

Annual Report 2007

May 31, 2008

**Electrical and Electronic Engineering,
Graduate School of Science and Engineering,
Tokyo Metropolitan University**

ELECTRONIC-CIRCUIT AND SYSTEM ENGINEERING DIVISION

Research Projects

INFLUENCE OF VISCOSITY LOSS ON 3-D VIBRATIONS OF RECTANGULAR AT-CUT QUARTZ PLATES

Hitoshi Sekimoto

We introduced the viscosity loss of quartz, and analyzed 3-D coupled vibrations of a VHF rectangular AT-cut quartz plate with partial electrodes. Classical mode matching was utilized to solve the 3-D problem for forced vibration. >From the admittance chart near the main TS response, we extracted the variation of resonant frequencies and resistances with the magnitudes of mode coupling. The results revealed that we could estimate the lower bound of resonant resistances or the upper bound of Q_s for VHF rectangular AT-cut plates by introducing the viscosity constants of quartz that were measured by Lamb and Richter. We also found that two series resonances on the real frequency axis could occur only within a limited range of the length-to-thickness ratio, and although each of two resonant frequencies was almost the same as that evaluated with an assumption of no losses, the corresponding resistances increased with the magnitudes of mode coupling.

A Proximate Optimality Principle Based Tabu Search

Keiichiro Yasuda

Most of the actual problems that have discrete structure can be formulated as a combinatorial optimization and many combinatorial optimization problems are supposed to be NP-hard from the viewpoint of complexity in a calculation theory. This means that it is extremely hard to obtain a strictly optimal solution within a feasible computation time. Meta-heuristics is a new paradigm that aims to obtain an approximate solution within a feasible computation time. In the meta-heuristics, Tabu search is one of the most effective algorithms for solving combinatorial optimization problems. While the intensification of Tabu Search is powerful, the diversification Tabu Search is not powerful. This paper proposes an algorithm - Multi Criteria Tabu Search coordinating the intensification and the diversification based on a Proximate Optimality Principle (POP) - which has several advantages for solving combinatorial optimization problems. The proposed algorithm is applied to some traveling salesman problems which are typical combinatorial optimization problems in order to verify the performance of the proposed algorithm.

An Adaptive Particle Swarm Optimization Method

Keiichiro Yasuda

This paper points out that meta-heuristics should have not only robustness and

adaptability to problems with different structure but also adjustability of parameters included in their algorithms. Particle Swarm Optimization (PSO), whose concept began as a simulation of a simplified social milieu, is known as one of the most powerful optimization methods for solving nonconvex continuous optimization problems. Then, in order to improve adjustability, a new parameter is introduced into particle swarm optimization on the basis of the Proximate Optimality Principle (POP). In this paper, we propose adaptive Particle Swarm Optimization and the effectiveness and the feasibility of the proposed approach are demonstrated on simulations using some typical nonconvex optimization problems.

Absolute Measurement of Surface Vibration in Piezoelectric Devices Using Two Lasers with Different Wavelengths

Yasuaki Watanabe

Our new method solves the limitation of the previous measurement system for in-plane vibration displacement, using two semiconductor lasers with adequately separated wavelengths. Different g_s , that is, interference factors, are determined for each speckle image by using lasers with different wavelengths. The ratio of the two g_s is proportional to the reciprocal of the wavelength ratio of the lasers. The distributions of the absolute vibration displacement can be mapped based on this relationship and statistical processing of the speckle images. A red laser and a violet laser were used in the actual measurement system. A 23-MHz circular AT-cut quartz resonator was used to test the validity of our method, and the results are compared here to the results previously obtained by the two-drive-level burst wave excitation method. Our experiments showed good agreement between the two displacements, thereby validating the proposed method.

Application of CIP scheme to computational electromagnetic field analysis

Yukihisa Suzuki

New computational technique to analyze electro magnetic field based on Cubic-Interpolated Propagation (CIP) scheme is investigated. CIP method has nature of good flux conservation as one of flux-corrected transport scheme, and does not required explicit absorption boundary condition (ABC). In this study, Maxwell equations are formulated into multi dimensional CIP scheme. CIP scheme for electro magnetic field indicate good performance rather than finite difference time-domain (FDTD) scheme on conservation of waveform and reduction of calculation costs caused by ABC.

Development of estimation technique on internal 3D SAR distribution for the dosimetry of high frequency electromagnetic field.

Yukihisa Suzuki

We have developed a new technique to estimate three-dimensional (3D) specific absorption ratio (SAR) distributions in transparency gel phantom. This technique is based on 3D temperature distribution imaging by means of micro-capsulated thermo-chromic liquid crystal (MTLC). To realize this new technique, high polymer gel constructed from “carrageenan”, which is extracted from seaweed and has high transparency, is employed as the substrate of the tissue equivalent phantom. We can adjust a value of complex permittivity of phantom to that of muscle at 1.5GHz. We have performed 1.5GHz high frequency electromagnetic field exposure on the tissue equivalent phantom in which MTLCs are uniformly dispersed. Time evolutionary images of two-dimensional (2D) temperature distribution inside of phantom are captured by CCD digital camera. Captured images are transformed into temperature value by using Hue-Saturation-Luminance (HSL) color scheme. Internal 2D SAR distribution on the cross section visualized by slit light is estimated from temperature elevation over a short period of time. This technique enables non-destructive and non-invasive SAR measurement within the phantom. It is possible to reconstruct 3D SAR distribution by sweeping imaging cross section with moving slit light.

Study on the effect of the relativistic electron beam injection on the high polymer materials

Yukihisa Suzuki

In the space environment, insulating materials used in spacecrafts are exposed to high-energy charged particles, such as electrons and protons, which are accelerated on the surface of the sun. In case of the irradiation with a large amount of the charged particles, the materials may sometimes melt and it gives a serious damage to the spacecraft. Hence, it is important to investigate the behavior of high-energy charged particle injected into high-polymer insulation materials. Relativistic electron beam irradiation experiment was performed to investigate the energy dumping distribution inside of epoxy resin, in which micro-encapsulated thermo-chromic liquid crystals (MTLCs) are uniformly dispersed. It is supposed from the preliminary result that energy dumping distribution has the peak in the vicinity of surface, and peak position becomes deeper according to increase of acceleration energy. The space charge accumulation is also measured by pulse electro-acoustic (PEA) method. It is found that the peak position for energy dumping caused by injected electrons is shallower than the accumulate position of space charge.

Velocity and Height of COG Tracking Control of Biped Robot Using PID Control

Takao Soma

We proposed velocity and height of COG tracking control of biped robot using PID control. In these studies, we adopted velocity feedback control in direction of movement (sagittal plane) and orthogonal direction (lateral plane), respectively. Control rules are described by PID and it is designed to simulate walking control method of human-beings. We also verified the usefulness of proposed methods through computer simulation.

The development of measurement methods of the scattering coefficients and the complex permittivity in the millimeter and microwave region:

Toshio Kamiyo

To remove an influence in the sample insertion hole which becomes a problem about the complex permittivity measurement of the material by the perturbed cavity resonator when the height of the resonator is low, we proposed a new type resonator without insertion holes. In the microwave and V-UHF band, we measured complex-dielectric-constant of the low-loss material such as rock salt and this new improved cavity clarified the usability. Also, we reviewed the possibility of the millimeter-wave permittivity measurement of the thin-film material using an open type Fabry Perrault type resonator.

Experimental Study of Long Term Stability of Cs CPT Atomic Clock Plates

Shigeyoshi Goka

A long term stability of Cs vapor cell atomic clock using a coherent population-trapping (CPT) resonance was experimentally investigated. The CPT resonances of Cs vapor cell with buffer gas were observed, and the line width of CPT resonance was about 100 Hz. The frequency stabilities of the phase-locked output signals to CPT resonance was $< 5 \times 10^{-12}/\text{day}$. The investigation of long-term stability was also considered.

Development of Strain Optimization Tool for Elastography

Takayuki Sato

In the traditional elastography, strain distribution applied to the biological tissue have been non-uniform, thus geometries of target objects have been misinduced. Here, we have performed FEM analyses to find the most uniform condition of strain distribution, and ultrasonic echo analyses based on FDTD have been performed. Obtained images of strain distribution showed the effectiveness of the uniformalization of strain distribution.

Compensation Technique of Systematic Error involved in Traditional Measurement of Thermal Pain Threshold

Takayuki Sato

Thermal pain threshold is widely known in medical and physiological fields as about 45°C which was measured with the traditional contact-type thermal dolorimeters. It is predicted that there is a considerable temperature difference, because a temperature measurement sensor and perceptive nerves are insulated with poor heat conductors. Thus, the purposes of this study are to numerically quantify the temperature difference between the sensor and the receptor, and to estimate the true pain threshold temperature. By performing heat transfer simulations based on the finite element method with a precise skin tissue model, changes in the temperature of the receptor with time were analyzed. As result, the systematic errors in the traditional measurements were about -2°C and thus the true threshold temperatures were estimated as about 43°C.

