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Tsutomu Ando is a professor at the Department of Mechanical Engineering, College of Industrial Technology, Nihon University. He received his doctoral degree in engineering at Tohoku University in 2003 with the thesis entitled "Study of MHD Induction Pump using a Rotating Twisted Magnetic Field for High-Temperature Molten Metal." From 2005 to 2008, he served as an assistant professor at the Graduate School of Frontier Sciences, The University of Tokyo. From 2011 to 2016, he served as an associate professor at the College of Industrial Technology, Nihon University. Since 2016, he has served as a professor at Nihon University. From 1991 to 1996, he also worked as a mechanical engineer in the Space Experiment System Development Department of Ishikawajima-Harima Heavy Industries Co., Ltd. (IHI), Japan. Dr. Ando is a member of the Japan Society of Mechanical Engineers, the Society of Chemical Engineers, Japan, the Magneto-Science Society of Japan, and the Japan Society of Applied Physics. His research interests include solid-liquid multiphase flow, electromagnetic processing of materials, mixing and magnetohydrodynamics.

Research Achievements

1) Angle Dependency of Intraoral Coil for Magnetic Stimulation Targeting the Base of the Brain, Advanced Biomedical Engineering, Vol. 11, 142-150, 2022.

2) Structure Formation of Magnetic Particles under Magnetic Fields toward Anisotropic Materials, IOP Conf. Series: Materials Science and Engineering, Vol. 424, 012076 (4pp), 2018.

3) In-situ observation of particles deposition process on ferromagnetic filter during high-gradient magnetic separation process, Journal of Magnetism and Magnetic Materials, Vol. 427, 296-299, 2016.

4) Development of recovery device for particulates in fluid by magneto-Archimedes separation, Separation and Purification Technology, Vol. 149, 197-207, 2015.

5) Simulation of fouling and backwash dynamics in dead-end microfiltration: Effect of pore size, Journal of Membrane Science, Vol. 392-393, 48-57, 2011.
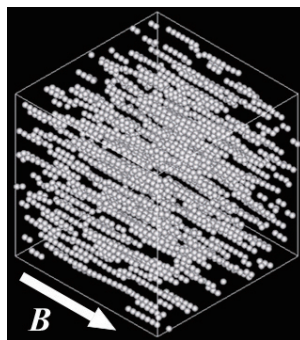

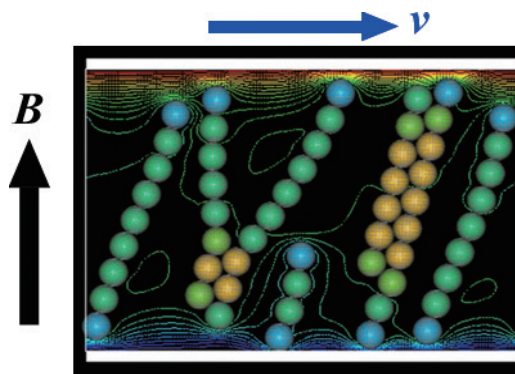Fig. Structure of magnetic particles under magnetic field.

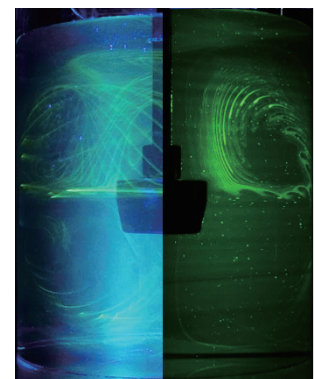Fig. Behavior of magnetic particles in MR fluid under shear field.

(*a*) Front view   (*b*) Cross section

Fig. Streak line of bladeless stirrer.

Structure Formation of Magnetic Particles under Magnetic Fields toward Anisotropic Materials

Tsutomu ANDO, Daisuke KATAYAMA, Noriyuki HIROTA, Osamu KOIKE, Rei TATSUMI,
and Masafumi YAMATO

Numerical simulations were performed on the structure formation of magnetic particles under a magnetic field for the development of anisotropic materials. In this study, we investigated the unsteady formation process of chain-like clusters and its characteristics in solvent-dispersed magnetic particles with diameters on the order of micrometers under the magnetic field. The non-dimensional boundary area (NBA) was used to evaluate the formation process of the structure with multiple particle sizes and particle volume concentrations. The structure formed by the magnetic particles did not depend on the particle size, but on the particle volume concentration. When the particle volume concentration $\phi = 5$ vol%, the chain-like clusters were almost one chain and a repulsive force acted between the chains, without the formation of bundles. However, when $\phi = 10$ vol% or more, a bundle structure was formed in which multiple chain-like clusters were in contact. In the process of the structure formation by magnetic particles, when a magnetic field was first applied, a single particle rotated while orientating the magnetic moment in the direction of the applied magnetic field. The particles then bonded together to form chain-like clusters. This suggests that the rotation time constant was much shorter than the time constant of the chain cluster formation. This simulation was based on SNAP-L, which uses the discrete element method (DEM), and was calculated by giving magnetic properties to the particles and applying a magnetic field. We are currently researching the rheological properties of MR fluid under an applied magnetic field based on SNAP-F, which considers particle–fluid interactions.

For SNAP (Structure of NAno Particles), please refer to the SNAP Research Group website (https://www.product-innovation.or.jp/snap/whats_snap.html).

Keywords : Magnetic particle, Chain-like cluster, Anisotropic material, Numerical simulation

異方性材料に向けた磁場下での磁性粒子の構造形成

　異方性材料開発に向けた磁場下での磁性粒子の構造形成について数値シミュレーションを行った。本研究では，溶媒中に分散された直径マイクロメートルオーダーの磁性粒子を対象にして，磁場印加時に磁性粒子が形成する鎖状クラスターの構造形成の非定常過程とその特徴を調べた。本研究では，Non-Dimensional Boundary Area (NBA) を使用して，複数の粒子径と粒子体積濃度で構造が形成されるプロセスを評価した。磁性粒子が形成する構造は粒子径には依存せず，粒子体積濃度に依存する。粒子体積濃度 ϕ=5 Vol% の場合，鎖状クラスターはほぼ 1 本の鎖でチェーン間に斥力が働き，束ができていない。しかし，ϕ=10 Vol% 以上の場合，複数の鎖状クラスターが接触した束構造が形成された。磁性粒子による構造形成過程では，まず磁場を印加すると印加磁場の方向に磁気モーメントを向けながら，単一粒子が自転する。その後粒子同士が結合し，鎖状のクラスターが形成される。このことから，自転の時定数が鎖状クラスター形成の時定数より極端に短い。

　本シミュレーションは離散要素法 (DEM) を使用した SNAP-L をベースにして，粒子に磁性を持たせ，磁場を印加して計算した。現在，粒子－流体相互作用を考慮した SNAP-F をベースにした MR 流体の磁場印加におけるレオロジー特性についても研究を行っている。SNAP (Structure of NAno Particles) については SNAP 研究会のホームページ (https://www.product-innovation.or.jp/snap/whats_snap.html) を参照願います。

キーワード：磁性粒子，鎖状構造クラスター，異方性材料，数値シミュレーション

Kohei OKITA
Professor, Department of Mechanical Engineering

Kohei Okita is a professor at the Department of Mechanical Engineering, College of Industrial Technology, Nihon University. He received his BScEng in 1996, his MScEng in 1998, and his DEng in 2002, all from Osaka University. From 2002 to 2006, he served as a postdoctoral fellow at the University of Tokyo. He joined the Functionality Simulation and Information Team of the VCAD System Research Program at RIKEN as a research scientist in 2006 and as a senior scientist from 2007 to 2011. While working at RIKEN, he also participated in the ISLiM project (Next-Generation Integrated Simulation of Living Matter) and developed the ZZ-HIFU-K (high-intensity focused ultrasound simulator for the K computer). He served as an associate professor at the Department of Mechanical Engineering, College of Industrial Technology, Nihon University from 2011 to 2022. Dr. Okita is a member of the American Physical Society, the Japan Society of Fluid Mechanics, and the Japan Society of Mechanical Engineers. His research interests include cavitating flow, acoustic cavitation, therapeutic ultrasound, and computational fluid dynamics.

Research Achievements

1) Numerical study on stress in a solid wall caused by the collapse of a cavitation bubble cloud in hydraulic fluid, International Journal of Multiphase Flow, 150, 103965, May 2022. https://doi.org/10.1016/j.ijmultiphaseflow.2021.103965

2) Effects of breast structure on high-intensity focused ultrasound focal error, Journal of Therapeutic Ultrasound, 6(4), Jun 2018. https://doi.org/10.1186/s40349-018-0111-9

3) The role of numerical simulation for the development of an advanced HIFU system, Computational Mechanics 54, 1023–1033 Apr 2014. https://doi.org/10.1007/s00466-014-1036-y

4) Microbubble behavior in an ultrasound field for high intensity focused ultrasound therapy enhancement, Journal of Acoustical Society of America, 134(2), 1576-85, Aug 2013. https://doi.org/10.1121/1.4812880

5) Development of High Intensity Focused Ultrasound Simulator for Large Scale Computing, International Journal for Numerical Methods in Fluids, 65, 43-66, Jan 2011. https://doi.org/10.1002/fld.2470
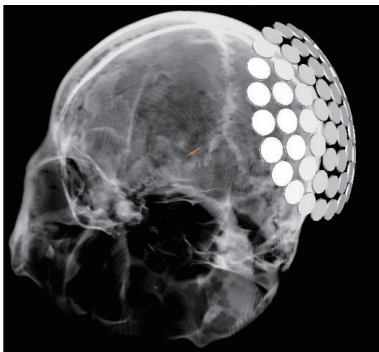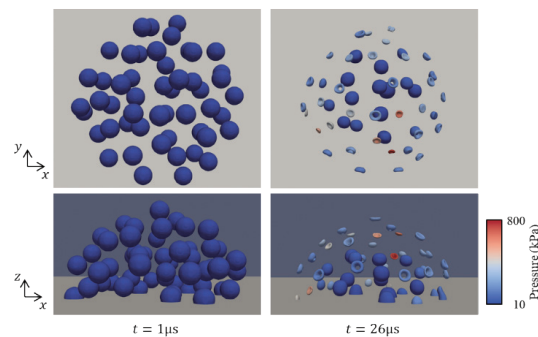

Fig.1 HIFU simulation for brain tumor

Fig.2 Collapse of bubble cloud near wall

Numerical study on stress in a solid wall caused by the collapse of a cavitation bubble cloud in hydraulic fluid

Kohei OKITA, Yuusuke MIYAMOTO, Teruyuki FURUKAWA, Shu TAKAGI

Cavitation is often observed in hydraulic machinery and causes noise and vibration. Cavitation erosion is a serious problem that leads to a shortened product life. Quantitative prediction of the cavitation erosion is desired, but is impossible experimentally and numerically. Previous works by many researchers have shown that the most destructive damage is caused by the collapse of a cavitation bubble cloud attached to a wall. The present study numerically examined the effect of the collapse of a cavitation bubble cloud in hydraulic fluid on the stress in a solid wall. The bubbles in a bubble cloud are assumed to be spherical and the dynamics of a spherical bubble are described by the Keller–Miksis equation. The thermal damping effect is considered for the bubble oscillation by using a reduced-order model. The translational motion of the bubble is assumed to be non-slip with the surrounding fluid. The bubbly mixture and the bubbles are coupled by the Euler–Lagrange method. On the other hand, to represent the stress in a solid due to the collapse of a bubble cloud, the bubbly mixture and the elastic solid are coupled by fluid–structure coupling. The conservation equations for the mass, momentum, and energy for both the bubbly mixture and the elastic solid are solved with an equation of state for hydraulic fluid. Numerical simulations for the collapse of the bubble cloud near the solid wall were performed for various parameters such as the offset distance, initial bubble size, and initial void fraction in the bubble cloud. The results revealed that the collapse of the bubble cloud with a quarter of it attached to the wall caused the highest von Mises stress in the solid. In addition, as the initial bubble decreased and the initial void fraction increased, the peak von Mises stress due to the collapse of the bubble cloud increased. The collapse patterns for various offset distances and the propagation of pressure waves and stress waves are also shown in this paper.

Keywords : Cavitation, Cavitation erosion, Fluid-Structure coupling, Numerical simulation

油中キャビテーション気泡クラウドの崩壊によって引き起こされる固体壁面内の応力に関する数値解析

　建設機械等の油圧機器においてキャビテーションがしばしば観察され騒音や振動の原因となっている．とくに，キャビテーションによる材料損傷であるキャビテーションエロージョンは製品寿命の低下を引き起こす重大な問題である．このため，キャビテーションエロージョンの定量的な予測が求められているが，実験的にも数値的にも未だ不可能となっている．これまでに多くの研究者らが行った研究によって，壁に付着したキャビテーション気泡クラウドの崩壊が最も破壊的であることがわかっている．本研究では，キャビテーション気泡クラウドの崩壊が固体壁面に生じる応力に及ぼす影響について数値シミュレーションによる解析を行った．気泡クラウドの個々の気泡に対して球形を仮定の下，体積振動を Keller-Miksis 方程式によって表現し，次元縮約モデルによって気泡振動における熱減衰の影響を考慮している．また，気泡の並進運動については周囲流体とノンスリップであると仮定し，気泡混合体と気泡は Euler-Lagrange 法によりカップリングした．一方，気泡クラウドの崩壊によって生じる固体内の応力を再現するために，気泡混合体と固体に対して流体構造連成解析を適用し，質量，運動量及びエネルギーに対する保存式と油の状態方程式を解いている．気泡クラウドと壁面のオフセット距離や気泡クラウド内の初期気泡径および初期ボイド率をパラメータとして，固体壁近傍での気泡クラウドの崩壊に対する数値シミュレーションを行った．その結果，4分の1が壁に付着した気泡クラウドの崩壊時に固体内に生じるミーゼス応力が最も高くなることがわかった．また，気泡クラウドの初期気泡径が減少し，初期ボイド率が増加するほど，崩壊によるミーゼス応力が増加することがわかった．また，論文ではオフセット距離による崩壊パターンや，液体中の圧力波および固体中の応力波の伝播の様子が示されている．

キーワード：キャビテーション，キャビテーションエロージョン，流体構造連成，数値シミュレーション

Kazuyuki HARA
Professor, Department of Electrical and Electric Engineering

Kazuyuki Hara received his BEng and MEng degrees from Nihon University in 1979 and 1981, respectively, and his PhD degree from Kanazawa University in 1997. He was engaged at NEC Home Electronics Corporation from 1981 until 1987, after which he joined the Toyama Polytechnic College as a lecturer. In 1998, he joined the Tokyo Metropolitan College of Technology as an associate professor and he became a professor in 2005. He served as a professor at Nihon University in 2010. Dr Hara is a director of the Research Center for Artificial Intelligence, the College of Industrial Technology, and a member of the Nihon University AI Society (NUAIS). His current research interests include the statistical mechanics of on-line learning and the applications of artificial intelligence in visual systems. He is a senior member of the IPSJ and a member of the JPS, IEEE, and IEICE.

