Research Division of Materials Joining Process, Dep. of Energy Control of Processing

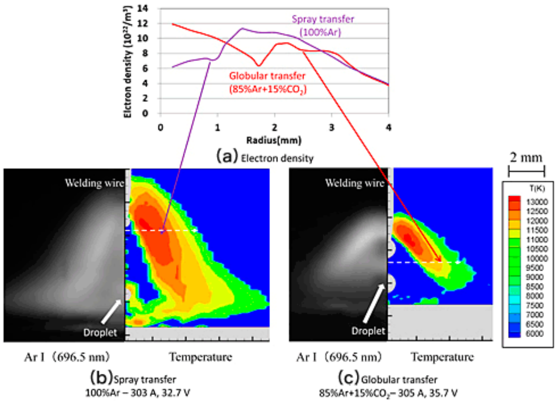
Research summary

The main research subject is the development of the high density energy source for processing advanced materials having special functions and properties. We undertake fundamental investigations of the properties of the high energy source interacting with materials, and we study advanced control techniques for optimizing the energy transport.

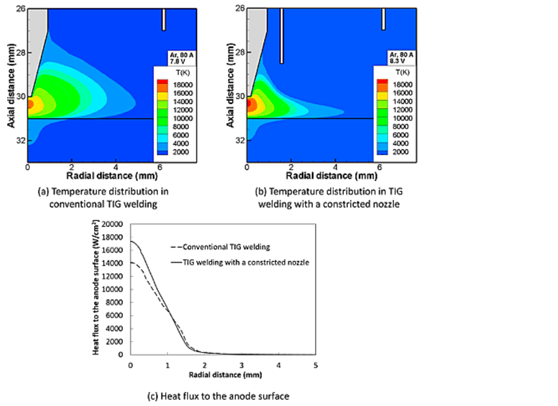
Major emphasis is placed on the generation, control and energy transport in arc plasmas, which are a high density energy source which have been applied to a variety of materials processing techniques such as welding, cutting, heating, high temperature processing, surface modification and the creation of powders.

Research subjects

(1) Generation and control of thermal plasmas, and their application to welding and joining processes
(2) Arc physics, molten pool behavior, and transport theory in fusion welding
(3) Development of new arc electrodes based on the analysis of electrode-plasma interaction
(4) Development of advanced high quality clean welding processes
(5) Development of new generation welding and joining processes employing atmospheric pressure plasma
(6) Control of arc discharge in lighting and electrical devices



Optical measurement of electron density and plasma temperature during spray transfer and globular transfer in gas metal arc welding process ((a) Electron density, (b) Spray transfer, (c) Globular transfer). An addition of CO_2 into shielding gas causes constriction of arc current toward the arc axis, which leads to globular transfer due to increase in arc pressure.



Numerical simulation on effects of constricted nozzle on arc phenomena in TIG welding process ((a) Temperature distribution in conventional TIG welding, (b) Temperature distribution in TIG welding with a constricted nozzle, (c) Heat flux to the anode surface). In TIG welding with a constricted nozzle, arc temperature increases due to constriction of arc. Consequently, larger heat flux to the anode surface is obtained compared with that of conventional TIG welding.

Major Papers

K. Tanaka, M. Shigeta, M. Tanaka and A. B. Murphy, "Investigation of Transient Metal Vapour Transport Processes in Helium Arc Welding by Imaging Spectroscopy", J. Phys. D-Appl. Phys., 53, 42 (2020), 425202 (8pp). doi

D. Wu, S. Tashiro. Z. Wu, K. Nomura, X. Hua, M. Tanaka, "Interactive Phenomena in Hybrid KPAW-GMAW ", Weld. J., 99 (2020), 146-s-155-s. doi

S. Maenaka, S. Tashiro, A. B. Murphy, K. Fujita and M. Tanaka, "Investigation of the Influence of Buoyancy on Gas Convection of a Horizontal Xenon Short Arc Lamp through 3D Numerical Simulation", J. Phys. D-Appl. Phys., 53 (2020), 85205(17pp). doi

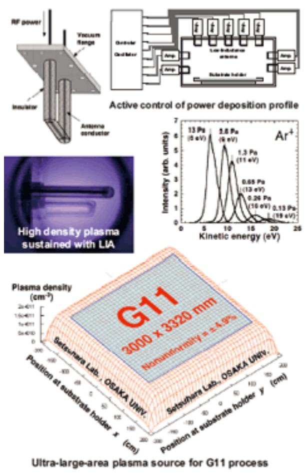
S. Tashiro, N. Mukai, Y. Inoue, A. B. Murphy, T. Suga and M. Tanaka, " Numerical Simulation of the Behavior of Hydrogen Source in a Novel Welding Process to Reduce Diffusible Hydrogen ", Materials, 13 (2020), 1619 (18pp). doi

Research summary

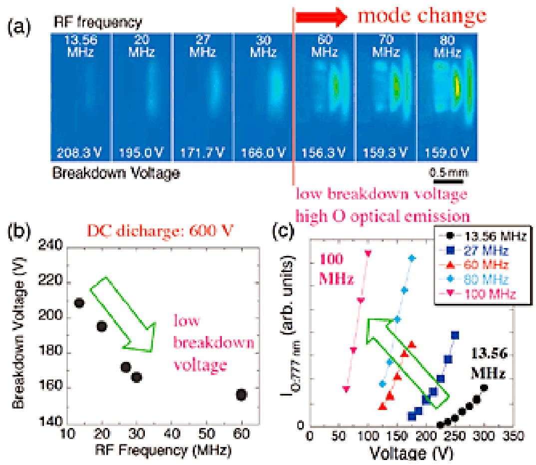
Our research activities encompass works on development of process control technologies of surface and interface for advancement of materials joining science and processing technologies through creation of novel process-energy sources (plasmas and particle beams), and span the range of applications from to functionalization of materials to their process control. These research activities are based on fundamental studies on energy transfer dynamics involved in a variety of materials processing with process-energy sources.

Research subjects

(1) Development of novel plasma sources and particle beams for advanced process technologies (CVD, PVD)
(2) Development of novel large-area, low-damage and high-density plasma sources for advanced process control of functional materials
(3) Development of novel large-area, low-damage and high-density plasma sources for advanced process control of functional materials
(4) Creation of softmaterial processing science for development of advanced green nanotechnologies with inorganic/organic flexible hybrid structures
(5) Studies on temporal and spatial control of discharge for development of innovative plasma sources for plasma medicine



Low-damage and ultra-large-area plasma source with multiple low inductance antenna modules



Development of innovative plasma source for plasma medicine
(a) ICCD images of atmospheric RF plasmas
(b) Frequency dependence of discharge breakdown voltage
(c) Frequency dependence of O optical emission intensity

Major Papers

T. Kawasaki, K. Nishida, G. Uchida, F. Mitsugi, K. Takenaka, K. Koga, Y. Setsuhara and M. Shiratani, “Effects of Surrounding Gas on Plasma-Induced Downward Liquid Flow”, Jpn. J. Appl. Phys., 59 (2020), SHHF02/1-SHHF02/6. doi

K. Takenaka and Y. Setsuhara, “Formation of Functional Oxide Thin Films Using Plasma-Assisted Reactive Process”, J. Jpn. Weld. Soc., 89, 7 (2020), 472-475. doi

G. Uchida, J. Ikeda, K. Takenaka and Y. Setsuhara, “Visualization Study on Interaction Between Nonequilibrium Atmospheric Pressure He Plasma Jet and Liquid Solution”, J. Smart Process., 9, 3 (2020), 90-96.

K. Takenaka, Y. Setsuhara, G. Uchida and A. Ebe, “Paradigms Explored with Non-Equilibrium Plasmas -From Thin Film Transistor Formation to Medical Treatment and Joining of Dissimilar Materials-”, Manuf. Technol., 72, 4 (2020), 15-19.

K. Inoue, S. Takahashi, N. Sakakibara, S. Toko, T. Ito and K. Terashima, “Spatiotemporal Optical Emission Spectroscopy to Estimate Electron Density and Temperature of Plasmas in Solution”, J. Phys. D: Appl. Phys., 53, 23 (2020) 235202. doi

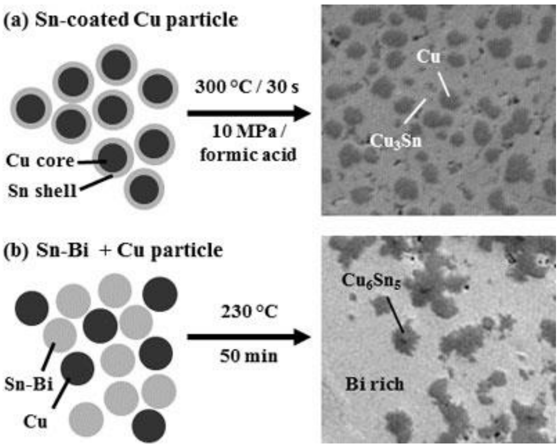
Research Division of Materials Joining Process, Dep. of Manufacturing Process

Research summary

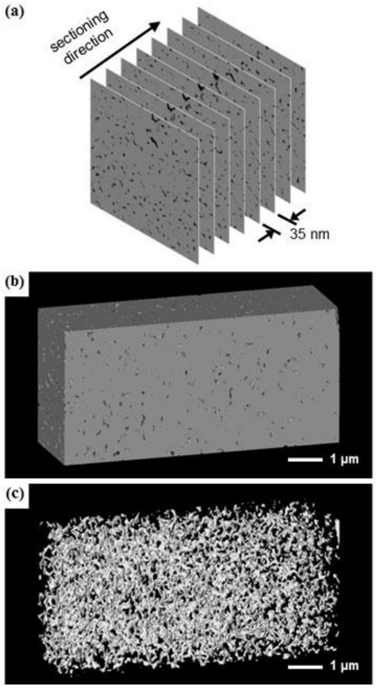
The main research objectives are to analyze the mechanisms of material process including joining by various energy sources, and to develop advanced processes with high efficiency and high productivity. Especially, for a micro joining process in electronics packaging, the creation of the functional joint materials, the development of novel advanced micro processes by various energy sources, and the enhancement of the highly reliable joints based on the control of interfacial structure and performance are performed to produce micro joints with superb functionality and high reliability. In addition, we are resolving the joining problems of newly-developed materials. And we are aiming to develop new appropriate material processes for these materials.