Recent Papers

H. Murata, K. Yasuda, E. Aiyoshi, "Proposal of Particle Swarm Optimization Methods with Nonlinear Dissipative Term", *IEEJ Transactions on Electronics, Information and Systems*, Vol. 127-C, No. 5, pp.787-792 (2007-5) (in Japanese)

T. Yamaguchi, N. Iwasaki, and K. Yasuda, "Autonomous Adaptive Particle Swarm Optimization Using Information about Global Best," *Journals in Electronics, Computers & Systems Sciences, Electrical Engineering in Japan*, Vol. 154, No. 1, pp.38-46 (2007-6)

D. Niizuma, K. Yasuda and A. Ishigame, "Multi-Point Tabu Search Based on Proximate Optimality Principle - Application of Parts Concept -," *IEEJ Transactions on Electrical and Electronic Engineering*, Vol. 2, No. 6, pp. 635-642 (2007-11)

M. Higashitani, A. Ishigame, K. Yasuda, "Pursuit-Escape Particle Swarm Optimization," *IEEJ Transactions on Electrical and Electronic Engineering*, Vol. 3, No.1, pp.136-142 (2008-1)

K. Yasuda, T. Nagaoka, and A. Ishigame, "Proximate Optimality Principle Based Multi-point Tabu Search," *IEEJ Transactions on Electronics, Information and Systems*, Vol.128-C, No.3, pp.515-516 (2008-3) (in Japanese)

M. Takei and K. Yasuda, "Constrained Particle Swarm Optimization Using Exterior Penalty Function and Swarm Activity}," *IEEJ Transactions on Electronics, Information and Systems*, Vol.128-C, No.3, pp.517-518 (2008-3) (in Japanese)

S. Nakano, A. Ishigame, and K. Yasuda, "Particle Swarm Optimization Based on The Concept of Tabu Search," *Proceedings of 2007 IEEE Congress on Evolutionary Computation (CEC2007)*, pp.3258-3263 (Sep. 2007)

N. Nakagawa, A. Ishigame, and K. Yasuda, "Particle Swarm Optimization with Quasi-Gradient," *Proceedings of The 7th International Conference on Optimization: Techniques and Applications (ICOTA7)*, CD-ROM (Dec. 2007)

S. Nakano, A. Ishigame, and K. Yasuda, "Examination of Particle Swarm Optimization using Tabu List," *Proceedings of The 7th International Conference on Optimization: Techniques and Applications (ICOTA7)*, CD-ROM (Dec. 2007)

M. Maeda, D. Niizuma, and K. Yasuda, "Combinatorial Optimization Method based on

Particle Swarm Optimization and Proximate Optimality Principle," Proceedings of The 7th International Conference on Optimization: Techniques and Applications (ICOTA7), CD/ROM (Dec. 2007)

M. Takei and K. Yasuda, "Particle Swarm Optimization for Constrained Optimization Problems, " Proceedings of The 7th International Conference on Optimization: Techniques and Applications (ICOTA7), CD/ROM (Dec. 2007)

Megumi Maeda and Keiichiro Yasuda, "A Parts-Concept Based Optimization Method for Combinatorial Optimization Problems, " Proceedings of Electronics, Information and Systems Conference Electronics, Information and Systems Society, I.E.E. of Japan, pp.399-404 (Sep.2007) (in Japanese)

Mari Takei and Keiichiro Yasuda, "Particle Swarm Optimization for Constrained Optimization Problems, " Proceedings of Electronics, Information and Systems Conference Electronics, Information and Systems Society, I.E.E. of Japan, pp.805-810 (Sep.2007) (in Japanese)

Masaru Kawarabayashi , Keiichiro Yasuda and Satoshi Kitayama, "Basic Study of Integrated Optimization System by Combining Optimization and Modeling Methods "Proceedings of Electronics, Information and Systems Conference Electronics, Information and Systems Society, I.E.E. of Japan, pp. 255-260 (Sep.2007) (in Japanese)

Masaru Kawarabayashi and Keiichiro Yasuda, "Study of Uniting Particle Swarm Optimization and RBF Network Based on Integrated Optimization " SICE Symposium on Systems and Information 2007, pp. 255-260 (Nov.2007) (in Japanese)

Masaru Kawarabayashi and Keiichiro Yasuda, "Integrated Optimization of Particle Swarm Optimization and RBF Network " , IIC Conference (IEEJ) IIC-08-5 (Mar.2008), pp25-30 (in Japanese)

Hiroyuki Jinnai and Keiichiro Yasuda, "Multi-point Optimization Method Based on Distance Structure Considering Proximate Optimality Principle, " Proceedings of Electronics, Information and Systems Conference Electronics, Information and Systems Society, I.E.E. of Japan, pp.405-409 (Sep.2007) (in Japanese)

Hiroyuki Jinnai and Keiichiro Yasuda, "Movement Strategy Considering Proximate Optimality Principle in Multi-point Tabu Search," SICE Symposium on Systems and Information 2006, pp.243-248 (Nov.2007) (in Japanese)

Hiroyuki Jinnai and Keiichiro Yasuda, "Evaluation of Proximate Optimality Principle based on Distance Structure and Proposal of Multi-point Tabu Search," IIC Conference (IEEJ) IIC-08-2 (Mar.2008), pp.7-12 (in Japanese)

Chen Qian and Keiichiro Yasuda, "Study about Parameter Tuning Based on Numerical Stability of Particle Swarm Optimization, " SICE Symposium on Systems and Information 2007, pp.261-266 (Nov.2007) (in Japanese)

Chen Qian and Keiichiro Yasuda, "Particle Swarm Optimization Based on Successive Optimization in Its Parameter Space, " IIC Conference (IEEJ), pp.13-18 (Mar.2008) (in Japanese)

Yuta Aoki and Keiichiro Yasuda, "A Basics Study on the Neighborhood Structure of Local Search, " Proceedings of Electronics, Information and Systems Conference Electronics, Information and Systems Society, I.E.E. of Japan, pp.410-414 (Sep.2007) (in Japanese)

Yuta Aoki and Keiichiro Yasuda, "An application of the Selected Neighborhood in Meta-Heuristics, " IIC Conference (IEEJ), pp1-6 (Mar.2008) (in Japanese)

Shinji Noda and Keiichiro Yasuda, "Parameter Setting of Particle Swarm Optimization Based on Numerical Stability Analysis, " IIC Conference (IEEJ), pp.19-24 (Mar.2008) (in Japanese)

E. Aiyoshi and K. Yasuda, "Metaheuristics and Their Applications", Ohmsha, (2007-10) (in Japanese)

K. Yasuda(co- authored) : "Softcomputing and Its Industrial Applications," Technical Report of IEEJ, Vol.1087 (2007-6)

K. Yasuda(co- authored) : "Report on Electronics, Information and Systems Society Annual Conference of IEEJ," IEEJ Transactions on Electronics, Information and Systems, Vol.128-C, No.1, pp.154-162 (2008-1) (in Japanese)

Hitoshi Sekimoto, Jun Tamura, Shigeyoshi Goka, and Yasuaki Watanabe, "Influence of Viscosity Loss on Three-Dimensional Vibrations of Rectangular AT-Cut Quartz Plates", Japanese Journal of Applied Physics, vol. 46, No. 7B, pp. 4656-4659, 2007-07.

Yasuaki Watanabe, Yuki Sato, Shigeyoshi Goka, Shigeyoshi Goka, Hitoshi Sekimoto, "An Unique Design of Temperature Compensated SC-cut Crystal Oscillators," Trans. IEEJ-C, Vol. 127, No. 8, pp.1192-1193, 2007

Yasuaki Watanabe, Sunao Ishii, Masahiko Kato, Shigeyoshi Goka, and Hitoshi Sekimoto,

"Absolute Measurement of Surface Vibrational Distribution in Piezoelectric Devices Using Burst-Wave Driving," Japanese Journal of Applied Physics, Vol. 46, No. 7B, pp. 4504-4507, 2007

Yasuaki Watanabe, Noriyuki Imaeda, Shigeyoshi Goka, Takayuki Sato, Hitoshi Sekimoto and Sunao Ishii, "Absolute Measurement of Surface-Vibration-Patterns in Piezoelectric Devices Using Two Lasers with Different Wavelengths," Proc. of 2007 Joint Meeting of the European Time and Frequency Forum (EFTF) and the IEEE International Frequency Control Symposium (IEEE-FCS), Geneva, Switzerland, 2007.

Noriyuki Imaeda, Yasuaki Watanabe, Shigeyoshi Goka, Takayuki Sato and Hitoshi Sekimoto, "High-speed Measurement of Mode Shapes and Vibration Amplitude in Piezoelectric Resonators Using Two-Lasers with Different Wavelengths," Proc. of 28th USE, Tsukuba, Ibaragi, Japan, 2007.

