

## Abstracts of Papers (2003)

Department of Mechanical Engineering

\*nonmember

Effect of Ni-Cu substrates on phase selection of hexagonal and cubic boron nitride thin films, Shigeo Kotake, Takaya Hasegawa, Kazutaka Kamiya, Yasuyuki Suzuki, Takami Masui\*, Yoshihiro Kangawa\*, Kohji Nakamura and Tomonori Ito: *Applied Surface Science*, 216, pp.72-77, 2003

In this study, the dependence of the phase selection of BN on the lattice parameter and the crystal structure of the substrate was clarified. BN thin film was prepared by reaction RF sputtering method on polycrystalline Ni-Cu complete solid solution alloy. Using empirical potentials, the polytypes of BN thin films were systematically investigated by considering lattice constraint due to various interface atomic arrangements and orientations such as c-BN or h-BN on cubic (0 0 1) or (1 1 1) substrates. From IR spectrum, merely c-BN phase was observed from the specimen on Cu and Ni<sub>0.8</sub>-Cu<sub>0.2</sub> alloy. Moreover, the empirical potential calculations reveal that c-BN thin films on (0 0 1) substrates can be stabilized in the substrate lattice parameter of  $3.2 < a < 4.4\text{\AA}$  including Cu and Ni at both thin film and interface regions. From these experimental and calculated results, the strain energy at the semiconductor-metal interface proved to be dominant factor for the phase selection of BN thin films.

In-Situ Surface Observations of Fracture in TiN Thin Films under Tensile Stress by AFM, Akihito Matsumuro\*, Daisuke Morino\*, Takamasa Suzuki\*, Shigeo Kotake and Kazuo Sato\*: *Seimitsu Kougakkai shi*, 69, pp. 1774-1779, 2003.

Fracture behaviors of TiN thin films and their dependence on substrate materials are clarified by in-situ surface observations of TiN thin films under tensile stress using AFM (Atomic Force Microscopy). The system has the ability to observe surface structures with atomic resolution under uni-axial tensile force. Specimens of TiN thin films on Si, Au and Pt substrate materials were prepared. The TiN thin films were deposited on Si test chips by electron beam evaporation in N<sub>2</sub> atmosphere. The Au and Pt substrates were prepared on the test chip before TiN deposition by magnetron sputtering. Three types of surface patterns that depended on the elasticity and thickness of substrate materials were observed. TiN thin films deposited on Si, Pt substrates showed periodic cracks that were perpendicular to the tensile force irrespective of substrate thickness. The periodicity in TiN thin films was explained by the Grinfeld instability. However, TiN films on Au substrate showed strong dependence with substrate thickness. When the substrate thickness was below 20 nm, the same crack patterns were observed (~ but the crack length tended to be repressed with increasing thickness. TiN films on Au substrates that were thicker than 60 nm exhibited a large number of small dotted cracks. These dramatic changes of fracture patterns were attributed to the stress relaxation of substrate materials.

Novel criterion for splitting of plate-like crystal growing in undercooled silicon melts, Tomotsugu AOYAMA and Kazuhiko KURIBAYASHI\*: *Acta Mat.*, Vol. 51, pp. 2297-2303, 2003.

An undercooled drop of silicon was grown to crystals in containerless states with electromagnetic and electrostatic levitators. A high-speed video camera was used to monitor the growth rate and observe the crystal-melt interface as a function of undercooling. The morphology of the growing crystal changed from a mono-plate crystal to a multi-plate crystal, and then to faceted dendrite with increasing undercooling. The mono-plate and multi-plate crystals observed at undercooling of less than 100K were shaped by a faceted planar interface and wavy-edge plane. The critical undercooling for the transition from mono-plate to multi-plate depends on the sample size; it was 50 and 80K for samples of 5 and 1.7 mm in diameter, respectively. A novel criterion for the transition from mono-plate to multi-plate based on the instability of the wavy-edge plane is proposed.

An aerodynamic levitation system for drop tube and quenching experiments, Yasutomo ARAI\*, Paul-François PARADIS\*, Tomotsugu AOYAMA, Takehiko ISHIKAWA\* and Shinichi YODA\*: Rev. Sci. Inst., Vol. 74, pp. 1057-1063, 2003.

This article describes an aerodynamic levitation system for the processing and study of undercooled insulator materials by drop tube and quenching experiments. Its operation principle relies on a convergent-divergent type aerodynamic levitator made of two halves that can be quickly separated along a plane collinear with gas flow through the action of air-actuated pistons. This article reports the concept of this new levitator and presents the proof of the technical feasibility of contactlessly melting, undercooling, and accurately free falling alumina samples. Short duration microgravity conditions could therefore be accessed with this system for a superheated or undercooled insulator sample. In addition, sample behavior in terms of position stability and rotation was investigated. It was found that tilt of the diffuser permitted sample rotation control. Moreover, experiments showed promise for the control of the cooling rate and the selection of the temperature at which quenching occurs due to the addition of computer-controlled hammer/anvil-type device, from which thin alumina strips were obtained. The paper further highlights the unique advantages of this novel facility and its potential uses for drop calorimetry of refractory or corrosive materials. Finally, it briefly addresses issues that need to be improved, especially in the context of thermophysical properties measurements.

Contactless density measurement of superheated and undercooled liquid  $\text{Y}_3\text{Al}_5\text{O}_{12}$ , Paul-François PARADIS\*, Jianding YU\*, Takehiko ISHIKAWA\*, Tomotsugu AOYAMA, Shinichi YODA\* and J. K. R. WEBER\*: J. Cryst. Growth, Vol. 249, pp. 523-530, 2003.

The density of liquid and undercooled  $\text{Y}_3\text{Al}_5\text{O}_{12}$  was measured over a wide temperature range with the help of an electrostatic levitation furnace. The density of a levitated droplet was measured with a ultraviolet-based imaging technique that illuminated the sample throughout all phases of processing, including at elevated temperatures. Over the 1470-2420K temperature range, the density can be expressed as  $\rho(T)/(\text{kgm}^{-3}) = 3.99 \times 10^3 - 0.29(T - T_m)/K(\pm 5\text{percent})$  with  $T_m = 2240\text{K}$ , yielding a volume coefficient of thermal expansion  $\alpha = 7.3 \times 10^{-5} \text{K}^{-1}$ .

Development of an electrostatic levitator for neutron diffraction structure analysis, Hirokatsu AOKI\*, Paul-François PARADIS\*, Takehiko ISHIKAWA\*, Tomotsugu AOYAMA, Tadahiko MASAKI\*, Shinichi YODA\*, Yoshinobu ISHII\* and Toshio ITAMI\*: Rev. Sci. Inst., Vol. 74, pp. 1147-1149, 2003.

An electrostatic levitation (ESL) furnace was designed for the neutron diffraction study of condensed matter. This apparatus is composed of an electrostatic levitator, a neutron inlet path with Cd slit, a 160 degree window for the scattered neutrons, a CO2 laser for sample heating, and an optical pyrometer for temperature measurements. A preliminary neutron diffraction experiment with this ESL was performed for polycrystalline alumina. The sample position could be controlled with an accuracy of  $\pm 0.1\text{mm}$ . The observed Bragg peaks were in complete agreement with those derived from the lattice data of alumina obtained from the literature value. This indicates that this facility is attractive for the structural study of condensed matter without containers.

Development of automotive mounted GPR system using improved antenna and signal processing in frequency domain, Yoshikazu Sudo, Susumu Baba\*, Yuji Nagashima\*, and Yoshihiko Nomura: CD-ROM Proc. of North American NO-DIG 2003

We developed an efficient automotive mounted GPR system, which detects buried objects and cavities under the surface. We improved S/N ratio of GPR images utilizing innovative antenna components and signal processing. First, we made a low-ringing antenna through adjustments in the antenna circuit. The antenna has only 2 or 3 ringing peaks without an original signal. Second, we applied digital filters to original signal of GPR to improve the image. Finally, we applied a new signal-processing algorithm that distinguishes cavity signals from reflected waves. Applying short-time Fourier analysis to reflected wave, we can obtain some frequency feature such as the central frequency, the half-width, and the direct current component ratio. The authors have found out an interesting and useful statistical property. Using this statistical property, we can achieve to distinguish between the signals and noises. As a result, we developed an automotive mounted GPR system, which can detect buried objects under the surface on road while traveling at 50km/hr.

Parametric Eigenspace Method using Multiple Discriminant Analysis, Satoru Nakanishi, Tokuhiko Sugiura, Yoshihiko Nomura and Norihiko Kato: Part of SPIE Conference on Intelligent Robots and Computer Vision XXI: Algorithms, Techniques, and Active Vision, vol. 5267, no.10, pp. 206-213, 2003

Parametric eigenspace methods are well known appearance-based methods for object recognition, which involves object classification and pose estimation. However, ordinary parametric eigenspace methods consider only the expressive features, and they suffer from a problem arising from the fact that discriminative features are not considered. So, there have been developed some methods to construct such eigenspaces considering the discriminative features. However, the method might suffer from another problem, i.e., the so-called generalized eigenvalue problem: yet, we can manage to solve the problem. In this paper, two methods are referred to as representative methods considering discriminative features. Conducting an experiment of object recognition on two similar objects, performances of the methods are compared to one another, and a piece of important knowledge is also presented that the discriminative features are more effective than the expressive features.

Mental-Map Creation Support System for Blind Person –Fusion of Verbal Message and Somesthetic Sense–, Y. Nomura, H. Kakehashi, T. Sugiura and N. Kato: Proceedings of HCI International 2003, vol.4, no.6, pp.1315-1319, 2003

Blind persons would feel uneasiness and insecure in walking unless they can make up mental maps before practically walking. The mental map is a conceptual map that is imaged in mind, and is exemplified as geometrically simplified town maps in this paper. Aiming at the people's needs, the authors focus their attentions on a computer-aided system, that helps blind person to create mental-map, utilizing commercially available user interface, i.e., a touch panel display. The system is especially characterized by a fusion of verbal-language message and human somesthetic sense.

Basic Study of Signal Extraction Methods Using Frequency Domain Characteristics of Reflected Waves from Ground Penetrating Radar, Y. Sudo, Y. Nomura and Y. Nagashima: Proceedings of the 2003 JSME-IIP/ASME-ISPS Joint Conference on Micromechatronics for Information and Precision Equipment, No. 03-208, pp. 86-87, 2003

The results from previous research revealed that pipes and cavities differ in the frequency domain characteristics of the waves reflected from these objects as captured by ground penetrating radar. Aerial tests to investigate the characteristics of reflected waves were conducted in order to uncover the reasons for the difference in characteristics. The frequency domain characteristics of radar waves from the aerial pipes and cavities showed a close match with those from actual underground pipes and cavities. It was concluded from this results that the difference in shape of buried objects resulted in the difference in frequency domain characteristics of their reflected waves. This suggests the possibility that shape of buried objects could be recognized using frequency domain characteristics.

A BASIC STUDY ON A FACE-TO-FACE IMAGE PRESENTATION SYSTEM, M. Ohnishi, Y. Nomura and S. Takahama: Proceedings of the 2003 JSME-IIP/ASME-ISPS Joint Conference on Micromechatronics for Information and Precision Equipment, No. 03-208, pp.94-95, 2003

Recently, broadband networks have made great progress and various interactive visual communication systems including video conferencing, video telephones and video networks for meetings are becoming increasingly popular. However, unnatural eye contact in the displays used by these communication systems has presented a barrier to natural conversation between communicators. We confirmed the possibility of realizing the feeling of eye contact that is part of natural face-to-face conversation. This paper also describes experimental results on the permissible eye-line angle that gives a sense of eye contact and the influence of image resolution.

Boundary Pixel Assigning Method for Image Segmentation Using Multi Dimensional Co-occurrence Matrix, T. Komori, T. Sugishita and Y. Nomura: Proceedings of the 2003 JSME-IIP/ASME-ISPS Joint Conference on Micromechatronics for Information and Precision Equipment, No. 03-208, pp. 96-97, 2003

Image segmentation is the basis of image processing, which is in heavy use for pre-processing of image recognition and analysis. There is an effective algorithm, called a co-occurrence matrix-based image segmentation algorithm (referred to COMBIS algorithm). The authors extended the co-occurrence matrix from a one-dimensional feature to a multi dimensional feature vector in the last paper. In this paper, the authors furthermore examined the COMBIS algorithm, especially, paying attention to an assignment of the boundary pixels.