Research Achievements

1) Node-perturbation Learning Applied for Soft-committee Machine, IPSJ Transaction on Mathematical Modeling and Its Applications, Vol. 13, No. 2, 61-68, Aug. 2020.

2) Performance of pre-learned convolution neural networks applied to recognition of overlapping digits, 2020 IEEE International Conference on Big Data and Smart Computing, Feb. 2020.

3) Statistical Mechanics of Node-perturbation Learning with Noisy Baseline, Journal of the Physical Society of Japan, 86, 024002 2017.

4) Analysis of Function of Rectified Linear Unit Used in Deep learning, International joint conference on neural networks, July 2015.

Research approach

Our research approach is a part of artificial Intelligence by using statistical mechanics. We use online learning which is supervised learning that uses a piece of data with its target in a learning iteration. There is no correlation between data in online learning, so we can apply the statistical mechanics method to analyse online learning behaviour. This analysis shows us how the network approaches the target at speed or error without simulations. Differential equations of order parameter are derived from the learning equation and are used to depict the behaviour of a network. In this case, the learning equation is a microscopic behaviour of the network, and the error of the network is a macroscopic behaviour. To derive the macroscopic equations from microscopic equation, we use the statistical mechanics. Derivation of the macroscopic equations is similar to the derivation of Boyle-Charles' law from a dynamic equation of the electron.

From this approach, we can get an insight into learning, then we can find out why and how the learning system is behaving and how accurate the network is.

Node-perturbation Learning Applied for Soft-committee Machine

Kazuyuki HARA, Kentaro KATAHIRAm and Masato OKADA

Node-perturbation learning is an online stochastic gradient descent method for neural networks. It estimates the gradient of the error surface by calculating the change in error between the perturbed output and the unperturbed output. Node perturbation can be applied to problems where the objective function is not defined. Node-perturbation learning is applied to only simple perceptrons, so we explored the application of node-perturbation learning to a multilayer neural network called a soft committee machine and analyzed the dynamic properties of the learning process. We conducted computer analysis to confirm the validity of the proposed method.

Keywords: node-perturbation learning, soft committee machine, on-line learning, perturbation, generalization error, statistical mechanics method

Statistical Mechanics of Node-perturbation Learning with Noisy Baseline

Kazuyuki HARA, Kentaro KATAHIRA, and Masato OKADA

Node-perturbation learning is a type of statistical gradient descent algorithm that can be applied to problems where the objective function is not explicitly formulated, including reinforcement learning. It estimates the gradient of an objective function by using the change in the object function in response to the perturbation. The value of the objective function for an unperturbed output is called the baseline. This paper reports the building of the statistical mechanics of Cho's model and on deriving coupled differential equations of the order parameters that depict the learning dynamics.

Keywords: node-perturbation learning, noisy baseline, teacher-student formulation, statistical mechanics

論文の説明

　上記の２件の論文では共にノードパータベーション学習という、生物の神経細胞の学習方法を機械学習モデルに適用し、その性能を統計力学的手法によって解析した。ノードパータベーション学習とは細胞（ノード）の出力に摂動（ノイズ）を加えたことによる評価関数の変化を用いて評価関数の勾配情報を得ようとする方法である。機械学習で多く用いられる勾配法では、ノードの出力関数の微分が可能な場合しか適用できないが、ノードパータベーションではノート出力関数の微分を用いないため、より広いクラスのモデルへの適用が可能となっている。第1の論文は機械学習モデルが階層型ネットワークの場合について議論しており、最終出力に摂動を加える方法が良いとの結論を導いている。また、勾配法を用いたノイズあり学習と比較した結果、ノードパータベーション学習では勾配情報を用いていないにも関わらず、ノイズあり学習と同等の性能を得ていることがわかった。また、第２の論文では入力と出力のみから成るパーセプトロンにおいて定常的にノイズがある状況でのノードパータベーション学習の有効性を議論している。定常的にノイズがある環境下での学習は生物モデルとして現実的であり、定常ノイズの影響が学習に及ぼす影響を調べた。
その結果、定常的に加えられるノイズと学習に用いる摂動の分散が同じ場合に最も学習の効果が高いことが解析的に示された。

Yasuaki HABA

Research Assistant, Department of Electrical and Electronic Engineering

Yasuaki Haba is a research assistant at the Department of Electrical and Electronic Engineering, College of Industrial Technology, Nihon University. He received his BSc in physics from Aoyama Gakuin University in 2003, and his MSc in particle physics and astrophysics at Nagoya University in 2006. From 2006 to 2017, he worked at private high schools. After receiving his PhD in particle physics and astrophysics in 2020 at Nagoya University with his research on "Negative ion beam focusing based on phase space structure," he moved to Nihon University. His major research topic aims to provide a better characterization of beams extracted from cesium-seeded negative ion sources that are utilized for advanced applications such as boron neutron capture therapy, experimental particle physics, and plasma heating for nuclear fusion. Concentrating on the investigation of beams in terms of transverse velocity distributions, a compact negative ion source equipped with a single extraction hole, including beam diagnostics, is being developed at Nihon University. Insights into the velocity distributions depending on the geometries of beam acceleration electrodes with cesium adsorption as well as magnetic fields to remove coextracted electrons will be revealed. Dr. Haba is a member of the Physical Society of Japan.

Research Achievements

1) Abundance ratio of multiple velocity distribution components in a single negative ion beamlet produced by a cesium-seeded negative ion source, *AIP Advances*, 12, 035223 (2022). https://doi.org/10.1063/5.0083300

2) Nonuniform plasma meniscus modelling based on backward calculation of negative ion beamlet, *Nuclear Fusion*, accepted manuscript (2022). https://doi.org/10.1088/1741-4326/ac8604

3) Characterisation of negative ion beam focusing based on phase space structure, *New Journal of Physics*, 22, 023017 (2020). https://doi.org/10.1088/1367-2630/ab6d41

4) Response of beam focusing to plasma fluctuation in a filament-arc-type negative ion source, *Jpn. J. Appl. Phys.*, 59, SHHA01 (2020). https://doi.org/10.35848/1347-4065/ab7473

5) Development of a dual beamlet monitor system for negative ion beam measurements, *Rev. Sci. Instrum.*, 89, 123303 (2018). https://doi.org/10.1063/1.5056260
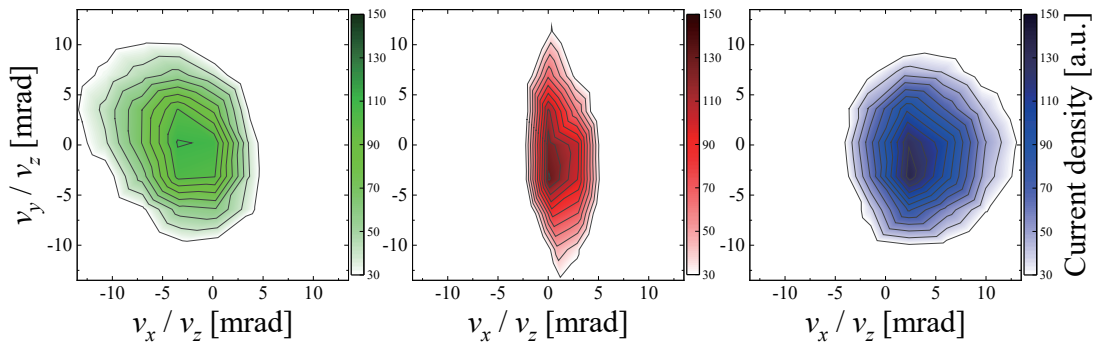
Fig. Transverse velocity distributions of a single negative ion beam produced by a cesium-seeded negative ion source. The multi-components, each of which has a particular velocity distribution, compose a resultant asymmetric profile of the single beam. This finding has been well described in our previous publication 1), which was selected as Featured. The cause of such multi-components has not yet been identified, and further investigation will follow.

Abundance ratio of multiple velocity distribution components in a single negative ion beamlet produced by a cesium-seeded negative ion source

Yasuaki HABA, Mitsutoshi ARAMAKI, Katsuyoshi TSUMORI, Masaki OSAKABE,
Katsunori IKEDA, Haruhisa NAKANO, and Kenichi NAGAOKA

Negative ion based neutral beam injection (NBI) systems are required for heating and current drive in magnetically confined fusion plasma experiments because negative ions have a higher neutralization efficiency than positive ions at a high beam energy above 100 keV. Every single negative ion beamlet must have a small divergence (3–7 mrad) for minimizing transmission losses into the fusion reactor, while the ITER-relevant negative ion beamlet divergence has a minimum of 14 mrad so far. The control of a single negative ion beamlet divergence is a significant challenge with the use of a cesium-seeded negative ion source, where negative ions are mainly produced by the conversion of hydrogen or deuterium atoms on the cesiated surface of the plasma grid. In our previous work, three Gaussian components were experimentally identified in a transverse emittance diagram (velocity vs position) of an isolated beamlet produced by a research-and-development negative ion source at the National Institute for Fusion Science. The focal points of the individual components differed from each other, indicating that the components were extracted from different areas of the plasma meniscus. However, the origins of the individual components are still under investigation. This paper describes the measurement of the abundance ratio of the three components based on a full picture of their transverse velocity distributions for the first time. The abundance ratio remained constant even when the electrostatic lenses formed at the downstream region of the plasma meniscus changed, while it was considered to be changed with the plasma parameters and geometries of the beam acceleration grids. The observed velocity distributions will be utilized for the initial values in backward beam trajectory calculations that are able to investigate the origins of the individual components. The abundance ratio can then be a key parameter for determining their origins.

Keywords : negative ion source, negative ion beam, beam divergence, velocity distribution function, abundance ratio

セシウム添加型負イオン源から引き出された
単一の負イオンビームに内在する複数の速度分布成分の含有率

　負イオンビームは，高エネルギー領域（>100 keV）でも，正イオンビームに比べて高い中性化効率を有する．このため，磁場閉じ込め型核融合プラズマの加熱および電流駆動では，負イオンを前駆体とする中性粒子ビーム入射が必須となっている．核融合プラズマに輸送されるビームの損失を最小限に抑えるために，個々の負イオンビームには非常に小さな発散角（3-7 mrad）が要請されているが，国際プロジェクト ITER 関連の負イオンビーム発散角は最善でも 14 mrad に制限されたままである．こうした負イオン源では，セシウムが添加されたプラズマ電極表面で水素原子が荷電変換されることで，多くの負イオンが生成される．従って，セシウム添加型負イオン源から引き出された負イオンビームの発散角を制御することは，重要な研究課題である．私たちの先行研究では，ビーム径方向のエミッタンス図（速度と位置との関係を示した図）を用いて，核融合科学研究所の開発研究用負イオン源から引き出された単一の負イオンビームが 3 成分で構成されていることが実験的に明らかにされた．各成分は異なる焦点を持つことから，それらはメニスカス（ビーム引出界面）上の異なる領域から引き出されたと考えられる．しかしながら，それらの起源については未解明のままである．

　この論文では，ビーム径方向の速度分布の全貌に基づいて，単一の負イオンビームを構成する 3 成分の含有率が計測可能であることを世界に先駆けて提示する．各速度分布成分の含有率は，メニスカスより下流領域における静電レンズ効果に依存せず不変であり，一方でプラズマパラメータ（負イオン密度，電子温度等）やビーム加速器を構成する電極の幾何構造に依存して変化すると推定される．実験的に取得された速度分布関数は，各速度分布成分の起源を調べるために実施する，ビーム軌道の逆流計算における初期値を与える．各速度分布成分の起源を同定するためには，各速度分布成分の含有率は重要なパラメータとなる．

キーワード：負イオン源，負イオンビーム，ビーム発散角，速度分布関数，含有率

Kazuhiko MINAKUCHI
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Kazuhiko Minakuchi is a professor at the Department of Civil Engineering, College of Industrial Technology, Nihon University. He received his PhD from Nihon University in 2003 and worked as a postdoctoral researcher at the High-Technology Research Center, College of Industrial Technology, Nihon University from 2005 to 2007. He specializes in the study of structural engineering, bridge engineering, and maintenance management engineering, having authored a number of technical papers. Dr. Minakuchi is a member of the Japan Society of Civil Engineering (JSCE) and the Japan Concrete Institute (JCI). His main research themes are: (1) Evaluation of load carrying capacity and fatigue resistance of RC slabs for highway bridges; (2) Research on maintenance management methods for concrete members; and (3) Diagnosis of deterioration of RC members subjected to salt and frost damage.

Research Achievements

1) Influence of UFC Panel with Different Synthetic Surface Shape in UFC/RC Column on Axial Compressive Load-Carrying Capacity and Failure Modes of Column Members, Cement Science and Concrete Technology, Vol.75, pp.294-301. 2022.

2) Effect of crack opening and closing width on fatigue durability of filling concrete with protruding rebars in panel joints of replacement precast RC slabs, Journal of Structural Engineering. A, Vol.68A, pp.711-721. 2022.