Yasuaki Watanabe, Noriyuki Imaeda, Shigeyoshi Goka, Takayuki Sato, Hitoshi Sekimoto, "Measurement of in-plane mode shapes using two lasers with different wavelengths," Proc of the Acoustical Society of Japan, Kofu, Japan, 2007.

Hitoshi Sekimoto, Yasuaki Watanabe and Kyoya Fukuda, "Technical report of precise frequency control society 2004-2006," Technical research report of electronic circuits division, IEEJ, 2007.

Yasuaki Watanabe, Shigeyoshi Goka, Takayuki Sato, Hitoshi Sekimoto, "High-speed measurement of in-plane mode shapes and vibrational displacement of piezoelectric devices," Proc. of the piezoelectric device symposium 2008, Tohoku univ., 2008.

S. Goka, Y. Mase, H. Sekimoto, Y. Watanabe, "Experimental Study of Mode-coupling Strength of AT-cut Quartz Resonators With High Mesa Step Height" IEEJ C-127, Vol. 8 (2007-8)

S. Goka, "Calculational Study of Bi-Mesa Structures Suitable for Mounting With High Mesa Step", The 2nd Japan-Taiwan Workshop on Future Frequency Control Devices, at Taipei, 2007.

Takayuki Sato, "Estimation of Receptor Temperature at Point of Heat Pain Perception based on Finite Element Analysis", Jpn. J. Ergo., vol. 44, no.1, pp.14-21, 2008.

H. Shinohara, K. Mitsuhashi, Y. Tanaka, T. Takada, Y. Suzuki and K. Fukunaga, "Development of measurement system for temperature distribution in electron beam irradiated polymeric insulating materials using thermo-chromic liquid crystal", Proc. 10th Space craft charging conference, in printing, (2007, Jun.)

Yukihisa Suzuki, "Development of 3D Temperature Imaging system with micro-encapsulated thermo-chromic liquid crystal for high-energy electron beam irradiation", Electrical Insulation News in Asia (EINA) magazine No.14(2007), pp.48-49, (2007, Nov.)

T. Soma, "Velocity and Height of COG Control of Biped Walking", The 13th Robotics Symposia

M Chiba, T Kamijo, Y Watanabe, M Fujii, Y Shibasaki, Y Takayama, F Yabuki, O Yasuda, A Amano, Y Chikashige, T Kon, S Mori, S Ninomiya, Y Shimizu, Y Takeoka and M Utsumi: "Measurement of Attenuation Length for Radio Wave in Natural Rock Salt and Performance of Detecting Ultra High-Energy Neutrinos", ARENA 2006, ACOUSTIC AND RADIO EeV NEUTRINO DETECTION ACTIVITIES 28, 30 June 2006, University of Northumbria, Newcastle, UK, Journal of Physics: Conference Series, Volume 81, 012003 (2007)

Masami Chiba, Yoko Arakawa, Toshio Kamijo, Shunsuke Nakamura, Yuji Shibasaki, Yasuhiro Takayama, Yusuke Watanabe, Fumiaki Yabuki, Osamu Yasuda, Akio Amano, Yuichi Chikashige, Keisuke Ibe, Tadashi Kon, Sosuke Ninomiya, Yutaka Shimizu, Yoshito Takeoka, Yasuyuki Taniuchi, Michiaki Utsumi and Masatoshi Fujii: "Reflection of microwave from energy deposit by X-ray irradiation in rock salt: Implication of an ultrahigh energy salt neutrino detector to act like a radio bubble chamber", Proceedings of 15th International Conference on Super symmetry and the Unification of Fundamental Interactions (SUSY07), Karlsruhe, Germany, 26 Jul - 1 Aug 2007 (2007-10)

Keisuke Ibe, Tadashi Kon, Yutaka Shimizu, Yuichi Chikashige, Sousuke Ninomiya, Yoko Arakawa, Toshio kamijo, Masami Chiba, Shunsuke Nakamura, Osamu Yasuda, Humiaki Yabuki, Michiaki Utsumi, , Yasuyuki Taniuchi, Masatoshi Fujii: "Evaluation of Cross Sections of UHE Neutrinos with Nucleons for Rock Salt Dome as Neutrino Detector"(in Japanese), The Physical Society of Japan 2008 Spring Meeting, 26aZJ-1 (2008-3)

Sousuke Ninomiya, Keisuke Ibe, Tadashi Kon , Yutaka Shimizu, Yuichi Chikashige, Yoko Arakawa, Toshio kamijo, Masami Chiba, Shunsuke Nakamura, Osamu Yasuda, Humiaki Yabuki, Michiaki Utsumi, , Yasuyuki Taniuchi, Masatoshi Fujii: "Improving a Perturbed Cavity Resonator without Sample Insertion Holes in 300MHz and

Measurement of Complex Permittivity of Rock Salt as Neutrino Detector in the UHF Band" (in Japanese), The Physical Society of Japan 2008 Spring Meeting, 26aZJ-2 (2008-3)

Masami Chiba, Yoko Arakawa, Toshio kamijo, Shunsuke Nakamura, Osamu Yasuda, Humiaki Yabuki, Keisuke Ibe, Tadashi Kon, Yutaka Shimizu, Yuichi Chikashige, Sousuke Ninomiya, Michiaki Utsumi, Yasuyuki Taniuchi, Masatoshi Fujii: "Study of reflection of microwave scattered from X-ray irradiation in rock salt for detecting ultra high energy neutrino"(in Japanese), The Physical Society of Japan 2008 Spring Meeting, 26aZJ-3 (2008-3)

Yoko Arakawa, Toshio kamijo, Masami Chiba, Shunsuke Nakamura, Osamu Yasuda, Humiaki Yabuki, Keisuke Ibe, Tadashi Kon, Yutaka Shimizu, Yuichi Chikashige, Sousuke Ninomiya, Michiaki Utsumi, , Yasuyuki Taniuchi, Masatoshi Fujii: "Study of reflection of microwave scattered from EM shower in rock salt for detecting ultra high energy neutrino"(in Japanese), The Physical Society of Japan 2008 Spring Meeting, 26aZJ-4 (2008-3)

Shunsuke Nakamura, Toshio kamijo, Masami Chiba, Yoko Arakawa, Osamu Yasuda, Humiaki Yabuki, Keisuke Ibe, Tadashi Kon, Yutaka Shimizu, Yuichi Chikashige, Sousuke Ninomiya, Michiaki Utsumi, Yasuyuki Taniuchi, Masatoshi Fujii: "Characterization of planer antenna and application to salt neutrino detector"(in Japanese), The Physical Society of Japan 2008 Spring Meeting, 26aZJ-5 (2008-3)

ELECTRICAL ENERGY AND APPLICATION OF ELECTRO-MAGNETICS ENGINEERING DIVISION

Research Projects

Exposure assessment for epidemiological studies on possible association between brain tumor and use of mobile phones

Masao Taki

There have been concerns about possible association between risk of brain tumors and prolonged use of mobile phones. International collaborative epidemiological study has been conducted under the coordination by International Agency of Research on Cancer (IARC). This study is a part of this project which provides means to exposure assessment in consideration of spatial distribution of specific absorption rate (SAR) of energy emitted from mobile phones. We proposed a method to estimate 3D SAR distribution in the brain from limited data of SAR obtained in the routine measurement for compliance testing. The method has been applied to Japanese case-control study, which provided an evidence that the association is unlikely to exist.

Vibration actuator cooperatively driven by both electromagnetic force and magnetostrictive force

Masao Taki

We proposed and developed a vibration actuator cooperatively driven by electromagnetic force and magnetostrictive force. The electromagnetic force has an advantage in low frequency range as the force is proportional to current, while magnetostrictive force has an advantage in high frequency range as the force is proportional to square of frequency with a constant current.

Assessment of a body area communication system with electrical coupling in consideration of electromagnetic compatibility with human body

Masao Taki

Body area network system is a communication system around the human body, which works as a transmission pathway for the electromagnetic signal. The human body affects the radiation of electric and magnetic field. The exposure of human body by this system should be assessed. In addition the effect of the system on the implanted medical devices should be examined. The electromagnetic compatibility is an important issue in this technology. We examined such various aspects of electromagnetic compatibility based on the numerical simulation with FDTD method for an electrically coupled body area network system.

Development and assessment of exposure setups for experiments on biological effects of microwaves and millimeter waves

Masao Taki and Yukihiisa Suzuki

Biological effects of high frequency electromagnetic fields have been investigated with experiments in vivo and in vitro. It is necessary to realize well-defined exposure conditions to perform reliable experiments with reproducibility. Exposure assessment is important for this purpose. We have been engaged in the development and exposure assessment for various experiments both in vivo and in vitro to investigate effects of microwaves and millimeter waves. Our work includes local exposure setup for experiment on rabbit eye, for rat brain with cranial window.