Performance Improvement of a Magnetically Levitated Microrobot Using an Adaptive Control, Mir Behrad Khamesee, Norihiko Kato and Tatsuya Nakamura: Proc. of 2003 International Conference on MEMS, NANO, and Smart Systems, pp. 332-338, 2003

This paper deals with an application of an adaptive control to a magnetically levitated micro-robot. Using an electromagnet device, a micro-robot is levitated and manipulated within a 3-D space inside a magnetic field. The micro-robot has two fingers that can grasp and elevate objects. PID controls are applied for positioning of the micro-robot in the three axes. However, as the micro-robot deals with various payloads, a PID control may not be sufficient to maintain the micro-robot on high performance in the vertical axis. To improve the performance, an adaptive control law is also examined for the positioning in the vertical axis so that the controller parameters become adjustable in real-time to cope with uncertainties and variations in payloads. A model-reference adaptive system based on the augmented error is designed, and simulations and experiments are conducted to verify the effectiveness of the control.

Dynamically Separating Learning Algorithm for Interactive Computers (DS-LA<sub>IC</sub>), Koichi NAKAYAMA, Hirokazu MATSUI, Katsumori SHIMOHARA and Osamu KATAI: Proceedings of the Sixth International Conference on Human and Computer, pp. 182-187 HC-2003

We propose a Dynamically Separating Learning Algorithm for Interactive Computers (DS-LA<sub>IC</sub>) that permits computers to learn actions that maximize task performance of the entire system. DS-LA<sub>IC</sub> extends DS-GA to a learning algorithm that is applicable to a computer system consisting of many computers connected by a network. In a system that uses DS-LA<sub>IC</sub>, we conduct an experiment on applying the proposed DS-LA<sub>IC</sub> to a networked computer. As a result, the DS-LA<sub>IC</sub> is shown to be effective in self-optimization of a computer's action and re-organization of the network itself. DS-LA<sub>IC</sub> proves to be effective as a learning algorithm for computers.

Optimal Vibration Control for Overhung Rotor System with Electromagnetic Actuator, Kazuki MIZUTANI, Naohito DOI\* and Ryojun IKEURA: Proceedings of The 11th International Congress on Sound and Vibration, pp. 4053-4060, 2003.

In order to reduce the unbalanced vibration of rotating machinery with an overhung rotor, we propose an active vibration control system where an electromagnetic actuator is used to apply a control force. This control device consists of a simply supported rotor-shaft system, a rotor of which is installed in four pairs of electromagnets to apply a control force. The analytical model is obtained for the overhung rotor system with an electromagnetic actuator. Feedback gains of the vibration control system are decided by solving the optimal regulator problem, and frequency response curves and maximum amplitudes up to the 2nd critical speed are simulated numerically. The numerical results are confirmed by the experiment for an overhung rotor with active vibration control system.

Application of optimal regulator theory to vibration control for an overhung rotor system, Kazuki MIZUTANI, Naohito DOI\*, Takashi Ito\* and Ryojun IKEURA: Proceedings of The ASIA-PACIFIC VIBRATION CONFERENCE 2003, vol. 2, pp. 475-479, 2003.

This paper describes an active vibration control to effectively reduce the unbalanced vibration of an overhung rotor system. A vibration control device is installed between a driving motor and an overhang rotor. The analytical model is obtained for the overhung rotor system with the vibration control device. Displacements and velocities of the control rotor and overhang rotor are defined as state variables. Feedback gains of the vibration control system are decided by solving the optimal regulator theory. For practical use, the simplification of the rotor model for controller design is examined in detail. The numerical results are compared with experimental ones for the overhung rotor system with the vibration control device, and both results show the similar tendency.

Previous notice method of robotic arm motion for suppressing threat to human (Announcement in moving of the arm)[in Japanese], Atsushi HAGIWARA, Ryojun IKEURA, Yohei KAWAKITA\* and Kazuki MIZUTANI: Journal of the Robotics Society of Japan, Vol. 21, No. 4, pp. 401-408, 2003

It is expected that robots play an important role coexisting with a human in a hospital, a welfare, and so on. In such a case, robot must not influence psychological threat to the human. This paper describe about the method for the previous announcement of robotic motions to reduce human's threat against the robot. The notice is performed by lighting several LED markers attached at the endpoint of the robotic arm. The effectiveness of the proposed method is evaluated as follows. First, the optimum time against the previous announcement in moving of the robotic arm was studied. As a result, it is found that the optimum time in which psychological threat of the human are low it is from 1.0 to 1.5 seconds. Second, the effectiveness of the previous announcement in moving of robotic arm was studied by psychological evaluation. As a result, it is verified that the psychological threat of the human can be controlled by giving the previous notice of the change of motion of the robotic arm.

Previous notice method of three dimensional robotic arm motion for suppressing threat to humans, Ryojun IKEURA, Atsushi HAGIWARA, Takashi KOSHA and Kazuki MIZUTANI: CDROM of 12th IEEE Workshop on Robot and Human Interactive Communication, pp. 1-5, 2003

This paper describes previous notice method of three dimensional robotic arm motion for suppressing threat to human using a device in which LED markers are arranged like a coordinate frame. Firstly, a previous notice method for the three dimensional position of the endpoint of the arm is shown. Secondly, relationship between the dimensional number of the motion and the feeling of the human is investigated using the device of the previous notice. Finally, the effectiveness of the notice device is evaluated for the three dimensional motion of the arm. This device is effective for all motions and, especially, is much effective for the motion of the upper level from the eyes of human.

Guidance of human by vibration stimulus, Ryojun IKEURA, Hirofumi YAMASHITA\* and Kazuki MIZUTANI: Proceeding of The 2nd International Conference on Mechatronics and Information Technology, pp. 195-200, 2003

This paper describes navigation of human by vibration stimulus. The vibration stimulus is used as the command signals for the guidance of visual impaired people. First, the response characteristics of the human in stamping his/her feet and walking to the vibration stimulus are investigated in frequency domain. The vibration is supplied by a motor with an eccentric weight. Next, the characteristics are modeled by an ARX model. Using the model, a proportional controller is designed for the guidance of the human so as to keep the system stable. Finally, it is tried to guide the human by the constructed system and the effectiveness is shown.

Experimental Research on Deformation of Ti-Ni SMA under Complex Loading Conditions, Kengo HASHIMOTO, Masataka TOKUDA, Tadashi INABA, Atsuhisa SHIODE, Petr SITTNER\* and Borut BUNDARA\*: Key Engineering Materials, Vols. 233-236, pp. 547-552, 2003

Shape memory alloys have been expected from a view point of engineering applications because of its unique mechanical properties. In this study, the pseudoelastic deformations of Ti-Ni shape memory alloy tube manufactured by the sintering synthetic method under the uni-axial tension, simple torsion, and uni-axial compression loading conditions are experimentally investigated. The obtained results are presented and discussed in this paper.

Experimental Research on Two-way Shape Memory Effect of Cu-based SMA Polycrystal, Tadashi INABA, Masataka TOKUDA, Souichi SUGINO, Toshihiko WARITA, Petr SITTNER\* and Borut BUNDARA\*: Key Engineering Materials, Vols. 233-236, pp. 553-558, 2003

The two-way shape memory effect is expected as prospective property for new engineering applications of shape memory alloys. In this study, the two-way shape memory behavior obtained by the mechanical loading training was investigated experimentally by the microscopic observation of stress- or temperature-induced martensite variants. The obtained results are presented and discussed in this paper.

Multi-axial Deformation Behavior and its Constitutive Equations for Superplastic Materials, Masataka TOKUDA, Tadashi INABA, Akira KURAKAKE, Satoshi IKUSHIMA, Shuichirou MAKINO and Farid U. ENIKEEV: Key Engineering Materials, Vols. 233-236, pp. 853-856, 2003

Superplasticity of polycrystalline metallic material is the phenomenon of large plastic deformation (for example, up to hundreds percents, or thousands percents) without necking under uniaxial tensile loading. Such phenomenon happens in the fine-grain metallic material whose main deformation mechanism is a grain boundary sliding, under some limited loading conditions, for example, low strain rate and elevated temperature. This phenomenon is expected as a new forming technology in the engineering/industrial field. Authors have been investigating the superplastic deformation under the general thermo-mechanical loading condition applying the combined loads of axial force and torque to the thin-walled tube specimen made of typical so-called superplastic materials 5083Al alloy and Zn-22%Al alloy. In the result, several unique deformation phenomena were observed. In this paper, a set of general constitutive equations is proposed on the basis of mathematical (phenomenological, potential) theory of plasticity.

Experimental Study of the Superplasticity of Mg Alloy, Satoshi IKUSHIMA, Masataka TOKUDA, Tadashi INABA, Akira KURAKAKE and Farid U. ENIKEEV: Key Engineering Materials, Vols. 233-236, pp. 863-868, 2003

Superplasticity is the phenomenon of the metallic material deforming without necking up to several hundred percents or sometimes a few thousand percents in the tension test under some special strain rate-temperature ranges. In this research work, the super-plasticity was investigated by applying the load of axial force or torque to the thin-walled tubular specimen of AZ31Mg alloy. As a result, several unique deformation phenomena have been observed.

Superplasticity under Combined Loading Conditions and Its Constitutive Equations [in Japanese], Masataka TOKUDA, Tadashi INABA, Akira KURAKAKE, Satoshi IKUSHIMA and Yu CHEN: J. Soc. Mat. Sci., Japan, Vol.52, No.10, pp. 1186-1191, 2003

The fine grain super-plasticity under the combined loading conditions was investigated experimentally by applying the combined loads of axial force and torque to the thin-walled tube specimen of 5083 aluminum alloy. Moreover, a set of constitutive equations for the fine-grained super-plastic materials was proposed on the basis of these experimental results and the classical (mathematical, phenomenological) theory of plasticity using the potential function. Here a new potential function was proposed by incorporating the second and third invariants of stress deviator. The proposed constitutive equation could predict well the mechanical behavior of 5083 Al alloy subjected to the combined loading conditions under the wide ranges of temperature and strain rate.

Stress Induced Martensitic Transformation in Tension/Torsion of CuAlNi Single Crystal Tube, P. Sittner, K. Hashimoto, M. Kato and M. Tokuda: Scripta Materialia, Vol. 48, No. 8, pp. 1153-1159, 2003

A CuAlNi single crystal tube was loaded in tension while keeping the torsional displacement free. The tube extended and simultaneously twisted during the stress induced martensitic transformation. A cooperative activity of four habit plane/shear direction transformation systems appearing at the same time in different quadrants of the tube wall is considered to rationalize the unusual mechanical behavior.

Analysis of Left Ventricular Wall Motion Using Magnetic Resonance Tagging Technique: Measurement of Circumferential Elongation of Ventricular Wall in patients with DCM [in Japanese], Tadashi INABA, Yasutomi KINOSADA\*, Shingo KAWASAKI\*, Hideaki OBATA and Masataka TOKUDA: Transactions of the Japanese Society for Medical and Biological Engineering, Vol. 41, No. 2, pp. 136-139, 2003

Deformation of left ventricular wall during systole was analyzed using a magnetic resonance tagging technique. Subjects were two patients with dilated cardiomyopathy accompanied with left bundle branch block. The circumferential strain at a short-axis section was employed as an index for an evaluation of the cardiac contractility. The obtained results showed that the circumferential strains in septal wall of the patients were different from those of the normal humans, and showed positive value. This study may suggest that the circumferential strain could be an effective index for the quantitative evaluation of the cardiac contractility.