3) Load-Carrying Capacity of Adhesive-Applied NSM Increasing Thickness Method Using Metal-Grid Expanded Type on Damaged RC Columns, Cement Science and Concrete Technology, Vol.75, pp.340-347. 2022.

4) Experimental study on Axial Compression Properties of RC column Members Reinforced with Thickness Increase Method using Expanded Grid-Metal, Proceedings of the Japan Concrete Institute, Vol.43, No.2, pp.799-804. 2021.

5) Study on axial compressive load-carrying capacity of composite column using UFC panels with different shapes of synthetic surface, Proceedings of the Japan Concrete Institute, Vol.43, No.2, pp.751-756. 2021.

PIC. 2 Wheel-running fatigue test unit   Fig. Result of salt percolation for EPMA plane analysis
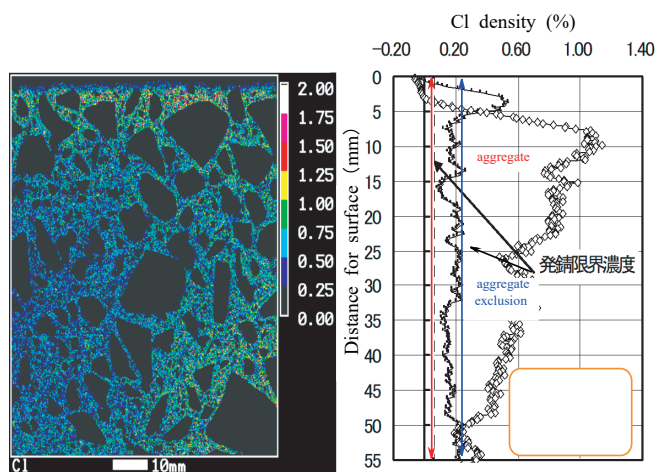
Evaluation of Fatigue Resistance of RC Member under Compound Deterioration for Running Fatigue and Frost Damage

Kazuhiko MINAKUCHI, Tadashi ABE and Shohei SUGURO

In this experimental study on the reiteration frost and wheel running combined damaged of the RC slabs. And damaged investigation of cause were the water and cement ratio (W/C). All results obtained by the Load carrying wheel tracking machine and result from the equivalent number of cycles and S/N curve. As the results, 57 percent W/C slabs specimens fatigue resistance had decreased 54 percent and decrease static elastic modulus was 23 percent, in another 50 percent W/C slabs specimens had decreased 50 percent of number of cycles and static elastic modulus was decrease 16 percent. Those specimens were compared to no damaged RC slabs. In snow and cold region RC slabs were effective improved of fatigue and frost deterioration by the W/C ratio.

Keywords : Running fatigue, Frost damage, Water-cement ratio, Deterioration damage, Fatigue resistant, Dynamic modulus of elasticity

輪荷重走行による疲労と凍害の複合劣化を受けた RC 部材の耐疲労性評価

　本研究は，輪荷重走行による疲労と凍害の複合劣化を受けた RC 部材の水セメント比（W/C）の違いが耐疲労性に及ぼす影響について実験より検証したものである。その結果，輪荷重走行と凍害による複合劣化を受けた場合，乾燥状態での等価走行回数に比して，水セメント比 57％、50％の供試体でそれぞれ 54％，50％の低下が見られた。また，動弾性係数では乾燥状態の供試体に比して 23％，16％低下している。劣化診断では，輪荷重走行と凍結・融解における融解時の湿潤状態によりセメント成分の溶出が多くスケーリングに至ることから，水セメント比を小さくすることで劣化の進行を抑制できることを明らかにした。

キーワード：走行疲労、凍害、水セメント比、劣化損傷、耐疲労性、動弾性係数

Akira ODA

Professor, Department of Civil Engineering

Akira Oda is a professor at the Department of Civil Engineering, College of Industrial Technology, Nihon University. He received his bachelor's and master's degrees in civil engineering from Nihon University in 1982 and 1984, respectively, and his PhD from Nihon University in 1995. He worked at Kumagai Gumi Co., Ltd. from 1988 to 1996. While working at the Technical Research Institute, his major research topics were experiments to verify the effects of a new wave-dissipating block. After retiring in 1996, he moved to the Civil Engineering Research Laboratory where his major research topics were erosion control by torrent and river model experiments. In 2008, he moved to Nihon University to expand his research topics to sedimentation in rivers, landslide dam failure with wood debris, and debris flow in volcanic areas. Dr. Oda is a member of the Japan Society of Civil Engineering (JSCE) and the Japan Society of Erosion Control Engineering (JSECE).

Research Achievements

1) Experimental Study on Failure of Landslide Dam with Wood Debris, Proceedings of the Japanese Conference on Hydraulics(Jsce),Vol77,No.2,I_661-I_666,2021.

2) Development of Indirect Grain Diameter Measuring Method for Sediment Transportation, Proceedings of the Japanese Conference on Hydraulics(Jsce),Vol74,No.5,I_637-I_642,2018.

3) Experimental study on Evaluation for Grain Diameter of Bed Load Material Using Contact Time when Gravel Collides with Elastic Plate, Proceedings of the Japanese Conference on Hydraulics(Jsce),Vol.67, No.4,I_1165-I_1170,2011.

4) Laboratory tests of a Japanese Pipe Hydrophone for Continuous Acoustic Monitoring of Coarse Bedload, U.S Geological Survey, Scientific Investigations Report 2010-5091, pp.319 ～ 335,2010.

5) The Estimate Method of Erosion Rate of Cohesive Materials(CRL-AET), International Society for Soil Mechanics and Geotechnical Engineering, Fourth International Conference on Scour and Erosion 2008, C-8, P.430 ～ 435

Driftwood moving towards erosion channel → Occurrence of landslides on left and right banks → Driftwood stops moving

Driftwood Accumulation on the Erosion Channel of a Natural Dam

Experimental Study on Failure of Landslide Dam with Wood Debris

Akira ODA, Michiaki NAKAMURA, Hirokazu SUMI, Takeshi TAKEMURA and Minoru OCHIAI

When a landslide dam collapses, the overflow discharge increases sharply. In addition, it is known that in landslide dams, high-concentration sediment flows down due to rapid vertical erosion and side bank collapse. However, when there is a large amount of wood debris in the flooded area of a landslide dam, there are many unexplained points regarding the collapse characteristics of landslide dams. In this study, we experimentally investigated the effects of wood debris deposited in the flooded area when a landslide dam collapses. As a result, it was confirmed that in the situation where the wood debris block stopped, the wood debris block was caught in the sediment on the downstream slope of the landslide dam, and the sediment on bank downstream of the landslide dam collapsed and was covered. Also, as the amount of wood debris increased, the maximum overflow discharge decreased, sediment concentrations increased, and tended to be the starting point for erosion channel collapse. Furthermore, it was suggested that the regime theory applies to the relationship between the erosion channel width and the overflow discharge during the overflow period.

Key words: landslide dam, wood debris, over topping water, erosion, regime theory

流木を伴う天然ダムの越流決壊特性に関する実験的研究

　天然ダムの越流決壊時には急激に越流流量が増加する．また，決壊時に発生する急激な縦侵食と側岸崩壊により高濃度な土砂が流下することが知られている．しかし、天然ダムの湛水域に流木が多量に存在する場合の天然ダムの決壊特性については不明な点が多い．本研究では湛水域に集積した流木が天然ダムの決壊時に及ぼす影響を実験的に検討した．その結果，流木塊が停止するときの状況として，天然ダム下流法面の土砂に流木塊が引っかかる場合と，天然ダム下流法面の土砂が流木塊の下流側に覆い被さるように崩れる場合が確認された．また，流木本数が多いほど越流流量の最大値は低下し，土砂濃度は高くなり，侵食流路の崩壊の起点となる傾向が示された．さらに，越流流量の増水期における侵食流路幅と越流流量の関係は regime 理論が成立することが示唆された．
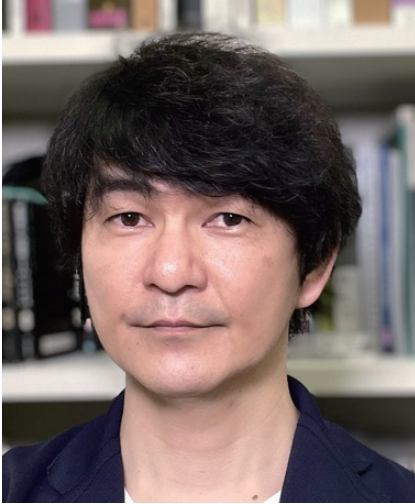
キーワード：天然ダム，流木，越流決壊，侵食，regime 理論

Shinichiro IWATA

Professor, Department of Architecture and Architectural Engineering

Shinichiro Iwata is an architect and a professor at the Department of Architecture and Architectural Engineering, College of Industrial Technology, Nihon University. He received his PhD from Kyoto University in 1993 with the doctoral thesis entitled "The architectural layout method based on the part-whole interactional relationship." His educational background in architecture was obtained at Kyoto University (graduated in 1996 and 1998). He started his research career at Kyoto University in 1999 and joined the College of Industrial Technology, Nihon University in 2004. His research theme is the evaluation methods of architectural space, urban environment, and people's activity using data analysis and information technology, which aims to propose a more comfortable and stress-safe life for people. Dr. Iwata is a member of the Architectural Institute of Japan (AIJ), the City Planning Institute of Japan (CPIJ), and the Architectural Design Association of Nippon (ADAN).

Research Achievements

1) THE SARTING FACTOR ANF CONTINUATION FACTOR OF SMARTPHONE USE WHILE WALKING FROM A STATION'S TICKET GATE -The influences of waiting at a stoplight and presence of other walkers in personal space-, Journal of Architecture and Planning ,AIJ, Vol.87, No.800, 2022

2) INTENTIONS OF SCHOOL MANAGERS AND USERS ABOUT OPENING ELEMENTARY SCHOOL FACILITIES FOR COMMUNITY USE -In the case of public elementary school in Chiba--In the case of public elementary school in Chiba-, Journal of Architecture and Planning ,AIJ, Vol.83, No.752, pp.1957-1967, 2018

3) A STUDY OF AED LAYOUT METHOD IN SHOPPING MALL BASED ON THE CUSTOMERS' SUBCONSCIOUSNESS, The AIJ Journal of Technology and Design, Vol.23, No.54, pp.101-106, 2017

4) THE LAYOUT SIMULATION OF TEMPORARY EVACUATION SHELTERS FROM TSUNAMI IN ISHINOMAKI, The AIJ Journal of Technology and Design, Vol.20, No.54, pp.305-310, 2014

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A STUDY OF AED LAYOUT METHOD IN SHOPPING MALL BASED ON THE CUSTOMERS' SUBCONSCIOUSNESS

Kota JIBIK, Shinichiro IWATA and Sakyo TAMAGAWA

The purpose of this study is to demonstrate the customers' subconsciousness on AED locations ("layout image") and to propose a method reflecting "layout image" to the layout-plan of AEDs in shopping malls. The comparison of the "layout images" and the "present layouts", the locations of AEDs and the functions in existing malls, made clear that the "layout images" of locations of the three functions; plaza, escalators, and toilets, are common. Installing AEDs where the "layout image" is higher is advisable and it is concluded the "layout image" of plaza guides customers to AED locations efficiently from the simulations.

Keywords : AED, Shopping mall, Subconsciousness, Layout planning, GIS

大型商業施設における利用者の潜在意識に基づいた AED の配置検討

　大型商業施設内における AED の配置計画において、「AED が設置されているとイメージする場所」に関する施設利用者の潜在意識 (以下、配置イメージ) の傾向を明らかにし、配置案に反映させる方法を提案している。実在する大型商業施設における AED や諸機能の設置状況を整理した「現状配置」と、代表的な大型商業施設の平面モデルを用いたプロット調査に基づいて導いた「配置イメージ」を比較し、多くの利用者が共通してイメージする 3 つの諸機能の配置傾向を明らかにした。配置イメージが共有されやすい諸機能の配置場所に AED を設置することが望ましいとの考えに基づいて 3 つの諸機能の配置イメージを考慮した配置シミュレーションを実施し、広場の配置イメージを用いることで最も効率的に AED へと誘導する配置案が得られることを示した。

キーワード：AED，大型商業施設，潜在意識，配置計画，GIS

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Kaori Nagai is a professor in the Department of Architecture and Architectural Engineering, College of Industrial Technology, Nihon University. She also serves as vice-president of the Japan Society for Finishings Technology and as a director of several institutions. After graduating from university, she worked as a research engineer at Taisei Corporation, and later began teaching and conducting research at Nihon University where she also organized the Material Design and Construction Strategy Laboratory. She was a guest researcher at the Fraunhofer Institute for Laser Technology (ILT) and RWTH Aachen University in Germany from 2017 to 2018. Her principal research is on the durability of materials, sustainability of historic buildings and skyscrapers, and development using lasers at construction sites. She is expanding her research by interacting not only with Fraunhofer ILT and Aachen University in Germany, but also with such institutions as Lille University in France, the Indian Institute of Technology, and CRISO in Australia.