Development and performance assessment of three dimensional dielectrophoretic devices

Satoshi Uchida

The trapping and concentration processes of bacteria are extremely important elements in various detection methods. At the present time, mesh filters and collection beads are used generally. However, there are some problems such as time waste and the rising cost due to their frequent exchange. In the present work, we developed a new concentration apparatus, i. e. dielectrophoretic device, in which bacteria are trapped or released electrically. It was possible to trap and to concentrate more bacteria by arrangement of dielectric pillars between electrodes in the device. In addition, it was clarified that the adequate collection frequency for *Escherichia coli* was different from that for yeast.

High-speed Detection of Bacteria by Dielectrophoretic Technique

Satoshi Uchida

Explosion of hospital infection and epidemic food poisoning by malignant bacteria is one of the most serious problems in the contemporary society. Therefore, full-time monitoring of bacteria is come under review to prevent the infection from occurring. However, the effective technique with fast detection and high selectivity for bacteria has not established at this moment. In the present work, we developed a monitoring system of bacteria using dielectrophoretic technique. For impedance measurement, dependence of dielectrophoretic characteristics on bacterial species was investigated for *Escherichia coli*, *lactobacillus* and yeast. Combination of fluorescence spectroscopy made possible to specify the mixture ratio and concentration simultaneously. Moreover, dielectrophoretic collection rate was deduced efficiently using an image analysis for fluorescently-stained bacteria.

Investigation of efficient sterilization in micro channel using dielectrophoretic concentration and low voltage pulse

Satoshi Uchida

Immediate sterilization is essential in food production processes because of strictness of food sanitation. However, it is difficult for conventional heat treatment to deal with all foods. In the present work, new treatment method was examined, i. e. pathogenetic bacteria were detected and concentrated in closed micro channel by dielectrophoresis, and were sterilized by pulse electric field under low voltage and electric power. At frequency as 100 kHz, *Escherichia coli* were concentrated efficiently as in our previous results. In addition, when 100 V pulse voltage is applied by high-speed semiconductor switch, 99.9% of the bacteria became extinct in one hour. The enhancement of dielectrophoretic concentration is due to limitation of the collection area in a closed micro channel.

Numerical analysis of fundamental properties in microplasmas

Satoshi Uchida

Microplasmas, a kind of atmospheric pressure plasmas, are available for various applications because of the high plasma density and minute structure. However, it is essential for the effective utilization to investigate the behavior of microplasmas under various discharge conditions. In the present work, we simulated discharge structure of microplasmas under various conditions and analyzed the fundamental discharge characteristics. The plasma formation strongly depended on electrode width and voltage polarity in a micro cell. Moreover, it was shown quantitatively that nitrogen microplasma was steady formed by an applied voltage of rectangular pulse.

Application of electrical gas discharges for environmental purification technologies

Fumiyoshi Tochikubo

We have studied the removal processes of nitrogen oxides (NO_x) by means of selective catalytic reduction with hydrocarbons (HC-SCR) with assistance of plasma chemical reactions. We have investigated the influence of gas composition, gas and catalyst temperature, plasma and catalyst arrangement on the NO_x removal characteristics. γ -Al₂O₃ is used as a catalyst for HC-SCR. Plasma treatment drastically improved the NO_x removal of HC-SCR in the temperature region below 300 °C. We examined two system, plasma-enhanced catalysis (PEC) and plasma-driven catalysis (PDC) in this work. The catalytic reactor is placed in the downstream of plasma reactor in PEC, so that the plasma reactor works as a pretreatment system of the catalytic reactor. The interaction between plasma and catalytic reaction is expected in PDC since the catalyst is placed in the plasma reactor as a dielectric material of packed-bed plasma reactor. In our experiment, the PEC showed the better performance for NO_x removal. This might

be that the oxidative species prevent the NO_x reduction on the catalyst in PDC. The modeling of catalytic reaction is started to investigate the interaction between plasma and catalytic reactions. As a first step of that, we tried to model the HC-SCR of NO_x by means of mass conservation equations in gas-phase and solid-phase on catalyst.

Electrical gas discharge in bubbles in water is also carried out for wastewater treatment.

Numerical simulation of microplasma with consideration of gas dynamics

Fumiyoshi Tochikubo

Microplasma is typically a nonthermal plasma source with high plasma density and micrometer size at high gas pressure. In microplasma at atmospheric pressure, the gas temperature increases by Joule heating and gas flow occurs by the ion drag force. It is necessary to understand the gas dynamics for the optimum control of microplasma. Therefore, we work on the development of simulation model of microplasma with gas dynamics consideration. This year, we performed the simulation of dc microplasma in atmospheric pressure helium in open system with gas dynamics consideration. We confirmed the gas heating at ion sheath in cathode fall region. The strong gas flow, which is generated by the ion drag force again in the cathode fall region, transports the heat. The surrounding cold air was taken in the hot discharge region by the gas dynamics.

A study of EMI noise of Inverter Circuits

Keiji Wada

This research discusses common-mode EMI problems for AC module inverters and shows an installation point for a common-mode chokes to reduce the noise voltage. In addition, it discusses noise currents in a control or gate-drive circuit of a 200-kHz PWM inverter. When the MOSFETs of the inverter are turned-on or -off, the noise current flows into the control and drive circuits. Three suppression methods are presented.

A study of a hybrid active filter for suppress harmonic currents

Keiji Wada

This research presents steady and transient states of a transformerless shunt hybrid filter consisting of a three phase passive filter tuned to the 7th-harmonic frequency, and a small-rated active filter based on a three-phase voltage-source PWM converter. The validity of the hybrid filter is confirmed by experimental results obtained from a 400-V, 15-kW laboratory system.

Study on a Halbach-type PM Surface Motor

Junichi Tsuchiya

The motor drive system becomes complex and high performance as the industrial machine device develops. Moreover, the drive of multi-degrees-of-freedom is requested. Then, the research of the surface motor that is a kind of a multi-dimensional movement is paid to attention. We developed a new type surface motor (SFM). This new type of SFM consists of many electromagnets as a stator, and a Halbach-type permanent magnets as a mover. Consequently, the mover is free from the connection of the wire, then the mover can rotate itself in addition to linear motion on the x-y plane by the excitation of the stator coils. This SFM might be useful for the application in the space sealed up, because the mover and stator are completely separate. We experimented in the prototype, confirmed the operation, and measured a basic characteristic. We are researching an analysis of the motion and a new driving method. The linear motion and rotational motion of this SFM is analyzed, and improved. Moreover a new method to measure the mover's position is examined and optimized. On the other hand, we are developing a novel SFM that uses the bulk superconductor. The mover composed of the bulk superconductor is supported by the pinning force, and levitate. And the mover moves freely on the x-y plane.

The construction of the optimum design system of electromechanical devices integrated with simulation and optimization

Junichi Tsuchiya

Recently, an optimum design of electromechanical devices with Metahuristics and an electromagnetic field analysis simulator is proposed. This system has high generality and flexibility that the highly accurate electromagnetic field analysis obtained by the complex simulation can be used for optimization immediately. The optimum design system of electromechanical devices that integrates optimization and the simulation can achieve a further performance improvement of electromechanical devices.

Study on a Ultrasonic Motor using a Coiled Stator

Junichi Tsuchiya

A micro motor that works in the blood vessel is requested by medical. However, it is already a limit in the motor of a past principle. The supersonic wave motor based on a new principle is researched. We make the new micro supersonic wave motor that uses coiled type Stata for trial purposes, and are examining the characteristic. It is easy to miniaturize, and as much as 1mm or less in the diameter is also possible in this motor because of a simple structure. Moreover, there is a feature of operation in the liquid and the rotation of the midair axis.