Evaluation of Brain Tissue Applying Equivalent Cross-relaxation Rate using MRI [in Japanese], Hideaki OBATA, Tadashi INABA, Shigeru MATUSHIMA\*, Yasutomi KINOSADA\*, Masataka TOKUDA: Transactions of the Japanese Society for Medical and Biological Engineering, Vol. 41, No. 3, pp. 221-227, 2003

The equivalent cross-relaxation rate (ECR) is a measurement method that can evaluate a change in organization structure quantitatively utilizing MRI. The goal of this study is to discover a parameter that we can use to evaluate aging of the human brain using ECR. Fourteen patients diagnosed with diseases other than those located in the cranium were imaged using a SIGNA model of GE Medical Systems equipped with a 1.5 Tesla clinical scanner. The ECR values were defined as the percentage of signal loss between unsaturated and saturated images. It was found that the ECR value of gray matter was lower than subcortical white matter. At ages under 70 years old, the mean of ECR values of subcortical white matter showed stable values with insignificant variance. Furthermore, there was no correlation between age and ECR value of every region calculated. On the other hand, it was found that there was a negative correlation for the ECR values of subcortical white matter and gray matter at ages slightly over 70 years old. It is possible that the reduction in ECR value shows demyelination by aging in the senium. When the offset frequency is near the water resonance frequency, the ECR values mean information about neurocytes. Accordingly, the  $ECR(320)/ECR(1200)$  value probably shows that information is related to the amount or activity of neurons.

Development of Intraoperative Measurement Device for Intervertebral Instability [in Japanese], Takaya KATOH, Yuichi KASAI\*, Tadashi INABA, Atsumasa UCHIDA\* and Masataka TOKUDA: J. of Japanese Society for Clinical Biomechanics, Vol. 24, pp. 99-103, 2003

Quantitative analysis of intraoperative intervertebral instability has been difficult. We have developed a simple device consisting of Kocher hemostatic forceps with a strain gauge and spring to measure lumbar instability intraoperatively. Using this device, repulsion of the spinal processes in the cephalocaudal direction can be calculated by deformation of the forceps. As the results of basic and clinical investigations, our measurement device enabled intraoperative measurement of intervertebral instability objectively and easily.

Equivalent Cross Relaxation Rate Image for Decreasing a False Negative Case of Sentinel Lymph Node Biopsy, S. Matsushima\*, F. Sasaki\*, S. Sarumaru\*, D. Ohta\*, S. Era\*, M. Sogami\*, T. Inaba and Y. Kinoshita\*: Magnetic Resonance Imaging, Vol. 21, No. 9, pp. 1045-1047, 2003

In the breast carcinomas, sentinel lymph node biopsy (SLNB) attracts attention as technique to be settled by axillary lymph node metastasis, but existence of a false negative case is a problem. Equivalent cross relaxation rate image (ECRI) is the measurement method that we can evaluate a change of organization structure quantitatively by magnetic resonance imaging. We executed axillary ECRI as a purpose with decreasing a false negative case of SLNB. ECRI related to a macroscopic image, and it was possible to evaluate yes or no of axillary lymph node metastasis. ECRI is the useful method to evaluate adaptability of SLNB.

In-Plane Elastic-Viscoplastic Behavior of Long Fiber-Reinforced Laminates: Analysis Based on a Homogenization Theory, T. Matsuda, H. Tanaka\* and N. Ohno\*: Key Engineering Materials, Vols. 233-236, pp. 691-696, 2003

In this paper, a homogenization theory of nonlinear time-dependent composites is used to investigate the effect of a transverse fiber arrangement in long fiber-reinforced laminae on the overall elastic-viscoplastic behavior of laminates. To this end, the symmetry of internal distribution with respect to cell facet centers is employed for taking into account the transverse randomness of fiber arrangements in laminae. The hexagonal periodicity of a fiber arrangement with no randomness is also assumed. As a numerical example, we analyze the in-plane elastic-viscoplastic deformation of three kinds of laminates, i.e., unidirectional, cross-ply, and quasi-isotropic. It is thus shown that the transverse randomness of a fiber arrangement has little influence on the homogenized elastic-viscoplastic behavior of laminates. It is also shown that the results of analysis agree well with the corresponding experimental results.

Effects of Fiber Distribution on Elastic-Viscoplastic Behavior of Long Fiber-Reinforced Laminates, T. Matsuda, N. Ohno\*, H. Tanaka\* and T. Shimizu\*: International Journal of Mechanical Sciences, Vol. 45, No. 10, pp. 1583-1598, 2003

In this paper, effects of transverse fiber distribution on the elastic-viscoplastic behavior of long fiber-reinforced laminates subjected to in-plane tensile loading are studied using a homogenization theory. To this end, a unit cell with random fiber distribution is arranged point-symmetrically with respect to cell facet centers and also Y-periodically. By discussing these two fiber arrangements in terms of standard deviations and a radial distribution function, it is demonstrated that the point-symmetric cell arrangement can enhance the randomness of fiber distribution in comparison with the Y-periodic arrangement. Then, on the assumption that the random fiber distribution generated by the point-symmetric cell arrangement prevails on the transverse section in each lamina, the in-plane elastic-viscoplastic deformation of carbon fiber/epoxy laminates is analyzed using a homogenization theory of nonlinear time-dependent composites. The analysis based on the perfectly periodic hexagonal fiber distribution in laminae is additionally performed for comparison. It is thus shown that the transverse randomness of fiber distribution in laminae has negligible influence on the macroscopic elastic-viscoplastic behavior of laminates, though it markedly affects the microscopic distribution of stress and strain. It is also shown that the analysis predicts very well the macroscopic behavior observed in the corresponding experiments.



Effect of Fiber Distribution on Elastic-Viscoplastic Behavior of Long Fiber-Reinforced Laminates [in Japanese], T. Matsuda, N. Ohno\*, H. Tanaka\* and T. Shimizu\*: J. Soc. Mat. Sci., Japan, Vol. 52, No. 10, pp. 1258-1264, 2003

In this work, the effect of transverse fiber distribution on the elastic-viscoplastic behavior of long fiber-reinforced laminates is studied using a homogenization theory. To this end, a basic cell with random fiber distribution is arranged point-symmetrically with respect to the cell boundary facet centers. The basic cell is also arranged Y-periodically. It is demonstrated that the point-symmetric cell arrangement enhances the randomness of fiber distribution than the Y-periodic arrangement. Then, by assuming the point-symmetry based fiber distribution as the transverse fiber array in lamina, the in-plane elastic-viscoplastic deformation of CFRP laminates is analyzed using the homogenization theory of non-linear time-dependent composites. Comparative analysis is further performed by assuming the perfectly periodic, hexagonal fiber distribution in laminae. It is thus shown that the transverse randomness of fiber distribution has negligible influence on the macroscopic elastic-viscoplastic behavior of laminates, whereas the microscopic distribution of stress in laminae is markedly affected by the fiber distribution. It is also shown that the results of analysis agree very well with the corresponding experimental results.

Fundamental Study of Caustic Experimental Method in Thermal Stress Analysis, Ahmad ALMALEH, Yutaka SAWAKI, Ahmad NAHHAS\* and Kiyoshi ISOGIMI: Journal of JSEM, Vol. 3, No. 2, pp.65-70, 2003.

Shadow optical method of Caustics has been applied in order to measure thermal stress distribution around a cylindrical heater inserted in a thin disk of acrylic resin. Caustics pattern has circular shape centered to the heater. Caustics pattern appears at certain stress value and then increases in diameter (Caustics Size). As soon as heating process goes to its steady state, Caustics pattern movement tends to slow and finally stops. A strong relation between Caustics pattern size and position of the highest value of the radial thermal stress has been observed. By this experiment a theoretical Caustics pattern size equation has also been successfully obtained. The comparison between the behavior of Caustics pattern movement and the thermal stress distribution and its behavior during heating process engages us to conclude that Caustics experiment method could be used to measure radial thermal stress gradient.

Microscopic Observation of Fiber Deformation and Fracture During Machining A-FRP, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: FACTA UNIVERSITATIS, Series: Mechanics, Automatic Control and Robotics, Vol. 3, No. 13, pp. 739-744, 2003.

We observed the deformation and fractural phenomena of Aramid fiber during machining of A-FRP by microscopically. We can make deformation and fracture of fiber clear that is situated in the matrix in transmittal. When the fiber angle  $q$  is 45 degree, Aramid fibers are strongly pressed and expanded widely towards the cutting direction and peel off under the machined surface during a cutting tool passes. After the tool passed, a deformed fiber remains as a fluff. Further, we simulated the phenomena with a very simple model to evaluate the deformation of fiber during machining. It is based on S. P. Timoshenko's theory of beams on elastic foundation. In our analysis, the modulus of the foundation is varied to prove the orientation of fiber. The calculated results have some Coincides With Experimental results.

Fundamental Study of Caustic Experimental Method in Thermal Stress Analysis – Investigation for One or Two Dimensional Stress Field in Circular Disk, Ahamad ALMALEH, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the International Conference on Advanced Technology in Experimental Mechanics 2003 (ATEM'03), CD-ROM, 2003.

Shadow optical method of Caustics has been applied in order to measure thermal stress distribution around a cylindrical heater inserted in a thin disk of acrylic. Caustics pattern has a circular shape centered to the heater. Caustics pattern appears at a certain stress value then increases in diameter (Caustics Size). As soon as heating process goes to its steady state, Caustics pattern movement goes slowly then stops. A strong relation between Caustics pattern size and position of the highest value of the radial thermal stress has been founded. Also theoretical Caustics pattern size equation has successfully obtained. The comparing between the behavior of Caustics pattern movement and thermal stress distribution as well its behavior during heating process engages us to conclude that Caustics experiment method could be used to measure thermal stress gradient.

Fracture Behavior of Aramid Short fiber FRP Laminates and the Simulation of Energy Absorption Capability, Qiang LIU, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the International Conference on Advanced Technology in Experimental Mechanics 2003 (ATEM'03), CD-ROM, 2003.

A series of 2-dimensionally random aramid short fiber (AsF) FRP laminates have been prepared with a range of fiber fraction volume by reinforcing unsaturated polyester (UP) resin with aramid short fiber (3mm) sheets. Tensile, compressive and three-point bending test of AsF FRP laminates have been performed to study the mechanical behavior on the fracture energy of the materials. It is expected that mechanical properties of the laminate may be much improved than directly reinforced FRP composite. On the other hand, the compressive destructed behavior is still not made clear even now. Originally, the difference between tensile strength and compressive strength is caused by the difference between their destructive mechanisms. And up to now, the reliable value of fracture energy of aramid short fiber FRP laminates has not been gotten. Therefore, we served our purpose of the research as the effect of fracture behavior on the energy absorption properties of aramid short fiber sheet FRP laminate. Reasonable agreement has been achieved between the predictions and available experimental data.

A Study for Fracture Endurance under Bending Loading of Aramid Sheet FRP Laminate, Qiang LIU, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the 6th International Symposium on Microstructures and Mechanical Properties of New Engineering Materials (IMMM2003), pp. 138-143, 2003.

A laminate has been prepared with random fiber orientation sheets. The laminate has been tested under bending condition to measure the specific strength. The formulation under consideration of laminated structure of Aramid FRP is performed under the normal temperature environment in this research. As a result, the bending fracture strength of Aramid FRP laminate was predicted with the probabilistic statistical method. The simulated equation of the fracture strength well reflected the bending characteristic of Aramid FRP laminate by comparing with the experimental results.

Microscopic Observation on Machining Process of A-FRP, Eitoku NAKANISHI, Yuji NAKAMOTO\*, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the 6th International Symposium on Microstructures and Mechanical Properties of New Engineering Materials (IMMM2003), pp. 200-204, 2003.

Composite materials are made from two or more kinds of materials, such as combination of glass fiber and polyester and so on. The machining of these materials becomes very difficult due to the differences of properties between the reinforcing materials and matrix materials. Especially the machining an A-FRP (Aramid fiber reinforcing plastics) causes the rough machined surfaces. The surface integrities are much affected by orientation of fibers. To clarify the effect of fiber orientation on the surface appearances, we observed the deformation and fractural phenomena of Aramid fiber during machining A-FRP by microscopically. And we can make an interior deformation and fracture of fiber clear that is situated in the matrix in transmittal.

The Observation of Phenomena during Ecological Dry Cutting, Kenichi YUDA, Daiki KATO, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the 7th Tri-University International Joint Seminar & Symposium 2003, pp. 359-364, 2003.

A lot of cutting fluid including chloric paraffin extreme pressure additives which cause outbreak of dioxin have usually been used to extend tool life and improve surface roughness, machining accuracy and chip flow. Now the environmental protection is considered all over the world. Especially, the environmental damage by cutting fluid is very serious. Therefore we focused attention on dry cutting. We named machining without lubrication ecological dry cutting or dry cutting. The advantage of ecological dry cutting is to reduce the environmental damage and cost. On the other hand, the dry cutting has some troubles of deterioration in the quality of surface and so on. In this paper, we tried to improve chip flow and surface roughness. The better conditions that improve them are made clear.