Research Achievements

1) FUNDAMENTAL STUDY ON SURFACE EROSION OF WOOD FOR EXTERIORS CAUSED BY PHOTODEGRADATION, J. Struct. Constr. Eng., AIJ, Vol. 86, No. 785, 1036-1045, Jul., 2021 DOI https://doi.org/10.3130/aijs.86.1036

2) Using a High-Power Fibre to Cut Concrete, May 2021, Applied Sciences 11(:4414, 1-10, https://doi.org/10.3390/app11104414

3) CONSERVATION WORK ON THE COPPER SHEET ROOF OF OKURA MUSEUM OF ART, AIJ J. Technol. Des. Vol. 26, No.64, 1242-1245, Oct., 2020 DOI https://doi.org/10.3130/aijt.26.1242

4) A STUDY OF THE EFFECT ON THE WETTABILITY OF LASER GENERATED MICROSTRUCTURE OF BUILDING MATERIALS, J. Struct. Constr. Eng., AIJ, Vol. 85, No. 774, 1005-1012, Aug., 2020

5) Drilling of Small Holes in Different Kinds of Concrete, Civil Engineering Journal, Vol.4, No.4, pp.766〜775,2018.4

Laser Cutting

Concrete 200mmdepth
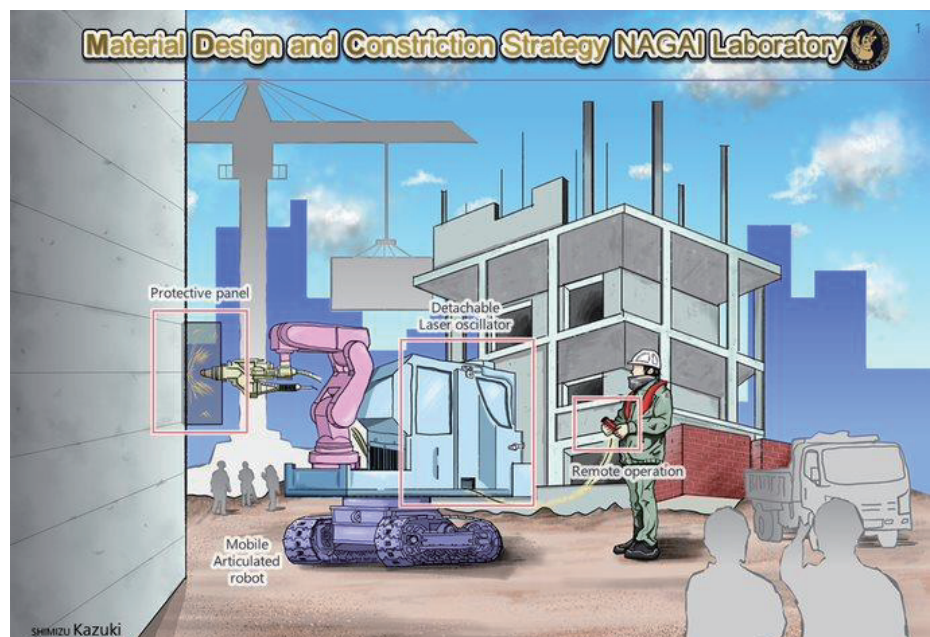
Imagine of concrete cutting robot in construction site

A study of the wettability of laser generated microstructure of building materials

Kaori NAGAI

The required performance of the surface of a building finishing material varies depending on the intended use. In the case of an exterior wall, in addition to "surface protection" and "durability", "aesthetical appearance" is a common demand and is required for interior and exterior materials. Various methods are used to maintain the aesthetics of the exterior wall, however a low-contamination paint is generally used. The low-contamination paint is increasing the water repellence of the surface. This leads to a "self-cleaning effect" of the wall because of the super hydrophobic property of the used special paint. Although the effectiveness of these methods has been confirmed, they also affect the elements of the exterior wall design. This study is performed to examine the effect of laser treatment regarding the water repellence and the aesthetical appearance of different kind of materials used for building exterior. There are three types of substrates: glass, stainless steel, and polycarbonate. With reference in comparison with the surface irregularities of the lotus leaf of the plant, the three levels of groove width 10,20,40 μm and the four levels of depth 5,10,20,40 μm were set as conditions for the investigation. As a result, the metal became water repellent and the glass became hydrophilic, further improving the performance of the substrate. Only polycarbonate had a water contact angle in the range of 80 to 120°, Further, a dirt acceleration test was conducted using a test body provided with a surface structure.

Keywords : Surface micro processing, Building material, Laser, Water-contact-angle, Beauty maintenance

レーザによる微細加工を施した建築材料の表面が
水接触角に及ぼす影響に関する研究

　建築仕上材料の表面に要求される性能は、使用目的によって異なる。外壁の場合、「表面保護」「耐久性」に加えて、「美観性」が内装材料および外装材料には共通して求められる。外壁の美観性を保つためには様々な方法があるが、一般的には低汚染性塗料が使用されている。低汚染性塗料は、表面の撥水性や親水性を高める効果がある。そのため、使用される特殊塗料の性能により、外壁の「セルフクリーニング効果」につながる。これらの手法の有効性は確認されているが、外壁のデザインにも影響を及ぼし定期的な塗替えが必要となる。

　本研究では，建築外装材に使用される各種材料の撥水性および美観に関するレーザ処理の機能性付与の効果を検証することを目的とする。供試体は、ガラス、ステンレス、ポリカーボネートの3種類とした。

　植物の蓮の葉の表面の凹凸を参考に、溝幅 10,20,40 μm の 3 段階、深さ 5,10,20,40 μm の 4 段階を実験条件として設定した。

　その結果、金属は撥水性に、ガラスは親水性になる傾向を示し、供試体としての性能がさらに向上した。また、ポリカーボネートのみ、レーザ照射条件によって水接触角が 80 〜 120°の範囲にあった。さらに、上記の表面構造を形成した試験体を用いて汚れ加速度試験も行い、その効果を確認した。

キーワード：表面微細加工，建築材料，レーザ，水接触角，美観性

Hayato ICHIKAWA
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Hayato Ichikawa is an associate professor at the Department of Applied Molecular Chemistry, College of Industrial Technology Nihon University. He earned his bachelor's and master's degrees in engineering from Iwate University in 1996 and 1998, respectively, and his PhD in science from Hokkaido University in 2001 under the supervision of Professor Keiji Maruoka. After a research period with Professor Duy Hua at Kansas State University, he joined Osaka University of Pharmaceutical Sciences as an assistant professor in 2002. In 2009, he moved to the Nihon University. His main research fields are the development of synthetic methods for heterocyclic compounds and a new synthesis using organoselenium compounds. He is a member of the American Chemical Society (ACS), the Chemical Society of Japan (CSJ), the Pharmaceutical Society of Japan (PSJ), the Society of Synthetic Organic Chemistry, Japan (SSOCJ), and the Kinka Chemical Society (KCS). Dr. Ichikawa received the 2008 Lonza Japan Award and the 2002 Young Presentation Award of the Society of Synthetic Organic Chemistry, Japan.

Research Achievements

1) Claisen Rearrangement of 4-Allyloxy-1-*p*-methoxybenzylpyrazole and Synthesis of Pyrazole-Fused 7-Membered Lactones, *Heterocycles*, 2021, *103*, 980-994.

2) Synthesis of 2-Amino-1,3-benzoselenazole via Metal-Free Cyclization from Isothiocyanate and Bis(*o*-Aminophenyl)diselenide, *Heterocycles*, 2020, *101*, 444-451.

3) Divergent Synthesis of Withasomnines via Synthesis of 4-Hydroxy-1*H*-pyrazoles and Claisen Rearrangement of Their 4-*O*-Allylethers, *Tetrahedron Lett*., 2011, *52*, 4448 - 4451.

4) Facile and Efficient Synthesis of Naturally Occurring Carbasugars (+)-Pericosines A and C, *Org. Lett*., 2009, *11*, 2699 – 2701.

5) Synthesis of Novel Organoselenium as Catalyst for Baeyer-Villiger Oxidation with 30% H_2O_2, *Tetrahedron Lett*. 2005, *46*, 8665 – 8668.
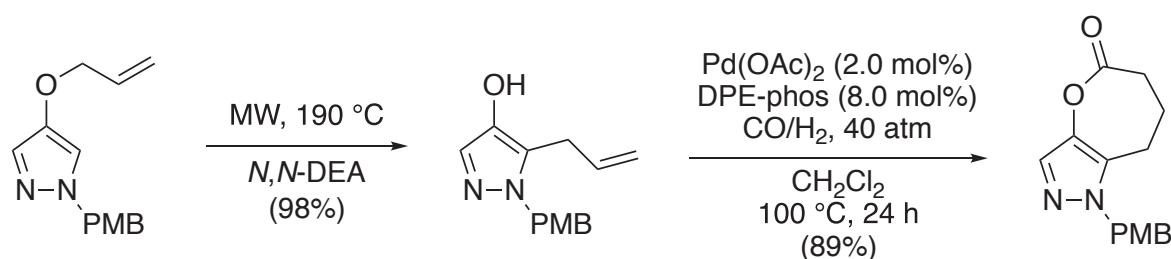

Fig. 1. Regio-selective Claisen rearrangement and ring size-selective hydrolactonization
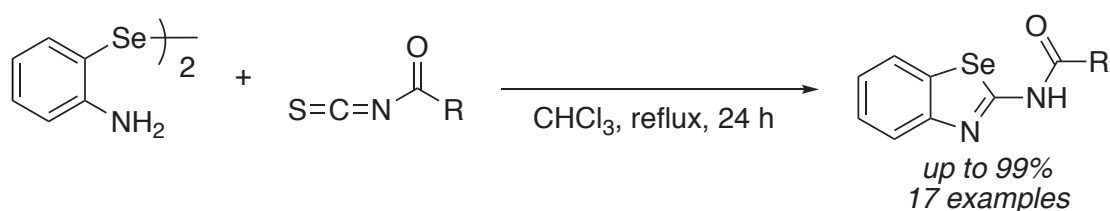

Fig. 2. Metal-free cyclization of bis(*o*-aminophenyl)diselenide and isothiocyanates

Synthesis of 2-Amino-1,3-benzoselenazole via Metal-free Cyclization from Isothiocyanate and Bis(*o*-Aminophenyl)diselenide

Hayato ICHIKAWA, Naoka MIYASHI, Yui ISHIKGAKI and Minako MITSUHASHI

This paper describes the synthesis of 1,3-benzoselenazole without metal catalysts. Benzothiazole is a bioisostere of benzoxazole, both of which are attractive heterocycles in pharmaceuticals, agricultural chemicals, natural products, and materials chemistry. Many heterocycles that contain selenium also exhibit biological activity. Benzoselenazole is an attractive compound; however, there are few reports of its synthesis. In particular, 2-amino-1,3-benzoselenazole has been synthesized with a copper catalyst in every report. We decided to synthesize 2-amino-1,3-benzoselenazole without any metal catalysts. The reaction of bis(*o*-aminophenyl)diselenide and benzoyl isothiocyanate was carried out in chloroform to generate *N*-2-(1,3-benzoselenazole)benzamide in 89% yield. Interestingly, when alkyl carbonyl isothiocyanates, such as methyl, *n*-propyl, or *n*-pentyl, were used as substrates, the corresponding benzoselenazoles were generated in 75%, 87%, and 99% yields, respectively. Bulky substituents would reduce the byproducts generated. To obtain 1,3-benzoselenazole with a free amino group at the 2-position, the acetoamide was treated with dilute sulfuric acid. As a result, the 2-amino-1,3-benzoselenazole was produced in 80% yield.

Keywords : Benzoselenazole, isothiocyanate, metal-free, cyclization

イソチオシアン酸エステルとビス（*o*-アミノフェニル）ジセレニドを用いた 金属を使用しない環化反応による 2-アミノ -1,3- ベンゾセレナゾールの合成

　この論文では金属触媒を使用しない 1,3- ベンゾセレナゾールの合成について報告する。ベンゾチアゾールはベンゾオキサゾールのバイオアイソスターであり，共に医薬品，農薬，天然化合物や材料化学の分野で魅力的な複素環化合物である。セレンを含む多くの複素環化合物も生理活性を示すが，それらは合成例がほとんどない。特に，2- アミノ -1,3- ベンゾセレナゾールの合成はこれまでに 2 例報告されているが，いずれも銅触媒を利用する環化反応により得られていた。そこで我々は，金属触媒を使用しない環化反応により，2- アミノ -1,3- ベンゾセレナゾールを合成することを検討した。ビス（*o*- アミノフェニル）ジセレニドとイソチオシアン酸ベンゾイルをクロロホルム中で反応したところ，*N*-2-（1,3- ベンゾセレナゾール）ベンズアミドが 89％の収率で得られた。興味深いことに，イソチオシアン酸アルキルカルボニルのアルキル基をメチル基，*n*- プロピル基，*n*- ペンチル基に変更して，クロロホルム中還流下で環化反応を行ったところ，それぞれ 75％，87％，99％の収率で対応するベンゾセレナゾールが得られた。これは，嵩高い置換基を用いると副反応が抑制され，副生成物が減少したためであると考えている。2 位に置換基を持たないフリーなアミノ基を持つ 1,3- ベンゾセレナゾールを得るために，アセトアミド体を希硫酸中で加水分解したところ，2- アミノ -1,3- ベンゾセレナゾールが 80% の収率で得られた。

キーワード：ベンゾセレナゾール，イソチオシアン酸エステル，メタルフリー，環化反応

Daisuke TAKAHASHI
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Daisuke Takahashi is an assistant professor at the Department of Applied Molecular Chemistry, College of Industrial Technology, Nihon University. He received his bachelor's and master's degrees in engineering from Nihon University in 1996 and 1998, respectively, and his doctoral degree in engineering from Nihon University in 2012. His main research fields are the physical chemistry of polymer solution and protein engineering. Dr. Takahashi is a member of the Chemical Society of Japan (CSJ), the Society of Polymer Science, Japan (SPSJ), and the Japanese Biochemical Society (JBS). His research interests include the development of an artificial refolding system and dialysis system through the separation of various materials such as urea, surfactants, unfolding proteins, dyes, and heavy metal ions using a molecularly imprinted method.