Research subjects

(1) Development and evaluation of advanced micro joining process
(2) Elucidation of micro joining phenomena and defect suppression
(3) Control and analysis of microstructure at soldered interface
(4) Development of eco-friendly fluxless soldering process using a reducing atmosphere
(5) Formation of high heat-resistance joint using three-dimensional nanostructure



Micro joining process using a transient liquid phase bonding (TLPB) method
(a)TLPB process and microstructure of joint using Sn-coated Cu particles
(b)TLPB process and microstructure of joint using Sn-Bi solder particles + Cu particles



Microstructure of sintered joint using Ag nanoparticle paste
(a)Serial sectioning of Ag sintered layer by FIB/SEM system
(b)Reconstructed 3D image of Ag sintered layer
(c)Reconstructed 3D pore distribution into Ag sintered layer

Major Papers

S. He, R. Gao, J. Li, Y.-A. Shen and H. Nishikawa, “In-situ Observation of Fluxless Soldering of Sn-3.0Ag-0.5Cu/Cu under a Formic Acid Atmosphere”, Mater. Chem. Phys., 239 (2020), 122309. doi

S. Koga, H. Nishikawa, M. Saito and J. Mizuno, “Fabrication of Nanoporous Cu Sheet and Application to Bonding for High-Temperature Applications”, J. Electronic Mater., 49, 3 (2020), 2151-2158. doi

D. L. Han, Y.-A. Shen, S. Jin and H. Nishikawa, “Microstructure and Mechanical Properties of the In-48Sn-xAg Low-Temperature Alloy”, J. Mater. Sci., 55 (2020), 10824-10832. doi

O. Mokhtari and H. Nishikawa, “Effect of Surface Potential Distribution on Corrosion Behavior of Cu/Al Interface in Cu Wire Bonding Applications”, Microelectronics Reliability, 113 (2020), 113942. doi

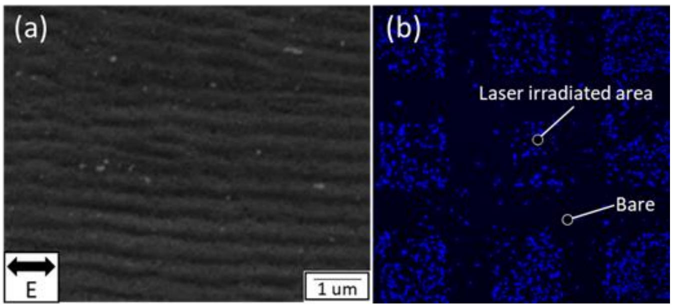
Research Division of Materials Joining Process, Dep. of Laser Materials Processing

Research summary

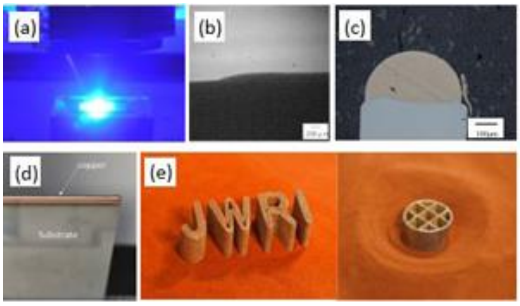
Fundamental studies are performed concerning welding, joining, cutting, surface modification and removal processing with laser beams, aimed at advanced fusion between laser science and production engineering. We focus on clarification of welding or joining mechanisms on the basis of the visualization of material processing phenomena with high-speed optical observation or X-ray transmission imaging techniques. Moreover, laser should be utilized with not only high thermal efficiency but also physicochemical effects induced by interaction between light and material. Thus we create innovative processes including laser direct joining of metal and plastic, put these processes to practical use and disseminate achievements of our research to the world.

Research subjects

(1) Development and evaluation of joining and welding processes for the advanced functional materials
(2) Development of additive manufacturing technologies with blue diode laser
(3) Creation of new function by surface modification with laser
(4) Fundamental studies on laser interaction with materials and fundamental studies of materials processing utilizing laser



PMMA film surface after femtosecond laser irradiation.
(a) SEM image with periodic nanostructures oriented to the direction perpendicular to the laser polarization vector (The period of the periodic nanostructure is about 230nm) on PMMA film surface.
(b) Fluorescence microscope image of cell cultivation test. Cells adhered to the periodic nanostructures surface rather than bare surface.



Copper cladding using blue diode laser (a)Blue diode laser (b) X ray observation of laser coating with blue laser (c) Cross section image (d) Surface image of pure copper coating layer (e) 3D object of pure copper by Blue diode laser

Major Papers

Y. Sato, S. Srisawadi, D. Tanprayoon, T. Suga, T. Ohkubo and M. Tsukamoto, “Spatter Behavior for 316L Stainless Steel Fabricated by Selective Laser Melting in a Vacuum”, Opt. Lasers Eng., 134 (2020), 106209. *doi*

D. Tanprayoona, S. Srisawadi, Y. Sato, M. Tsukamoto and T. Suga,"Microstructure and Hardness Response of Novel 316L Stainless Steel Composite with TiN Addition Fabricated by SLM”, Opt. Laser Technol., 129 (2020), 106238. *doi*

K. Ono, Y. Sato, R. Higashino, Y. Funada, N. Abe and M. Tsukamoto,"Pure Copper Rod Formation by Multibeam Laser Metal Deposition Method with Blue Diode Lasers”, J. Laser Appl., 33, 1 (2020), 012013. *doi*

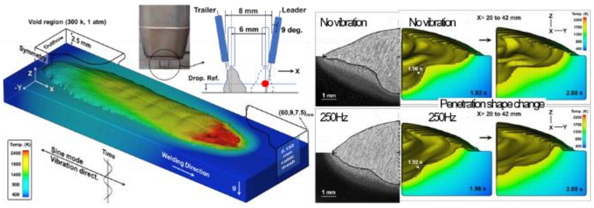
Research Division of Materials Joining Mechanism, Dep. of Welding Mechanism

Research summary

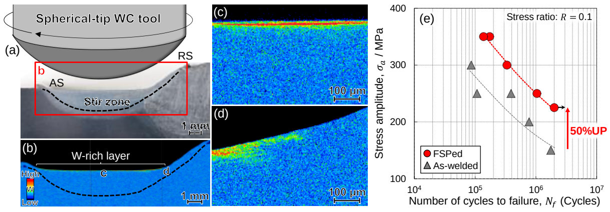
Mechanisms controlling the joint performance of structural and functional materials, which obtained by fusion welding, liquid-state/solid-state bonding, and solid-state bonding, are metallographically characterized to establish a scientific basis to produce joint materials featuring superior performance. The microstructures of the weld-deposited metal, the heat-affected zone of fusion-welded joints, and the interfacial region of solid-state bounded joint are thoroughly investigated utilizing various methods such as X-ray diffraction, electron-microscopy observation, elementary analysis, EBSP analysis, and numerical modeling and simulation. Formation processes of the microstructures and their relation to joint performance are discussed from the material scientific viewpoint.

Research subjects

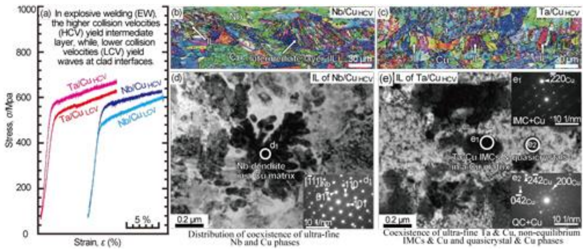
(1) Weld microstructure analyses of structural material such as steel
(2) Bonding mechanism of solid-state joining of metals and ceramics, and its application to microstructural control
(3) Application of welding and joining phenomena to development of advanced materials
(4) Synthesis of new functional materials at welding and joining interface
(5) Evaluation of the effect of microstructure on mechanical behavior of structural materials joints



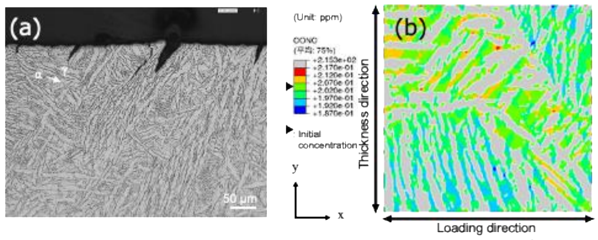
Welding-time variation of penetration shape change in the simulated vibration assisted tandem-pulsed GMAW using the Flow-3D commercial software in the presence of sine-vibration parallel to the welding direction (250 Hz) and the



Geometry modification and W-rich layer formation for weld toe of high-strength low-alloy steel joints using friction stir processing (FSP) with spherical-tip WC tool, resulting in fatigue strength improvement.



Designing high bending strength Nb/Cu and Ta/Cu clads produced by explosive welding (EW) with high micro-hardness intermediate layers (ILs) at their interfaces.



Cracks observed in hydrogen charged weld metal after slow strain rate tensile test (a), and numerical simulation of diffusible hydrogen concentration distribution in weld metal (b).