Drilling of AFRP with YAG Laser, Takao YOSHIMOTO\*, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the International Conference on Leading Edge Manufacturing in 21st Century (LEM21), pp. 843-848, 2003.

Because of their high properties, FRPs (Fiber Reinforced Plastics) have been at the center of attention. They consist of the high-strength and high-modulus fibers and the heat-resistant and corrosive-resistant plastics. In some cases, FRP is required to be machined to apply it to the electronic parts etc, especially very high performance drilling. Therefore in this research, hole drilling of FRP with YAG laser is treated as the objective and the workability is inquired into in detail. Irradiating time and flash lamp voltage are changed in wide range and the hole configuration and HAZ are observed. The appropriate conditions of YAG laser are proposed clearly.

Machining Process of Aramid Fiber Reinforcing Plastics, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the International Conference on Leading Edge Manufacturing in 21st Century (LEM21), pp. 1007-1012, 2003.

The machining of composite materials becomes very difficult due to the differences of properties between the reinforcing materials and matrix materials. Especially the machining an A-FRP (Aramid fiber reinforcing plastics) causes the rough machined surfaces. The surface integrities are much affected by orientation of fibers. To clarify the effect of fiber orientation on the surface appearances, we observed the deformation and fractural phenomena of Aramid fiber during machining A-FRP by microscopically. And we can make an interior deformation and fracture of fiber clear that is situated in the matrix in transmittal. Further, we simulated the phenomena with a very simple model to evaluate the deformation of Aramid fiber during machining. It is based on Dr. Timoshenko's theory of beams on elastic foundation. In our analysis, the beams are regarded as Aramid fibers and the elastic foundation is regarded as matrix material. Further, the modulus of the foundation is varied to prove the orientation of fiber. The calculated results have some coincides with experimental results.

Modeling of Fiber Deformations During Machining A-FRP, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the 8th Japan International SAMPE Symposium & Exhibition (JISSE-8), Vol. 1, pp. 521-524, 2003.

The machining of A-FRP causes machined surface rough. It is well known the surface integrities are much affected by the orientation of reinforcing fibers and by deformation of fibers during machining. Our aim in the present paper is clarify the unique deformation of fiber during machining. Then, we made a very simple model to evaluate the deformation of Aramid fiber during machining.

The Effect of Intralaminar and Interlaminar Fractures on Energy Absorption of Aramid Short Fiber FRP Laminates, Qiang LIU, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: Proceedings of the 8th Japan International SAMPE Symposium & Exhibition (JISSE-8), Vol. 2, pp. 917-920, 2003.

Aramid short fiber (AsF) FRP laminates are manufactured under the normal temperature environment in this research, which is consisted of aramid short fiber (Kevlar29) sheet of random fiber orientation and unsaturated polyester resin (AM8285) have been presented with a wide range of fiber fraction volume. AsF FRP laminates have been tested under bending load conditions to measure the specific mechanical properties of the composite laminates. After that, the effect of interlaminar and intralaminar fractures to the energy absorption capability of AsF FRP laminates is simulated. The simulated equation reasonably reflects the characteristics of aramid short fiber FRP laminate by comparing with the experimental results.

Fundamental Study for Establishing the Ecological dry Cutting, Eitoku NAKANISHI, Yutaka SAWAKI and Kiyoshi ISOGIMI: Research Report of Faculty Engineering Mie University, Vol. 28, pp. 1-7, 2003.

A lot of cutting fluid including chloric paraffin extreme pressure additives which cause outbreak of dioxin have usually been used to extend tool life and improve surface roughness, machining accuracy and chip flow. Now the environmental protection is considered all over the world. Especially, the environmental damage by cutting fluid is very serious. Therefore we focused attention on dry cutting. We named machining without lubrication ecological dry cutting or dry cutting. The advantage of ecological dry cutting is to reduce the environmental damage and cost. On the other hand, the dry cutting has some troubles of deterioration in the quality of surface and so on. In this paper, we tried to improve chip flow and surface roughness for finish machining during cylindrical turning. The better conditions that improve them are made clear.

Storage Stability of CO<sub>2</sub> in C<sub>60</sub>-C<sub>70</sub> Binary System [in Japanese], Yutaka TAKAHASHI and Ken YAMAZAKI: J. Jpn. Inst. Metals, Vol. 67, No. 3, pp. 116-121, 2003.

CO<sub>2</sub> was absorbed into C<sub>60</sub>-C<sub>70</sub> binary solids at room temperature using a commercially available autoclave. The solids were then immersed in liquid CO<sub>2</sub> for 24 h at a gas pressure of 5 to 6 MPa, and the degree of CO<sub>2</sub> storage was evaluated by infrared (IR) spectroscopy and X-ray diffraction (XRD). CO<sub>2</sub> was detected in pure C<sub>60</sub> by IR measurement, and the stoichiometry was estimated to be C<sub>60</sub>(CO<sub>2</sub>)<sub>0.34</sub> based on the increase in the lattice parameter. Although no trace of CO<sub>2</sub> storage was detected for pure C<sub>70</sub>, the addition of C<sub>70</sub> to C<sub>60</sub> at a mole fraction of up to 0.16 did not appreciably degrade the storage capacity of CO<sub>2</sub> from that in pure C<sub>60</sub>. The stability of CO<sub>2</sub> trapped in solid fullerenes is explained in terms of geometrical considerations based on hard-sphere packing at octahedral sites.

High-Pressure Phase Diagram of Mg-Al Alloys and Variation of Mechanical Properties in Solid Solutioning and Aging Process[in Japanese], Akihito MATSUMURO\*, Futoshi MAEKAWA, Masaya MITSUDA, Iwao KONDO and Yutaka TAKAHASHI: J. Soc. Mat. Sci. Japan, Vol. 52, No. 7, pp. 851-856, 2003.

The high-pressure phase diagram of a magnesium-rich Mg-Al alloys at a 5.4GPa pressure was investigated. To determine the equilibrium state under high-pressure and high-temperature conditions, the quenching method was applied and a phase analysis of the sample was performed using X-ray diffraction and microscopic observation. The resultant solid solubility of aluminum in magnesium was subsequently increased up to 20at% and the eutectic temperature up to 500°C. The variations of elastic moduli and micro-Vickers hardness of supersaturated Mg-Al solid-solutions against the aluminum concentration and during isochronal aging were measured. Especially, the attractive increase in hardness for Mg-20at%Al solid solution was observed. Hardness per unit density after aging at 120°C for 3h increased more than those of extra super duralumin A7075 and Ti-6Al-4V.

Intermolecular Collision Scheme of DSMC Taking Molecular Locations within a Cell into Account, Masaru USAMI and Tsutomu NAKAYAMA: Rarefied Gas Dynamics, Edited by A. D. Ketsdever and E. P. Muntz, American Institute of Physics, Vol. 663, pp. 374-381, 2003.

The intermolecular collision scheme is developed to obtain an excellent result even if cells are lengthened (more than the local mean free path) in the DSMC calculation. In the new scheme, the velocity of one molecule of a collision pair is modified before and after the substantial collision calculation (the core of the collision calculation), assuming that velocity distributions in all flowfield are in local equilibrium with some temperature and flow velocity (local Maxwellian distribution). The new collision scheme is applied to a one-dimensional normal shock wave, a two-dimensional vortex in a square cavity, an axisymmetric supersonic free jet, and a three-dimensional supersonic jet, respectively, and its effect on them is confirmed. In the axisymmetric problem and the three-dimensional problem, however, the velocity modifications might be limited to 50 or 60% of their full effect.

Effect of terrain configuration on vertical wind profile measured by SODAR, T. Maeda, T. Yokota, Y. Shimizu, Y. Kamada and S. Homma: Proc. of the EWEC European Wind Energy Conference & Exhibition, Madrid, Spain, 2003.

This paper describes the effect of terrain configuration on the atmospheric boundary layer for siting the wind turbine. Comparison between measured data by Doppler SODAR and the data predicted from observation of the wind condition at lower layers is performed. Large difference is seen in the measured boundary layer profile and calculated power law plots of the wind flowing from the sea. It means that there is considerable inaccuracy on the wind assessment at higher layers by observing wind conditions at lower layers. The power-law index is difficult to determine by observing low layers, when ups and downs features of the terrain change drastically. In the complex terrain, it can be said that observation of the low layers does not suffice to assess accurately the wind, while Doppler SODAR measurement is very useful.

Field tests on a small HAWT with passive pitch-flap mechanism, Yukimaru SHIMIZU, Yasunari KAMADA, Takao MAEDA, Edmond ISMAILI, Kiwamu KANEKO and Kazuma YAMANAKA: Proc. of the EWEC European Wind Energy Conference & Exhibition, Madrid, Spain, 2003.

This paper presents the experimental data acquired from testing of two small HAWTs in a mountainous area. The rotors were equipped with a passive pitch-flap mechanism. The purpose of the experiment was to verify and to validate the functionality of the pitch-flap passive mechanism in case of strong fluctuating wind conditions. The mechanism developed in this study fulfills simultaneously two functions: 1) acting as an independent passive brake for each blade, 2) acting as a damper of the fluctuating forces acting on the blades. The performance tests of the mechanism were carried out in a test site located in a complex terrain. The effect of the rotor diameter was studied and the effect of a tip-mounted Mie vane was investigated with flow visualization. The results prove that the excessive output power can be suppressed and the fluctuating forces on the blade can be reduced passively due to the passive pitch-flap mechanism.

Power Augmentation of a HAWT by Mie-type Tip Vanes, considering Wind Tunnel Flow Visualization, Blade-Aspect Ratios and Reynolds Number, Yukimaru SHIMIZU, Edmond ISMAILI, Yasunari KAMADA and Takao MAEDA: Wind Engineering-the international journal of Wind Power, Vol. 27, No3, pp. 183-194, 2003.

Wind tunnel results are reported concerning the effects of blade aspect ratio and Reynolds number on the performance of a horizontal axis wind turbine (HAWT) with Mie-type tip attachments. The flow behavior around the blade tips and the Mie-type tip vanes is presented. Detailed surface oil film visualization and velocity measurements around the blade tips, with and without Mie vanes, were obtained with the two-dimensional, Laser-Doppler Velocimetry method. Experiments were performed with rotors having blades with different aspect ratio and operating at different Reynolds numbers. The properties of the vortices generated by the Mie vanes and the blade tips were carefully studied. It was found that increased power augmentation by Mie vanes is achieved with blades having smaller aspect ratio and smaller Reynolds number.

FEASIBILITY STUDIES ON A SMALL-SCALE WIND TURBINE FOR THE MOUNTAINOUS AREA, Yasunari KAMADA, Kazuma YAMANAKA, Takao MAEDA and Yukimaru SHIMIZU: Proc. of 4<sup>th</sup> ASME JSME Joint Fluids Engineering Conference, FEDSM2003-45358, CD-ROM, p7, 2003.

In this study, a small-scale wind turbine for the mountainous area is developed. The technical features of this wind turbine are the high performance rotor with a blade tip-mounted Mie vane, the passive power control by a pitch-flap mechanism and a variable speed induction generator with inverter system. The test wind turbine is tested in Mie University wind turbine test field in a mountainous area. The output power performance, the passive power control in high wind speed, the performance improvement by the variable speed operation and the quality of power are discussed. As the results, it is demonstrated the power control by a passive pitch-flap mechanism, the suppressing effects for the fluctuating moments on the blade root and the characteristics of the variable speed generating system. Some flow patterns on the blade are shown.

DETAILED FLOW ANALYSIS AROUND BLADE TIP WITH A MIE VANE IN CASE OF DIFFERENT BLADE ASPECT RATIOS AND DIFFERENT REYNOLDS NUMBERS, Yukimaru SHIMIZU, Edmond ISMAILI, Yasunari KAMADA and Takao MAEDA: Proc. of 4<sup>th</sup> ASME JSME Joint Fluids Engineering Conference, FEDSM2003-45367, CD-ROM, p. 8, 2003.

