablet has been performed. In the introduction and penetration process of the media tablet in the educational spots, this method can be a useful example using the media tablet.

Competitive Advantages

The developed system, which makes possible diagnostics of a problem made by a learner, is a pioneering work internationally. There is no similar work available presently. This work has an advanced feature and the usage experience of the system has been accumulated. The author is largely leading this area compared to other research groups.

Patent/Journal/Award

2009 Encouragement Award at Society of Educational System Information National Convention
2008 Distinguished Award at Research Committee of Society of Artificial Intelligence

URL http://learning-engineering.com/le-home

Computer Science, Information, Communication and System Engineering

Computer Simulation Material for Learning Physics

Keywords Computer Simulation, Educational Material Development, Physics Education

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Department Information Media Center

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Field Physics

Outline

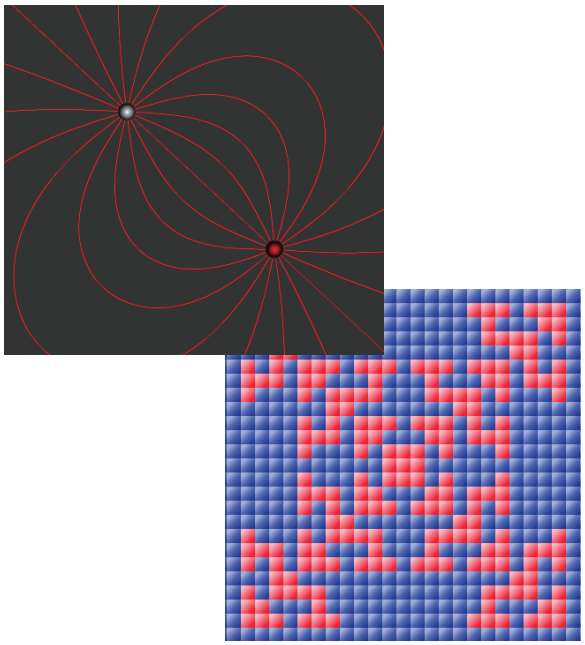
Background

Developing computer simulation material so that the learner discovers fun in learning natural sciences and starts considering natural phenomena from scientific point of view.

Research Summary

Developing material which encourages the learner to think of concepts of natural sciences with specific images, while visually experiencing the situation that is not available in reality and behavior of modeling system using computer simulation.

Ongoing research covers simulation algorithm, visualization, and interface of parameter operation which are considered according to learning subject, and learning effective use of educational material.



Result

Developed educational material using Flash Actionscript, on various fields of physics such as classical mechanics, wave, electromagnetics, quantum mechanics, elementary particle, and nucleus, and cell game and chaos, applying computer simulation. Material is published and distributed on the internet website mentioned below.

For Application

Contribute to the development of studies in related fields by distributing educational material together with source file, which is basically free of charge and editable.

Competitive Advantages

Patent/Journal/Award

PSE Paper Award (2005)

URL http://home.hiroshima-u.ac.jp/inagaki/

Computer Science, Information, Communication and System Engineering

Ray-tracing Simulation and Visualization Based on Wave Optics

Keywords Computer Graphics, Spectrum of Light, Visual Simulation, Structural Color

Kazufumi KANEDA

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Title Professor

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Field Information Science, Information Engineering, Visual Computing

Outline

Background

Traditional rendering algorithms use three primary colors in a process of ray-tracing simulation. In order to visualize optical phenomena accurately, spectral distribution of light should be taken into account in rendering algorithms.

Research Summary

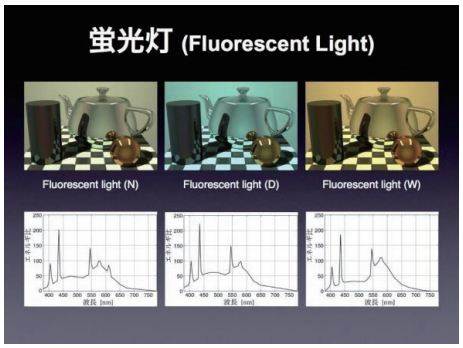
A physically based ray-tracing algorithm is developed and implemented taking into account both spectral distribution of light and optical property of an object. A human visual perception model is also employed to display the simulation results realistically to a display monitor.

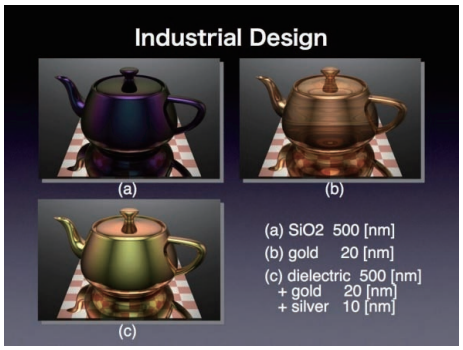
Result

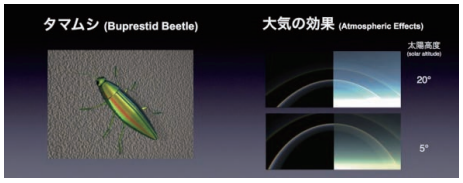
Taking into account both spectral distribution of light and optical property of an object, we can display the difference of object appearance illuminated by different spectral distributions of light. We can also visualize iridescent colors appearing on an object coated with thin films, structural colors appearing on the surface of a beetle, and beautiful atmospheric phenomena such as rainbows.