Major Papers

H. H. Zargari, K. Ito, M. Kumar, A. Sharma, "Visualizing the Vibration Effect on the Tandem-Pulsed Gas Metal Arc Welding in the Presence of Surface Tension Active Elements", Int. J. Heat Mass Transf., 161 (2020), 120310. doi

H. H. Zargari, K. Ito, T. Miwa, P. K. Parchuri, H. Yamamoto and A. Sharma," Metallurgical Characterization of Penetration Shape Change in Workpiece Vibration-Assisted Tandem-Pulsed Gas Metal Arc Welding", Materials, 13 (2020) 3096. doi

H. Yamamoto, Y. Aoyama, K. Ito, T. Yamada, M. Tanaka, H. Hoshikawa, A. Nagata and T. Kumagai,"Friction Stir Welding of Ultrahigh-Purity Aluminum Thin Sheets Never to Lower High Conductivity at Ultra-Low Temperature", Q. J. Jpn. Weld. Soc., 38, 4 (2020), 253-262. doi

G. Ogita, K. Matsumoto, M. Mochizuki, Y. Mikami and K. Ito," Numerical Simulation on Effect of Microstructure on Hydrogen-induced Cracking Behavior in Duplex Stainless Steel Weld Metal", Tetsu-to-Hagane, 106, 4 (2020), 224-234. doi

G. Ogita, K. Matsumoto, M. Mochizuki, Y. Mikami and K. Ito," Evaluation of Hydrogen-induced Cracking Behavior in Duplex Stainless Steel by Numerical Simulationof Stress and Diffusible Hydrogen Distribution at the Microstructural Scale", Tetsu-to-Hagane, 106, 4 (2020), 214-223. doi

Research Division of Materials Joining Mechanism, Dep. of Joint Interface Structure and Formation Mechanism

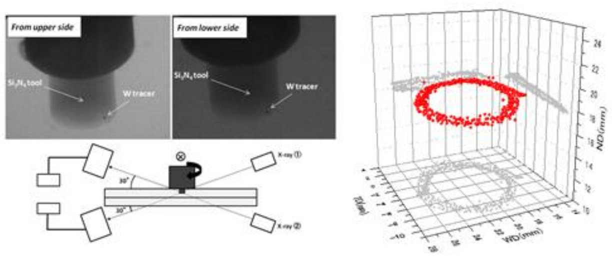
Research summary

In this department, based on the elucidation of the various phenomena at the joint interfaces of ferrous, nonferrous, non-metal materials at both macroscopic and microscopic levels, the interface formation mechanisms during various joining processes are clarified to create new interface control methods.

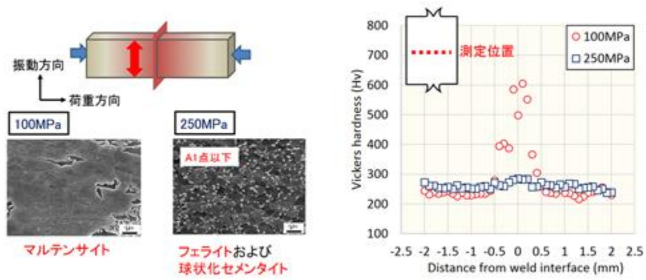
In addition, novel welding and modification processes are developed, mainly based on fusion welding methods and friction welding methods such as the friction stir welding, rotary friction welding and linear friction welding methods, which is the core of the fundamental technologies having a great potential to produce new values. These developments are going to be used and focused simultaneously in our society in order to create a new research field and elevate the continuous growth of industrial competitiveness of our country.

Research subjects

(1) Control of interface and elucidation of formation mechanism during friction welding (FSW, Friction welding, Linear friction welding)
(2) Development of novel joining and modification processes
(3) Elucidation of formation mechanism of weld interface and molten pool
(4) Analysis of joint interface structure
(5) Control of solid-liquid interface formation



Three-dimensional visualization of the material flow using a W tracer during the FSW.



SEM microstructures and Vickers hardness along the central axis of LFWed joints.

Major Papers

M. Zhou, Y. Sun, Y. Morisada, K. Ushioda and H. Fujii, “Quasi-in-situ Investigation into the Microstructure and Texture Evolution of Pure Magnesium during Friction Stir Welding”, J. Magnes. Alloy., 8, 4 (2020), 1071-1083. doi

Y. Hu, H. Liu, H. Fujii, H. Araki, K. Sugita and K. Liu, “Ultrasonic-induced Excess Vacancies in Friction Stir Processing and Exploration of Acoustoplastic Effect”, Scr. Mater., 185 (2020), 117-121. doi

J. W. Choi, Y. Morisada, H. Liu, K. Ushioda, H. Fujii, K. Nagatsuka and K. Nakata, “Dissimilar Friction Stir Welding of Pure Ti and Carbon Fibre Reinforced Plastic”, Sci. Technol. Weld. Joining, 25, 7 (2020), 600-608. doi

Y. Sun, H. Fujii and Y. Morisada, “Double-sided Friction Stir Welding of 40 mm Thick Low Carbon Steel Plates Using a PcBN Rotating Tool”, J. Manufacturing Processes, 50 (2020), 319-328. doi

H. Liu, Y. Aoki, Y. Aoki, K. Ushioda and H. Fujii, “Principle for Obtaining High Joint Quality in Dissimilar Friction Welding of Ti-6Al-4V Alloy and SUS316L Stainless Steel”, J. Mater. Sci. Technol., 46 (2020), 211-224. doi

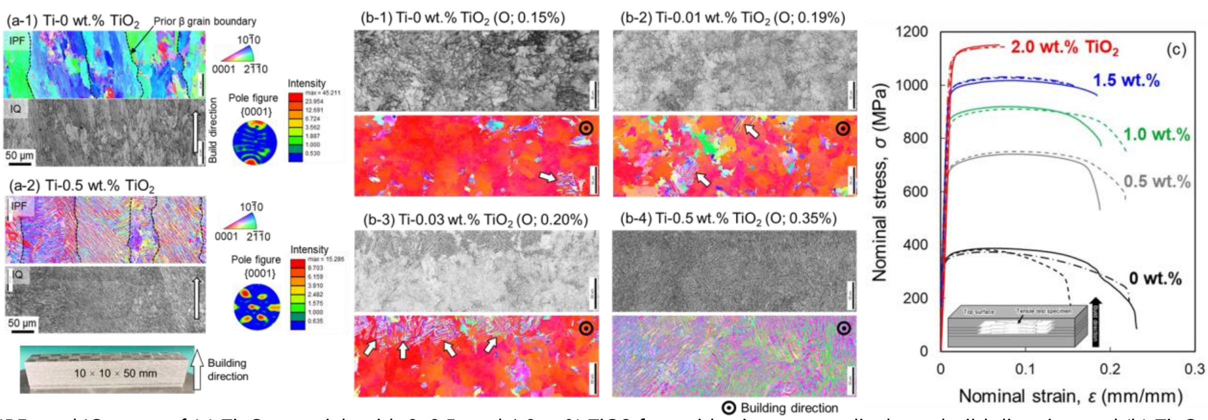
Research Division of Materials Joining Mechanism, Dep. of Composite Materials Processing

Research summary

From a viewpoint of the energy saving and environmental problem solutions, the research fields of this department focus on both of the effective reuse of resources and energy including renewable ones and reduction of life hazardous materials and air pollutions. In particular, by controlling the interfacial mechanics and high-performance of materials, atomic/nano-scale composite materials and processing designs for the environmentally benign are established, and applied to innovative industrial development.

Research subjects

(1) Titanium materials with high-strength and ductility via atomic-scale microstructure optimization by first principle calculation
(2) Selective laser melted titanium alloys strengthened by solid-solution and nano-dispersoids
(3) Nano-carbon materials reinforced metal matrix composites through interfacial mechanics
(4) Direct bonding of plastic materials to metals by molecular structure control
(5) Ni-rich TiNi shape memory alloys with nano-precipitation and expansion ability evaluation in application to stent devices



IPFs and IQ maps of (a) Ti–O materials with 0, 0.5, and 1.0 wt% TiO2 from side view perpendicular to build direction and (b) Ti–O materials (0, 0.01, 0.03, and 0.5 wt% TiO_2) from top view parallel to build direction. (c) Stress–strain curves from tensile tests of SLMed Ti–O materials with different TiO_2 contents. Mater. Sci. Eng. A., 795 (2020), 139983.

Major Papers

J. Umeda, T. Tanaka, T. Teramae, S. Kariya, J. Fujita, H. Nishikawa, Y. Shibutani, J. Shen and K. Kondoh, "Microstructures Analysis and Quantitative Strengthening Evaluation of Powder Metallurgy Ti-Fe Binary Extruded Alloys with (α+β)-dual-phase", Mater. Sci. Eng. A., 803 (2021), 140708. doi

K. Kondoh, M. Fukuo, S. Kariya, K. Shitara, S. Li, A. Alhazaa and J. Umeda, "Quantitative Strengthening Evaluation of Powder Metallurgy Ti-Zr Binary Alloys with High Strength and Ductility", J. Alloy. Compd, 852 (2020), 156954. doi

K. Yokota, A. Bahador, K. Shitara, J. Umeda and K. Kondoh, "Mechanisms of Tensile Strengthening and Oxygen Solid Solution in Single β-Phase Ti-35 At.%Ta+O Alloys", Mater. Sci. Eng. A., 802 (2020), 140677. doi

T. Teramae, T. Tanaka, M. Fukuo, K. Shitara, J. Umeda, S. Li, A. Alhazaad and K. Kondo, "Acicular Microstructure Formation and Strengthening Behavior of Ti-4%Fe Alloys by Zr Addition", J. Alloy. Compd, 858 (2020), 158292. doi

A. Issariyapat, P. Visuttipitukul, J. Umeda and K. Kondoh, "Refined grain formation behavior and strengthening mechanism of α-titanium with nitrogen fabricated by selective laser melting", Additive Manufacturing, 36 (2020), 101537. doi

K. Kondoh, E. Ichikawa, A. Issariyapat, K. Shitara, J. Umeda, B. Chen and S. Li, "Tensile Property Enhancement by Oxygen Solutes in Selectively Laser Melted Titanium Materials Fabricated from Pre-Mixed Pure Ti and TiO_2 Powder", Mater. Sci. Eng. A., 795 (2020), 139983. doi