The results of an experimental research work related to the performance of a HAWT with a tip-mounted Mie type vane are presented in this paper. From experiments carried out on four sets of blades, it was found that the application of a tip-mounted Mie vane resulted in a larger increase in power coefficient for rotors with smaller aspect ratio and for lower Reynolds number. To investigate further the phenomenon and to explain the relationships found between power increase due to a Mie vane, detailed flow visualization around blade tip and the Mie vane were performed. It was found that the tendency of the power increase due to a Mie vane was dependent on the size of a corner vortex between blade tip and the downstream extension of the Mie vane.

Effect of Terrain Configuration on Wind Characteristics by High Layer Wind Assessment [in Japanese], Takao MAEDA, Yukimaru SHIMIZU, Shuichiro HOMMA and Miwa NAKANO: Wind Energy, Vol. 27, No. 3, pp. 89-92, 2003.

In this paper, the velocity profile of the atmospheric boundary layer is discussed with experimentally measured data. In the experiments, the Doppler SORDER is set in the coastal area and measured the velocity profile for various wind direction. The relation between velocity profile and configuration of the land is discussed..

Field Measurement of Pressure Distribution on Rotating Blade of Horizontal Axis Wind Turbine, Takao MAEDA, Hideyuki KAWABUCHI, Yukimaru SHIMIZU, Yasunari KAMADA, Atsushi KATO, Albert BRUINING\* and Ruud van ROOIJ\*: Proc. of 7<sup>th</sup> Asian International Conference on Fluid Machinery, CD-ROM, p. 8, 2003.

This paper shows the pressure distribution on the rotor blade of a 10m-diameter wind turbine. The pressure sensors were mounted on the blade. The local angle of attack was measured with the use of five-hole pitot-probes at 1 chord length upwind of the blade leading edge. Comparison of three-dimensional field rotor data and two-dimensional wind tunnel measurements data was carried out. The normal force coefficient at 70% radial section shows good agreement between field and wind tunnel measurements data at the linear range of low local angle of attack. In this linear part, pressure distribution of field measurement also agrees well with those of wind tunnel measurement. There are some differences between field measurements data and those of wind tunnel on the normal force coefficient at 70% radial section, at high local angle of attack. In addition, from field experiments it was found that local slip angle was proportional to normal force coefficient. The causes are examined by investigating relation between local slip angle and pressure distribution.

Growing wind Power Development in Japan, Yukimaru SHIMIZU: Proc. of The World Wind Energy Conference and Renewable Energy Exhibition, WVEC 2003, CD-ROM, p.5, 2003.

Present paper introduces recent status and perspectives for the near future of wind power development in Japan. The presence of very good wind potential sites, combined with Japanese government policy of promotion of the construction of large-scale wind turbines, has opened the way for a very successful development of wind power industry. Somewhere between 2004-2005, the total wind power installed in Japan would be around 1GW. Though there is good promise for the wind power development, Japan still lags behind other countries. There are considerable efforts from the Japanese government to promote the wind power development. Two key issues, such introduction of subsidies for construction of wind power generation facilities and the enforcement of the law RPS, are determinant in Japanese government policy towards wind power. This paper describes and explains the details of the subsidy RPS law, and details of wind power stations as well.

THE EFFECT OF LOCAL INFLOW ANGLE, CROSS & PARALLEL, ON THE SECTION PERFORMANCE OF A ROTOR BLADE, Takao MAEDA, Hideyuki KAWABUCHI, Yasunari KAMADA, Yukimaru SHIMIZU, Albert BRUINING\* and Ruud van ROOIJ\*: Proc. of The World Wind Energy Conference and Renewable Energy Exhibition, WVEC 2003, CD-ROM, p. 9, 2003

This paper shows the pressure distribution on the rotor blade of a 10m-diameter wind turbine. The local angle of attack was measured with the use of five-hole pitot-probes at 1 chord length upwind of the blade leading edge. Comparison of three-dimensional field rotor and two dimensional wind tunnel measurements were carried out. The normal force coefficient at 70%R shows good agreement at the linear range of low local angle of attack in the field and wind tunnel measurements. In this linear part, pressure distribution of field measurement also agrees well with those of wind tunnel measurement. The normal force coefficient at 70%R at high local angle of attack in field shows differences from those of wind tunnel. In this paper, the effect of the local angle of attack and local slip angle on the pressure distributions of the rotor blade is mainly demonstrated.

Rotor Configuration Effects on the Performance of a HAWT With Tip-Mounted Mie-Type Vanes, Yukimaru SHIMIZU, Edmond ISMAILI, Yasunari KAMADA and Takao MAEDA: Journal of Solar Energy Engineering, Vol. 125, pp. 441-447, 2003.

In this paper, the relationships between the power augmentation of a HAWT due to Mie type tip vane application and other factors influencing the efficiency such as the blade aspect ratio, number of blades, blade pitch angle and Reynolds number are investigated. Rotor models included two- and three-blade upwind turbines with four sets of blades with different aspect ratios. With the rotor blades tested, a power augmentation of about 14.5% was achieved due to Mie vane application. The relationships between power augmentation and the above factors are investigated. It is found that the application of a Mie vane results in a larger increase in power coefficient for rotors with smaller aspect ratios and for lower wind speeds. Surface oil-film and surface tuft visualization methods were used to detect the flow patterns at the blade tip. Addition of the Mie vanes causes significant changes in flow behavior near the tip, resulting in additional blade lift.

Research and development of wind turbine airfoil [in Japanese], Yukimaru SHIMIZU, Takao MAEDA, Yasunari KAMADA, Toshiyuki YOSHIDA and Kouji YOSHIOKA: Proc. of 52nd Annual Conference of JSME Tokai Branch, pp. 43-44, 2003.

This paper describes the development of airfoils for wind turbine. The combination of lower surface and upper surface of airfoil shows the productive method for the airfoil design. The performance of these airfoils are evaluated by the wind tunnel test.

The experimental analysis of flow behavior around rotor blade [in Japanese], Yukimaru SHIMIZU, Takao MAEDA, Yasunari KAMADA, Kouichi MATSUMOTO and Koutarou SUGI: Proc. of 52nd Annual Conference of JSME Tokai Branch, pp. 45-46, 2003.

The rotor performance are investigated by the LDV measurements. The flow field around rotating blade are measured in the three components. The local circulations around blade are calculated by using velocity distribution.

Studies on Orthoptere Water Turbine (Effect of Water Head on Turbine Power) [in Japanese], Yukimaru SHIMIZU and Noriyasu YAMADA: Proc. of 52nd Annual Conference of JSME Tokai Branch, pp. 55-56, 2003.

The Orthoptere water turbine for ultra Low head hydro-energy is investigated experimentally. The performance of the Orthoptere water turbine are tested various condition, flow ratio, water head in downstream and outlet configurations.

Studies on gate generation system for ultra low head hydropower (Improvement of performance by nozzle and interlock of gates) [in Japanese], Yukimaru SHIMIZU and Shota NAKAI: Proc. of 52nd Annual Conference of JSME Tokai Branch, pp. 57-58, 2003.

The gate system for ultra Low head hydro-energy is investigated experimentally. The performance of the gate system are tested in nozzle configurations and operational mode.

Research and Development of Orthoptere Wind Turbine [in Japanese], Yukimaru SHIMIZU, Takao MAEDA, Yasunari KAMADA, Shintaro KAWAGUCHI and Takashi SATO: Proc. of Annual Conference of JSME, No. 03-1, pp. 65-68, 2003.

This paper describes the power augmentation of the Orthoptere wind turbine due to several diffusers. The Orthoptere wind turbine is a kind of paddle-type vertical axis wind turbine operated by the effects of both lift and drag forces exerted on the blades. The performance of the Orthoptere wind turbine shows middle characteristics between Sabonius wind turbine and Darius wind turbine. Different from other vertical axis wind turbine, the Orthoptere wind turbine shows directivity respect to wind direction. Using diffuser, power augmentation of the Orthoptere wind turbine could be achieved. The diffuser we used has rectangular cross section. The diffuser is composed of straight duct and divergence part for power augmentation. The experiment was carried out in an wind tunnel.

Experimental studies on horizontal axis wind turbine in wind tunnel [in Japanese], Yukimaru SHIMIZU, Takao MAEDA, Yasunari KAMADA, Kotaro SUGI and Yusaku SAKAI: Proc. of Annual Conference of JSME, No. 03-1, pp. 79-82, 2003.

This paper describes the performance and power augmentation effect of three-bladed wind turbine. Three sets of blade were tested the blade had the same geometry and configuration, but were different on the way of arranging airfoil sections. One of them is tapered blade which consists 4 kind of airfoil section and twisted, the others are slant arranged airfoil of it. The performance data are given and relationship between the performance, and the flow behavior around the blade obtained by use of LDV is investigated.



Numerical Simulation of Flow around Blade of Horizontal Axis Wind Turbine [in Japanese], Yukimaru SHIMIZU, Takao MAEDA, Kouji TAKEMURA and Hiroaki ITO: Proc. of Annual Conference of JSME, No. 03-1, pp. 99-102, 2003.

This paper describes the numerical analysis of the wind turbine located on the far in Mie University. The grid of calculation is arranged by the shape of circular cylinder. The rotor performances of CFD agree well with that of BEM. To make simplify the calculation, one third of the rotor plane is need for calculation. The calculation code involves an equation of motion and continuity. As the algorithm of solving, finite volume method. In addition to calculate pressure distribution, velocity distribution is also calculated from pressure ones.

Research and Development of Wind Farm due to Higher Layer Assessment [in Japanese], Takao MAEDA, Yukimaru SHIMIZU, Yasunari KAMADA, Shuichiro HOMMA, Miwa NAKANO and Yusuke KINPARA: Proc. of Annual Conference of JSME Tokai Branch, pp. 24-25, 2003.

In this study, the method of wind resource assessment for wind park is discussed. The velocity profile up to 700m measured by Doppler SODAR is presented. It was find that for wind resource assessment, the higher layer velocity is important.

Numerical Analysis and Experimental Study on Wind Turbine Airfoil [in Japanese], Yukimaru SHIMIZU, Takao MAEDA, Yasunari KAMADA, Kouji YOSHIOKA and Atsushi KAWAMURA: Proc. of Annual Conference of JSME Tokai Branch, pp. 26-27,2003.

In this paper, the development of airfoil for wind turbine is described. In this studies, the numerical analysis are used for design and the experiments in wind tunnel are used for evaluation of the characteristics.

Consideration for relationship between wind condition and roughness [in Japanese], Takao MAEDA, Yukimaru SHIMIZU, Yasunari KAMADA, Miwa NAKANO, Shuichiro HOMMA and Yusuke KINPARA: Proc. of the 81<sup>st</sup> Conference of JSME Fluids Engineering Division, p. 92, 2003.

In this study, relationship between wind condition and roughness is discussed. The velocity profile up to 200m measured by Doppler SODAR is used for the discussion. It was found that the wind speed estimations for higher layer by using power law have error by roughness of the ground.

Relationship between Wind Assessment and Terrain Configuration due to Doppler SODAR [in Japanese], T. Maeda, Y. Shimizu, Y. Kamada, Y. Kinpara, M. Nakano and S. Honma: Proc. of 25th Wind Energy Utilization Symposium, JWEA, Tokyo, pp. 145-148, 2003.

In this paper, the velocity profile of the atmospheric boundary layer is discussed with experimentally measured data. In the experiments, the Doppler SORDER is set in the coastal area and measured the velocity profile for various wind direction. The relation between velocity profile and configuration of the land is discussed.

Temperature Measurement using Ultrasonic CT in Combination with Numerical Analysis (Verification of CT Reconstruction Algorithm and Basic Experiment), Ning Zhu, Seizo Kato and Yong Jiang: Journal of Fluid and Heat Engineering Research, Vol. 38, No. 1, pp. 39-, 2003

The purpose of this study is to suggest a new CT reconstruction algorithm for intrusive temperature measurement under the condition of limited projected angle. The new CT reconstruction algorithm combines numerical analysis with ART (Algebraic Reconstruction Technique) to compensate the incomplete projection data for CT reconstruction. Computer simulation of CT reconstruction with a Gaussian function was conducted to verify the feasibility of the suggested CT reconstruction algorithm by comparing a defined similarity function under different limited projection angles. In order to apply this new algorithm to actual temperature measurement, numerical analysis of a natural convection field is done in advance. An experiment system set-up with the same experimental conditions as numerical analysis is established. As a result of the simulation and the experiment, it was confirmed that the reconstruction accuracy was greatly improved with the algorithm suggested in the current paper.