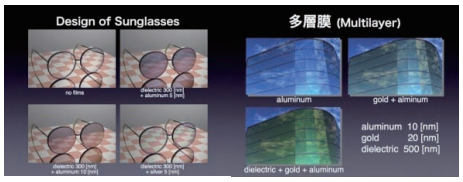
For Application

Application requiring high definition computer graphics, such as advanced industrial design, lighting design, special effects in movies, optical design of multi-layer thin films.









Competitive Advantages

Physically based ray-tracing simulation and visualization taking into account both spectral distribution and optical property.

Patent/Journal/Award

Research papers published in journals such as The Visual Computer, Computers & Graphics, etc.

URL http://www.eml.hiroshima-u.ac.jp

Computer Science, Information, Communication and System Engineering

Statistical Pattern Recognition and its Applications for Image Recognition

Keywords Pattern Recognition, Image Recognition, Machine Learning

Takio KURITA

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Field Informatics

Outline

Background

Information technology (IT) such as internet or smart phone, etc. has been rapidly developing and its application fields are becoming diverse and complex. But the current IT is still inferior to the human ability such as recognition, learning, decisions depending on the situation, or attentions, etc. Although such abilities of the current IT have gradually improved, the applications are still restricted because of the weakness of the current IT. If such abilities of the current IT improve, the application fields of IT could be extended more.

Demographic survey system

Research Summary

Although face detection has recently been included in many of the digital cameras, general purpose computer vision is not commonly used in other equipments. To make the general purpose computer vision available, we have been studying statistical pattern recognition or machine learning and its applications for image recognition. For example, we have been developing car and pedestrian detection algorithm for safe driving assistance and the demographic survey system.

Result

As one of the applications of image recognition, we have been developing a demographic survey system in which the number of persons and their characteristics are estimated from the image sequences captured by the camera. In the system, the upper part of the body is detected and the sex and the age are estimated from the detected face. The statistics of the number of persons, the sex, and the age are reported for marketing purposes. Now demonstrative experiments have been undertaken in a shopping mall under a joint research project.

For Application

After the economic crisis, the age of mass production is over and the people ask for richness of mind. As it is becoming difficult to find the demand of the consumers, the need for the marketing research is increasing. If the marketing research could be automated, so many applications would be expected.

Competitive Advantages

The person detection and the sex and age estimation can be performed in nearly real time with this technology. The similar algorithm can be applied for counting the number of cars or motorcycles for the traffic density measurement system.

Patent/Journal/Award

Keiji Shimada, Yoshihiro Noguchi, Tetsu Matsukawa and Takio Kurita, “Appearance-Based Smile Intensity Estimation by Cascaded Support Vector Machines,” Proc. of The 2nd International Workshop on Video Event Categorization, Tagging and Retrieval, November 8–12, 2010, Queenstown, New Zealand.

URL http://home.hiroshima-u.ac.jp/tkurita/

Computer Science, Information, Communication and System Engineering

Efficient and Effective Information Filtering Methods for Utilizing Big Data

Keywords Big Data, Information Filtering, Skyline Query, Outlier Detection, Knowledge Discovery, Hadoop MapReduce

Yasuhiko MORIMOTO

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Field Information Science

Outline

Background

Growth of information technologies, acquisition technologies, storage technologies make our database size larger. In order to utilize such big data, efficient information filtering is indispensable. We have developed an efficient calculation method by using Hadoop MapReduce to compute skyline query that can be used to filter information. We have developed unique skyline queries especially for graph databases and privacy-aware databases.

Research Summary

Each record of a database can be compared with another record by certain criterion, for example by “price”. When we analyze a large database, we should filter out unnecessary records that are dominated by another. Skyline query is the method for filtering dominated records and making compact database that only contain worthy records.

We have developed unique skyline queries for graph databases such as GIS road data, network data. For example, we can extract noteworthy road segments that contains a peculiar characteristic. We have also developed unique skyline queries for privacy-aware databases.

Result

We have implemented above mentioned functions and examined. We have published the results in journals, conferences.

For Application

We plan to apply the above mentioned methods in practical applications and resolve practical problems. Therefore, we seek for partners who have large databases especially graph databases, privacy-aware databases.

Feel free to contact us. We can explain and advise concerning the technologies if you can interest.

Competitive Advantages

Skyline can be used for filtering information for big data, retrieving data without specifying conditions, etc. Hence, skyline queries have been studies in many universities and research organizations. However, there is a few research for graph databases such as GIS road data, network data. We have developed unique skyline queries for graph databases such as GIS road data, network data. We have also developed unique skyline queries for privacy-aware databases.

Patent/Journal/Award

URL http://www.morimo.com/morimo-ken/pub.htm

Computer Science, Information, Communication and System Engineering

Knowledge Discovery from Diverse Large-scale Information Sources

Keywords Data Mining, Information Retrieval, Privacy Protection, Geographic Information System, Database Marketing, Financial Risk Analysis

Yasuhiko MORIMOTO

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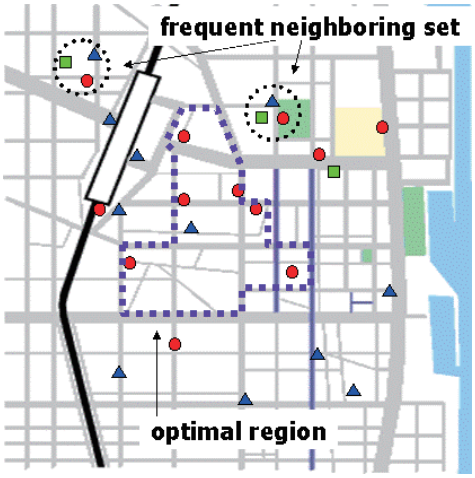
Field Information Science

Outline

Background

I have been studying knowledge discovery technologies from large and diverse information sources such as world wide web, transactional databases. I have focused on data mining methods from spatio-temporal databases in particular.
I am also studying privacy preservation methods in data mining tasks.