Research Achievements

1) Pharmaceutical Production of Tableting Granules in an Ultra-Small-Scale High-Shear-Granulator as a Pre-Formulation Study, *Drug Development and Industrial Pharmacy*, 38 (11), 1390-1393 (2012)

2) Immobilization of lysozyme on poly (N-isopropyl acrylamide)/2-hydroxyethyl methacrylate copolymer core–shell gel beads, *Polymer Bulletin*, 68, 1777-1788 (2012)

3) Activities of Lysozyme Complexed with Polysaccharides and Potassium Poly (vinyl alcohol sulfate) with Various Degrees of Esterification, *Polymer Bulletin*, 67, 741-751 (2011)

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5) 熱応答性高分子膜，和泉剛，髙橋大輔，公開特許，公開番号：特開 2002-194116（r-map（公開）登録番号 3557394）

Immobilization of lysozyme on poly (*N*-isopropyl acrylamide)/2-hydroxyethyl methacrylate copolymer core–shell gel beads

Daisuke TAKAHASHI, Takehiko HAMADA, and Tsuyoshi IZUMI

We studied the immobilization of chicken egg-white lysozyme (Lyz) molecules on poly(*N*-isopropyl acrylamide) gel beads containing 2-hydroxyethyl methacrylate (HEMA) (PGBH) as a function of the temperature and HEMA content. The radii of the PGBH and Lyz-immobilizing PGBH, the amount of immobilized Lyz, and the activity of immobilized Lyz depended on both the HEMA content and the temperature. Moreover, the activity of the immobilized Lyz also depended on the molecular size of the substrates, and the Lyz immobilized on PGBH particles with a higher HEMA content showed activity toward low molecular weight substrates at 40°C nearly equal to that of native Lyz, which indicates that no conformational change in the Lyz molecule occurred after immobilization. These results demonstrate that PGBH is a useful material as an enzyme immobilization carrier. Furthermore, nanometer-sized PGBH particles were shown to exhibit thermoresponsive behavior during temperature changes from 25 to 40°C. These results led to our current molecular imprint research, such as the development of a new dialysis system and the development of adsorbents for urea and carbon dioxide.

Keywords: Enzyme immobilization, Poly(*N*-isopropyl acrylamide) gel beads, 2-Hydroxyethyl methacrylate content, Enzymatic activity of immobilized Lysozyme

ポリ（*N*-イソプロピルアクリルアミド）/2-ヒドロキシエチルメタクリレート共重合コアーシェル型ゲルビーズへのリゾチームの固定化

本論文では，ポリ (*N*-イソプロピルアクリルアミド) ／2-ヒドロキシエチルメタクリレート（HEMA）共重合コアーシェル型ゲルビーズ (以下，PGBH) への鶏卵白リゾチーム (Lyz) の固定化に及ぼす HEMA 含有量と温度の影響について報告している。PGBH への Lyz の固定化量，Lyz 固定化 PGBH の粒径および固定化した Lyz の活性が HEMA 含有量や温度に依存することを明らかとした。また，固定化 Lyz の活性が基質の分子サイズにも依存することや，HEMA 含有量の高い PGBH 粒子に固定化された Lyz がネイティブ Lyz とほぼ同等の活性を保持できることから，固定化による Lyz 分子のコンフォメーション変化が少ないことも明らかとした。これらの結果は，PGBH が酵素固定化担体として有用な材料であることを示している。さらに，調製したナノメーターサイズの PGBH 粒子が 25 ～ 40°C において熱応答性挙動を示すことも報告している。これらの成果は，現在分子インプリントポリマーを用いて取り組んでいる尿素や二酸化炭素などの吸着剤の開発や新しい透析システムの開発および研究につながっている。

キーワード：酵素固定化，ポリ（*N*-イソプロピルアクリルアミド）ゲルビーズ，2-ヒドロキシエチルメタクリレート含有量，固定化リゾチームの酵素活性

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Research Achievements

1) Effectiveness of Driver's Workload Reduction by Hands-off Function in Driver Assistance System, Transactions of Society of Automotive Engineers of Japan, Vol.53, No.3, 541-548, 2022 (in Japanese)

2) A Study on Verbal Reward to Enhance Motivation and Its Effect on Change of Visual Behavior in Hazard Prediction Task, Transactions of Society of Automotive Engineers of Japan, Vol.50, No.2, 530-535, 2019 (in Japanese)

3) Evaluation of Muscle Load of Hand and Forearm During Operation of Cross-shaped Switch by Thumb, Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018), Volume X, 322-328, 2018

4) A Study on Layout of Combiner Head-up Display on the basis of Visual Field Characteristics, Human Factors in Japan, Vol.21, No.1, 16-23, 2016 (in Japanese)

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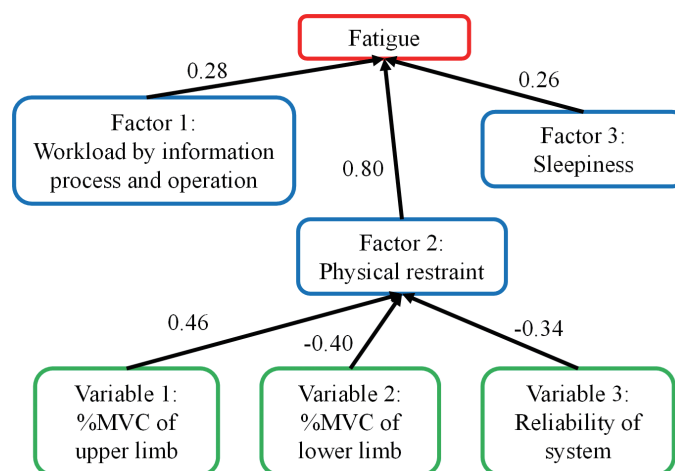
※ Each value means weight of each factor/variable.

Fig.1 Structure of workload factors which lead to fatigue in automated driving Level2 [1]

Effectiveness of Driver's Workload Reduction by Hands-off Function in Driver Assistance System

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In order to reduce driving workload, advanced driver-assistance systems (ADAS) have been developed. In recent years, a "hands-off" function that releases the driver from having to turn the handle has been developed and implemented in automated driving Level 2 vehicles. In this study, the reduction in workload by this hands-off function compared to hands-on was studied by conducting experiments with actual highway driving. The factors of the driver's workload and their structure were clarified. Twenty-eight participants drove for approximately 2 hours on the Tohoku Expressway (round trip). The results showed that subjective fatigue, muscular workload of the upper limb (EMG of the anterior deltoid) and mental workload (LF/HF of heart rate variability spectrum) were lower in the hands-off than hands-on condition. Subjective task loads of "effort," "frustration" and "fatigue" in hands-off were lower than those in hands-on. In addition, the reduction in workload was larger among drivers who used the Active Lane Change Assist function in hands-off. Next, factor analysis with the variables of subjective rating, indices of EMG and index of HRV was conducted. The analysis revealed that the four factors of the driver's workload in Level 2 were: "workload by information process and operation," "physical restraint," "sleepiness," and "unwillingness of driving". From multiple regression analysis, "overall subjective fatigue" as an objective variable was explained by three factors: "workload by information process and operation," "physical restraint" and "sleepiness" ($R^2 = 0.80$, p < 0.01). Furthermore, it was found that "physical restraint" as an objective variable was explained by three explanatory variables: muscular workload of upper limb, muscular workload of lower limb (EMG of the right anterior tibial muscle), and subjective trust in the system ($R^2 = 0.39$, p < 0.01).

Keywords : Human factors and ergonomics, Automated driving, Workload, Physiological measure, Multivariate analysis

運転支援におけるハンズオフ機能による運転負担軽減の有効性評価

　自動車運転の負担軽減をめざして、先進運転支援システムの研究開発が進められている。近年、負担軽減の効果向上に向けて、運転自動化レベル 2 の中でもドライバがハンドル操作から解放される「ハンズオフ」の技術が導入されつつある。本研究では、高速道路での実車走行により、ハンズオンと比べたときのハンズオフの負担軽減の有効性を身体的側面と精神的側面から検討した。次に、レベル 2 での運転負担の構成要因とその構造を明らかにした。実験参加者（N=28）は、ハンズオンとハンズオフの各条件で、東北自動車道で約 2 時間の運転を行った。解析の結果、ハンズオンと比べてハンズオフでは、疲労感、上肢筋負担（三角筋前面の筋電図で指標化）、精神的負担（心拍変動スペクトルの LF/HF で指標化）が軽減された。主観的なタスク負荷の面では、「努力」「不満」「疲れる作業」が低いことが分かった。そして、特にハンズオフ時に車線変更操舵支援機能を使用するドライバで負担軽減効果があることが示された。次に、主観評価、筋電図指標、心拍変動指標を変数とした因子分析を行った。その結果、レベル 2 での運転負担の構成因子として「情報処理・操作の煩わしさ」「身体拘束性」「眠気」「運転への意欲の低さ」を明らかにした。「全体的な疲労感」を目的変数、各因子を説明変数とした重回帰分析から、「全体的な疲労感」は「情報処理・操作の煩わしさ」「身体拘束性」「眠気」の 3 因子で説明されることが分かった（R^2=0.80，p<0.01）。さらに、「身体拘束性」を目的変数とした重回帰分析より、「身体拘束性」が上肢筋負担、下肢筋負担（右脚の前脛骨筋の筋電図で指標化）、システムへの信頼感の 3 変数で説明されることが分かった（R^2=0.39，p<0.01）。以上より、運転自動化レベル 2 におけるハンズオフの負担軽減効果や構造を明らかにし、今後のシステム進化に向けた知見を得た。

キーワード：人間工学，自動運転，運転支援，負担，生体計測，多変量解析

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Research Achievements

1) Development of an AI Prediction System for Corrosion Mechanisms of Non-Metallic Materials, ZAIRYO-TO-KANKYO, 71(5), 143-148, May 2022.

2) A ship navigator's mental workload using salivary NO3 − concentration for simulator-based experiment, Intelligent Automation & Soft Computing, 23(1), 161-166, 2017
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3) A Study on Accident Scenario Identification Method to Application on Risk Assessment, Proc. International Conference on Probabilistic Safety Assessment and Management (PSAM13), a-370, 2016

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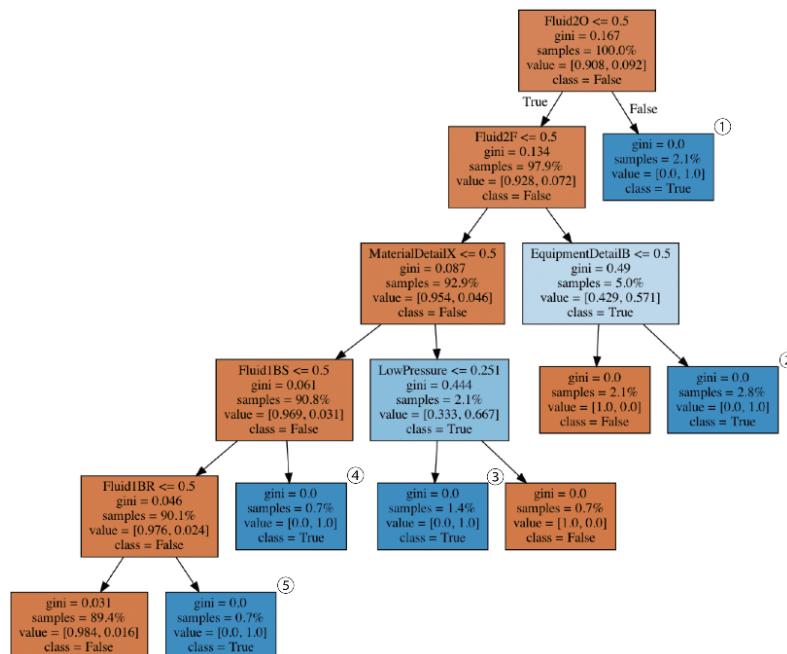

Fig. 1　Example of decision tree analysis

Development of an AI prediction System for Corrosion Mechanism of Non-Metallic Materials

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Many of the chemical plants in Japan are aging and deteriorating, but it is almost impossible to reconstruct them from an economic standpoint. In chemical plants, not only metallic materials but also non-metallic materials are widely used. Metallic materials have been used in many places for a long time, and various data and knowledge, including damage mechanisms, are available; however, non-metallic materials have a shorter history and are used in fewer places. For this reason, the damage mechanisms of non-metallic materials are still unknown compared to those of metallic materials, and there is currently little data and knowledge collected on these materials. Meanwhile, damage to the materials in the equipment in chemical plants is highly likely to lead to safety problems and accidents, resulting in enormous economic losses. Accurate prediction of plant damage is an important issue from the standpoint of preventing accidents caused by material damage, as well as from the standpoint of economic efficiency and effective use of resources. Especially for non-metallic materials, it is necessary to predict material damage with a small amount of data. In addition, the aging of specialists in chemical plant maintenance requires that tacit knowledge and know-how be passed on to the next generation, and there is a strong demand for the visualization of tacit knowledge for non-metallic materials. As a means to solve these problems, we investigated the use of decision tree analysis, one of the machine learning methods.

As mentioned above, data on non-metallic materials is scarce, but we organized the data from reports of non-metallic material damage cases and conducted further data cleansing and analysis. As a result, although there are some problems such as the volume of data and over-learning, we obtained valid results regarding the extraction of damage mechanisms.