Environmental Conscious for Vending Machine (Analysis and Assessment of Environmental Load by LCA Method), Yukio Kimura, Seizo Kato and Naoki Maruyama: Journal of Fluid and Heat Engineering Research, Vol. 38, No.2, pp.33-44, 2003

This study describes the environmental influences of the vending machines by implementing of the LCA (Life Cycle Assessment) evaluation method. The LCA has been used for assessing the environmental aspects and potential of the impacts which associated with the whole life of a product "from the cradle to the grave" synthetically. The objective of this study is to evaluate the vending machines by the developed software called "Mie-LCA", which could be calculated the environmental impacts of a product using the LCA-NETS (Numerical Eco-Load Total Standardization) method. The LCA-NETS is one of the useful methodology for being an LCIA (Life Cycle Impact Assessment) tool. As the results, the ecological improvements were discussed on the impacts in various stages of the vending machines such as material production stage and the operation stage. It can be shown that the carbon-dioxide emission and environmental loads have been reduced more than 50% as improvement results. For further study, LCA-NETS should be conducted with regards to the depletion of fossil fuels and natural resources as well as waste processing.

Temperature Field Visualization of Hot & Cold Liquids Mixing in Cup-type Vessel by Using Thermo-paint, Takafumi Ito and Seizo Kato: Journal of Visualization Society, Vol. 23, No. 8, pp. 66-71, 2003

Temperature field visualization by using Thermo-paint is performed on hot and cold liquids mixing process encountered in cup-type beverage vending machines. In this experiment, four kinds of Thermo-paint in micro capsule of 10  $\mu\text{m}$  are mixed to response for a wide temperature difference range of 60°C and applied to a cup type vessel contained initially separated hot and cold liquids which is stirred by flat-plate paddles at 900 rpm. The visualized images are recorded by a digital video camera and processed by contrast technique to identify its temperature. As a result, this Thermo-paint technique is found to be attractive to reflect sensibly the temperature field of hot and cold liquids mixing process with high speed and to analyze the temperature mixing mechanics.

Environmental Impact Analysis of Indonesian Electric Generation Systems (Development of a Life cycle Inventory of Indonesian Electricity), Anugerah Widiyanto, Seizo Kato and Naoki Maruyama: JSME International Journal, Series B, Vol. 46, No. 4, pp. 650-659, 2003

The life cycle inventory (LCI) of the electric power generation plays a vital role on LCIs of the industrial products. However there are no formal life cycle assessment (LCA) studies in Indonesia so far due to limited number of LCA expertise and lack of sufficient databases relevant to domestic conditions. The objective of this study is to introduce life cycle assessment (LCA) method for Indonesian electric power generation systems and to establish LCI for electricity grid mix of Indonesia. In this paper, the emissions of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, CO, CH<sub>4</sub>, NMHC, N<sub>2</sub>O, Dust (SPM), Ni, As, Cd, Cr, Hg, Pb, Zn per kWh of electricity generated were estimated for the systems using a combined method of process analysis and input-output analysis. Additional analyses on the impacts of emerging and future technologies as well as the influences of changes of various assumptions are helpful for a better understanding. As the result, the LCA evaluations are discussed for further ecological improvement.

Environmental Impact of Fossil Fuel Fired Co-generation Plants Using a Numerically Standardized LCA Scheme, Anugerah Widiyanto, Seizo Kato, Naoki Maruyama and Yoshimasa Kojima: Journal of Energy Resources Technology, Vol.125, No. 1, pp. 9-15, 2003

This paper describes the LCA environmental impacts resulting from fuel fired co-generation systems using our *NETS* (Numerical Eco-load Total Standard) scheme having GUI (Graphic User Interface). Following a brief introduction of the NETS evaluation method, firstly the total eco-load from commercial electricity power plants in Japan is numerically calculated in the *NETS* unit. We take here almost all factors into account including fuel mining, transportation and processing, plant manufacturing, assembling and its building construction, fuel consumption and maintenance during twenty durable years, plant dismantling and waste processing, thermal efficiency and delivery loss, etc. This evaluation greatly helps in the eco-load estimation of co-generation plants when electricity purchase is needed during the plant operation with a minimum eco-load. Next, co-generation systems are paid attention to their ecological effectiveness. Here, we select different fuel fired co-generation plants of natural gas, heavy oil, and coal. Environmental impacts resulting from the respective plants include fossil fuel depletion and natural resources depletion, global warming due to green house gases, ozone layer depletion due to CFC type gas emission, various water and air pollution, rain acidification due to NO<sub>x</sub> and SO<sub>x</sub>, waste processing, recycling etc. Each item can be successfully calculated from the inventory database accumulated by authors. Hourly energy demands of electricity and heat (steam, hot water and cold water) are set to a typical model for eight office buildings and two hotels. The *NETS* method is applied to the co-generation model, resulting in the best cost-operating scheme of co-generation plants with a minimum environmental impact.

Integrated Evaluation of Environmental-load for Industrial Products and Eco-Products Design by LCA-NETS, Seizo Kato and Yucho Sadamichi: Research of Machine, Vol. 53, No. 3, pp. 167-173, 2003

Nowadays, producing Environmental Conscious Products (ECP) is a basic strategy in makers. However, since there are few tools supporting producing ECP quantitatively in planning or designing products stage, makers often suffer. This paper describes outline of integrated evaluation method of environmental-load "LCA-NETS (Numerical Eco-load Total Standard)" which authors have proposed based on Life Cycle Assessment (LCA) for supporting eco-design. This paper also mentions the case study that developed LCA-NETS as CAE software is applied to actual products and carries out the eco improvement. In the future, it is expected that LCA evaluation tool like this scheme plays an important role on eco-products design.

Eco Design with Life Cycle Assessment, Seizo Kato: Journal of the Heat Transfer Society of Japan, Vol. 42, No. 174, pp. 19-20, 2003

Consideration to environment with care is necessary for making product connected with heat as well as heat transfer. Since almost resource of heat is fossil fuel and phenomena is always irreversible and efficiency is very low, there is a lot of factors which gives bad influence to global environment. In this paper, I would like to introduce the “recommendation of eco design based on the concept of LCA (Life Cycle Assessment)”.

Reforming of Carbon Dioxide into Fuel-like Species with Photocatalyst, Akira Nishimura, Seizo Kato, Masahiro Hagi and Nobumasa Sugiura: Proceedings of Asia-Pacific Conference on Sustainable Energy and Environmental Technologies, pp. 24-28, 2003

In this study, for the purpose of clarification of mechanism and optimum condition of reforming  $CO_2$  into fuel-like species which are  $CH_4$ ,  $C_2H_4$  and  $C_2H_6$  with the aid of photocatalyst, the experimental investigation has been carried out. The acrylic tube reactor composed of the ultraviolet (UV) lamp and copper ring coated with  $TiO_2$  by the sol-gel and dip-coating technique was used. After filling the mixture of  $CO_2$  and saturated vapor into the reactor, UV lamp was illuminated for 48 hours continuously. The effect of the power of UV lamp and the coating number on the amount of produced fuel-like species was examined. As a result,  $CH_4$  production is influenced stronger by coating number than by the power of UV lamp.  $C_2H_4$  concentration is increased with increasing the power of UV lamp and coating number. The reaction scheme of  $CO_2$  reforming into fuel-like species has been revealed.

Evaluation of Indonesian's Grid Electricity System from a life Cycle Assessment Point of View, Anugerah Widiyanto, Seizo Kato and Naoki Maruyama: Proceedings of the 16<sup>th</sup> International Conference on Efficiency, Cost, Optimization, Simulation, and Environmental Impact of Energy Systems, pp. 521-528, 2003

In evaluating various kinds of energy systems from the lack concept, an identical standard measure is to be introduced, as there are many different causes for generating environmental loads to the environment and the respective causes have their respective characteristics. Consequently the authors have proposed an integrated scheme called the LCA-*NETS* (Numerical Eco-load Total Standard) to express the amount of environmental load from different causes, using an identical standard based on objective data. This is a “Loader-Receiver Tolerant Balance Theory”, which indicates the balance of the maximum tolerance value that the Loader can discharge or consume with the maximum tolerable value by the Receiver. This LCA-*NETS* scheme is applied to Indonesian grid system, and the LCA evaluations are discussed for further ecological improvement.

A Design Methodology of Environmentally Conscious Products for Co-Generation Systems, Anugerah Widiyanto, Yucho Sadamichi, Seizo Kato, Naoki Maruyama and Akira Nishimura: Proceedings of the 16<sup>th</sup> International Conference on Efficiency, Cost, Optimization, Simulation, and Environmental Impact of Energy Systems, pp. 529-536, 2003

This issue of the environmental effect of fossil fueled power plants is presently being discussed; they are directly involved in global environmental problems such as fossil fuel depletion, global warming, and acid rain. Owing to the new sensitivity arising towards the environment, power generation design must respect the environment. However, today no standardized environmentally conscious products (ECP) design criteria for power plants is exist. In this paper, the implementation of environmental management system (EMS) and its evaluation of environmental compatibility for power plants in the design phase, are discussed. As a case study, the methodology is applied to evaluate environmental load and cost performance of co-generation plants. For expressing quantitatively environmental loads, we have newly proposed an objective numerically standardized LCA scheme, called LCA-*NETS* (Numerical Eco-load Total Standard), in which various kinds of environmental impacts can be commonly evaluated in a newly standardized unit of [NETS]. As the result, co-generation systems seemed to be the best available technology from an economic and environmental point of view.

LCA Environmental Load Minimization for Operating Different Cogeneration Systems, Seizo Kato, Yucho Sadamichi and Anugerah Widiyanto: Proceedings of the International Conference on Power Engineering-03 (ICOPE-03), pp. 229-234, 2003

To estimate environmental impacts through the entire life cycle of any industrial activity like co-generation system (CGS) operation, Life Cycle Assessment (LCA) has been found to be a powerful tool. Therefore the authors have first proposed a standardized method called the LCA-*NETS* scheme (*NETS*: Numerical Eco-load Total Standard) based on objective data, in which a new unit of [NETS] is used for the standardized numerical value of eco-load, and second developed a new version software of the LCA-*NETS* scheme for analyzing numerically the eco-loads from a specified CGS and then minimizing the impacts due to the CGS operation. As a result, the LCA-*NETS* eco-load evaluation scheme constructed here is found to be an attractive and powerful tool to analyze the quantitative LCA environmental loads for any type of co-generation system and to predict its most ecologically and economically optimized operation scheme, resulting in compromising compatibility between eco and cost performance.

LCA-*NETS* Evaluation of Coal-fired and Natural Gas-fired Power Generations in Thailand, Sate Sampattagul, Seizo Kato, Tanongkiat Kiatsiriroat and Anugerah Widiyanto: Proceedings of the International Conference on Power Engineering-03 (ICOPE-03), pp. 235-239, 2003

This paper describes about life cycle evaluation of two kinds of power generation system which are using major resources of energy in Thailand between using natural gas and coal. Those power plants hold the share of Electricity Generating Authority of Thailand (EGAT) about 52.5% and 22.7% respectively classified by gross electricity production and by the type of fuel used in 2000. Therefore, it is necessary to understand the environmental influences from electricity production systems, in which could be instructed the component of environmental plan for reducing emissions and resources consumption. The aim of the study is to apply Life Cycle Assessment (LCA) with Numerical Eco-Load Total Standardization (*NETS*), which is used for evaluating the environmental burdens by identifying and quantifying energy and materials used and waste released to environment. And the Life Cycle Inventory (LCI) and Life Cycle Costing (LCC) of the power plant systems have been developed and estimated. As a result, the LCA-*NETS* point of view was discussed for further ecological power generating systems which will be acting more environmental friendly in the future.