Research Summary

- Spatio-Temporal Data Mining
(We developed a co-location pattern function that can find patterns that occurred in close proximity. For example, it may find that “traffic accidents frequently occurred in locations that are close to both convenience stores and traffic signals.” We also developed a function that can efficiently calculate high density regions of an event such as “crime”. (See Figure))

- Information Retrieval by Using Skyline Query
(We developed a user friendly database system in which we can get concise and accurate answer by simple keyword query interface.)

- Data Mining from Aggregated Records
(We developed a method for finding association rules from aggregated records instead of individual records.)

Result

We have developed the above mentioned functions and verified them. We have published the results in journals, conference, and competition.

For Application

We plan to apply the above mentioned methods in practical applications and resolve practical problems. Therefore, we seek for partners who have (spatio-temporal) databases.

Competitive Advantages

Our specialties are techniques for handling spatio-temporal databases.

Patent/Journal/Award

ACM SIGKDD, ACM SIGMOD, VLDB, etc.
Best Paper Award (DBKDA’10 France), Special Award (Data Mining Competition), Best Author Award (IPSJ)
Visit “http://www.morimo.com/morimo-ken/pub.htm” for more detail.

URL http://www.morimo.com/morimo-ken/

Computer Science, Information, Communication and System Engineering

Design of Energy Saving Control via Stochastic Dynamic Game Theory

Keywords Energy Saving, Nash Game

Hiroaki MUKAIDANI

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Title Professor
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Field Informatics, Electric/Electronic

Outline

Background

The stability, control and filtering problems of the stochastic systems with Brownian motions governed by the Ito differential equations have attracted much research attention over the past few decades because such systems include many practical applications. On the other hand, Markov jump linear systems are used in many applications of signal processing, control theory and communications. They are well used to describe diverse fields including networked control, fault tolerant systems, communication networks and aerospace.

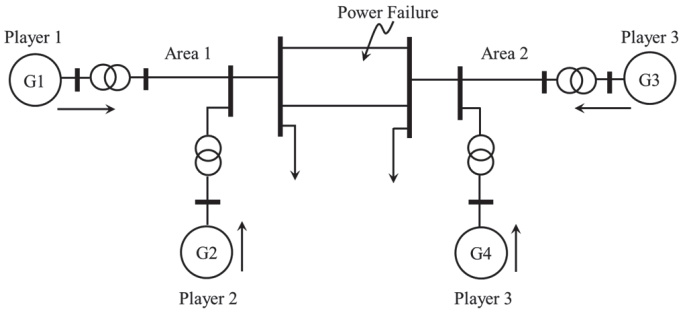

Fig. 1. Single-line diagram of the two-area four-machine power systems.

Research Summary

This research investigates dynamic games for a class of linear stochastic systems governed by Ito's differential equation with Markov jump parameters. Particularly, Pareto and Nash games are considered intensively.

Result

Earlier studies on dynamic games did not take the transitions among the models governed by a Markov process into consideration. It should be noted that even if dramatic random parameter changes such as power failure occur in the plant, the Nash equilibrium can still be attained by means of the proposed strategies. The main contributions of this research are as follows. First, stochastic Nash games are investigated with respect to a Markov process. In order to obtain the Nash equilibrium strategies, some conditions are formulated. After introducing an asymptotic structure for the solutions, linear matrix inequality (LMI) approach is applied to avoid complicated procedures for the calculation.

For Application

The obtained results can be applied to practical power plant for the ordinary frequency control. Moreover, it is expected that the problem of the engineering/economics or anything in the social sciences are preferable.

Competitive Advantages

Even if a power failure and a dramatic random parameter for the operating point are observed, the robustness against the potential of abrupt change is still satisfied.

Patent/Journal/Award

H.Mukaidani, "A New Design Approach for Solving Linear Quadratic Nash Games of Multiparameter Singularly Perturbed Systems," IEEE Trans. Circuits & Systems I: Regular Papers, Vol.52, No.5, pp.960–974, 2005.

H. Mukaidani and H. Xu, "Pareto Optimal Strategy for Stochastic Weakly Coupled Large Scale Systems with State Dependent System Noise," IEEE Trans. Automatic Control, Vol.54, No.9, pp.2244–2250, 2009.

URL http://home.hiroshima-u.ac.jp/mukaida

Computer Science, Information, Communication and System Engineering

Development of Technologies for High-precision/High-stability Control and Reduced Power Consumption Based on the Takagi-Sugeno (T-S) Fuzzy Inference

Keywords Fuzzy Inference, Modern Control Theory, Reduced Power Consumption, High Precision, High Stability

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Title Professor

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Field Informatics, Electric/Electronic

Outline

Background

Research Summary

In recent years, many methods for controlling intelligent control systems by applying the fuzzy inference were proposed, resulting in significant achievements. In particular, it was reported that, by introducing the Takagi-Sugeno (TS) fuzzy inference, desired control performance could be achieved even if unknown disturbances were contained.

However, in the present situation, such factors as consideration for higher precision of control results, failure resistance of systems, and reduction in power consumption are not made for systems in which the T-S fuzzy inference is introduced. Therefore, there is still room for improvement in applying the system to actual machines.

Under such circumstances, our laboratory is involved in studies on new high-function fuzzy control system design that guarantees high-precision/high stability control and reduced power consumption by integrating the T-S fuzzy inference that features ease-of-use with state-of-the-art modern control theory, robustness, and additional development of the controller thereof. At present, the technology is applicable to motor control of household appliances and a wide range of other fields.