Recent Papers

W. Tangtheerajaronwong, T Hatada, K. Wada, and H. Akagi, "Design and Performance of a Transformerless Shunt Hybrid Filter Integrated Into a Three-Phase Diode Rectifier," *IEEE Transactions on Power Electronics*, vol. 22, no. 5, pp. 1882-1889, 2007

M. Hagiwara, K. Wada, H. Fujita, and H. Akagi, "Dynamic Behavior of a 21-Level BTB-Based Power-Flow Controller Under Single-Line-to-Ground Fault Conditions," *IEEE Transactions on Industry Applications*, vol. 43, no. 5, pp. 1379-1387, 2007

K. Wada, K. Shirakawa, T. Shimizu, "Discussion of Internal Noise Currents in a Control Circuit on a 200-kHz Switching PWM Inverter," *IEEE/IEEE Power Conversion Conference(PCC)*, pp. 423-428, 2007

F. Shinjo, K. Wada and T. Shimizu, "A Single-Phase Grid-Connected Inverter with a Power Decoupling Function," *IEEE/PELS Power Electronics Specialists Conference*, pp. 1245-1249, 2007

K. Wada and T. Shimizu, "Reduction Methods of Conducted EMI Noise on Parallel Operation for AC Module Inverters," *IEEE/PELS Power Electronics Specialists Conference*, pp. 3016-3021, 2007

K. Terashima, K. Wada, T. Shimizu, and et. al, "Evaluation of the Iron Loss of an Inductor Based on Dynamic Minor Characteristics," *EPE 2007*, 2007

Keiji Wada, "A Study of EMI Noise of Photovoltaic Inverter Circuits," 2007 EMC forum

Fumihiko Shinjo, Keiji Wada, Toshihisa Shimizu, "Single-Phase Grid Connected Inverter utilizing a Power Decoupling Function," *IEEEJ/IAS Conference*, no. 1-21, 2007

Kazuhito Terashima, Keiji Wada, Toshihisa Shimizu, "Evaluation of the Iron Loss of an Inductor Based on Dynamic Minor Characteristics," *IEEEJ/IAS Conference*, no. 1-81, 2007

Kanretsu Kim, Keiji Wada, Toshihisa Shimizu, "A Novel Iron Loss Reduction for AC Filter Inductors on PWM Inverters," *IEEEJ/IAS Conference*, no. 1-82, 2007

Yosei Sakamoto, Keiji Wada, Toshihisa Shimizu, "The Experimental Validation of Reducing Gate-Driving Power at Source Grounded High Frequency Inverters," IEEJ/IAS Conference, no. Y-26, 2007

Tetsuya Mitani, Keiji Wada, Toshihisa Shimizu, "Discussion of the Factors of an Internal Noise Current in a Power Converter," IEEJ/IAS Conference, no. Y-28, 2007

Satoshi Taniguchi, Keiji Wada, Toshihisa Shimizu, "A Study on a Single-phase Inverter Control Based on a Rotational Coordinate Transformation," IEEJ/IAS Conference, no. Y-29, 2007

Kazuhiro Terashima, Keiji Wada, Toshihisa Shimizu, "Evaluation of the Iron Loss of an Inductor Based on Dynamic Minor Characteristics," IEEJ Technical Meeting on Semiconductor Power Converter, SPC-08-33, 2008

Kanetsu Kim, Keiji Wada, Toshihisa Shimizu, "Dynamic Iron Loss Measurement Method for AC Filter Inductor," IEEJ Technical Meeting on Semiconductor Power Converter, SPC-08-34, 2008

Fumihiko Shinjo, Keiji Wada, Toshihisa Shimizu, "High Efficiency Single-Phase Grid Connected Inverter utilizing Power Decoupling Function," IEEJ Technical Meeting on Semiconductor Power Converter, SPC-08-35, 2008

Takashi Matsuura, Keiji Wada, "Measurements of Magnetic Fields from a Induction Heating with Power Adjustment," IEEJ Annual Meeting, no. 1-149, 2008

Zen Ariga and Keiji Wada, "Evaluation of Near Field Noise Caused by Switching Action on a Converter," IEEJ Annual Meeting, no. 4-32, 2008

Yu Komatsubara, Keiji Wada, "Development of a Power Supply for the Micro Sterilization System," IEEJ Annual Meeting, no. 4-74, 2008

Hiroshi Masuda, Akira Ushiyama, Shogo Hirota, Kanako Wake, Soichi Watanabe, Yukio Yamanaka, Masao Taki and Chiyoji Ohkubo, "Effects of Acute Exposure to a 1439 MHz Electromagnetic Field on the Microcirculatory Parameters in Rat Brain", *in vivo* 21: 555-562 (Jul. and Aug. 2007)

Hiroshi Masuda, Akira Ushiyama, Shogo Hirota, Kanako Wake, Soichi Watanabe, Yukio Yamanaka, Masao Taki and Chiyoji Ohkubo, "Effects of Subchronic Exposure to a 1439 MHz Electromagnetic Field on the Microcirculatory Parameters in Rat Brain. *in vivo* 21: 563-570(Jul. and Aug. 2007)

E. Cardis, L.Richardson, I. Deltour, B.Armstrong, M. Feychting, C. Johansen, M. Kilkenny, P. McKinney, B. Modan, S. Sadetzki, J. Schuz, A.Swerdlow, M. Vrijheid, A.Auvinen, G.Berg, M.Blettner, J. Bowman, J. Brown, A. Chetrit, H. C. Christensen, A. Cook, S.Hepworth, G.Giles, M.Hours, I.lavarone, A.Jarus-Hakak, L.Klaeboe, D.Krewski, S.Lagorio, S.Lonn, S.Mann, M.McBride, K.Muir, L.Nadon, M-E.Parent, N.Pearce, T.Salminen, M.Schoemaker, B.Schlehofer, J.Siemiatycki, M.Taki, T.Takebayashi, T.Tynes, M. van Tongeren, P.Vecchia, J.Wiart, A.Woodward, N.Yamaguchi, “The INTERPHONE study: design, epidemiological methods, and description of the study population”, *European Journal of Epidemiology*. Volume 22, Number 9, pp.647-664 (Sep. 2007)

Toru Takebayashi, Nadege Varsier, Yuriko Kikuchi, Kanako Wake, Masao Taki, Soichi Watanabe, Suminori Akiba and Naohito Yamaguchi, “Mobile phone use, exposure to radiofrequency electromagnetic field, and brain tumour: a case-control study”, *British Journal of Cancer*, 98, 652-659(Feb. 2008).

Nadege Varsier, Kanako Wake, Masao Taki, Soichi Watanabe, Toru Takebayashi, Naohito Yamaguchi and Yuriko Kikuchi, “SAR characterization inside intracranial tumors for case-control epidemiological studies on cellular phones and RF exposure. *Annals of Telecommunications*, Volume 63, Numbers 1-2 (Feb. 2008).

Dai Kaburagi, Masao Taki, Yukihisa Suzuki, “Magnetostrictive vibration actuator with improved characteristics at low frequencies”, *Journal of System Design and Dynamics*, Vol.2, No.1, pp.139-145(Mar. 2008).

M.Kojima, Y.Yamashiro, M.Hanazawa, S.Watanabe, H.Sasaki, M.Taki, K.Sasaki, "Investigation of frequency specificity of ocular effects through quasi-millimeter and millimeter wave exposure", 2007 Annual Meeting of ARVO (Association for Research in Vision and Ophthalmology) (May 2007).

Yoshikazu Ugawa, Yasuo Terao, Toshiaki Furubayashi, Yoko Mizuno, Kei Shirasawa, Akira Kageyama, Tomoko Okano, Masami Nishikawa, Kaori Miyawaki, Asako Yasuda, Mitsunori Uchiyama, Hitomi Kobayashi Yamashita, Akira Ushiyama, Hiroshi Masuda, Shogo Hirota, Miyuki Takahashi, Shigeru Sokejima, Eiji Maruyama, Pornanong Pongpaibool, Kanako Wake, Soichi Watanabe, Masao Taki, Chiyoji Ohkubo, "Effects of electromagnetic field exposure from mobile phone base stations: Does it differ between subjects with mobile phone related symptom and those without? . A population-based questionnaire survey and provocation study in Japan". *Proc. 29th Bioelectromagnetics Society Annual Meeting, Knazawa Bunka Hall, Kanazawa, Japan*, p.60, (June 2007)

Naohito Yamaguchi, Toru Takebayashi, Suminori Akiba, Yuriko Kikuchi, Masao Taki, Kanako Wake, Soichi Watanabe, Nadege Varsier, Noriko Kojimahara, Satoru Shimizu, Ikuko Kato, Yasuto Sato, Osami Kubo, Shigeru Sokejima, "Epidemiology of mobile phone and health", Proc. 29th Bioelectromagnetics Society Annual Meeting, Kanazawa Bunka Hall, Kanazawa, Japan, p.144, (June 2007)

Nadege Varsier, Kanako Wake, Masao Taki, Soichi Watanabe, Toru Takebayashi, Naohito Yamaguchi, Yuriko Kikuchi, "SAR characterization inside intracranial tumors for case-control epidemiological studies on cellular phones and RF exposure", Proc. 29th Bioelectromagnetics Society Annual Meeting, Kanazawa Bunka Hall, Kanazawa, Japan, p.254,(June 2007)

Toshiaki Furubayashi, Yasuo Terao, Yoko Mizuno, Kei Shirasawa, Akira Kageyama, Tomoko Okano, Masami Nishikawa, Kaori Miyawaki, Asako Yasuda, Mitsunori Uchiyama, Hitomi Kobayashi-Yamashita, Akira Ushiyama, Hiroshi Masuda, Shogo Hirota, Miyuki Takahashi, Shigeru Sokejima, Eiji Maruyama, Pornanong Pongpaibool, Kanako Wake, Soichi Watanabe, Masao Taki, Chiyoji Ohkubo, Yoshikazu Ugawa, "Effects of EMF exposure from mobile phone base stations: Differences in reaction times between subjects with mobile phone related symptoms and without them", Proc. 29th Bioelectromagnetics Society Annual Meeting, Kanazawa Bunka Hall, Kanazawa, Japan, p.347, (June 2007)