Environmental Impacts Evaluation of Electricity Grid Mix Systems in Four Selected Countries Using a Life Cycles Assessment Point of View, Anugerah Widiyanto, Seizo Kato, Naoki Maruyama, Akira Nishimura and Sate Sampattagul: Proceedings of EcoDesign2003 (Third International Symposium on Environmentally Conscious Design and Inverse Manufacturing, pp. 26-33, 2003

The life cycle inventory (LCI) data of the electric power generation plays a vital role on LCIs of the industrial products. However there are no formal life cycles assessment (LCA) studies in Indonesia so far due to limited number of LCA expertise and lack of sufficient databases relevant to domestic conditions. Therefore, the aim of this study is, firstly to introduce life cycle power generation systems, Japan, Thailand and China. Finally, to analyze and to investigate the environmental burdens for these four selected countries from a life cycle impact assessment (LCIA) point of view using the proposed LCA-*NETS* (Numerical Eco-load Total Standard) method. As the results, the LCA evaluations are discussed for further ecological improvement.

LCA-NETS Tool for Environmental Design of Natural Gas-fired Power Generation Systems in Thailand, Sate Sampattagul, Seizo Kato, Tanongkiat Kiatsiriroat, Naoki Maruyama and Anugerah Widiyanto: Proceedings of EcoDesingn2003 (Third International Symposium on Environmentally Conscious Design and Inverse Manufacturing, pp. 141-146, 2003

Natural gas power generating plant accounts for 52.5% of all of the electricity produced in Thailand. The attractiveness of small amount combustion gas emission bring the number of natural gas power plant increasing. On the other hand, natural gas is not a renewable energy then the life cycle efficiency is negative, indicating that more energy is consumed by the steam than is produced in the form of electricity. It is very important, therefore, to understand the environmental influence due to the electricity production from natural gas, which could be instructive component of any plan to reduce total emissions and also the resources consumption. This study has introduced LCA and LCC to three kinds of natural gas power plant systems. As the result according to the LCA and LCC point of vies, the environmental load and the economical cost are discussed for further ecological and economical improvement.

LCA Evaluation of Reuse/Recycle Impact for Environmental Conscious Industrial Products, Yucho Sadamichi, Yukio Kimura, Anugerah Widiyanto, Seizo Kato, Naoki Maruyama and Akira Nishimura: Proceedings of EcoDesingn2003 (Third International Symposium on Environmentally Conscious Design and Inverse Manufacturing, pp. 339-343, 2003

An industrial activity like manufacturing products inevitably results in some load on the environment such as the fossil fuel depletion, global warming, air pollution and etc. Owing to the new sensitivity arising towards the environment, reuse and recycles for products have to be regarded as important. However, no numerical environmental impact analyses of reuse and recycle have been expressed. As a tool that estimates numerical environmental impacts caused by different environmental problems through the entire life cycle (cradle to grave) of industrial products, Life Cycle Assessment (LCA) has been greatly paid attention. In this paper, we have evaluated environmental impacts of reuse for vending machine and recycling for PET bottle by the aid of the LCA-*NETS* (Numerical Eco-load Total Standard) software that we have newly proposed as a LCA scheme to analyze quantitatively environmental loads of any industrial products. As the result, it is clarified that LCA-*NETS* software is found to be a powerful tool to analyze the quantitative LCA environmental loads for various industrial products and that reuse and recycling of products are greatly needed for ECP (environmentally conscious product).

Life Cycle Management for Power Plant Optimization by LCA Consolidated Evaluation Scheme, Naoki Maruyama, Seizo Kato and Anugerah Widiyanto: Proceedings of 1<sup>st</sup> International Energy Conversion Engineering Conference, CD-ROM, 2003

In this paper, the LCA (Life Cycle Assessment) consolidated evaluation technique of energy system is described. The integration and evaluation of a variety of environmental load factors of various causes using an identical standard must be taken into account. It is important to measure the various environmental impacts caused by a variety of causes, using the same standard. However, the standard indices for international LCA integration have not yet been determined, and the enactment of ISO 14040s as an international standard will take another few years. We are proposing an integrated scheme called the Eco-Load Standardization Scheme (ESS) to express the amount of environmental load from different causes, using an identical standard based on objective data. This "L-R Tolerant Balance Theory", expresses the maximum tolerance value that the "Loader" (primarily ecosystem), integrated and standardized according to the so-called "left and right balancing rule". This LCA-*NETS* scheme is applied to different energy systems such as various kinds of power plants and co-generation systems, and the LCA evaluations are discussed for further ecological improvement. A unique result of environmental load consolidation is that it has been found to give a relatively favorable evaluation to coal burning power generation systems (inclusive of costs) as to environmental friendliness.

Proposal and Feasibility Study on Circulating Hydrogen Gasifier and Storage Using Acid Water, Tatsuya Shimizu, Seizo Kato and Akira Nishimura: Proceedings of the 10<sup>th</sup> Tri-University International Joint Seminar & Symposium 2003, pp. 111-115, 2003

Due to the present energy production system utilizing combustion the fossil fuel depletion and global warming are becoming serious environmental issues. Therefore, the developments of alternative energy systems with a minimum dependence on fossil fuel are now required. From the viewpoint of environmental harmony, hydrogen is the best candidate for the alternative energy source, but the key subject is how we produce and store up hydrogen. The aim of this study is to propose an alternative hydrogen gasifier from acid water. By means of immersing electrodes in the acid water and electrodes separately, it can be thought that we store up hydrogen. Consequently, this system can be used as the gasifier and storage of hydrogen. The reason why we pay attention to acid water is to intend to reuse huge wastewater in sewage works, incinerator, etc. for hydrogen production and neutralization, simultaneously. Firstly, we selected  $\text{D}_2\text{SO}_4$  and Zn plates as acid and aqueous solutions electrode, respectively. The gasifier experiment on hydrogen production rate was carried out with changing the metal surface area, pH and temperature of the solution. The gasifier shows a good performance of hydrogen production of about  $0.047[\text{g}/(\text{m}^2\text{s})]$  at 333K and  $\text{pH} = 0.5$ . Secondly, we tried to reproduce Zn and the acid water by using lead as the electrode. Generally speaking, zinc ion cannot be collected as metal by electrolysis since the standard electrode potential of zinc is lower than that of hydrogen. Therefore, we try to reproduce of zinc by using the character of zinc that is the hydrogen over voltage and success in the reproduction. From the experiments, the efficiency of the reproduction is about 25%.

Environmental-load Evaluation and Environmental friendliness of Coal Fuel and Coal-fired Power Plant, Seizo Kato: Proceedings of LCA Lecture Meeting on Coal, pp. 159-166, 2003

The issue of LCA environmental impacts produced energy systems is presently being discussed; they are directly involved in fossil fuel depletion, global warming, air pollution, rain acidification, etc. In evaluating various kinds of energy systems from the lack concept, an identical standard measure is to be introduced, as there are many different causes for generating environmental loads to the environment and the respective causes have their respective characteristics. Consequently the authors have proposed an integrated scheme called the ESS (Eco-load Standardization Scheme) to express the amount of environmental load from different causes, using an identical standard based on objective data. This is a "Loader-Receiver Tolerant balance Theory", which indicates the balance of the maximum tolerance value that the Loader can discharge to consume with the maximum tolerable value by the Receiver. This ESS employs the NETS (Numerical Eco-load Total Standard) as the unit for expressing quantitatively the integrated and standardized environmental load. This LCA-NETS scheme is applied to different energy systems such as various kinds of power plants and co-generation systems, and the LCA evaluations are discussed for further ecological improvement.

Optimization Control of Wake and Under-floor Flow for  $C_D \cdot C_L$  Compatible Reduction of Large Commercial Vehicles, Yasushi Kato, Seizo Kato and Kenta Yamamoto: Proceedings of 2003 JSAE Annual Congress, No. 35-03, pp. 1-4, 2003

Larger aerodynamic drag due to the wake is loaded on large commercial vehicles running with high-speed to long distance. In this study, wind tunnel test is performed by using a 1/16-bus model on a moving ground with the purpose of its grad and lift compatible reduction. This scheme realized setting the under-floor at an optimum height, and by installing aero-devices at the rear based surface corners. As a result, a significant drag reduction of and lift reduction of are resulted compatibly under the optimum control of wake and under-floor flow.

Power Plant Design Optimized from Environmental and Economical Aspects, Seizo Kato, Anugerah Widiyanto and Naoki Maruyama: Proceedings of 40<sup>th</sup> National Heat Transfer Symposium of Japan, Vol. 1, pp. 105-108, 2003

In evaluating various kinds of energy systems from the lack concept, an identical standard measure is to be introduced, as there are many different causes for generating environmental loads to the environment and the respective causes have their respective characteristics. The authors have proposed an integrated scheme called the *LCA-NETS* (Numerical Eco-load Total Standard) to express the amount of environmental load from different causes, using an identical standard based on objective data. This is a “Loader-Receiver Tolerant Balance Theory”, which indicates the balance of the maximum tolerance value that the Loader can discharge or consume with the maximum tolerable value by the receiver. This *LCA-NETS* scheme is applied to a various kinds of power generation systems, and the LCA evaluations are discussed from environmental and economical aspects for further ecological improvement.

Verification on the Software “LCA-NETS” Evaluating Environmental Load for Industrial Products, Yucho Sadamichi, Seizo Kato, Naoki Maruyama, Akira Nishimura and Yukio Kimura: Proceedings of 2003 Symposium on Environmental Engineering, pp. 374-377, 2003

To estimate environmental impacts caused by different environmental problems through the entire life cycle of any industrial products, Life Cycle Assessment (LCA) has been greatly paid attention. This technique assesses the environmental aspects and potential impacts of a product through a product’s life (cradle to grave). This “LCA-NETS” software has been developed in order to support the LCA study, and the “LCA-NETS” method that has been proposed here is applied for life and display not only the calculation results by tables and graphs, but also analysis results that help make eco-design decision. In this study, “LCA-NETS” has been applied for evaluations of many industrial products. As the result, it is clarified that “LCA-NETS” is found to be a powerful tool to analyze the quantitative LCA environmental loads for various industrial products.

Development of Eco-Accounting System ~ Proposal of Monetization Method for Environmental Protection Effect by *LCA-NETS* ~, Seizo Kato, Naoki Maruyama, Akira Nishimura, Yoshiyuki Izu, Anugerah Widiyanto, Yucho Sadamichi, Yuki Yamaoka and Yukio Kimura: Proceedings of 2003 Symposium on Environmental Engineering, pp. 378-381, 2003

Life Cycle Assessment (LCA) becomes a more critical tool for ECP (Environmentally Conscious Products) designing. At the same time, Life Cycle Costing (LCC) and Environmental Accounting (Eco-Accounting) are becoming a necessary tool to make decision scheme of the environmental load reduction expressed in physical units due to counter-measure into money units based on the CO<sub>2</sub> emission dealing right price, which is able to be evaluated by the CO<sub>2</sub> equivalent *NETS* values. Additionally, several criteria for the environmental costs performance are proposed with case studies.

Environmental Load Evaluation of Industrial Products in Manufacturing Stage (Inventory Analysis of Painting-coating and Plastic-injection Molding Processes), Seizo Kato, Naoki Maruyama, Akira Nishimura, Yuki Yamaoka, Anugerah Widiyanto, Yucho Sadamichi, Yoshiyuki Izu, Yukio Kimura and Masaaki Nakamura: Proceedings of 2003 Symposium on Environmental Engineering, pp. 382-385, 2003

Life Cycle Assessment (LCA) has been greatly paid attention to its effectiveness in evaluating environmental impacts through the life cycle of any industrial products. In this paper we are focusing the LCA environmental-load evaluation of the manufacturing phase in industries, especially painting-coating and plastic-injection molding processes. The *LCA-NETS* method is have used to analyze the environmental load of the processes. The various kind of inventory data base the processes has collected by measuring respective parameters. Based on the data analysis, a structure is developed to evaluate the LCA Eco-load in these two manufacturing processes. And, a list of estimations using *NETS* values as points of reference for further development and refinement to much more environmental friendly manufacturing.