Result

For Application

Provision of knowledge, surveying, consulting and technical guidance is possible.

Provision of lectures and advice concerning the subject is possible.

We propose participation in joint studies and contracted research together with other enterprises.

Competitive Advantages

Introduction of the T-S fuzzy inference enabled high-precision/high-stability control, which is robust for disturbances and modeling errors. Control inputs can be regulated only by establishing simple control rules according to the fuzzy inference. By introducing the fuzzy inference, reduction in power consumption cost can be expected as a secondary utility.

Patent/Journal/Award

H. Mukaidani, M. Kimoto and T. Yamamoto, “Decentralized Guaranteed Cost Control for Discrete-Time Uncertain Large-Scale Systems Using Fuzzy Control,” IEEE World Congress on Computational Intelligence, pp.3099–3105, Vancouver, July 2006.

URL

Computer Science, Information, Communication and System Engineering

Identification of the Glyphs and Font Versions Used in Digital Documents

Keywords Digital Document, Font, Privately Used Characters

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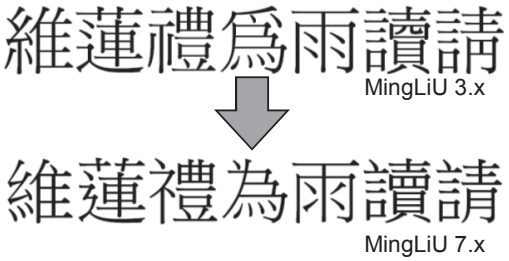
Field Information Technology, Media Database

Outline

Background

In most digital documents, the font is only referred by its family name, without the versions. Thus, even if some versions of typeface have serious update of the glyphic shapes (as from MingLiU 3.x to MingLiU 7.x) and the user extract the text from the document and paste to other documents, some glyph shapes are remarkably changed. To prevent such information loss or maltransformation, the identification of the glyphs, fonts and versions are important.

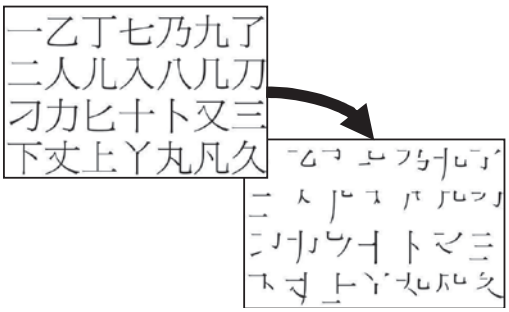
Glyphic Difference of Same Typeface



Research Summary

The digital document formats designed for printing, like PostScript, PDF, strip the metadata of the fonts; the fullname of the typeface, the vendor and the version. Other editable digital document formats like ISO/IEC 29500, with embedded fonts are also subsetted to reduce the size of data and there is a difficulty to identify the fonts. In this research, the graphic data (TrueType instructions) are extracted from the font and their hash values are stored in the database, it can be provided to the non-licensee of the fonts because the hash values of the copyrighted materials would not be regarded as copyrighted.

Broken Glyphs by Misidentification of Fonts



Result

By using the glyph identification with the hash values of their graphic instructions, the identification of the embedded fonts could be processed automatically.

For Application

This technology is useful to reduce the cost to check the document referring various fonts of rarely used characters, especially for the document that unexpected font substitution should not occur.

Competitive Advantages

In comparison with image recognization strategy, the identification by the glyphic instruction has no ambiguity in the identity. Also the identification by hash values is useful for publicly accessible database over the network without wide bandwidth.

Patent/Journal/Award

Yamashita Memorial Award, Information Processing Society of Japan (2011)

URL

Ⅷ

Measurement & Control/ Scientific Analyses

Measurement & Control/ Scientific Analyses

Large Deviations in Dynamical Systems

Keywords Dynamical Systems, Ergodic Theory, Large Deviation Principle, Multifractal Analysis

Yong CHUNG

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Field Mathematics

Outline

Background

It is necessary to investigate a large class of chaotic dynamical systems with nonuniform hyperbolicity.

Research Summary

We study the large deviations and the multifractal spectra for smooth dynamical systems using topology, differential geometry and functional analysis.

Result

We gave a sufficient condition to hold a large deviation principle for smooth dynamical systems with nonuniform hyperbolicity.

For Application

These results will contribute to the study of the chaotic phenomena appeared in natural and social sciences.

Co-researchers

Hiroki TAKAHASI (Keio Univ.), Michihiro HIRAYAMA (Univ. Tsukuba), Juan Rivera-LETERIER (PUC, Chile), Sandro VAIENTI (Univ. Sud Toulon-Var, France)

Competitive Advantages

The study confirmed a large deviation principle and a multifractal formalism for chaotic dynamical systems given by the family of Pomeau-Manneville transformations and that of quadratic maps.

Patent/Journal/Award

Yong Moo Chung, Stochastics and Dynamics, 10, 2010, 53–75.
Yong Moo Chung, Nonlinearity, 24, 2011, 1229–1252.
Yong Moo Chung and Hiroki Takahasi, Communications in Mathematical Physics, 315, 2012, 803–826.
Yong Moo Chung and Hiroki Takahasi, Ergodic Theory and Dynamical Systems, 34, 2014, 1116–1141.