Akira Ushiyama, Hiroshi Masuda, Shogo Hirota, Miyuki Takahashi, Shigeru Sokejima, Eiji Maruyama, Yoshikazu Ugawa, Yasuo Terao, Toshiaki Furubayashi, Yoko Mizuno, Kei Shirasawa, Akira Kageyama, Tomoko Okano, Masami Nishikawa, Kaori Miyawaki, Asako Yasuda, Mitsunori Uchiyama, Hitomi Kobayashi-Yamashita, Pornanong Pongpaibool, Kanako Wake, Soichi Watanabe, Masao Taki, Chiyoji Ohkubo, "Effects of electromagnetic field exposure from mobile phone base stations-subjective perception of the fields and physiological responses during exposure among the people with/without mobile phone related symptoms -", Proc. 29th Bioelectromagnetics Society Annual Meeting, Kanazawa Bunka Hall, Kanazawa, Japan, p.350, (June 2007)

Masami Nishikawa, Kaori Miyawaki, Asako Yasuda, Mitsunori Uchiyama, Hitomi Kobayashi-Yamashita, Yasuo Terao, Toshiaki Furubayashi, Yoko Mizuno, Kei Shirasawa, Akira Kageyama, Tomoko Okano, Akira Ushiyama, Hiroshi Masuda, Shogo Hirota, Miyuki Takahashi, Shigeru Sokejima, Eiji Maruyama, Pornanong Pongpaibool, Kanako Wake, Soichi Watanabe, Masao Taki, Chiyoji Ohkubo, Yoshikazu Ugawa, "Effects of electromagnetic field exposure from mobile phone base stations -mental and psychological responses during exposure in the subjects with/without mobile phone related symptoms-", Proc. 29th Bioelectromagnetics Society Annual Meeting, Kanazawa Bunka Hall, Kanazawa, Japan, p.352, (June 2007)

Hiroshi Masuda, Akira Ushiyama, Miyuki Takahashi, Shogo Hirota, So Tanaka, Hiroki Kawai, Kanako Wake, Soichi Watanabe, Masao Taki, Chiyoji Ohkubo, "Effects of local exposure to 1,457 MHz electromagnetic field under high intensity conditions on cerebral blood flow in the rat brain", Proc. 29th Bioelectromagnetics Society Annual Meeting, Kanazawa Bunka Hall, Kanazawa, Japan, p.439,(June 2007)

Masami Kojima, Masahiro Hanazawa, Yoko Yamashiro, Soichi Watanabe, Hiroshi Sasaki, Masao Taki, Kazuyuki Sasaki, "Possibility of frequency specificity of ocular effects by quasi-millimeter and millimeter wave exposure, Proc. 29th Bioelectromagnetics Society Annual Meeting, Kanazawa Bunka Hall, Kanazawa, Japan, p.452, (June 2007)

Dai Kaburagi, Masao Taki, Yukihisa Suzuki, "Magnetostrictive Vibration Actuator with Improved Characteristics at Low Frequencies", 12thAsia Pacific Vibration Conference, Sapporo, Japan (Aug. 2007)

Dai Kaburagi, Masao Taki, Yukihisa Suzuki, "Magnetostrictive vibration actuator with improved characteristics for active vibration and noise control", INTER-NOISE 2007, Istanbul, Turkey (Aug. 2007)

Akimasa Hirata, Soichi Watanabe, Masao Taki, Osamu Fujiwara, Masami Kojima, Kazuyuki Sasaki, "FDTD simulation of temperature elevations in rabbit eye due to microwave energy", IEICE Technical Report on Electromagnetic Compatibility, vol. 107, no. 25, EMCJ2007-4, pp. 19-24, (Apr.2007)

Masao Taki, Yukihisa Suzuki, Kyohei Watanabe, "Exposure assessment of a human-body communication system with electric field coupling with body", IEICE Technical Report on Electromagnetic Compatibility, vol. 107, no. 226, EMCJ2007-47, pp. 25-30 (Sep.2007)(in Japanese)

Nadege Varsier, Kanako Wake, Taki Masao, Soichi Watanabe, "RF exposure to mobile phones and cancer risk -- SAR distribution in different brain structures --", IEICE Technical Report on Electromagnetic Compatibility, vol. 107, no. 310, EMCJ2007-81, pp. 7-12 (Nov. 2007).

Masateru Ikehata, Sachiko Yoshie, Yukihisa Suzuki, Masao Taki, Toshio Hayakawa, "Effects of combined magnetic fields with static and 50Hz on mutagenesis", IEICE Technical Report on Electromagnetic Compatibility, vol. 107, no. 310, EMCJ2007-91, pp. 57-61 (Nov.2007)(in Japanese).

Dai Kaburagi, Masao Taki, Yukihiisa Suzuki, "A broadband vibration actuator cooperatively driven by electromagnetic force and magnetostrictive force", Technical Committee Meeting on Noise and Vibration, Feb.2008 (in Japanese).

Masao Taki, Soichi Watanabe, "Review of guidelines on exposure limits of electromagnetic fields and regulations based on the guidelines", J. Natl. Inst. Public Health, 56(4), pp.363-370 (2007) (in Japanese).

T. Kubota, S. Uchida and F. Tochikubo, "Influence of voltage polarity and electrode configuration on discharge formation for microplasma array", 18th International Symposium on Plasma Chemistry Abstracts, p. 248, at Kyoto, 2007

Y. Furuta, N. Uchiya, H. Nishikawa, J. Haga, M. Oikawa, T. Satoh, Y. Ishii, T. Kamiya, R. Nakao and S. Uchida, "Fabrication of High -aspect-ratio Pillars by Proton Beam Writing and Application to DEP-devices", 20th International Microprocesses and Nanotechnology Conference, Digest of Papers, pp. 340-341, at Kyoto, 2007

K. Ninomiya, T. Enjoji, S. Uchida and F. Tochikubo, "High-Speed Selective Detection of Bacteria Using Combined Method with Dielectrophoretic Impedance Measurement and Fluorescence Spectroscopy", Proceedings of 8th Annual Meeting of Japan Society for Food Engineering, p. 84, 2007

Y. Furuta, N. Uchiya, H. Nishikawa, J. Haga, M. Oikawa, T. Satoh, Y. Ishii, T. Kamiya, R. Nakao and S. Uchida, "Fabrication of High-Aspect-Ratio Pillars by Proton Beam Writing and Device Applications", Extended Abstracts (The 68th Autumn Meeting, 2007); The Japan Society of Applied Physics, Vol. 2, p. 736, 2007

S. Imafuku, S. Uchida and F. Tochikubo, "Fundamental Investigation on The Transportation Model of Single Microorganism for Dielectrophoretic Devices", Proceedings of 2007 Annual Meeting of The Institute of Electrostatics Japan, pp. 159-160, 2007

T. Enjoji, S. Uchida and F. Tochikubo, "A Fundamental Study on Metabolism Activity Monitoring of Bacteria in Foods Using Dielectrophoretic Impedance Measurement Method", The Program of Joint Conference on Environmental Engineering in Agriculture 2007, p. 60, 2007

S. Uchida, "Measurement and Treatment of Bacteria in Micro Reactor Using High Electric Field Technology", The 2008 Annual Meeting Record I.E.E. Japan, Vol. 1, 1-S3, pp. 33-36, 2008

T. Kubota, S. Uchida and F. Tochikubo, "Optimization of Segment Geometry in Microplasma Array for Discharge Stability", Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, Vol. 1, p. 204, 2008

Y. Furuta, N. Uchiya, H. Nishikawa, J. Haga, M. Oikawa, T. Satoh, Y. Ishii, T. Kamiya, R. Nakao and S. Uchida, "Fabrication and Evaluation of DEP-Device Utilized by Proton Beam Writing", Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, Vol. 2, p. 714, 2008

K. Ninomiya, S. Uchida, T. Enjoji and F. Tochikubo, "Selective Detection of Bacteria by Dielectrophoretic Impedance Measurement Combined with Fluorescence Spectroscopy", Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, Vol. 3, p. 1367, 2008

R. Nakao, S. Uchida, Y. Furuta and H. Nishikawa, "Collection Characteristics of Bacteria for Dielectrophoretic Device with Three Dimensional Structure ", Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, Vol. 3, p. 1371, 2008

T. Enjoji, S. Uchida, K. Taima and F. Tochikubo, "Bacteria Concentration Characteristics of Dielectrophoretic Filter Made of Resin Film Substrate", Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, Vol. 3, p. 1368, 2008