Research Division of Materials Joining Assessment, Dep. of Joining Mechanics and Analyses

Research summary

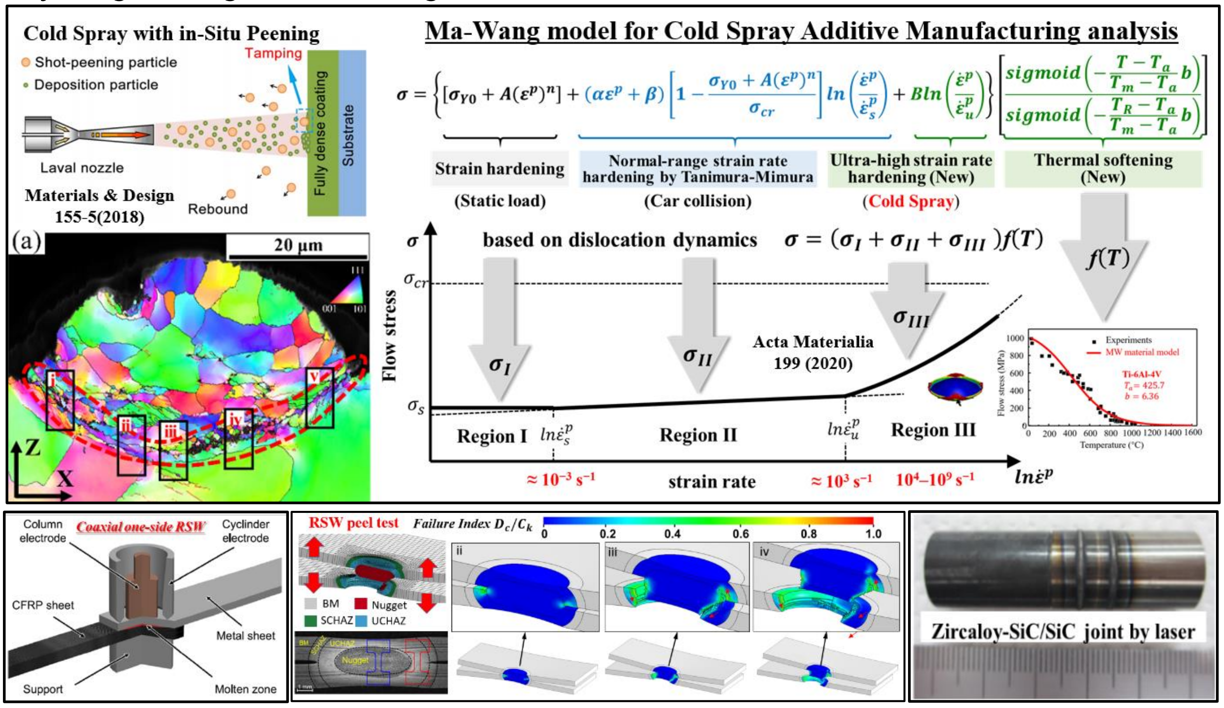
The mathematical and numerical modelling is a basis of AI (Artificial Intelligent) and one of the most efficient approaches to look into various detail phenomena involved in joining & welding & additive manufacturing processes. In addition, assessment to residual stress/strain and strength of various types of joints between dissimilar materials is being studied through both the advanced measuring technology and numerical computational approaches.

Research subjects

(1) Computational modelling of nonlinear thermo-mechanical-metallurgical phenomena in multi-materials additive manufacturing, fusion welding and solid-state joining,

(2) Field Measurement and FEM (M-FEM) for identification of internal residual stress and fracture criteria of materials and various types of joints.

(3) Artificial Intelligent (AI) and digital twin for full manufacturing processes including metal forming, joining, welding and assembling of structures.



Major Papers

Q. Wang, N. Ma, M. Takahashi, X. Luo and C. Li, "Development of a Material Model for Predicting Extreme Deformation and Grain Refinement during Cold Spraying", Acta Mater., 199 (2020), 326-339. doi

R. Geng, J. Du, Z. Wei and N. Ma, "Multiscale Modelling of Microstructure, Micro-segregation and Mechanical Properties of Al-Cu Alloy in Wire and Arc Additive Manufacturing", Addit. Manuf. 36 (2020), 101735. doi

P. Geng, G. Qin, J. Zhou, T. Li and N. Ma, "Characterization of Microstructures and Hot-Compressive Behavior of GH4169 Superalloy by Kinetics Analysis and Simulation", J. Mater. Process. Technol., 288 (2020), 116879. doi

S. Ren, Y. Ma, S. Saeki, Y. Iwamoto, C. Chen and N. Ma, "Fracture mechanism and strength evaluation of Al5052/CFRP joint produced by coaxial one-side resistance spot welding", Compos. Struct., 252, 11 (2020), 112766. doi

H. Serizawa, K. Mitsufuji and F. Miyasaka, "Development of New Particle Method Based on MPS and Its Applicability for Friction Stir Welding of Dissimilar Joint", Mater. Sci. Forum, 1016 (2020), 218-222. doi

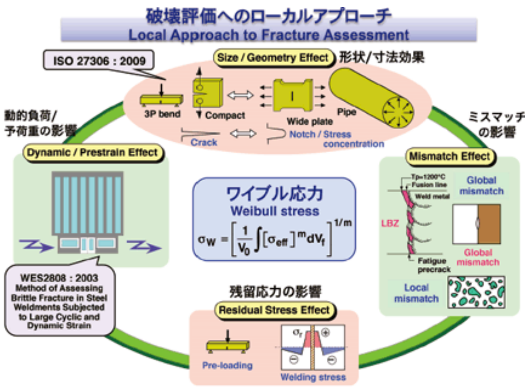
Research Division of Materials Joining Assessment, Dep. of Structural Integrity and Failure Assessments

Research summary

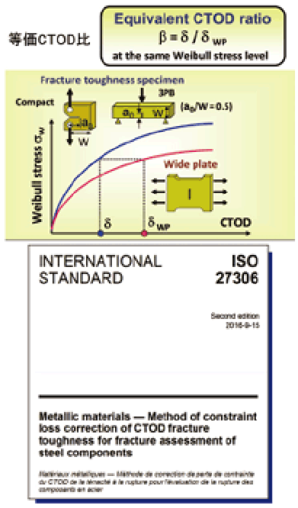
The welding & joining design should use the properties and qualities of materials to their best advantage in service conditions. A need has been increased for more creative joint design and manufacturing in the industry. This department focuses on the development of a procedure for fitness-for-service assessment, in particular fracture assessment of metallic structures constructed by joining & welding. The methodology is founded on the local approach to fracture, which enables the transferability analysis between the strength of fracture toughness specimen and the performance of structural component. With this procedure, the critical allowance of flaw and damage in service conditions is predicted. The results are published as national and international standards or guidelines for user friendliness.

Research subjects

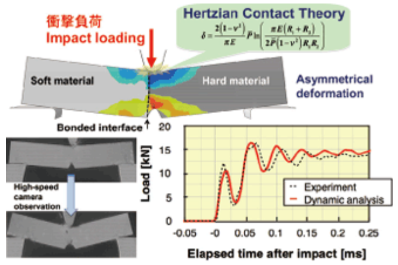
(1) Structural integrity assessment by the Weibull stress approach
(2) Development of fitness-for-service assessment procedure for welded structures in service
(3) Interface strength evaluation of dissimilar joints
(4) Fracture performance assessment under dynamic loading
(5) Science of go/no-go of dynamic crack propagation



Structural integrity assessment of weld structures by the Weibull stress criterion



Development of international fracture assessment standard, ISO 27306, for steel structures



Dynamic analysis of stress-strain fields in Charpy specimen of dissimilar joints

Major Papers

D. Lin, L. Xu, H. Jing, Y. Han, L. Zhao and F. Minami, "Effects of Annealing on the Structure and Mechanical Properties of FeCoCrNi High-Entropy Alloy Fabricated via Selective Laser Melting", Addit. Manuf. 3 (2020), 101058. doi

T. Kawabata, T. Inoue, T. Tagawa, T. Fukui, Y. Takashima, K. Shibanuma and S. Aihara, "Historical Review of Research on Brittle Crack Propagation Arresting Technology for Large Welded Steel Structures Developed in Japan with the Application of K_{ca} Parameters", Mar. Struct., 71 (2020), 102737. doi

L. Zhao, C. Shao, Y. Takashima, F. Minami and F. Lu, "Numerical Investigation on Fracture Initiation Properties of Interface Crack in Dissimilar Steel Welded Joints", Chin. J. Mech. Eng., 33 (2020), 27. doi

Research Division of Materials Joining Assessment, Dep. of Joining Design and Dependability

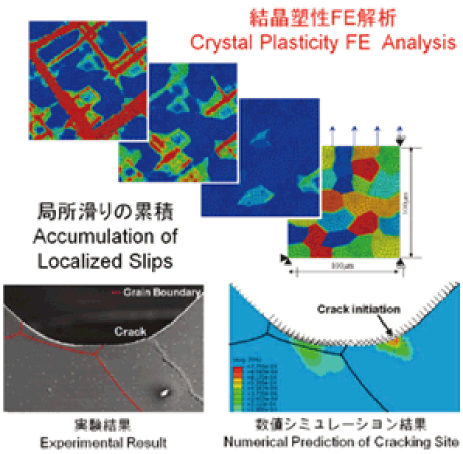
Research summary

In evaluating the reliability of the structures, this department investigates not only the conventional optimization for the safety and the durability in constructing steel structures but also the reliability (Dependability) including the maintenance, the repair/reinforcement and the evaluation of lifetime considering cultural science and social science. Moreover, making researches on the procedure to safely break up the structures completing the lifetime, the circulating loop in which the members or the units are reused is concretized.