URL

Measurement & Control/ Scientific Analyses

Development of Laser Desorption/VUV Photoionization Mass Spectrometry for Nonvolatile Molecules

Keywords Laser Ablation, Nonvolatile Molecules, Mass Spectrometry

Takayuki EBATA

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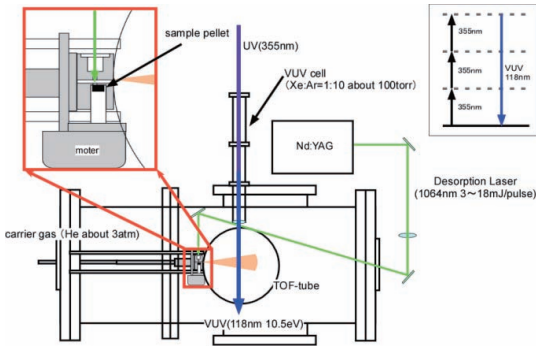
Field Physical Chemistry

Outline

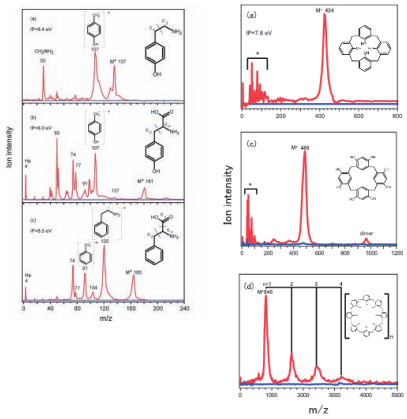
Background

MALDI-MS and ESI-MS have been widely used as mass spectrometry for nonvolatile large size biomolecules. A common characteristic in these methods is that the generated ions are normally protonated, deprotonated, or in some cases metal cation is attached. In this work, we develop another mass spectrometry method for nonvolatile molecules by combining laser desorption and photoionization.



Research Summary

The desorption of the samples was achieved by irradiating IR laser light to a pellet of samples mixed with graphite, where the latter works as a matrix. Vaporized samples are ionized by single photon ionization with VUV light generated by high harmonic generation of a Nd:YAG laser. This spectrometry method is called LD/VUVPI mass spectrometry (LD/VUVPIMS, and we applied this method to bio-related biomolecules, tyramine, L-phenylalanine (Phe) and L-tyrosine (Tyr), and functional molecules such as calix [4] arene (C4A), calix [8] arene (C8A) and calix [4] resorcinarene (C4RA).



Result

As seen from the mass spectra in the right figure, this method is successfully applied to the molecules cited above. For tyramine, Phe and Tyr, the mass spectra show considerable fragmentation because the high energy of VUV light. On the other hand, the fragmentation is rather small for encapsulation molecules such as C4A, C8A and C4RA, even though their masses are larger.

For Application

This method is essentially applied for the use of mass spectrometry for nonvolatile molecules such as large size biomolecules.

Competitive Advantages

The advantage of this method is that we only use graphite as a matrix. Thus, we do not worry about which matrix we use different from MALDI method.

Patent/Journal/Award

The CSJ Award for Creative Work, March 2008

URL

Measurement & Control/ Scientific Analyses

Study of Gamma-ray Bursts by One-shot Wide-field Polarimeter, HOWPol

Keywords Optical and Near-infrared Astronomy, Polarization, Gamma-ray Burst

Koji KAWABATA

Department Hiroshima Astrophysical Science Center

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Field Astronomy

Outline

Background

Gamma-ray bursts (GRBs) are most energetic explosions in the universe which are discovered roughly once in a day somewhere in the sky. However, the mechanism of their intense emission is still unclear. The polarization and its time variation of their early optical emission could be a key to the emission mechanism as well as the structure of their relativistic jets and electron energy, etc.

Research Summary

We have developed a one-shot wide-field polarimeter, HOWPol and an automatically-responding observation system for GRB alerts brought by GRB hunting astronomical satellites. HOWPol is attached to 1.5-m 'Kanata' telescope at Higashi-Hiroshima Observatory of Hiroshima University. HOWPol uses a wedged double Wollaston prism which enables us to obtain all three Stokes parameters for linear polarization, I, Q, and U, from a single exposure. HOWPol is useful for time-resolved observations to rapidly variable astronomical objects.

Result

We started our automated observation in 2009 summer, and observed new GRBs roughly once in 1–2 months. Most of them were very faint or invisible optically and we could not measure the polarization. However, for GRB 091208B, GRB 111218A (and possibly GRB 120212A) we successfully measured their polarization and we are now analyzing them.

For Application

We are interested in new technologies of large format photon sensors, optical devices, because we need to measure the faint radiation from astronomical sources with low noise and high efficiency. By the way, we are looking for any laboratory which can perform manufacturing process for metals according to our drawings in (or around) Higashi-Hiroshima city.

Competitive Advantages

Our capability of extensive monitoring observation with polarimetry and/or in optical and near-infrared bands simultaneously is very unique and we can produce precious observational data for astronomical objects.

Patent/Journal/Award

Kawabata, K.S., et al. 2008, Proc. SPIE, 7014, 70144L-10

URL http://hasc.hiroshima-u.ac.jp/instruments/howpol/ http://www.hiroshima-u.ac.jp/hasc/

Measurement & Control/ Scientific Analyses

The Approach via the Enclosure Method for Inverse Boundary Problems of Heat Equations

Keywords Inverse Boundary Value Problems, Identification of Cavities, Identification of Inclusions, The Enclosure Method

Mishio KAWASHITA

Department Graduate School of Science

Title Professor

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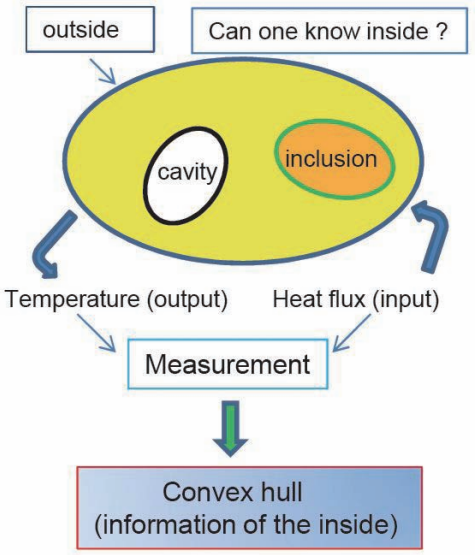
Field Mathematics (basic analysis)

Outline

Background

It is important to investigate theoretically using mathematics about a setup of inverse boundary value problems for heat equations and what information about cavities or inclusions can be reconstructed from the measurements only given on the outside boundary.