Keywords : Non-Metallic Materials, Damage mechanism, AI, Machine Learning, Decision Tree

非金属材料の腐食機構等の AI 予測システムの開発

　我が国では多くの化学プラントにおいて高経年化・老朽化が進んでいるが，経済性の観点等からプラントの建て替えを行うことはほとんどできないのが現状であり，安全なプラントの運転のためには，経済性を考慮した既存設備等の効果的，効率的な維持管理を行うことが求められている．

　化学プラントにおいては金属材料だけではなく，非金属材料も多く用いられている．金属材料は古くから多くの箇所で用いられており，損傷機構を含め様々なデータや知見があるが，非金属材料は，歴史的にも短く，使用箇所についても少ない．そのため，非金属材料の損傷機構等は金属材料に比べ不明な点が多く，収集されたデータや知見は少ないのが現状である．一方，化学プラント内の機器等における材料の損傷は事故に繋がる可能性が高く，安全上の問題に加え経済的損失も膨大になる．

　材料損傷に起因する事故の未然防止のため，また経済性あるいは資源有効利用の観点から，プラントの損傷を精度よく予測することは重要な課題である．特に非金属材料においては，少ないデータで材料の損傷を予測する必要がある．さらに，化学プラントの保全を行う専門家の高齢化等から，専門家の暗黙知やノウハウを次の世代へ伝承することが強く求められており，非金属材料に対する暗黙知の可視化要求は大きい．これらを解決するための手段として，機械学習の手法の一つである決定木分析を用いて検討を行った．

　前述の通り数少ない非金属材料のデータではあるが，非金属材料の損傷事例の報告書等から整理し，さらにデータクレンジングを行い解析を行った．その結果，データ数や過学習の問題等はあるが，損傷機構の抽出等については妥当性のある結果が得られた．

キーワード：非金属材料，損傷機構，人工知能，機械学習，決定木
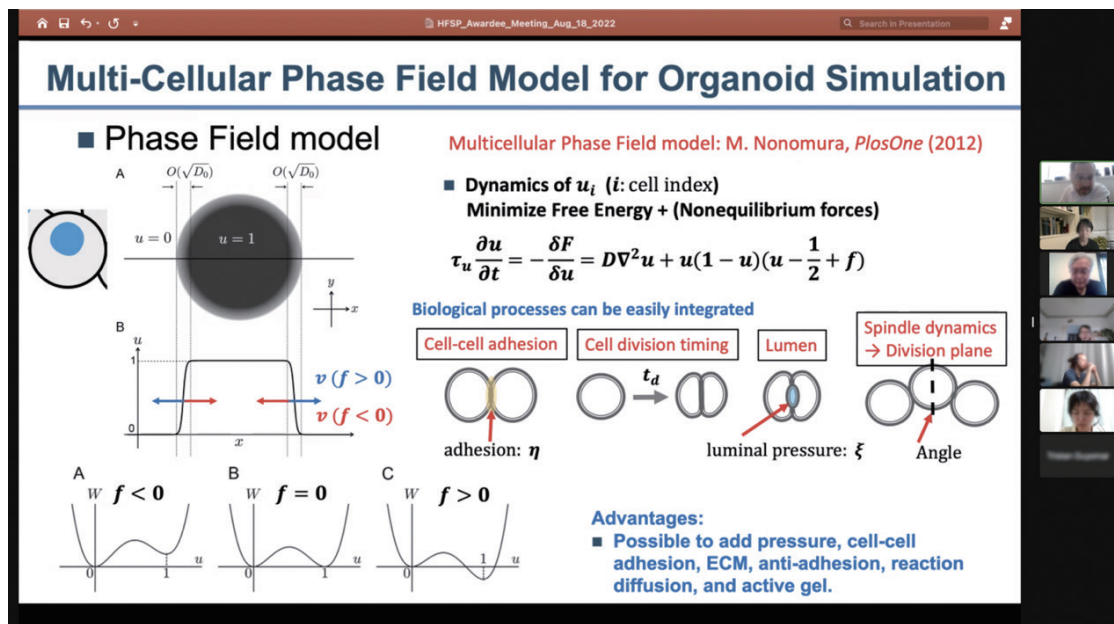
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Makiko Nonomura is a professor at the Department of Mathematical Information Engineering, College of Industrial Technology, Nihon University. After leaving the Physics Department of the Faculty of Science at Ochanomizu University, she completed the master's course of the Graduate School of Humanities and Sciences at Ochanomizu University in 1997 and the doctoral course of the Graduate School of Humanities and Sciences at the same university in 2000. The title of her doctoral thesis was "Dynamics of microemulsion and sponge phases." She started her research career at Hokkaido University as a frontier researcher at RIKEN in 2000. She worked at Hiroshima University from 2001 to 2009, and spent eight months from November 2005 at McGill University in Canada under a JSPS Fellowship. From 2009, she worked as a PRESTO researcher at Chiba University, and in 2011 she moved to Nihon University. Her current main research interest is the mathematical modeling of cells, and she participates in Zoom meetings with HFSP project members regarding organoid formation. Dr. Nonomura is a member of the Physical Society of Japan (JPS), the Japanese Society for Mathematical Biology (JSMB), and the Japan Society of Mechanical Engineers (JSME).

Research Achievements

1) Computational approaches for simulating luminogenesis, Seminars in Cell & Developmental Biology, 131, 173-185 (2022).
2) Numerical study on spindle positioning using phase field method, Physical Biology 16, 016005 (2019).
3) Study on Multicellular Systems Using a Phase Field Model, PLoS One, 7, e33501 (2012).

Regular meetings on Zoom

Computational approaches for simulating luminogenesis

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Lumens, liquid-filled cavities surrounded by polarized tissue cells, are elementary units involved in the morphogenesis of organs. Theoretical modeling and computations, which can integrate various factors involved in biophysics of morphogenesis of cell assembly and lumens, may play significant roles to elucidate the mechanisms in formation of such complex tissue with lumens. However, up to present, it has not been documented well what computational approaches or frameworks can be applied for this purpose and how we can choose the appropriate approach for each problem. In this review, we report some typical lumen morphologies and basic mechanisms for the development of lumens, focusing on three keywords - mechanics, hydraulics and geometry - while outlining pros and cons of the current main computational strategies. We also describe brief guidance of readouts, i.e., what we should measure in experiments to make the comparison with the model's assumptions and predictions. (Note: this abstract is reprinted from the original paper.)

Keywords : Computational approaches, Luminogenesis, Mathematical modeling

内腔形成をシミュレーションするための計算手法

　内腔とは，生体組織などの細胞集団の中に形作られる，細胞外液体で満たされた領域のことである。内腔はもっぱら極性を持った細胞集団に囲まれており，内腔と細胞集団とは協同して機能的に働く。組織の形づくりにおいてもその協同が重要である。こうして内腔は複雑な形の組織を作り出すのに重要な役割を担っており，そのため，生体組織の形成メカニズムを解明するためには，細胞集団だけでなく内腔も含んだ形づくりの過程をまず理解する必要があると考えられている。このプロセスは様々な要因が入り組んだ複雑なものであるため，その理解のためには，諸要因を統合できる数理モデリングとその計算が必要不可欠である。しかし，現状では，どのようなモデリングと計算の手法がそのために利用できるのか，また，各問題に対してどのように適切な手法を選択すればよいのかについて，十分な議論がなされていない。本レビュー論文では，力学，水理学，幾何的拘束の３つのキーワードを軸として典型的な内腔の形態とその形成メカニズムについて概観したのちに，現時点における主な計算手法の長所と短所を整理した。また，モデルの仮定や予測との比較を行うためには実験で何を測定すべきかの簡単な指針についても述べた。

キーワード：計算手法，内腔形成，数理モデリング

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Kouya Tochikubo is a professor in the Department of Mathematical Information Engineering, College of Industrial Technology, Nihon University. He received his BSc degree from Tokyo University of Science, his MSc degree from Japan Advanced Institute of Science and Technology (JAIST) and his DEng degree from Tokyo Institute of Technology in 1996, 1998, and 2004, respectively. He joined the Systems Integration Technology Center, Toshiba Corporation in 1998. He was a visiting professor at the University of Waterloo from 2012 to 2013. His research interests are information theory and information security. Dr. Tochikubo is a member of the Institute of Electronics, Information and Communication Engineers (IEICE) and the Information Processing Society of Japan (IPSJ). He received the SCIS Paper Award and the IEICE Best Paper Award in 2002 and 2005, respectively.

Research Achievements

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Efficient secret sharing schemes realizing general access structures

Kouya TOCHIKUBO

In 1979, Blakley and Shamir independently introduced the concept of secret sharing. The basic idea of secret sharing is that a dealer distributes a piece of information (called a share) about a secret to each participant such that authorized subsets of participants can reconstruct the secret but unauthorized subsets of participants cannot determine the secret. In Shamir's (k, n)-threshold scheme, every k participants can recover the secret K, but no group of less than k participants cannot get any information about the secret. The collection of all authorized subsets is called the access structure. A (k, n)-threshold scheme can only realize particular access structures that contain all subsets of k or more participants. In 1987, Ito, Saito and Nishizeki proposed a secret sharing scheme realizing general access structures, called the multiple assignment secret sharing scheme (MASSS). Their scheme can realize an arbitrary access structure. In the implementation of secret sharing schemes, an important issue is the number of shares distributed to each participant. Obviously, a scheme constructed by small shares is desirable. However, MASSS's are impractical in this respect when the size of the access structure is very large. In this paper, we propose new MASSS's which are perfect secret sharing schemes and include Shamir's (k, n)-threshold schemes as a special case. Furthermore, the proposed schemes are more efficient than the original MASSS from the viewpoint of the number of shares distributed to each participant.

Keywords: (k, n)-threshold scheme, multiple assignment secret sharing scheme, general access structure

効率のよい一般アクセス構造を実現する秘密分散法

　1979 年に Blakley と Shamir はそれぞれ独自に秘密分散方法の概念を発表した。秘密分散方法では，ある秘密情報を複数個の分散情報に分割して情報の管理者に分配する。秘密情報を復元する権限のある管理者のグループは，分散情報を集めることにより秘密情報を復元することができ，また，秘密情報を復元する権限のない管理者のグループでは，秘密情報に関する情報を得ることができないという手法である。秘密情報を復元する権限を持つ管理者のグループの集合をアクセス構造と呼ぶ。(k, n) しきい値法では，アクセス構造は n 人の管理者のうち k 人以上のグループの集合という特別な場合を実現していることになる。1987 年に伊藤，斎藤，西関は複数割り当て法 (MASSS) と呼ばれる一般アクセス構造を実現する秘密分散法を提案した。彼らの手法は任意のアクセス構造を実現することができる。秘密分散方式を実現するとき，各管理者に配布する分散情報の数は重要な課題である。当然ながら，少ない分散情報で構成される手法が望ましい。しかしながら，アクセス構造のサイズが非常に大きい場合，MASSS はこの点で実用的ではない。本論文では，Shamir の (k, n) しきい値法を特別な場合として含む完全な秘密分散法である新しい MASSS を提案する。提案手法は各参加者に配布される分散情報の数の観点から，従来の MASSS よりも効率的である。

キーワード：(k, n) しきい値法，複数割り当て法，一般アクセス構造

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Eiichi Takahashi is a professor at the Department of Sustainable Engineering, College of Industrial Technology, Nihon University. He received his BSc, MSc, and DSc degrees in physics from Tsukuba University in 1989, 1991, and 1994, respectively. From 1994 to 2000, he worked as a researcher at the Electro-Technical Laboratory (ETL) engaged in laser plasma research. From 2001 to 2020, he was a senior researcher at the National Institute for Advanced Industrial Science and Technology (AIST). Since 2020, he has been with the College of Industrial Technology, Nihon University, where he is currently a professor. His research interests include carbon-neutral synthetic E-fuel, plasma-assisted combustion, and other plasma applications, such as the plasma actuator. Dr. Takahashi is a member of the Combustion Society of Japan, the Society of Automotive Engineers of Japan, Inc., and the Japan Society of Plasma Science and Nuclear Fusion Research.

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4) Demonstration of Knock Intensity Mitigation through Dielectric Barrier Discharge Reformation in an RCEM, E. Takahashi, Y. Nagano, T. Kitagawa, M. Nishioka, T. Nakamura, M. Nakano, Combustion and Flame, 216, 185-193 (2020)

5) Flame Propagation Enhancement by Dielectric Barrier Discharge-Generated Intermediate Species, A. Kuramochi, E. Takahashi, D. Asakawa, N. Saito, M. Nishioka, Combustion Science and Technology, 191-11, 1972-1989(2018)
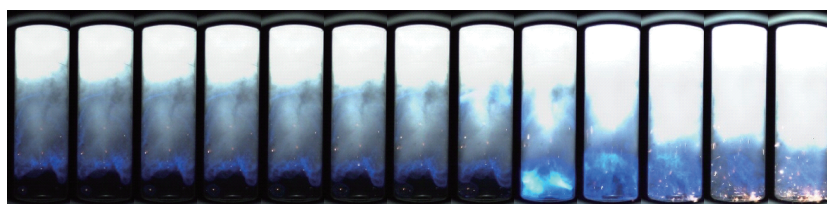
High-speed camera imaging of end gas auto-ignition showing aburupt combustion

DBD plug photo
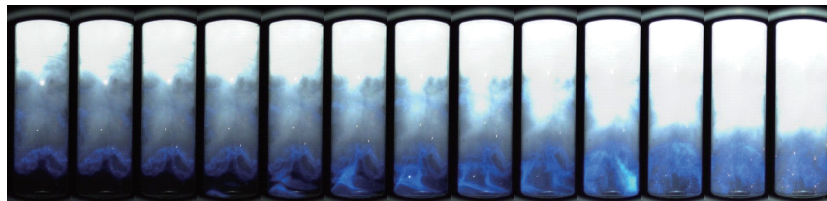
Mitigating of the end gas auto-ignition by DBD application

Demonstration of knock intensity mitigation through dielectric barrier discharge reformation in an RCEM

Eiichi Takahashi, Yukihide Nagano, Toshiaki Kitagawa, Makihito Nishioka, Taizo Nakamura, Michio Nakao

A knock intensity mitigation effect resulting from the application of dielectric barrier discharge (DBD) was experimentally demonstrated. The DBD was utilized to reform fuel–air premixtures. A rapid compression and expansion machine (RCEM) was used for the demonstration experiment. A rectangular combustion channel was installed in the RCEM's cylinder to observe flame propagation and end-gas auto-ignition behavior. The effect of the DBD was investigated by installing a plug-shaped DBD reactor in the combustion chamber. Part of the fuel-air mixture was reformed by the DBD and diffused in the chamber, and the combustion behavior was observed by a color and a monochrome high-speed camera with several different interference filters. In ordinary end-gas auto-ignition, a hot flame rapidly appears throughout the end-gas region, and generates strong pressure oscillation; whereas, in the present study, when the DBD was applied, the magnitude of the pressure oscillation decreased and a blue flame was generated in the end gas before full end-gas auto-ignition. The onset time of the blue flame, and the interval between the onset and the hot flame's appearance, depended on the fuel and initial temperature. The effect was investigated in the case of a primary reference fuel, surrogate gasoline, and n-butane lean mixture; however, though the magnitude of the effect varied, the mitigation effect was demonstrated for every fuel-air mixture. The proposed method is therefore expected to mitigate knocking in internal combustion engines and contribute to greater thermal efficiency.