S. Uchida, "Concentration, Detection and Sterilization of Microorganisms by Microscale Dielectrophoretic Technique", BIOINDUSTRY, Vol. 24, No. 8, pp. 64-70, 2007

A. Mizuno, F. Tochikubo, S. Uchida, A. Oda, K. Takaki and N. Hayashi, "Let's Obtain an Atmospheric Pressure Plasma - 2. Leaning -", Journal of Plasma and Fusion Research, Vol. 83, No. 11, pp. 913-919, 2007

H. Yoshizawa, F. Tochikubo, S. Uchida and T. Watanabe, "Study on Reaction Products in Plasma-Assisted Selective Catalytic Reduction of NO_x", IEEJ Transactions on Fundamentals and Materials, Vol. 127, No. 4, pp. 193-198, 2007 (in Japanese)

Y. Matsushita, F. Tochikubo, S. Uchida and T. Watanabe, "Influence of Penning Ionization on Glowlike Dielectric Barrier Discharge Formation in Medium-Pressure Ar", Japanese Journal of Applied Physics, Vol. 46, No. 10A, pp. 6817-6821, 2007

F. Tochikubo, "Numerical Simulation of Reaction Processes in Flue Gas Treatment

Using Dielectric Barrier Discharge”, The 20th Symposium on Plasma Science for Materials, p.20, 2007

F. Tochikubo, S. Otsuka and S. Uchida, "Numerical Simulation of Capacitively Coupled High-Frequency Driven Microplasma with Gas Dynamics - Influence of Gas Flow -", 18th International Symposium on Plasma Chemistry Abstracts, p. 247, at Kyoto, 2007

A. Ichinose, F. Tochikubo, S. Uchida and T. Watanabe, "Spatiotemporal dynamics of capacitively coupled microplasma jet generated in glass capillary", Proceedings of 2007 Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering, pp. 359-362, at Tokyo, 2007

H. Yoshizawa, F. Tochikubo, S. Uchida and T. Watanabe, "Influence of reaction temperature on NO_x removal property by plasma-assisted selective catalytic reduction with g-Al₂O₃ pellet", Proceedings of 2007 Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering, pp. 391-394, at Tokyo, 2007

M. Okita, F. Tochikubo and S. Uchida, "Numerical Simulation of Gas Dynamics in DC Microplasmas", Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, Vol. 1, p. 205, 2008 (in Japanese)

F. Tochikubo, Y. Matsushita and S. Uchida, "Penning Ionization in Argon/Hydrocarbon Mixtures and Its Contribution for Atmospheric Pressure Glow Discharge Formation", Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, Vol. 1, p. 248, 2008 (in Japanese)

H. Yoshizawa, F. Tochikubo, S. Uchida and T. Watanabe, "Influence of Catalyst Arrangement in Plasma-Assisted Selective Catalytic Reduction of NO_x", The 2008 Annual Meeting Record I.E.E. Japan, Vol. 1, p. 123, 2008 (in Japanese)

Y. Hosomi and F. Tochikubo, "Modeling of Catalytic Reaction for Plasma-Assisted Selective Catalytic Reduction of Nitrogen Oxides", The 2008 Annual Meeting Record I.E.E. Japan, Vol. 1, p. 124, 2008 (in Japanese)

J.Tsuchiya, K.Yasuda, "The Positional Detection System for the Surface Motor using Halbach-type Permanent Magnets," Proceedings of The International Symposium on LINEAR DRIVES FOR INDUSTRY APPLICATIONS (LDIA 2007)

J.Tsuchiya, A Mori, M.Ohsato, "Introduction to Electrical engineering in Electrical Engineering Department," Proceedings of Japanese Society for Engineering Education 55th Annual Conference (2007)

ELECTRONIC MATERIAL AND DEVICE ENGINEERING DIVISION

Research Projects

Phosphorus removal and recovery from treated water of large sewage disposal plants with zirconium ferrite adsorbent by high gradient magnetic separation

Daisuke Ito

Zirconium ferrite particles are good adsorbent for phosphate ion. The magnetic separation characteristics for removal of phosphate from treated water of sewage disposal plants with the adsorbent have been studied to prevent eutrophication of closed bay and pond. Very rapid magnetic filtration velocity, i.e., 106 times larger than that of percolation method, regeneration properties of the adsorbent and zero emission of excess sludge indicate that the zirconium ferrite is the excellent adsorbent for phosphorus removal and recycle from the treated water of large scale sewage disposal plants with the superconducting high gradient magnetic separation.

Estimation of structural and electrical properties of next-generation MEMS devices using finite element method

Tsugunori Okumura

Micro-electro-mechanical systems (MEMS) are micrometer-scale devices that integrate electrical and mechanical elements. MEMS devices are becoming increasingly widespread in a variety of applications. In this period, we have analyzed several types of wineglass-shaped Si-MEMS resonators using the finite element method (FEM) in order to establish the optimization of the design parameters of the devices for the portable digital appliances. In addition, in order to realize new functional MEMS devices, we have also studied the relationship between structure and electrical properties of strained compound semiconductors by FEM analysis.

Study on deactivation and reactivation mechanisms of plasma-induced defects in n-GaN

Tsugunori Okumura

For fabrication of the GaN-based devices, the plasma process is widely used, for example dry etching and deposition of insulating films. However, the plasma process often induces damages on GaN surfaces. In order to realize of high performance GaN device, establishment of low-damage device process and damage restoration or removal method is essential. In this study, the electrical properties as well as generation mechanism of defects in n-GaN introduced during plasma process have been studied. Moreover, the restoration mechanism of carrier depletion has been also studied.

Change of Coulomb Potential of Electron due to Band Structure in Semiconductor

Shigeru Sasabe

The quantization of Lorentz-Dirac equation leads to a weakened Coulomb barrier for the charged particle. This weakened Coulomb potential depends on some critical length R_c . Unfortunately, R_c is too small to achieve some effect in vacuum. However, it is expected that R_c becomes large in material and overcomes the Coulomb barrier to facilitate the nuclear reaction. Our expectation is examined by the use of band electron in semiconductor. Making use of the spin-magnetic moment of electron in semiconductor, we found positive results.

CHARACTERIZATION OF ARGON FAST ATOM BEAM SOURCE TOWARDS APPLICATION TO SEMICONDUCTOR DRY ETCHING PROCESS

Michihiko Suhara

Towards an application for the mesa etching process of semiconductor quantum devices, a saddle-field argon fast atom beam source was characterized in terms of energy distribution spectra for residual ions and neutralization coefficient under various process conditions. The neutralization coefficient was evaluated to be in the order of 90 % and slightly depended on operating parameters. Argon FAB etching was performed to form a mesa structure of GaInP/GaAs triple-barrier resonant tunneling diodes, and clear negative differential resistance characteristics were obtained with high yields.

ANALYSIS OF RADIATION CHARACTERISTICS ULTRA BROADBAND MONOLITHIC ANTENNAS INTEGRATED WITH SEMICONDUCTOR DEVICES

Michihiko Suhara

We analyzed a design rule for monolithic integration of on-chip antennas and semiconductor devices towards realization of ultra broadband integrated devices in terahertz region. Effect of geometrical parameters of finite sized self-complementary antenna and semiconductor mesa structures on radiation performance was analyzed.

A PROPOSAL OF BROADBAND HIGH-Q MONOLITHIC ACTIVE INDUCTORS

Michihiko Suhara

Planar thin-film spiral inductors are widely used in monolithic microwave integrated circuits (MMICs), however performances of the spiral inductor, such as self-resonant frequency and Q-factors, are limited by conductive loss due to eddy current produced in the device structure. Moreover, the spiral inductor is hardly scaled down and always occupies large area in the MMICs to obtain desired inductance. We propose and analyze a novel broadband high-Q active inductor on the basis of integration with resonant tunneling diodes revealing negative differential resistance up to sub-millimeter regime.

Improvement of critical current density for MgB₂ superconductor tapes fabricated by PIT process

Osuke Miura

B-rich and SiC doped MgB₂ tapes were fabricated by a modified in-situ PIT method with two stage heat treatment. B composition ratio and an amount of SiC doping were systematically changed. The effect of pre-heating and final heating conditions on J_c-B properties was also studied. Mean grain size of MgB₂.8 specimens reduced to about 100 nm by increasing SiC doping 5.7%. In low fields J_c slightly increased for a little SiC doped specimens. On the other hand, in high fields J_c obviously increased with increasing SiC doping. Maximum J_c reached 1.8×10³ A/cm² at 3 T, 20 K for MgB₂.8 specimen doped SiC 5.7 mol%. Birr also increased with increasing SiC doping. J_c systematically increased with the decrease of temperature of pre-heat treatment. In contrast J_c systematically increased with the increase of temperature of final heat treatment. Best J_c of 8.6×10⁴ A/cm² at 20 K, 0 T was achieved for specimen with 700 °C for 5 hours + 800 °C for 1 hour heating.