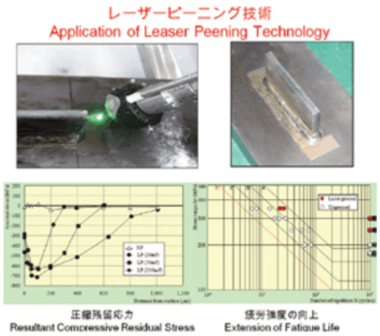
The department purposes to establish the evaluating methods to satisfy the high accuracy and the high quality in cutting, processing and assemblage for "products of steel structures" based on the dependability in the circulating loop containing the maintenance, the repair/reinforcement and the evaluation of lifetime.

Research subjects

(1) Soundness diagnosis of structural members and joints
(2) Development of simulation technology of mechanical behavior
(3) Development of fatigue life assessment technology (crack nucleation, propagation)
(4) Development of measurement technology of deformation and crack
(5) Development of life extension technology for structural members and joints
(6) Assessment of Weldability and Quality of New and Functionally Graded Materials



Numerical simulation of mechanical fatigue phenomena



Development of life extension technology for steel structures

Ultra-dynamic and cyclic loading test for large structures
Soundness diagnosis of structure members by ultra-dynamic structural testing system （Speed 1,200mm/sec, Load 1,200kN, Stroke 500mm）

Major Papers

R. Gadallah and S. Tsutsumi, "An Interaction Integral Retardation Model for Predicting Fatigue Life under Multi-Step Loading", Eng. Fract. Mech., 236 (2020), 107224 (1-19). doi

R. Fincato and S. Tsutsumi, "An Overstress Elasto-Viscoplasticity Model for High/low Cyclic Strain Rates Loading Conditions: Part I - Formulation and Computational Aspects", Int. J. Solids Struct., 207 (2020), 279-294. doi

R. Fincato and S. Tsutsumi, "An Overstress Elasto-Viscoplasticity Model for High/low Cyclic Strain Rates Loading Conditions: Part II - Numerical Analyses", Int. J. Solids Struct., 208-209 (2020), 247-261. doi

Y. Wang, Y. Luo and S. Tsutsumi, "Parametric Formula for Stress Concentration Factor of Fillet Weld Joints with Spline Bead Profile", Materials, 13, 20 (2020), 4639. doi

R. Gadallah, S. Tsutsumi, T. Yonezawa and H. Shimanuki, "Residual Stress Measurement at the Weld Root of Rib-To-Deck Welded Joints in Orthotropic Steel Bridge Decks Using the Contour Method", Eng. Struct., 219 (2020), 110946. doi

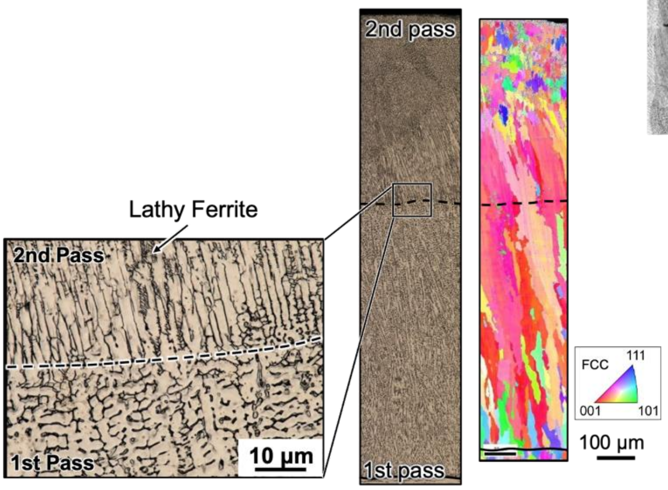
Research Division of Materials Joining Assessment, Dep. of Reliability Evaluation & Simulation

Research summary

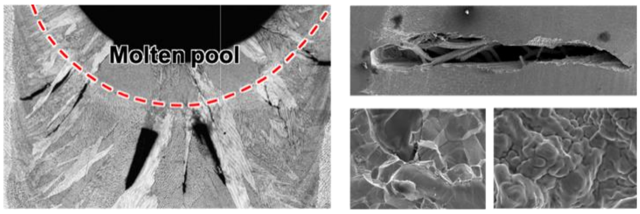
Development of innovative manufacturing technology is required to manufacture high-performance machine products and structures of the next-generation. Department of Reliability Evaluation & Simulation conducts research and education for elucidation and control of the factors on weldment properties by high accurate evaluation based on material science and engineering. In order to create innovative and attractive technique of welding & Joining as a final aim, our department are working on elucidation of metallurgical phenomenon such as solidification and transformation, and on developing the predication method for the microstructures and the properties of weldments.

Research subjects

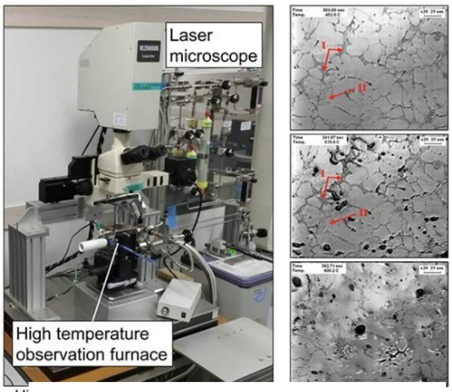
(1) Elucidation for mechanism of microstructural evolution during solidification and solid state in weld metal of stainless steels and carbon steels
(2) Investigation of controlling factor of hot cracking susceptibility and establishment of the prediction technology of the cracking during welding and additive manufacturing
(3) Clarification of influential factors of corrosion resistance of stainless steel welds
(4) Analysis of solidification/transformation behavior and accurate evaluation of hot cracking susceptibility by using In-situ observation technique
(5) Development of improvement technology of properties of weld metal by microstructural control



Control of Lathy ferrite formation in weld metal of austenitic stainless steel



Evaluation and analysis of hot cracking susceptibility test



Hi High temperature in-situ observation by laser microscope

Major Papers

K. Kadoi, S. Ueda, S. Tokita and H. Inoue, "Effect of MC Carbide Formation on Weld Solidification Cracking Susceptibility of Austenitic Stainless Steel", J. Alloy. Compd, 828, 5 (2020), 154423. doi

K. Kadoi, Y. Nakata, H. Inoue and S. Saruwatari, "Relationship between Solidification Sequence and Toughness of Carbon Steel Weld Meta", Mater. Charact., 165 (2020), 110402. doi

S. Tokita, K. Kadoi, S. Aoki and H. Inoue, "Relationship between the Microstructure and Local Corrosion Properties of Weld Metal in Austenitic Stainless Steels", Corrosion Sci., 175 (2020), 108867. doi

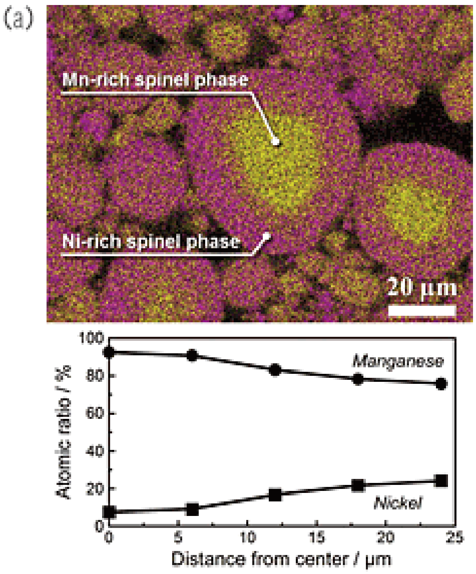
Smart Processing Research Center, Dep. of Smart Coating Processing

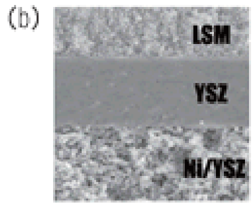
Research summary

This department deals with smart coating processing based on nanoparticle processing, which leads to advanced manufacturing technology as well as safe, security, environmental and energy issues. By making use of new properties of nanoparticles, nanoporous or multi-component films can be created without any heat assistance. Nano and microscale design of particles will lead to high reliability and functional coating films with various kinds of coating processes. Smart coating on the surface of particles will make key materials for new areas such as DDS (Drug Delivery System) or Fuel Cells.

Research subjects

(1) Development of solid-state processing in water vapor for functional fine-particle synthesis
(2) Low temperature synthesis of composite oxide nanoparticles by mechanochemical method
(3) Development of Li ion battery electrodes by controlling their composite structure
(4) Wet processing for composite nanoparticles and their applications for fuel cells
(5) Development of fuel cell electrodes for PEFC and SOFC
(6) Development of low thermal conductivity materials using composite particles
(7) Development of 3D direct-assembly process of nanoparticles
(8) New recycling process of composite materials by bonding and disassembling of their interface





(a) Fabrication of cathode particle with gradient composition for Li ion battery by dry processing

(b) Fabrication of both cathode and anode nanostructure for SOFC by wet processing

Major Papers

H.-Y. Chang, Y.-C. Chen, P.-Y. Hsu, W.-H. Tuan, A. Kondo, T. Kozawa and M. Naito, "Strengthening Bioceramic through an Approach of Powder Processing", Adv. Powder Technol., 31, 10 (2020), 4180-4186. doi

D. Lee, A. Kondo, S. Lee, S. Myeong, S. Sun, I. Hwang, T. Song, M. Naito and U. Paik, "Controlled Swelling Behavior and Stable Cycling of Silicon/Graphite Granular Composite for High Energy Density in Lithium Ion Batteries", J. Power Sources, 457, (2020) 228021. doi

T. Kozawa, T. Harata and M. Naito, "Fabrication of an $LiMn_2O_4$@$LiMnPO_4$ Composite Cathode for Improved Cycling Performance at High Temperatures", J. Asian Ceram. Soc., 8, (2020) 309-317. doi

T. Kozawa and K. Nishikawa, "Macroporous Mn_3O_4 Microspheres as a Conversion-Type Anode Material Morphology for Li-Ion Batteries", J. Solid State Electrochem., 24, (2020), 1283-1290. doi