Keywords : Knocking, Auto-ignition, Dielectric barrier discharge, Blue flame, Non-thermal plasma

誘電体バリア放電の RCEM 筒内ガス改質によるノック強度緩和の実証

誘電体バリア放電 (DBD) によるノック強度緩和効果を実験的に示した。DBD は燃料と空気の予混合気の改質に用いた。本実証実験には急速圧縮膨張装置（Rapid Compression and Expansion Machine: RCEM）を使用した。火炎の伝播とエンドガスの自動着火挙動を観察するために、RCEM 燃焼室に矩形燃焼チャネルを設置した。燃焼室内にプラグ形状の DBD 反応器を設置しその効果を調べた。燃料と空気の混合気の一部を DBD によって改質し，チャンバー内に分布させた．いくつかの異なる干渉フィルターを備えたカラーおよびモノクロの高速度カメラによって燃焼の様子を観察した。ノッキングに相当するエンドガス自着火では、エンドガス領域全体に高温の火炎が急速に現れ、強い圧力振動が発生する。一方、DBD を予め形成することによって圧力振動の大きさが減少し、エンドガス自己着火の前に青色を呈する炎が観測された。青炎の発生時間、および開始から熱炎が現れるまでの間隔は、燃料と初期温度に依存した。PRF、サロゲートガソリン、n- ブタン希薄混合気の場合の影響を調査した。油種に応じて効果の大きさ変化したが、緩和効果はすべての燃料空気予混合気で確認された。従って、本 DBD による手法は内燃機関のノッキングを抑制し、熱効率の向上に寄与することが期待される。
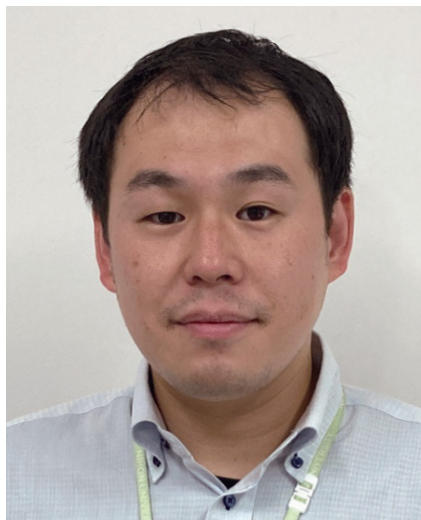
キーワード：ノッキング，自着火，誘電体バリア放電，青炎，非熱プラズマ

Naoki TOYAMA

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Naoki Toyama is an assistant professor at the Department of Sustainable Engineering, College of Industrial Technology, Nihon University. He received his BEng in Materials and Applied Chemistry from Nihon University in 2012, and his PhD from Nihon University in 2017. He worked at the Institute for Materials Research, Tohoku University as a postdoctoral researcher from 2017 to 2019. He worked at the Department of Engineering for Future Innovation, National Institute of Technology, Ichinoseki College as an assistant professor from 2019 to 2021. While working at the Graduate School of Science and Technology, his major research topic was inorganic material chemistry, especially the synthesis of solid acid catalysts for the generation of hydrogen from complex hydrides. After leaving Ichinoseki College in 2021, he moved to Nihon University. Dr. Toyama is a member of the Chemical Society of Japan, the Ceramic Society of Japan, the Catalysis Society of Japan, the Society of Inorganic Materials, Japan, and the Japan Institute of Energy.

Research Achievements

1) Enhanced activity for reduction of 4-nitrophenol of Ni/single-walled carbon nanotube prepared by super-growth method, *Nanotechnology*, 33, 065707(1-6), 2022.

2) Synthesis of mesoporous silica-zirconia composite hollow spheres with enhanced activity toward hydrolysis of ammonia borane, *Microporous and Mesoporous Materials*, 294, 109839(1-6), 2020.

3) Lithium ion conductivity of complex hydrides incorporating multiple *closo* -type complex anions, *Journal of Energy Chemistry*, 38, 84-87, 2019.

4) A complex hydride lithium superionic conductor for high-energy-density all-solid-state lithium metal batteries, *Nature Communications*, 10, 1081(1-9), 2019.

5) Influence of aluminum precursors on structure and acidic properties of hollow silica-alumina composite spheres, and their activity for hydrolytic dehydrogenation of ammonia borane, *International Journal of Hydrogen Energy*, 42, 84-87, 2017.

Synthesis of mesoporous silica-zirconia composite hollow spheres with enhanced activity toward hydrolysis of ammonia borane

Naoki TOYAMA, Natsumi NIKURA, Ikaru ITO, Tetsuo UMEGAKI, Yoshiyuki KOJIMA

In this paper, we report the synthesis of mesoporous silica–zirconia composite hollow spheres and their activity for the hydrolysis of ammonia borane. The mesoporous silica-zirconia composite hollow spheres were synthesized by a sol-gel method using polystyrene particles as the templates. Morphological observation revealed that the obtained mesoporous hollow spheres had a diameter of ~350 nm and a shell thickness of ~25 nm. In addition, we found that the cetyltrimethylammonium bromide concentration affected the formation of uniform mesopores in the silica–zirconia composite shells. Furthermore, our investigation of the hydrolysis of ammonia borane revealed that the presence of the mesoporous hollow spheres promoted the hydrolysis reaction. Because of their larger number of acid sites, the mesoporous hollow spheres exhibited a higher hydrogen generation yield and rate compared to the composite oxide hollow spheres reported in previous studies.

Keywords : Mesoporous hollow spheres, Hydrolysis, Hydrogen evolution, Silica-zirconia composite

アンモニアボランの加水分解に対する活性が向上された
メソポーラス球状中空シリカ - ジルコニアの合成

　本研究では，メソポーラス球状中空シリカ - ジルコニアの合成とそのアンモニアボランの加水分解活性について報告した．メソポーラス球状中空体はポリスチレン粒子をテンプレートとしたゾル - ゲル法で合成した．得られたメソポーラス球状中空体は，形態観察の結果から粒径が〜 350 nm であり，中空壁厚が〜 25 nm であった．さらに，臭化セチルトリメチルアンモニニウム濃度は，シリカ - ジルコニア壁の均一なメソ細孔の形成に影響があることを明らかにした．さらに，このメソポーラス球状中空体を用いてアンモニアボランの加水分解活性を検討した．メソポーラス球状中空体は，完全にこの加水分解反応を進行させることができた．メソポーラス球状中空体は，酸点量が多いため以前の研究で報告された球状中空複合酸化物よりも高い水素発生量および速度を示した．

キーワード：メソポーラス球状中空体，加水分解，水素生成，シリカ - ジルコニア複合体

Yasuyuki UCHIDA

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Yasuyuki Uchida is a professor at the Department of Conceptual Design, College of Industrial Technology, Nihon University. He received his BEng and MEng in mechanical engineering from the Tokyo University of Science in 1991 and 1993, respectively, and his PhD from the Tokyo Institute of Technology in 2000. He worked at the Ministry of Defense from 1993 to 2009. While working at the Acquisition, Technology & Logistics Agency (ATLA), his major research topics were unmanned ground vehicles, mine clearance, facility equipment, and modeling and simulation for the Self-Defense Forces. After retiring in 2009, he moved to Nihon University to expand his knowledge on unmanned vehicles, robotics, mechatronics, and mechanism design for humans. His current research topics are information gathering robots, maintenance robots, welfare equipment, communication design, regional promotion design, and KAWAII design. Dr. Uchida is a member of the RSJ, JSME, JSDE, VRSJ, JSSD, and JSSDR.

Research Achievements

1) A Railway Track Mobile Mechanism for the Information Gathering Robot, JSDE, Vol.54, No.5, 309-322, May 2019.

2) Proposal of Corrugated Cardboard Toilet for Disasters Using PET Bottles-Consideration about Fabrication Method and Structural Strength, JSSD, Vol.66, No.1, 11-18, Jun 2019.

3) A Proposal of Intangible AR Manual for Improvement of Training Effect and Working Efficiency-A Consideration to Apply This System Using HMD and Kinect to the Operation of the Large Printer, JSSD, Vol.63, No.6, 27-36, Mar 2017.

4) Study on Command System using Hand Signals to Control a Mobile Robot, JSDE, Vol.52, No.3, 161-172, Mar 2017.

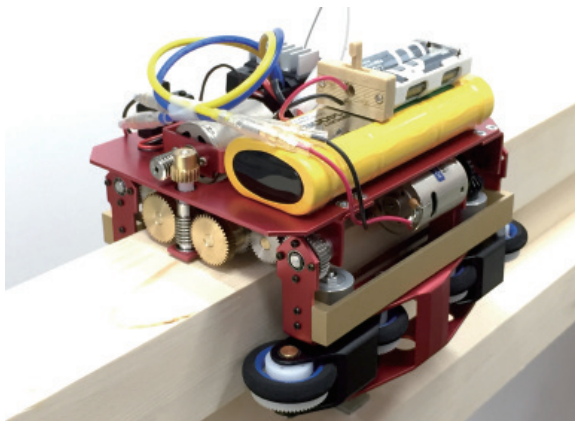5) Machine Design of Information Gathering Robot with Extendable Spiny Wheels, JSSD, Vol.60, No.6, 65-70, Dec 2013.

Fig.1 A Railway Track Mobile Mechanism

Fig.2 Corrugated Cardboard Toilet for Disasters

A Railway Track Mobile Mechanism for the Information Gathering Robot

Yasuyuki UCHIDA, Naoya ISHIDA, Minatsu SUGIMOTO, Tomosato UMEMORI,
Katsutoshi KAMATA, Mitsuki HIRANUMA and Takeshi AOKI

Terrorist attacks on subways are happening all over the world. When terrorism occurs in a subway tunnel, the police and the Self-Defense Forces must confirm the safety, which requires searching the tunnel despite the danger of explosives. Members need robots that can handle such dangerous missions. Therefore, we are developing an information gathering robot with the necessary functions. This robot is small and lightweight so that it can be carried around. In addition, it must be able to move on subway rails, inside stations, and on the ground. In response, we devised a bogie wheel mechanism to move on small steps and curved rails. We also devised an open/close leg mechanism to enable movement on rails and on the ground. In this paper, we first present the design concept of the locomotion mechanism of this robot. Next, we describe the design process and design calculation results for the robot. The structure of the bogie wheel mechanism and the opening/closing leg mechanism are shown, as well as the power transmission state. Furthermore, the system configuration and appearance of the robot that was actually manufactured are also shown. Since it is necessary to grasp the performance of the manufactured robot, we examined the shape of the simulated rail used for the running experiment and manufactured one that simulated the actual rail by connecting multiple rails. We then prepared several types of simulated rails with different curvatures and inclinations, and conducted running experiments with the manufactured robot, confirming that it has the necessary running ability.

Keywords : terrorism, information gathering robot, railway track, bogie wheel mechanism

情報収集ロボットのための鉄道レール走行機構

　地下鉄を対象としたテロは世界各地で起こっている．地下鉄のトンネルでテロが発生したとき，警察や自衛隊はトンネル内の安全を確認する必要がある．安全を確認するためには，爆発物等による危険を承知でトンネル内を偵察しなければならない．隊員らはそのような危険な任務を代行できるロボットを必要としている．そこで，我々は必要な機能を備えた情報収集ロボットを開発している．このロボットは，持ち運びできるように小型で軽量とする．また，地下鉄のレール上，駅構内ならびに地上を移動可能とする．そこで，小さな段差やカーブしたレール上を移動するためにボギー車輪機構を考案した．さらに，レール上と地上を移動可能とするために，開閉脚機構を考案した．本論文では，最初にこのロボットの移動機構に関するデザインコンセプトを述べている．次に，このロボットの設計プロセスと設計計算の結果を述べている．そして，ボギー車輪機構と開閉脚機構の構造を示し，また動力の伝達の様子を示している．さらに，実際に製作したロボットのシステム構成と外観を示している．製作したロボットの性能を把握する必要があるため，走行実験に用いる模擬レールの形状について検討した結果，複数本を連結することで実際のレールを模擬できるものを製作した．そして，異なる曲率と傾斜の模擬レールを複数種類用意して，製作したロボットによる走行実験を行い，必要な走行能力を有していることを確認した．

キーワード：テロリズム，情報収集ロボット，軌道，ボギー機構

Tetsuhito KINOSHITA
Specialized teacher, Department of Conceptual Design, College of Industrial Technology

Tetsuhito Kinoshita is a specialized teacher at the Department of Conceptual Design, College of Industrial Technology.

1995 Admitted to the Department of Crafts, Faculty of Fine Arts, Tokyo University of the Arts

1999 Bachelor of Fine Arts from Tokyo University of the Arts

1999 Admitted to the master's program at the Graduate School of Fine Arts, Tokyo University of the Arts

2001 Master of Fine Arts from the same program

2001 Admitted to the doctoral program at the Graduate School of Fine Arts, Tokyo University of the Arts

2004 Doctor of Fine Arts (No. 126) from the same program

2007 Part-time lecturer at the Department of Sculpture, Faculty of Arts and Crafts, Okinawa Prefectural University of Arts

2008 Education and research assistant at the Metal Hammering Laboratory, Department of Crafts, Faculty of Fine Arts, Tokyo University of the Arts

2011 Part-time lecturer at the Metal Hammering Laboratory, Department of Crafts, Faculty of Fine Arts, Tokyo University of the Arts

2010 Part-time lecturer at the Department of Conceptual Design, College of Industrial Technology, Nihon University

2012 Assistant professor at Nihon University

2020–present Full-time lecturer at Nihon University

Research Achievements

1) A Study on Location Characteristics of Monuments In the Coastal Area of Chiba Prefecture, Japanese Association for Coastal Zone Studies, Vol.32, No.3,pp.41-51,2019

2) Proposal of Corrugated Cardboard Toilet for Disasters using PET bottles, Japanese Society for the Science of Design, Vol.66,No.1,pp.11-18,2019

3) Algorithmic Design and Manufacturing for Creating Metal Object,Institue of Environmental Art and Design, Vol.18,pp.68-73,2017
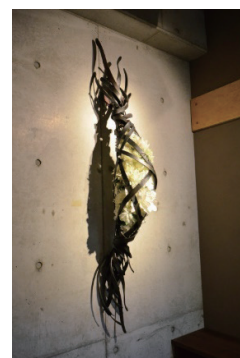
The Work

「GERMINATION44　2010」　　　　「GERMINATION　2007」　　　「AMECYAN for Rom maai」

A Study on Location Characteristics of Monuments
In the Coastal Area of Chiba Prefecture

Tetsuhito KINOSHITA, Kiminori NAKAZAWA, Yuri SUZUKI and Narumi TSUSHIMA

Monuments located in parks and other open spaces as memorials or as part of the landscape provide an important function as street furniture that enhances walkability in parks and other open spaces. Parks and other open spaces located in the coastal area have lower accessibility compared to those in the city, lacking "action elements" due to fewer events being hosted. Therefore, monuments placed in coastal areas have a higher effect as "object elements" and are expected to hold some connection to the place or the location.