Research Summary

Prof. Masaru Ikehata (Graduate School of Engineering, Hiroshima University) advocated the “enclosure method” which is the procedure of obtaining the minimal convex set containing cavities or inclusions (called a convex hull), and he gave the theoretical justification using mathematics. In this research, for inverse boundary value problems over the heat equations, he tried to investigate with mathematical arguments about how effective the view of the “enclosure method” is.

This is a joint research with Prof. Masaru Ikehata.

Result

If it is assumed that infinitely many observational data can be obtained (finite approximation should be carried out in practice), it becomes clear theoretically what kind of data recovers the information, especially the convex hull for cavities or inclusions. When only one measurement is given, the distance between the outside boundary and cavities or inclusions can be found. In the case of cavities, it is shown that more detailed information is also acquired (but is not known for a convex hull). From the given mathematical proof, the following two remarks are obtained:

1. When gathering observational data, initial temperature of the inside must be kept constant. For example, it is necessary to observe after sufficient cooling.
2. Internal information is obtained only from the change of the heat flow at the moment of beginning the observation. On the contrary, it is difficult to acquire internal information without giving change of heat flow in the beginning. (from the proof, this opinion can be considered to be right though “the contrary is not necessarily true”).

For Application

Verification by numerical analysis has not been given yet. It is one of the future subjects to investigate its effectivity.

Co-researchers

Masaru IKEHATA

Competitive Advantages

In the theoretical research to the inverse boundary value problem, it is usually assumed that infinite observations are carried out. On the other hand, the “enclosure method” can provide the procedure of reconstruction theoretically even from many finite observational data. This is one of the reason why the “enclosure method” should be investigated.

Patent/Journal/Award

Ikehata, M., and Kawashita, M., Inverse Problems 25 (2009) 075005.
Ikehata, M., and Kawashita, M., Inverse Problems 26 (2010) 095004.

URL http://www.researchgate.net/profile/Masaru_Ikehata (Prof. Masaru Ikehata’s Homepage)

Measurement & Control/ Scientific Analyses

Non-equilibrium Quantum Field Theory and Origin of Matter and Anti-matter Asymmetry

Keywords Non-equilibrium field theory, Elementary Particle Physics, Flavor Physics, Rare B Meson Decay, CP Violation

Takuya MOROZUMI

Department Graduate School of Science

Title Associate Professor

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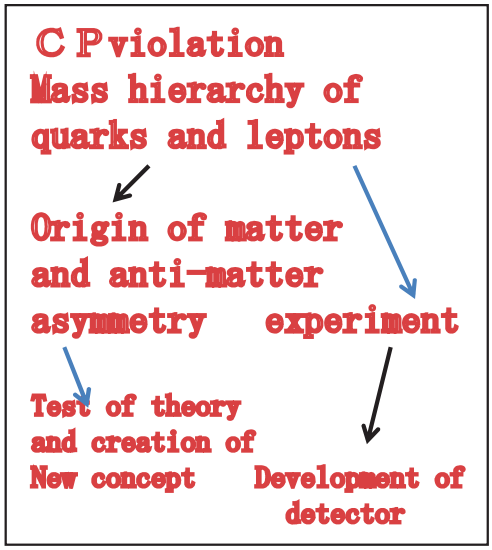
Field Elementary Particle Physics (theory)

Outline

Background

In the standard model of elementary particle physics, there are several problems which are not solved yet. The purpose of my research is to study the theoretical framework which may give an answer to the questions. The methods which test the standard model and verify the new frameworks are also proposed. Even within the standard model, there are several problems which cannot be addressed properly because of technical reasons. They are also within the scope of my research.



Research Summary

The origin of mass hierarchy of quarks and leptons and the tiny mass of neutrinos are clue for developing the new framework beyond the standard model of particle physics. For instance, in the Seesaw mechanism, the theory predicts new particles whose mass is much heavier than the heaviest particle of the standard model. We study the direct and indirect ways of detecting such heavy particles effect and study the ways verifying the theory.

Result

We study CP violation of seesaw model. We show how CP violation related to the matter and anti-matter asymmetry may lead to the CP violation of neutrino oscillation. We propose various new measurements and methods which are useful for verifying the effect of the standard model and beyond the standard model using the Rare B and K mesons and tau lepton decays.

For Application

The proposed measurements such as the forward and the backward asymmetry of b->s ll is measured in various experiments including Belle in KEK and LHCB. We continue to develop the theory and the methods in collaboration with particle physics experimentalists . We also hope to obtain some astrophysical hints which are related to the theory.

Competitive Advantages

We have the advantage because we start from very fundamental theory and framework and also show how to prove it.