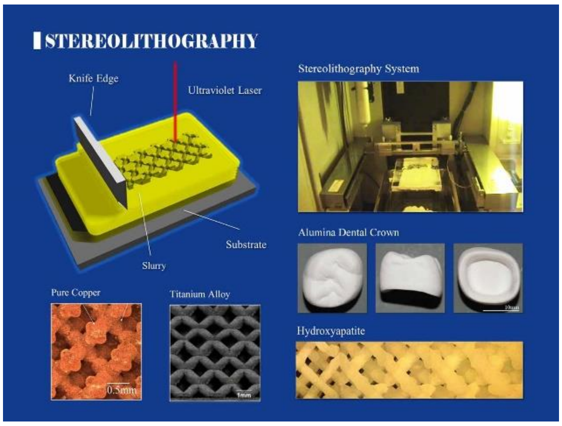
Smart Processing Research Center, Dep. of Nano/Micro Structure Control

Research summary

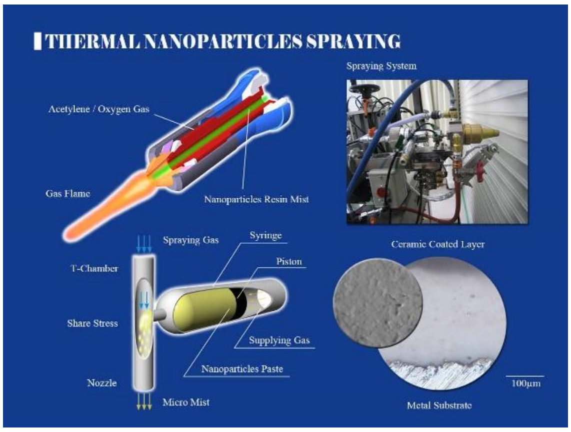
Additive Manufacturing (AM) was newly developed as novel process to create three dimensional (3D) structures through two dimensional (2D) layer laminations. Metal and ceramic nanoparticles were dispersed into resin paste to use for our original process. In lithography techniques, a high power laser beam was scanned on the spread paste for 2D layer drawing and 3D structure forming. In deposition techniques, the paste was introduced into high temperature plasma or gas flame for 2D cladding and 3D patterning. Created electric devices, biological implants and energy modules will contribute to sustainable development.

Research subjects

(1) Stereolithographic Additive Manufacturing of Metal and Ceramic Parts Using Nanoparticles Pastes
(2) Structural Fabrication of Photonic Crystals with Diamond Structures for Terahertz Wave Control
(3) Modulation of Micro Porous Structures in Biological Ceramic Implants for Artificial Metabolism
(4) Manufacturing of Micro Metal Lattices for Effective Controls of Heat Flow and Stress Distributions
(5) Advance Development of Thermal Nanoparticles Spraying for Additive Manufacturing Technique
(6) Fine Separator Formation in Solid Oxide Fuel Cells by Using Thermal Nanoparticles Spraying
(7) Fine Ceramic Coating with Thermal Conductivity and Corrosion Resistance for Heat Exchanger Tubes
(8) Layer Laminations by Fine Particles Spraying and Sintering to Create Functionally Graded Structures



Laser Scanning Stereolithography of Additive Manufacturing to Fabricate Bulky Metal and Ceramic Components with Micro Geometric Patterns



Thermal Spraying Using Fine Particle Pastes to Laminate Metal and Ceramic Coated Layers with Functional Nano/Micro Structures

Major Papers

T. Shimizu and S. Kirihara, "Stereolithographic Additive Manufacturing of Silicon Carbide Components", J. Smart Process., 9, 4 (2020), 185-189. doi

T. Shimizu and S. Kirihara, "Stereolithographic Additive Manufacturing of Artificial Tree Models Using Sawdust Woodchips Dispersed Resin Paste", J. Smart Process., 9, 4 (2020), 190-193. doi

T. Ito and S. Kirihara, "Stereolithographic Additive Manufacturing of Fluid Channels Bundles with Graded Aperture Sizes in Thermoacoustic Converters", J. Smart Process., 9, 4 (2020), 194-198. doi

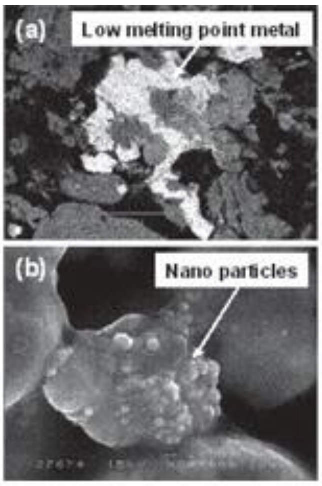
Smart Processing Research Center, Dep. of Smart Green Processing

Research summary

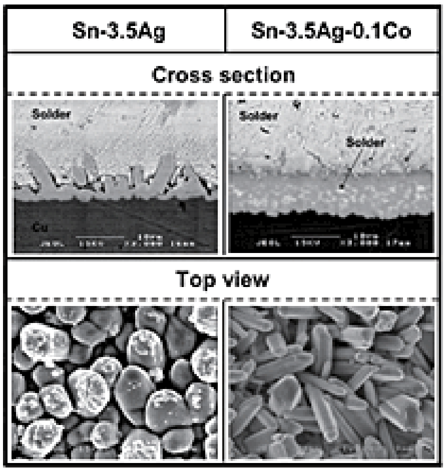
The aim of this division is to develop the environmentally conscious smart technology to reduce the environmental impact in manufacturing, waste treatment and recycle processing. Especially, the research focuses on the following topics; substitution of materials to toxic free and eco-materials in electronics assembly, the use of low environmental impact materials in joining process, enhancement of reliability of fine-pitch high density packaging, and design for reuse. Also low temperature joining, substitution of rare materials and precious metals to popular substances, and development of low energy consumption new smart joining process which can make highly reliable joint are the targets of research in smart green processing department.

Research subjects

(1) Promotion of toxic-free manufacturing of fine pitch high density packaging in electric equipments and electronics
(2) Interfacial reaction between lead-free solder and materials
(3) Improvement of joint lifetime by controlling microstructures at interface
(4) Nano-particle assisted smart bonding
(5) High reliability of Cu filler conductive adhesive bonding
(6) Low temperature joining of metallic glasses



Addition of various particles into electrical conductive adhesives to improve the performance of electrical conductive adhesive
(a) With low melting point metal
(b) With nano-particles



Influence of Co addition to Sn-3.5Ag solder on intermetallic compound at solder/Cu interface

Major Papers

S. Zhou, S. He and H. Nishikawa, "Effect of Zn Addition on Interfacial Reactions and Mechanical Properties between Eutectic Sn58Bi Solder and ENIG Substrate", J. Nanosci. Nanotechnol., 20, 1 (2020), 106-112. doi

R. Gao, S. He, J. Li, Y.-A. Shen and H. Nishikawa, "Interfacial Transformation of Preoxidized Cu Microparticles in a Formic-Acid Atmosphere for Pressureless Cu-Cu Bonding", J. Mater. Sci. -Mater. Electron., 31 (2020), 14635-14644. doi

S. He, R. Gao, Y.-A. Shen, J. Li and H. Nishikawa, "Wettability, Interfacial Reactions, and Impact Strength of Sn-3.0Ag-0.5Cu Solder/ENIG Substrate Used for Fluxless Soldering under Formic Acid Atmosphere", J. Mater. Sci., 55, 7 (2020), 3107-3117. doi

R. Gao, Y.-A. Shen, J. Li, S. He and H. Nishikawa, "Mechanical and Microstructural Enhancements of Ag Microparticle-Sintered Joint by Ultrasonic Vibration", J. Mater. Sci. -Mater. Electron., 31 (2020), 21711-21722. doi

Smart Processing Research Center, Dep. of Life-Innovation Materials Processing

Research summary

This department focuses on developments of new materials and their processing technologies that contribute to the life-innovation, aiming to realize a sustainable and healthy society from the viewpoint of advanced process science. In particular, we will develop functional materials including magnetorheological fluids that have human-friendly power transmission for next-generation rehabilitation robots. In addition, we will explore processing methods for the life-innovation materials, based on nanostructural controls of various joint configurations including solid-liquid interfaces.

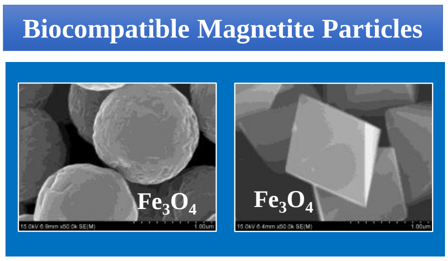
Research subjects

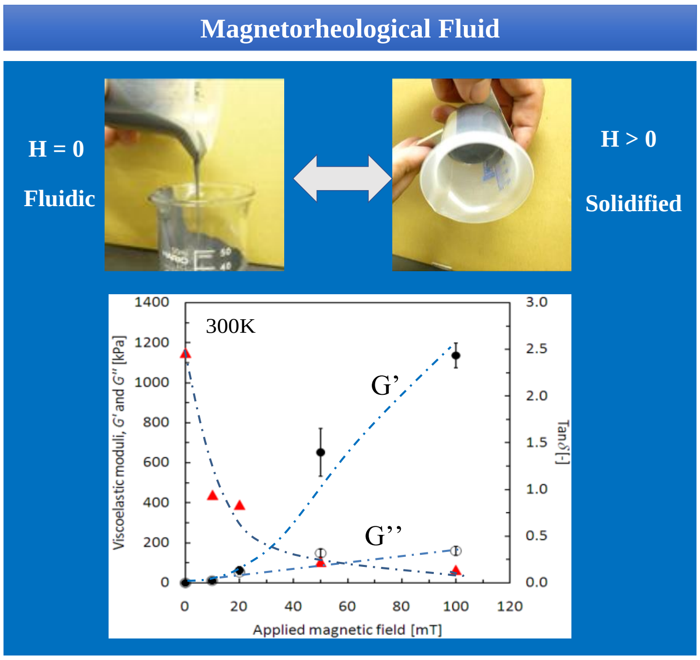
(1) Synthesis of biocompatible nano/micro particles