   This study examined 69 monuments located in parks and other open spaces in coastal Chiba, investigated the characteristics of their design and location, and analyzed their relationships. The results revealed that semi-figurative and abstract motifs were often found in the Keiyo industrial area where population density is higher, and monuments reflecting culture were the majority in other areas. Hilly areas tend to house monuments that utilize the ocean view or another special characteristic of a park by the coast.

Keywords: Monument, Street furniture, Location characteristics, Parks and open spaces

千葉県沿岸域におけるモニュメントの立地特性に関する研究

　公園緑地等に設置されるモニュメントは，記念碑及び修景を目的として，公園緑地等のウォーカビリティを高めるストリートファニチュアとして重要な機能を果たしている。特に臨海部に立地する公園緑地等は，都心部に立地するものに比べてアクセスビリティが弱く，イベント開催等の「コト要素」に欠けるため，「モノ要素」としてのモニュメント設置の効果が高く，場や立地との結びつきが求められる。そこで本研究は，千葉県沿岸域に立地する公園緑地等に設置されている 69 基のモニュメントのデザイン特性及び立地特性を調査し，その関係性を分析した。その結果，人口集中地区を後背にする京葉工業地域に半具象形式と抽象形式のモチーフが多く，他の地域では文化を反映した碑等のモチーフが大半を占めた。また丘陵地域は海の眺望や沿岸域の公園の特性をうまく生かしたモニュメントが多く設置されていた。

キーワード：モニュメント，ストリートファニチュア，立地特性，公園緑地

Yuichiro KITAJIMA

Professor, Department of Liberal Arts and Basic Sciences

Yuichiro Kitajima is a professor at the Department of Liberal Arts and Basic Sciences, College of Industrial Technology, Nihon University. He received his B.A. in Nuclear Engineering from Kyoto University in 1997, his M.S. in Nuclear Engineering from Kyoto University in 2001, and his Ph.D. from Hokkaido University in 2005. He studied at the Graduate School of Letters, Kyoto University from 2007 to 2010 under a Research Fellowship for Young Scientists, and at the Department of Philosophy, Princeton University in 2008 as a visiting postdoctoral research associate. He has been studying reality and locality in quantum theory focusing on the argument related to reality and locality in quantum mechanics by Einstein-Podolsky-Rosen. They concluded that quantum mechanics is incomplete on the assumption that the measurement of one particle does not affect the element of reality of another particle that is spatially distant from that particle. Bohr, on the other hand, disagreed with the assumption and concluded that quantum mechanics is complete. In other words, the difference between Einstein-Podolsky-Rosen's and Bohr's views on the completeness of quantum mechanics stems from whether the measurement of one particle affects the element of reality of another particle that is spatially distant from that particle. Dr. Kitajima attempted to clarify the objection by Bohr and examined what Bohr's element of reality would be under the conditions that Bohr seems to assume implicitly. With regard to locality in quantum theory, he also noted the Einstein-Podolsky-Rosen argument. The states they used in their discussion are called EPR states, which have properties that do not appear in the classical world. One such property is called Bell's inequality violation, and it is known that Bell's inequality cannot be violated in the classical world, but it can be violated in the quantum world. However, the logical relationship between the Einstein-Podolsky-Rosen argument and Bell inequality violation was not clear. Dr. Kitajima showed that Bell's inequalities are always violated in states where the Einstein-Podolsky-Rosen argument holds. Dr. Kitajima has also studied the contextuality in quantum theory, which concerns reality. In the classical world, measurement results are independent of the context of the measurement. For example, when measuring the length of a pencil, the measurement result is the same whether the pencil's color or hardness is measured at the same time. In contrast, in quantum theory, the measurement result can be different depending on the context of the measurement. Dr. Kitajima studied an inequality called the KCBS inequality, which is related to contextuality in quantum theory.

Research Achievements

1) Negations and Meets in Topos Quantum Theory, Foundations of Physics, Vol. 52, No. 1, Article number: 12, Dec 2021.

2) A State-Dependent Noncontextuality Inequality in Algebraic Quantum Theory, Physics Letters A, Vol. 381, No. 29,2305-2312, May 2017.

3) Characterizing Common Cause Closedness of Quantum Probability Theories, Studies in History and Philosophy of Modern Physics, Vol. 52, 234-241, Nov 2015.

4) EPR states and Bell Correlated States in Algebraic Quantum Field Theory, Foundations of Physics, Vol. 43, No. 10, 1182-1192, Oct 2013

5) Reconstructing Bohr's reply to EPR in Algebraic Quantum Theory, Foundations of Physics, Vol. 42, No. 4, 475-487, Feb 2012.

Negations and Meets in Topos Quantum Theory

Yuichiro Kitajima

Unlike classical logic, it is known that the distributive law does not hold in quantum logic. Using the example of the famous quantum hotel, ordering "eggs and (bacon or sausage)" does not necessarily mean "(eggs and bacon) or (eggs and sausage)." If one thinks this is a problem, then it would be difficult to accept quantum logic as logic. In contrast, in intuitionistic logic, the distributive law holds as in classical logic. In this sense, intuitionistic logic is a logic that is easy for humans to accept. Recently, Döring, Isham, and others attempted to reconsider quantum theory from the viewpoint of the topos theory. Based on this attempt, quantum logic can be translated into intuitionistic logic by a mapping called daseinisation, so that quantum theory can be viewed as intuitionistic logic rather than quantum logic. It has been shown that this intuitionistic logic always contains an element corresponding to the element of the original quantum logic, but it may also contain new elements that do not correspond to the element of the original quantum logic. In this study, we investigated the conditions under which a new element that does not correspond to the element of the original quantum logic is included. As a result, it was found that a new element appears not only in quantum logic but also in classical logic by daseinisation.

Keywords : Quantum Logic, Intuitionistic Logic, Topos Quantum Theory

トポス量子論における否定と選言

　古典論理とは異なり、量子論理では分配則が成り立たないことが知られている。有名な量子ホテルという例をもちいると、「卵かつ（ベーコンまたはソーセージ）」と注文しても、これは「（卵かつベーコン）または（卵かつソーセージ）」ということを意味しているとは限らないことになる。このことが問題であると考えるならば、量子論理を論理として受け入れることは難しいだろう。それに対して、直観主義論理では、分配則は古典論理と同様に成立する。この意味で、直観主義論理は人間にとって受け入れやすい論理といえる。

近年、デーリングとアイシャムなどによってトポス理論の観点から量子論を捉え直す試みがなされている。この試みに基づけば、現存在化とよばれる写像によって量子論理は直観主義論理へ翻訳されるので、量子論を量子論理ではなく直観主義論理として捉えることができる。この直観主義論理はもとの量子論理の元に対応する元を必ず含むことが示されているが、もとの量子論理の元に対応しないような新たな元を含むこともある。

　本論文では、もとの量子論理の元に対応しない新たな元が含まれる条件を調べた。その結果、量子論理のみならず古典論理においても現存在化によって、新たな元が現れることがわかった。

キーワード：量子論理，直観主義論理，トポス量子論

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Shoji Mikado is an associate professor at the College of Industrial Technology, Nihon University. His primary research is on elementary particle physics mainly in the high energy physics region. In recent years, he has focused specifically on the neutrino experimental field. He received his BSc, MSc, and DSc from Toho University in 1987, 1989, and 1992, respectively. His career started under a postdoctoral fellowship at the University of Wisconsin–Madison in the U.S. from 1992 to 1995 where he worked on the Fermilab-E791 charm particle production experiment and engaged in data tape production as the manager of the experiment. In 1995, he joined NEC Corporation and worked in the planning and development department of personal computers. Since 2007, he has been working at Nihon University. His experience in high energy physics was obtained through the CERN-WA75, Fermilab-E653, Fermilab-E791, KEK-E176, OPERA, and J-PARC NINJA experiments. Three years of experience in the U.S. and seven years at NEC Corporation had a great impact on his life. Dr. Mikado is a member of the Physical Society of Japan (JPS) and the Japan Association of High Energy Physicists (JAHEP).

Prizes: The 7th Outstanding Paper Award of the Physical Society of Japan (2002), Highlights of 2011 New Journal of Physics, Highlights of 2012 New Journal of Physics, and the 21st Outstanding Paper Award of the Physical Society of Japan (2016).

Research Achievements

1) Measurements of protons and charged pions emitted from $\nu\mu$ charged-current interactions on iron at a mean neutrino energy of 1.49 GeV using a nuclear emulsion detector, Phys. Rev. D **106**, 032016, Aug. 2022.

2) The SHiP experiment at the proposed CERN SPS Beam Dump Facility, Eur. Phys. J. C **82**, 486, May 2022.

3) Observation of tau neutrino appearance in the CNGS beam with the OPERA experiment, PTEP (**10**, 101C01, Oct. 2014.

4) Application of Neutron Capture Autoradiography to Boron Delivery Seeking Techniques for Selective Accumulation of Boron Compounds to Tumor with Intra-arterial Administration of Boron Entrapped Water-in-oil-in-water Emulsion, Nuclear Inst. and Methods A, **605** 1–2, 171, June 2009.

5) Measurements of lifetimes and a limit on the lifetime difference in the neutral D meson system, Phys. Rev. Lett. **83**, 32-36, July 1999.

Discovery of tau neutrino appearance in the CNGS neutrino beam with the OPERA experiment

OPERA Collaboration (N. Agafonova, S. Mikado, et.al.)

This paper describes discovery of tau-neutrino appearance in a muon-neutrino beam. The OPERA experiment detected five cases of muon neutrinos transforming into tau neutrinos during a 730 km flight from the CNGS beamline at CERN in Geneva, Switzerland to the Gran Sasso laboratory in Italy, providing conclusive evidence of the neutrino oscillation on appearance mode. Three types of neutrinos are known to exist in nature: electron, muon, and tau neutrinos. Each neutrino produces an electron, muon, or tau charged particle corresponding to its name, when it interacts with matter. Neutrino oscillation is a phenomenon in which neutrinos of a particular flavor (either electron, muon, or tau type) are periodically converted to another type of neutrino with time. The 2015 Nobel Prize in Physics was awarded to neutrino oscillation from natural sources, and this study was referred in the "Scientific Background on the Nobel Prize in Physics 2015". The OPERA detector is able to identify all three types of charged particles produced and to detect the reactions. The laboratory is located underground then backgrounds from cosmic rays were small. The detector was exposed muon-neutrino beams from 2008 to 2012, and a total exposure corresponding to 17.97×10^{19} protons on target resulted in 19505 neutrino interactions in the target fiducial volume. To sort out tau-neutrino interaction candidates from many muon-neutrino background events through tau leptons that have only a short flight length, for this purpose, the nuclear emulsion film technique was employed, which can measure even short flight length with high positional accuracy. A fifth $\nu\tau$ candidate event found in an enlarged data sample is described in this paper. This result established for the first time the oscillation phenomenon in appearance mode from muon neutrino to tau neutrino with a statistical confidence level of 5 sigma.

Keywords : neutrino oscillations, appearance mode, nuclear emulsion films

OPERA 実験によるタウニュートリノ出現事象の発見

　本論文は，ミューニュートリノビームにおけるタウニュートリノの出現事象の発見について述べたものである。OPERA 実験は，スイスからイタリアまでの 730km の飛行中にミューニュートリノがタウニュートリノに変化する 5 例の事象を検出し，ニュートリノ振動現象により明示的にタウニュートリノが出現する決定的な証拠をとらえた。自然界には，電子ニュートリノ，ミューニュートリノ，タウニュートリノの 3 種類のニュートリノが存在することが知られてる。そして，それぞれのニュートリノは物質と反応したときに，その名前に対応する電子，ミューオン，タウの荷電粒子を生成する。ニュートリノ振動は，特定のフレーバー（電子型，ミュー型，タウ型のいずれか）のニュートリノが，時間とともに周期的に別のタイプのニュートリノに変換される現象である。2015 年のノーベル物理学賞は自然界からのニュートリノ振動に授与されたが，本研究はその「2015 年ノーベル物理学賞の科学的背景」においても言及された。OPERA 検出器は，生成された 3 種類の荷電粒子をすべて識別しその反応を検出することが可能である。2008 年から 2012 年にかけて上記ミューニュートリノビームを検出器に照射したが，その総照射量は標的において 17.97×10^{19} 個の陽子に相当し，19505 個のニュートリノ反応が蓄積されたことになる。反応検出には，大量のミューニュートリノバックグラウンド事象から飛跡の短いタウレプトンを介しタウニュートリノ反応候補を選別する必要がある。本実験では短い飛跡であっても高い位置精度で測定できる原子核乾板技術を採用した。本論文では，拡大されたデータサンプルで見つかった 5 番目のタウニュートリノ反応を報告し，この結果は，ミューニュートリノからタウニュートリノへの出現モードでの振動現象を，統計的信頼度 5 シグマで初めて立証したものである。

キーワード：ニュートリノ振動，アピアランスモード，原子核乾板