Patent/Journal/Award

Forward and Backward asymmetry of dilepton angular distribution of b->sll, PLB, (With A.Ali and T. Mannel)
Power Corrections of the decay rates and distribution in B-> Xs l l , PRD, (With A.Ali, L.Handoko, G.Hiller)
A Model independent Analysis of the Rare B decays B->Xs ll , PRD, (With C.S. Kim, S. Fukae , T. Yoshikawa)
Azimuthal Angle distribution of B->K*(K pi) ll at low invariant mass region, PRD, (With C.S.Kim,Y.G.Kim,C.D.Lu)
CP violation of neutrino oscillation and leptogensis ,PRL, (With T.Endoh, S.Kang, S.Kaneko, M. Tanimoto)
Primordial family asymmetries in seesaw model, PTP, (With T. Endoh, Z.Xiong)
Bridge between CP violation and leptogenesis ,NuclPhys.B(With G.C. Branco, B.Nobre, M.Rebelo)
Chiral Weak Dynamics, PRL, (With A.I. Sanda, C.S.Lim)
CP violation of Seesaw Model, PRD, (With T. Endoh, T Onogi, A. Purwanto)

URL

Measurement & Control/ Scientific Analyses

Numerical Analysis of Micro-scale Gas Flows Using the CIP Method

Keywords Micro-fluid, Numerical Simulation, CIP Method

Youichi OGATA

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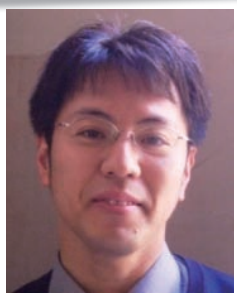
Field Numerical Fluid Dynamics, Fluid Engineering



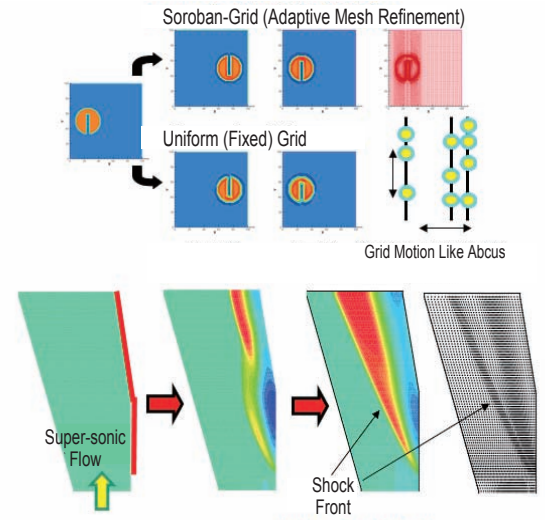
Outline

Background

It is needed to simulate micro-scale gas flows depending on the Knudsen number ; Kinematic approach by Boltzmann Equation and macroscopic one by Navier-Stokes equation with wall slip boundary.

Research Summary

Flows with high Kn number and low Kn number are solved using BGK equation and Navier-Stokes equation with wall slip boundary by the CIP method which has a high accuracy for hyperbolic equations. In addition, Soroban-grid which is suitable for the CIP method is introduced, then, dependence of Kn number on super-sonic flows in high Kn number (BGK equation) and wall slip boundary on low Kn number flows (N-S equation) was calculated.



Super-sonic flow on wall (red line)
⇒ Shock wave ; grid points gather near wave front
(BGK equation ：CIP method ＋Soroban-grid)

Result

BGK equation has four-dimensional phase space even in 2D space, but CIP with Soroban-grid can simulate flows on the wide range of Kn number effectively. Macroscopic approach based on the CIP method can also realize Flows with low Kn numbers comparable with BGK approach.

For Application

Flows in MEMS such as micro-pump has Kn number around Kn < 0.2, which can be effectively treated by the macroscopic approach. On the contrary, flows in hard-disk must be solved by BGK equation type. Hence, accurate simulations for each flow can be compared with experiments and these predict optimized design for MEMS.

Competitive Advantages

CIP method is robust and effective for both BGK and N-S equations using the small number of meshes compared to conventional schemes. 3D space (6D phase space) calculations will be possible.

Patent/Journal/Award

JACM

URL http://home.hiroshima-u.ac.jp/ryutai/jp_index.html

Measurement & Control/ Scientific Analyses

High-resolution Spin-resolved Photoelectron Spectrometer by Use of Highly Efficient Spin Polarimeter

Keywords Spin, Photoelectron Spectroscopy

Taichi OKUDA

Department Hiroshima Synchrotron Radiation Center

Title Associate Professor

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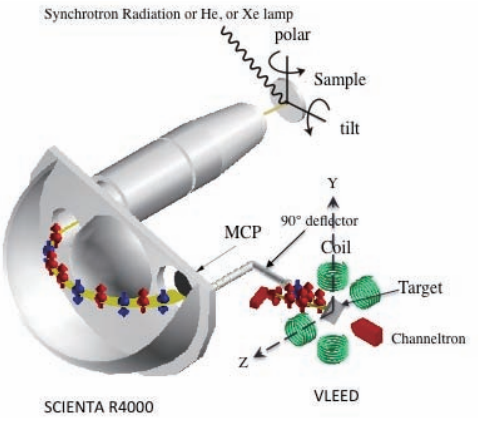
Field Surface Physics, Spintronics, Synchrotron Radiation, Photoemission

Outline

Background

Realization of electronic devices utilizing the spin degree of freedom of electron is strongly demanded, recently. Spin-resolved photoelectron spectroscopy (SRPES) is one of the key techniques to investigate the spin property of electrons in solids in which one can observe directly spin as well as energy and momentum of electrons. However, the efficiency of conventional spin detector is quite low (1/10000) and it was difficult to observe the spin-electronic structure of material precisely.