(2) Development of rheological stimuli-responsive materials

(3) Hierarchical interface controls for non-adhesive and antifouling

(4) Ceramics technology for life innovation





(Above) Biocompatible Magnetite particles
(Below) Hierarchical interface control on metal surface

Colloidal magnetorheological fluid for soft-robotics

Major Papers

C. Sakaguchi, Y. Nara, T. Hashishin, H. Abe, M. Matsuda, S. Tsurekawa and H. Kubota, "Direct Observation of Potential Phase at Joining Interface between *p*-MgO and *n*-$MgFe_2O_4$", Sci. Rep., 10 (2020), 17055. doi

T. Naka, J. Valenta, J. Kastil, M. Misek, J. Prchal, V. Sechovsky, H. Abe, T. Nakane, M. Nakayama and T. Uchikoshi, "Chemical and Physical Pressure Effects in the A-site Spinel Antiferromagnetes CoM_2O_4(M=Al, Co, Rh)", Mater. Res. Express, 7 (2020), 056105(13pages). doi

Hitachi Zosen Advanced Welding Technology Joint Research Chairs

Research summary

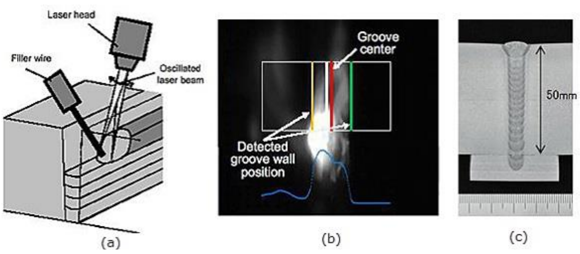
This research chair has been developing welding technology to realize international competitive manufacturing for wide range of thick-plate structures by fusing advanced technologies owned by JWRI and Hitachi Zosen Corporation. It aims to realize smart manufacturing factory.

The high power laser technology for thick plate welding developed in this chair has reached a practical level at the factory. Now, we are developing the foundation of the digital welding technology required at next generation like process simulation technology and waveform controlled the high heat input digital submerged arc welding technology.

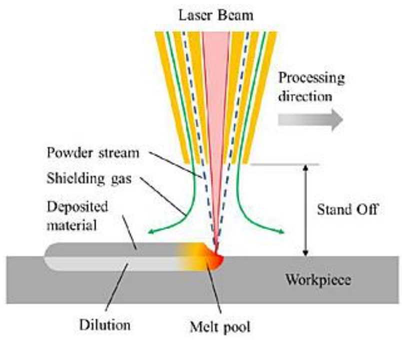
Furthermore, as a new development of laser welding technology, we will promote the development of three dimensional overlay welding technology that realizes high wear resistance by utilizing blue laser etc.

Research subjects

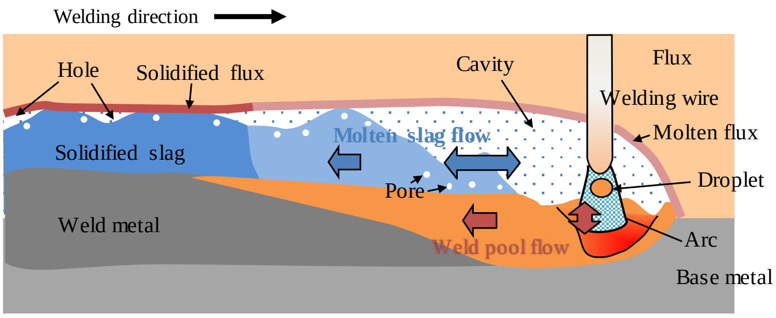
(1) Development of Laser Welding Technology for Thick Plate
(2) Development of High Efficiency SAW Technology
(3) Development of Overlay Welding Technology using Additive Manufacturing
(4) Smart Welding & Manufacturing System



Laser Multi-layer Welding Technology for Thick Plate
(a) Schematic diagram of welding process
(b) Schematic diagram of gap sensing system
(c) Groove shape and cross section of weld



Overlay Welding Technology using Additive Manufacturing



SAW Phenomena

Major Papers

Y. Abe, T. Fujimoto, M. Nakatani, M. Shigeta and M. Tanaka, “Development of a Welding Condition Optimization Program for Narrow Gap SAW”, Q. J. Jpn. Weld. Soc., 38, 2 (2020), 98s-102s. doi

U. K. Mohanty, Y. Abe, T. Fujimoto, M. Nakatani, A. Kitagawa, M. Tanaka, T. Suga and A. Sharma, " Performance Evaluation of Alternating Current Square Waveform Submerged Arc Welding as a Candidate for Fabrication of Thick Welds in 2.25Cr-1Mo Heat-Resistant Steel”, J. Press. Vessel Technol. -Trans. ASME, 142 (2020), 041506 (11 pages). doi

Osaka Fuji "Advanced Functional Processing" Joint Research Chairs

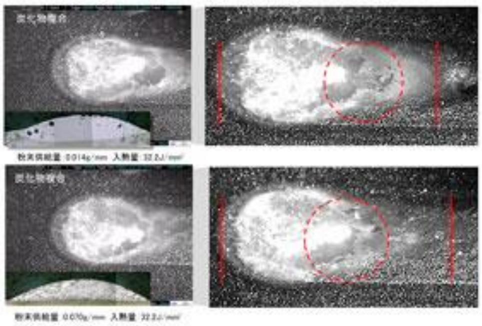
Research summary

This research chair aims to develop advanced functional processing technics by combining laser processing technology and materials knowledge in JWRI and advanced functional manufacturing technologies of Osaka Fuji Corporation.

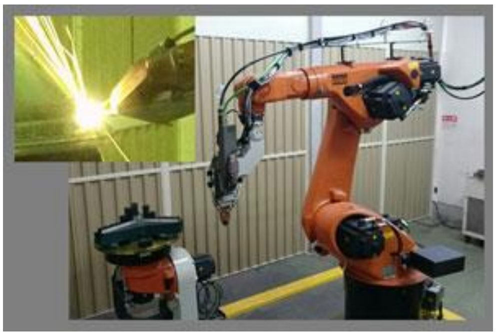
The main purpose is to develop the surface functioning of various materials by laser cladding method, low weldability materials. Finally, these fruits are applied to the next generation of manufacturing technology for various industrial fields.

Research subjects

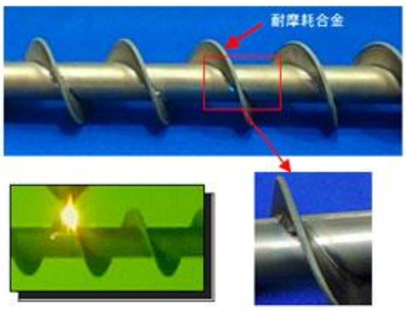
(1) Development of highly functional surface by laser cladding
(2) Development of functional surfaces of small or thin parts
(3) Development of hybrid technology of laser and conventional surfacing technologies
(4) Fundamental research of laser additive manufacturing technology



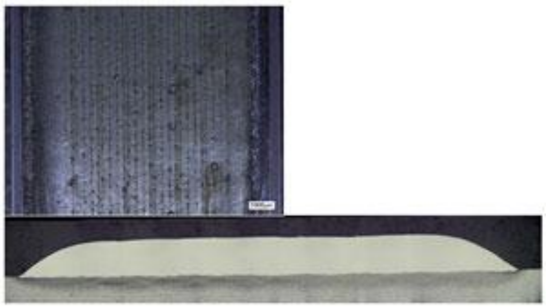
Dynamic observation of molten pool behavior for analysis of blow halls formation using high-speed camera



Experimental apparatus for laser cladding



Example of laser cladding on edge of screw



Wide, flat cladding layer which was provided by beam control

Major Papers

K. Ono, Y. Sato, R. Higashino, Y. Funada, N. Abe and M. Tsukamoto, “Pure Copper Rod Formation by Multibeam Laser Metal Deposition Method with Blue Diode Lasers”, J. Laser Appl., 33, 1 (2020), 012013. doi

K. Ishida, S. Tashiro, M. Mizutani and M. Tanaka, “Effect of Focal Position on Laser-MAG Arc Hybrid Weld Bead of Thick High-Strength Steel Plate”, Q. J. Jpn. Weld. Soc., 38 (2020), 131s-134s. doi

K. Ishida, S. Tashiro, M. Mizutani and M. Tanaka, “Study on the Weld Bead Formation on Square-Groove Butt Joint Using Plasma-MIG Hybrid Welding Process”, Q. J. Jpn. Weld. Soc., 38 (2020), 135s-138s. doi

T. Hara, Y. Sato, R. Higashino, Y. Funada, T. Ohkubo, K. Morimoto, N. Abe and M. Tsukamoto, “Pure Copper Layer Formation on Pure Copper Substrate Using Multi-Beam Laser Cladding System with Blue Diode Lasers”, Appl. Phys. A, 26 (2020) 418. doi

Development Base on Development of Interdisciplinary and International Researchers for Creation of Life Innovation Materials

Research summary

The Project, Development Base on Creation of Life Innovation Materials for Interdisciplinary and International Researcher Development, has started from 2016 as inter-university cooperative research project (Joining and Welding Research Institute, Osaka Univ., Institute for Materials Research, Tohoku Univ., Laboratory for Materials and Structures, Tokyo Institute of Tech., Institute of Materials and Systems for Sustainability, Nagoya Univ., Institute of Biomaterials and Bioengineering, Tokyo Medical and Dental Univ., Research Organization for Nano & Life Innovation, Waseda Univ.) This development base promotes the joint research for development of life innovation materials for applications in the environment and medical fields through the inter-university cooperative researches by the 6 research institutes at 6 universities.