Development of high critical current density REBa₂Cu₃O_y coated conductors with artificially controlled flux pinning nano-structure

Osuke Miura

A metal-organic deposition (MOD) technique is suitable for mass production of REBa₂Cu₃O_y (REBCO) coated conductors because this technique is a non-vacuum and cost effective process. Especially, a MOD technique using metal-naphthenates and metal-octhenates is a relatively simple one with no removal of fluorine during the process. In addition, metal-naphthenates and metal-octhenates have the advantages of a moderate viscosity and a pyrolysis behavior so that coating and heating process are fairly easy. In this study, we have investigated the relation between surface morphology, micro structure and critical current densities REBCO films made by the MOD technique using metal-naphthenates and metal-octhenates. REBCO films were prepared by firing precursor films on LaAlO₃ single-crystal substrates at a low oxygen partial pressure under various heating conditions. Their properties of the REBCO films depended strongly on the heating conditions. An EuBCO film calcined at 450 °C for 20 min and fired at 830 °C for 2 h achieved high T_c of 92.0K and J_c of 1.04 MA/cm² at 77.3 K at self-field, respectively.

Study on superconducting rectifier using the asymmetric shaped artificial pinning centers

Osuke Miura

We started the study for development of superconducting rectifiers using the asymmetric shaped artificial pinning centers. The step-shaped grooves were introduced

as asymmetric flux pinning centers in 0.5 μm thick Nb films by the lithographic technique. In field-cooling conditions it was clarified that an addition of neodymium permanent magnets for applying magnetic fields was very important to make asymmetric critical current densities when the polarity of the transport current was changed. By measuring critical current density for Nb films with circuit-grooves with different depth, critical current densities corresponding to the pinning potential of the grooves were confirmed.

Study on high-sensitive hydrogen sensors based on nitride semiconductors

Seiji Nakamura

GaN is one of the most promising materials for applications in next-generation electronic devices. In this period, we have studied the electrical properties as well as generation mechanism of defects in n-GaN exposed to fast atom beam under ultraviolet illumination. In addition, we have studied the Pd/AlGaN/GaN high electron mobility transistor-based hydrogen sensor. The proposed Pd/AlGaN/GaN HEMT hydrogen sensor can detect 100 ppm hydrogen in air. The turn-on and turn-off transient times for the proposed sensor have been estimated to be approximately 7 and 33 seconds at 160°C, respectively.

Recent Papers

O. Miura A. Saeki, H. Tomioka, D. Ito, N. Harada, “Flux pinning properties of B-rich and SiC-doped MgB₂ tapes prepared by in situ PIT two-stage heat-treatment process”, *Physica C: Superconductivity and its applications*, 463, pp. 812-816, Oct 2007

O. Miura, H. Tomioka, D. Ito and N. Harada, “Enhanced J_c of B-rich and SiC doped MgB₂ tapes fabricated by a modified in-situ PIT method with two stage heat treatment”, *Journal of Physics*, Volume 97, 2008, 012156

T. Nakamura, R. Kita, O. Miura, A. Ichinose, K. Matsumoto, Y. Yoshida, M. Mukaida, S. Horii, “Fabrication of GdBa₂Cu₃O_y films by metal-organic deposition using metal-naphthenates” *Physica C: Superconductivity and its applications*, 463, p.540-543, Oct 2007.

K. Nishimura, O. Miura, and D. Ito, “Removal of radioactive heavy metal ions from solution by superconducting high-gradient magnetic separation with schwertmannite adsorbent”, *Proc. of International Conference on Magneto-Science*, p. 130, November 2007

R. Kita, S. Kato, T. Nakamura, A. Ichinose, O. Miura, K. Matsumoto, Y. Yoshida, M. Mukaida, S. Horii, “Stability of Ba related oxides in REBa₂Cu₃O_y superconductors” 20th International symposium on superconductivity, Nov. 5-7, 2007 Tsukuba Japan. BLP-1 p 199.

N. Harada, H. Naito, H. Asada, T. Ishibashi, O. Miura, “Observation of the flux penetration in superconducting Nb films with groove-shaped artificial pinning centers using magneto-optical imaging” *J. 20th International symposium on superconductivity*, Nov. 5-7, 2007 Tsukuba Japan. WTP-4 p 225.

H. Terasawa, H. Tomioka, O. Miura, D. Ito, N. Harada, “Transport properties of B-rich and SiC doped MgB₂ tapes obtained by a modified in-situ PIT process” 20th International symposium on superconductivity, Nov. 5-7, 2007 Tsukuba Japan. WTP-22 p 234.

T. Nakamura, R. Kita, O. Miura, A. Ichinose, K. Matsumoto, Y. Yoshida, M. Mukaida, S. Horii, “Influence of compositions of precursor films on the fabrication of GdBCO films by metal-organic deposition” 20th International symposium on superconductivity, Nov. 5-7, 2007 Tsukuba Japan. WTP-75 p 261.

S. Watanabe, O. Miura, D. Ito, R. Kita, T. Nakamura, K. Matsumoto, Y. Yoshida, A. Ichinose, S. Horii, M. Mukaida, “Critical current density properties on RE123 films fabricated by MOD process using mixed solution of metal-naphthenates and metal-octhenate” 2007 Teionkougaku autumn meeting p 77.

H. Terasawa, H. Tomioka, O. Miura, D. Ito, “Enhanced J_c of B-rich and SiC doped MgB₂ tapes fabricated by a modified in-situ PIT method with two stage heat treatment” 2007 Teionkougaku autumn meeting p 103.

K. Kondo, O. Miura, D. Ito, “Anomalous peak effect in J_c on low magnetic field in Nb-Ti multifilamentary composites with artificial pins” 2007 Teionkougaku autumn meeting p 184.

S. Kamohara and T. Okumura, “New Physical Model to Explain Logarithmic Time Dependence of DATA Retention in Flash EEPROM”, Fifth International Symposium on Control of Semiconductor Interfaces, Proc. of ISCSI-V, pp. 57-58, 2007.

H. Tsukahara, Y. Wada, S. Nakamura, T. Okumura, “Finite Element Method Analyzing of Structure and Piezoelectricity with Strained System with Nitride Semiconductors”, Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, No.28p-P9-10, pp.1466 (in Japanese).

N. Takahashi, S. Nakamura, M. Suhara, T. Okumura, “Sensing Characteristics of Hydrogen Gas Sensor with Pd/AlGa_N/Ga_N High Electron Mobility Transistor”, Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, No.30a-D-12, pp.1484 (in Japanese).

S. Ochiai, Y. Ikadai, S. Nakamura, M. Suhara, T. Okumura, “Behavior of plasma-induced damages in n-GaN exposed to Fast Atom Beam”, Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, No.29a-A-5, pp.396 (in Japanese).

Y. Ikadai, S. Ochiai, S. Nakamura, M. Suhara, T. Okumura, “ Behavior of plasma-induced damages in n-GaN under UV illumination”, Extended Abstracts (The 68th Autumn Meeting, 2007); The Japan Society of Applied Physics, No.8a-ZQ-5, pp.390 (in Japanese).

H. Tsukahara, Y. Wada, S. Nakamura, T. Okumura, “Finite Element Method Analyzing of Structure and Piezoelectricity with Strained System with Nitride Semiconductors”, Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied

Physics and Related Societies, No.28p-P9-10, p.1466 (in Japanese).

N. Takahashi, S. Nakamura, M. Suhara, T. Okumura, “Sensing Characteristics of Hydrogen Gas Sensor with Pd/AlGa_N/Ga_N High Electron Mobility Transistor”, Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, No.30a-D-12, p.1484 (in Japanese).

S. Ochiai, Y. Ikadai, S. Nakamura, M. Suhara, T. Okumura, “Behavior of plasma-induced damages in n-GaN exposed to Fast Atom Beam”, Extended Abstracts (The 55th Spring Meeting, 2008); The Japan Society of Applied Physics and Related Societies, No.29a-A-5, p.396 (in Japanese).

Y. Ikadai, S. Ochiai, S. Nakamura, M. Suhara, T. Okumura, “ Behavior of plasma-induced damages in n-GaN under UV illumination”, Extended Abstracts (The 68th Autumn Meeting, 2007); The Japan Society of Applied Physics, No.8a-ZQ-5, p.390 (in Japanese).

S. Sasabe, K. Tsuchiya, "What is spin-magnetic moment of Electron?", Physics Letters A372, 381(2008).

S. Sasabe, K. Tsuchiya and K. Watanabe, "Change of Coulomb Potential of Electron due to Band Structure in Semiconductor", Proceedings of 8th Meeting of Japan CF Research Society, 2007.

K. Tsuchiya, S. Asano, M. Ozaki and S. Sasabe, "A New Approach to Observe Optical Phonon in Hydrogen Storage Pd Using Raman Spectroscopy", Proceedings of 8th Meeting of Japan CF Research Society, 2007.