Research Summary

By utilizing very-low-energy-electron diffraction (VLEED) type spin detector which has been invented in 1989, the efficiency of spin detection can be improved about 100 times in principle. However, because of the instability of this kind of spin detector, the VLEED type spin detector was not common. In this research, we solved this problem with using stable material as the target of spin detector and realized the high-efficient spin polarimeter. By use of this spin-polarimeter, high energy- and angular-resolution spin-resolved photoelectron spectroscopy has been realized.

Result

Using pre-oxidized Fe(001) film as the target, the life time of target is dramatically improved and now one can use the same target for more than a month stably. The efficiency of the spin detection of the new spin-polarimeter is 100 times higher than conventional Mott type spin detector. Because of this high efficiency, more than 10 times higher energy and angular resolutions are realized in the SRPES measurement.

For Application

If this new spin polarimeter is commercialized, not only the specialist but also general researchers can do the high-resolution SRPES measurement and the research of spintronics will be accelerated.

Competitive Advantages

In case of conventional Mott type spin detector, high-voltage (a few tens kV) is needed for the spin detection. However, the new spin detector is operable with low voltage (~10 eV) and easy to handle. The efficiency of the new detector is 100 times higher than that of Mott detector and more than 10 times higher energy and angular resolutions have been realized.

Patent/Journal/Award

T. Okuda et al., Review of Scientific Instruments, 82,103302 (2011).

Technology award of the Surface Science Society of Japan (2011).

URL http://www.hsrc.hiroshima-u.ac.jp/spin2.htm

Measurement & Control/ Scientific Analyses

Bifurcation Problems in Nonlinear Elliptic Equations

Keywords Non-Linear, Eigenvalue, Bifurcation Curve

Tetsutaro SHIBATA

Department Graduate School of Engineering

Title Professor

Field Mathematics (differential equations)

Outline

Background

The study of bifurcation problems has a long history and it is quite important to study the global structures of its bifurcation diagrams.

Research Summary

The global and local structures of the bifurcation curves are studied.

Result

The precise asymptotic formulas for the bifurcation curves are established.

For Application

The application to biology and physics are expeceted.

Competitive Advantages

The original approach to the bifurcation curves are developed.

Patent/Journal/Award

T. Shibata, Inverse bifurcation problems for nonlinear Sturm-Liouville problems, Inverse Problems 27 (2011), 055003.

T. Shibata, Critical exponents of the asymptotic formulas for two-parameter variational eigencurves, Differential and Integral Equations 25 (2012), 899–914.

T. Shibata, Inverse bifurcation problems for diffusive logistic equation of population dynamics, J. Math. Anal. Appl. 413 (2014), 495–501.

T. Shibata, S-shaped bifurcation curves for nonlinear two-parameter problems, Nonlinear Analysis 95 (2014), 796–808.

URL

Measurement & Control/ Scientific Analyses

Longitutinal Data Analysis

Keywords Longitudinal Data, Random Effect

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Field Mathematical Statistics

Outline

Background

Asymptotic theory is needed for analyzing longitudinal data with random effects

Research Summary

Asymptotic expansions for the test statistics, estimators are derived for the model including random effects. Information criteria are also derived for such models.

Result

Asymptotic expansion formula is derived for a test statistic on a covariance structure related to a parallel profile model.

For Application

Provide some knowledge about methods of analyzing longitudinal data.

Competitive Advantages

Considering random effects, we can analyze more detail about the data.

Patent/Journal/Award

URL

Measurement & Control/ Scientific Analyses

New Type of Zeta Potential Measurement Device by Use of Sedimentation Method

Keywords Powder Technology, Classification, Standard Particle, Numerical Simulation

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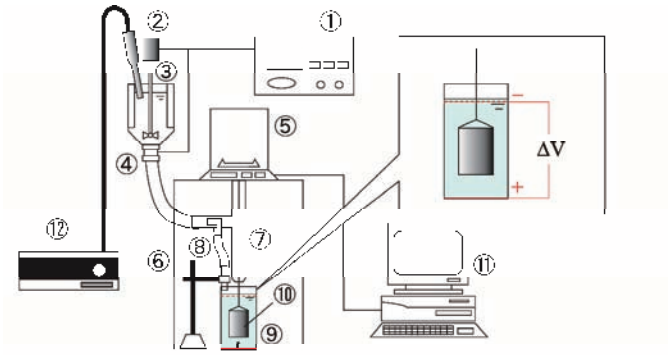
Outline

Background

Sedimentation method is widely used in the measurement of particle size distribution. Our laboratory developed the new type of automatic sedimentation balance method. Zeta potential measurement is also possible by use of this new method.

Research Summary

Conventional sedimentation balance method requires complicated process in the measurement. The new type of sedimentation balance method is simple in operation and it is possible to measure zeta potential in each size range.



① Controller ② Mixing impeller ③ Mixing tank ④ Balve
⑤ Electnic balance ⑥ Protection box ⑦ Supply pipe ⑧ Bypass
⑨ Sedimentation tank ⑩ Detection tray ⑪ Personal Computer
⑫ Ultrasonic probe

Result

Accurate particle size distribution with particle size from 1 to 100μm is possible and the results agree with the microscopic method. And also zeta potential of each particle size range is also measured by use of this new method.

For Application

This new apparatus is expected to be applied to various powder handling process including food and semiconductor industries.

Competitive Advantages

Conventional particle size measurement requires complicated data handling processes. This apparatus is simple in use, data handling friendly and easy to estimate zeta potential of each size range.

Patent/Journal/Award

Yoshida, H. et al Advanced Powder Technology, 23, 185–190 (2012)
Yoshida, H. et al Powder Technology, 219, 29–36 (2012)

URL http://home.hiroshima-u.ac.jp/powder/

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