Research subjects

(1) Environmental and sustainable materials
(2) Biomedical and healthcare materials
(3) Base materials and technology

6 universities cooperative research project

(1) Joining and Welding Research Institute, Osaka Univ.
(2) Institute for Materials Research, Tohoku Univ.
(3) Laboratory for Materials and Structures, Tokyo Institute of Tech.
(4) Institute of Materials and Systems for Sustainability, Nagoya Univ.
(5) Institute of Biomaterials and Bioengineering, Tokyo Medical and Dental Univ.
(6) Research Organization for Nano & Life Innovation, Waseda Univ.

Research topics

(1) Synthesis and integration of tailor-made ceria nanocubes towards environmental applications
(2) Synthesis and coating of tailor-made titania nanosheets towards bio-medical applications

Cooperation system of the six research institutes at six universities

Major Papers

K. Hayashi, K. Nozaki, Z. Tan, K. Fujita, R. Nemoto, K. Yamashita, H. Miura, K. Itaka, and S. Ohara, "Enhanced Antibacterial Property of Facet-Engineered TiO_2 Nanosheet in Presence and Absence of Ultraviolet Irradiation", Materials, 13, 1 (2020), 78-1-13. doi

S. Ohara, T. Naka, K. Sunakawa, S. Kubuki, M. Senna and T. Hashishin, "Emergence of Ferromagnetism Due to Charge Transfer in Compressed Ilmenite Powder Using Super-High-Energy Ball Milling", Sci. Rep., 10 (2020), 5293-1-7. doi

Z. Dai, J. Cao, Z. Guo, K. Zheng, X.-Z. Song, W. Wen, X. Xu, X. Qi, S. Ohara and Z. Tan, "Soft X-ray-Enhanced Reactive Oxygen Species Generation in Mesoporous Titanium Peroxide and the Application in Tumor Synergistic Therapy", ACS Appl. Bio Mater., 3, 11 (2020), 7408-7417. doi

Center to Create Research and Educational Hubs for Innovative Manufacturing in Asia

Summary

From FY 2013-FY 2018, the project called "Center for the Project to Create Research and Educational Hubs for Innovative Manufacturing in Asia" were implemented to establish new joining and welding technologies, to create research networks, and to cultivate global leaders in the region.

Since FY 2018 namely the second phase, based on the research network established through former activities, the project has been continued to strengthen and obtain higher international competency both in institution wide and in university wide through high quality international collaborative research achieved by having organic cooperation with ASEAN Campus Programme and with Global Knowledge Partners promoted by Osaka University.

As in detail, two pillars are set as follows: 1) Strengthen International Collaborative Research: Increase number of co-authored papers by implementing international collaborative research with overseas universities, establish international joint laboratory, 2) Conduct practical Global Leader Training: Implement Inbound & Outboud Coupling Internship (CIS) takes place both overseas and domestic which is composed of students from different majors and different cultures.

From FY 2020, the CIS starts to award 2 credits for participants. Due to the COVID-19 situation, all activities for the CIS in FY 2020 had been implemented by online which created a new type of interaction and learnings.

Activities

(1) Strengthen International Collaborative Research: Increase number of co-authored papers by implementing international collaborative research, establish international joint laboratory

(2) Conduct practical Global Leader Training: Implement Inbound & Outboud Coupling Internship (CIS) both overseas and domestic which is composed of students from different majors and different cultures.

Table.1 Some major international joint research topics in FY 2020 (Excerpt)

Partner	Research Topics
University of Technology Malaysia, Kocaeli University, Turkey	Microstructure control of high oxygen concentration dual phase Ti alloys via hot extrusion
University of Technology Malaysia, Kocaeli University, Turkey	Strengthening and high-temperature behavior of Ti using ubiquitous elements (Ti–Fe–O–Cu–Si)
Xi'an Shiyou University, China	Measurement of local material properties and failure analysis of resistance spot welds of advanced high-strength steel sheets
Shanghai Jiao Tong University, China	Microstructure and strength assessment of friction self-piercing riveted aluminum alloy AA7075-T6 joints

Table.2 Some major papers issued in FY 2020 (Excerpt)

	Papers
1	A. Bahador, J. Umeda, R. Yamanoglu, H. Ghandvar, A. Issariyapat, T.A. Abu Bakar, K. Kondoh, Deformation mechanism and enhanced properties of Cu–TiB2 composites evaluated by the in-situ tensile test and microstructure characterization, Alloys and Compounds, vol. 847, (2020)
2	A. Bahador, J. Umeda, R. Yamanoglu, T.A. Abu Bakar, K. Kondoh, Strengthening evaluation and high-temperature behavior of Ti–Fe–O–Cu–Si alloy, Materials Science and Engineering A, vol. 800, pp. 140324 (2021).
3	Yunwu Ma, He Shan, Sizhe Niu, Yongbing Li, Zhongqin Lin, and Ninshu Ma, A Comparative Study of Friction Self-Piercing Riveting and Self-Piercing Riveting of Aluminum Alloy AA5182-O, Engineering, (2020)
4	Yunwu Ma, Sizhe Niu, He Shan, Yongbing Li, and Ninshu Ma, Impact of Stack Orientation on Self-Piercing Riveted and Friction Self-Piercing Riveted Aluminum Alloy and Magnesium Alloy Joints, Automotive Innovation, (2020)
5	M. Katsumata,C Hashimoto, A Comparative Study on the Recognition of Humanities and Engineering Students Through a Practical Internship (From Coupling Internship at Osaka University), Journal of Global Competency Education, vol.7 No.2, pp.14-21, (2020)

Table. 3 List of Online Coupling Internship in FY 2020

Partner Country	Host Company	Partner University
Thailand	OTC Daihen	Kasetsart University
Vietnam	IHI Infrastructure Asia	Hanoi Univ. of Science and Technology
Myanmar	J&M Steel Solutions	Yangon Technological. University
Indonesia	Cilegon Fabricators	Indonesia University

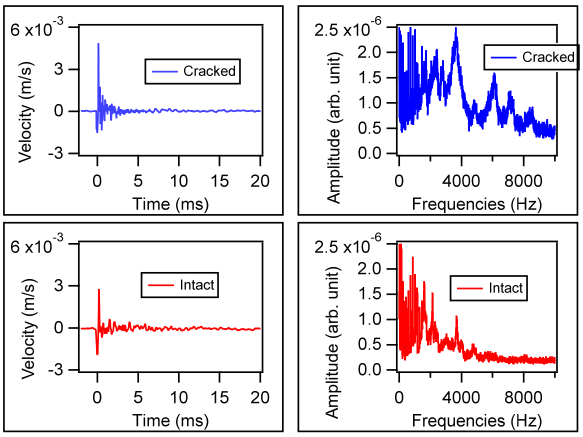
R&D Project for Environmental Resources and ECO Joining

Research summary

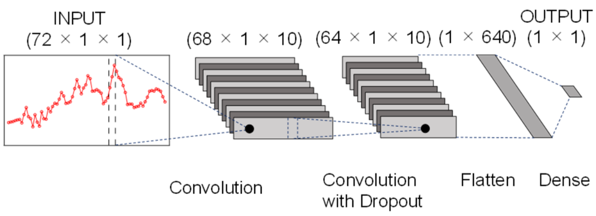
We study concerning the environmental resources/energy system and ECO-joining in this project. Efficient repair technology for aging concrete structures is an important topic not only in terms of economy but also in terms of environmental impact. Joint-defect detection is necessary to repair and restore the concrete infra-structures. We investigated an inspection technique using a laser Doppler vibrometer and AI (artificial intelligence) deep learning for the purpose of developing a method to detect concrete defects with high accuracy regardless of inspectors' skills. Also, an environment harmony energy device, for example, Mg-air battery is being developed to prepare lighting for blackouts due to natural disasters of earthquakes and typhoons. It is, also, very important to improve energy efficiency and to save resources by establishing bonding technologies adequate for manufacturing ecological products without toxic substances. Micro-joining processes for advanced electronic assembly such as wire and ribbon bonding have been studied. Establishment of the way to sustainable human society overcoming global environmental problems is the final purpose of the R&D project.

Research subjects

(1) Cathode materials design of Mg-air battery
(2) Improvement of structures of Mg-air battery for establishing the long lift and high power
(3) Development of Mg-air battery for charging smartphones
(4) Solid state micro joining (ultrasonic joining) for power electronic packaging
(4) Interfacial nanostructures between wide-gap semiconductors and their electrodes.
(5) Study of joint-defect detection of infra-structures, using the laser Doppler technique and AI deep learning system
(6) Study of separation and collection of toxic substances
(7) Study of sustainable system for cleating environmental resources.



(Left) Temporal waveform of a laser Doppler vibrometer signal of a concrete pillar of a defective (upper) and an intact part (bottom). (Right) Fourier transformed spectra. Characteristic peak frequencies were different between the defective and the intact part.



Architecture of the convolutional neural network. Fourier transformed spectra of a laser Doppler vibrometer signal were dimensionally reduced to 72 parameters by pre-processing with a melt filter bank. The parameters were then transformed into 64 x 10 parameters using two layers of one-dimensional convolutional networks and connected into a dense layer. The neural network architecture was able to distinguish between defective and intact parts with over 90% accuracy.

Major Papers

M. Muramatsu, S. Uchida and Y. Takahashi, "Noncontact Detection of Concrete Flaws by Neural Network Classification of Laser Doppler Vibrometer Signals", Eng. Res. Express, 2 (2020), 025017. doi

Y. Takahashi, M. Tsutaoka and M. Maeda, "Effect of SiC Crystal Orientation on Ti_3SiC_2 Formation between SiC and Al/Ti Bi-Layered Film", Ceram. Int. (2020), in Press. doi