LCA/LCC of Mae Moh Coal-fired Power Plant in Thailand, Seizo Kato, Sate Sampattagul, Tanongkiat Kiatsiriroat, Naoki Maruyama, Anugerah Widiyanto, Akira Nishimura and Yucho Sadamichi: Proceedings of 2003 Symposium on Environmental Engineering, pp. 402-405, 2003

Mae Moh Coal-fired Power Plant in Thailand has held the second share of utility power generation in Thailand, approximately 22.7% of all utility-produced electricity. However, there are plenty of environmental arguments of this only one power plant that using coal energy for generating electricity. Therefore, understanding the environmental impacts of the power system is necessary in order to find possible and suitable ways for waste reduction and system improvement. The aim of the study is first to apply Life Cycle Assessment (LCA) with Numerical Eco-Load Total Standardization (NETS), which used for evaluating the environmental burdens by identifying and quantifying energy and materials used and waste released to environment based on the balance of L&R (Loader and receiver) tolerance. And the Life Cycle Inventory (LCI) of the power plant system has been developed. The second is to determine the performance cost by using Life Cycle Costing analysis (LCC) and to compare with other types of coal-fired generating systems. As the result, environmental load and economical cost for comparative power plants are discussed from life cycle thinking point of view to indicate for the better ecological and economical coal-power generation system for Thailand.

Circulating Hydrogen Gasifier and Storage Using Acid Water, Tatsuya Shimizu, Seizo Kato and Akira Nishimura: Proceedings of 12<sup>th</sup> Conference of Japan Institute of Energy, pp. 286-287, 2003

In this study, we propose the circulating hydrogen gasifier and storage using acid water. This method has the character that it can produce hydrogen by reacting acid water and metal without external energy input. We have succeeded to recycle the zinc solved in solution with electricity input after hydrogen production since standard electrode voltage of zinc is lower than that of hydrogen and hydrogen over voltage of zinc is high. In the proposed circulating hydrogen gasifier and storage using acid water, hydrogen is produced and preserved as acid water by recycling zinc with electricity energy input and returning pH of acid water to the state before hydrogen production. We have verified the usefulness of proposed circulating hydrogen gasifier and storage using acid water.

LCA Evaluation and Eco-operation for Co-generation Systems, Yucho Sadamichi, Seizo Kato, Naoki Maruyama and Akira Nishimura: Proceedings of 12<sup>th</sup> Conference of Japan Institute of Energy, pp. 418-419, 2003

Recently, owing to mass consumption of fossil fuel, global environmental problems like fossil fuel depletion and global warming become serious. Since operation of energy system like power plant is closely connected with these global problems, construction of environmentally friendliness structure of energy supply and demand, which can decrease the environmental-load and grow economy, is requested. LCA (Life Cycle Assessment) is drawing attention since it can evaluate quantitatively these environmental-loads through a product's life (cradle to grave). Then, authors construct the software, which can estimate the environmental-load according to thermal and electricity demand and type of system, by using the proposed LCA environmental-load integration scheme "LCA-NETS (Numerical Eco-load Total Standard)". We have calculated environmental-load of co-generation system and investigated the optimum eco-operation condition for minimizing environmental-load.

Assessing the Environmental Impact of Indonesian Electricity Grid System Using an LCA Method, Anugerah Widiyanto, Seizo Kato and Naoki Maruyama: Proceedings of 12<sup>th</sup> Conference of Japan Institute of Energy, pp. 422-423, 2003

This paper describes the life cycle assessment (LCA) consolidated evaluation technique of energy systems for Indonesia electric grid system. The emissions of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, CO, CH<sub>4</sub>, Dust (SPM), Ni, As, Cd, Cr, Hg, Pb, and Zn were studied in a cradle-to-grave manner. In here, the proposed LCA-NETS (Numerical Eco-load Total Standard) method is used as life cycle impact assessment method. As the results the LCA evaluation are discussed for further ecological improvement.

Environmental-load Evaluation and Eco-Improvement of Thermal Energy System by LCA, Akira Nishimura, Yucho Sadamichi, Naoki Maruyama and Seizo Kato: Proceedings of the 36<sup>th</sup> Autumn Meeting of the Society of Chemical Engineers, CD-ROM, 2003

Authors construct the software, which can estimate the environmental-load according to thermal and electricity demand and type of system, by using the proposed LCA environmental-load integration scheme "LCA-NETS (Numerical Eco-load Total Standard)". We have calculated environmental-load of co-generation system and investigated the optimum eco-operation condition for minimizing environmental-load.

Development of an Airtight Oscillating Fluidized Bed, Seiichi Deguchi, Masayuki Deguchi, Akira Nishimura and Yukihiisa Fujima: Kagaku Kogaku Ronbunshu, Vo.29, No.4, pp.493-499, 2003

An airtight oscillating fluidized bed, which can fluidize a particle bed in an airtight vessel without supplying a fluidization gas from outside, was proposed. This system is composed of an airtight vessel and a gas duct with a valve connecting upper and lower spaces of the vessel divided by a particle stopper and a distributor plate. It was considered that fluidization could be formed by rectifying the gas flow induced by the enforced oscillation of the airtight vessel and induced particle bed inertia with the help of the gas duct and valve. In this development study, the gas duct contained a valve comprising a steel ball, of which the length of vertical movement was restricted, and its pedestal was firstly prepared as a trial. Then, theoretical simulation was performed based on experimentally obtained pressure drop through the gas duct, demonstrating the possibility of fluidization in this supposed system. Fluidization was verified in conformity with the assumed fluidization mechanism in the trial model of the oscillating fluidized bed with this gas duct. As the oscillating frequency increased, the fluidization state changed from static bed to incipient fluidization, bubbling fluidization and bubbling fluidization with surface wave. Finally the structure of a gas rectifier to be placed in the gas duct for efficient operation of this system was presented.

Heat Transfer Characteristics in an Airtight Oscillating Fluidized Bed and Their Relation with Bubble Behavior, Seiichi Deguchi, Masayuki Deguchi, Mikitaka Isobe, Akira Nishimura and Yukihiisa Fujima: Kagaku Kogaku Ronbunshu, Vo.29, No.4, pp.585-587, 2003

Heat transfer rates in an airtight oscillating fluidized bed (AOFB) were compared with those in the same system operated as a conventional fluidized bed with a supply of fluidization air from beneath the distributor. Heat transfer rate in the AOFB increased with an increase in the oscillating frequency. Though fluidization air was intermittently introduced to the bed in the AOFB, the largest heat transfer rate obtained was roughly equal to that in a conventional fluidized bed. The vertical heat transfer rate distribution in the AOFB showed like sine curve, which could be quantitatively explained by the stagnating positions and frequencies of bubbles.

Algebraic Expression of the Minimum Gas Velocity Restraining Downward-Flowing Particles through the Contraction Midway of a Circulating Fluidized Bed Riser, Seiich Deguchi, Takaaki Mizuno, Kumi Matsuoka, Akira Nishimura, Hideo Nasu and Yukihiisa Fujima: *Kagaku Kogaku Ronbunshu*, Vo.29, No.5, pp.660-666, 2003

Using a circulating fluidized bed (CFB) as a typical column-type solid/gas system, this study aimed to determine the minimum gas velocities restraining the downward-flowing particles through the contraction midway of the CFB riser, and to formulate an algebraic expression of these critical velocities. Using glass-beads as circulating particles, change in the amount of downward-flowing particles at the contraction with change in gas velocity was examined experimentally for different solid feeding rates. Algebraic expression of critical velocities was performed with a growing chain model (GCM) and a revised GCM (RGCM). The GCM proposed by us and others is an ideal cluster model that assumes a vertical chain of particles of a constant size. The RGCM further takes account of the size distribution of circulating particles. The experimental results with circulating particles of different size ranges of 125–280, 90–225, 28–90 $\mu\text{m}$  revealed that the critical gas velocities are proportional to the solid feeding rates, and the slopes of those curves are almost the same, irrespective of the size distribution of circulating particles. The critical velocities obtained by extrapolating the curves of experimental critical velocity towards zero of solid feeding rate showed a linear relations with the theoretical terminal gas velocities of an infinitely long chain of particles. The theoretical expression of the critical velocity using the theoretical terminal gas velocity of an infinitely long chain of particles by the RGCM is confirmed to be adequate, since this expression can also predict experimental critical velocities for 28–280 $\mu\text{m}$  circulating particles with an error of only  $\pm 10\%$ .

Classification of Ultra Fine Powder by a New Pneumatic Type Classifier, Hiroshi MORIMOTO and Toshihiko SHAKOUCI: *Journal of Powder Technology*, Vol. 131, No.1, pp. 71-79, 2003.

It is very important to make fine solid particle of micron-meter or sub-micron-meter order in the fields of material engineering, food, medicine and agricultural chemicals, etc. In the making process of fine solid particle pulverization method of raw material and classification method are important essentially. In this study, an entirely new pneumatic type ultra fine solid particle classifier is proposed and the classification mechanism is made clear by flow analysis. This new classifier can classify sub-micron-meter solid particle efficiently.

A study on Resonance Impinging and Wall Jets, Toshihiko SHAKOUCI, Takumi MARUYAMA, Toshitake ANDO, Koichi TSUJIMOTO and Atsushi WATANABE: *Proc. of Fourth ASME/JSME Fluids Engineering Conference*, CD-ROM, 2003.

The round free jet issued from an orifice nozzle with a volume  $v$ , resonance room, just before it shows resonance phenomena and oscillates periodically. The relation among nozzle exit velocity  $u$ , the  $v$  and oscillate frequency, dominant frequency,  $f$  were examined experimentally. The  $f$  increases with increasing  $u$  and decreasing  $v$ . Now, impinging jet has excellent heat and mass transfer properties at and around the stagnation point and then it uses widely in the fields of thermo engineering and others. In order to improve the heat and mass transfer properties impinging velocity, fluctuating velocity and turbulence levels may be very important and influential. It is considered to use a resonance impinging jet for it, and the good results were obtained.

Gas Absorption, Aeration by Fluidic Oscillator Operated by Gas-Liquid Two-Phase Flow, Toshihiko SHAKOUCI: *Proc. of Fourth ASME/JSME Fluids Engineering Conference*, CD-ROM, 2003.

Gas absorption, aeration, into a liquid is very important in the field of chemical engineering, especially treatment of sewage water, etc. It is desired strongly to develop a new compact type aerator. In this study, fluidic oscillator operated gas-liquid two-phase flow is proposed newly as a compact type aerator. It is shown that a fluidic oscillator can be operated not only for single-phase fluid but also for gas-liquid two-phase flow, and in the fluidic oscillator gas and liquid are mixed vigorously because the flow oscillates periodically. The relation among the oscillatory frequency  $f$ , void fraction  $a$  and nozzle exit velocity  $u$ , and the relation among the absorption rate of dissolved oxygen and them are made clear experimentally. It is well known that the new fluidic oscillator type aerator has good mixing and mass transfer properties.

Flow and Heat Transfer of Impinging Jet with Low Nozzle-Plate Spacing and Their Control (Effects of Nozzle Wall Thickness and Geometry), Toshihiko SHAKOUCHI, Hideki SUGIMOTO, Toshitake ANDO, Koichi TSUJIMOTO and Tsuyoshi TANABE: Transaction of the Japan Society of Mechanical Engineers (Trans. of the JSME), Vol. 69, No. 686 B, pp. 2305-2312, 2003.

Impinging jet has excellent heat and mass transfer characteristics at and near the stagnation point. As the nozzle-plate spacing decreases considerably, the heat transfer characteristics is improved remarkably. In this paper, the effects of thickness and geometry of nozzle wall on the flow and heat transfer characteristics of impinging jet with low nozzle-plate spacing are examined experimentally. The result shows that the heat transfer characteristics can improved considerably and the power consumption of nozzle-plate system decreases by varying the thickness and geometry of nozzle.

High Temperature Air Jet Flow and Its Application to globular Forming of Fine Particles, Hirokazu MORIMOTO, Toshihiko SHAKOUCHI and Atsushi KUSUDA: Kagaku kogaku Ronbunshu, Vol. 29, No. 6, pp. 836-842, 2003.

High temperature air jets are used widely in the fields of drying, sintering, powder treatment, sterilization and others, but the velocity and temperature fields and their relation have not been sufficiently clarified. The main purpose of this study is to improve the performance of surface fusing, or globular forming systems of thermoelastic fine particles. First, the flow and thermal characteristics and their relation of high temperature air jet from a pipe nozzle were clarified by measuring the mean and fluctuating velocity and temperature profiles. In order to control the jet diffusion in the radial direction, a ring nozzle with a ring-shaped contraction near the nozzle exit was used and its flow and thermal characteristics were determined. Next, the effect of nozzle shape on the performance of the globular forming was examined, and the ring nozzle was shown to be suitable.