Materials and Structures Laboratory
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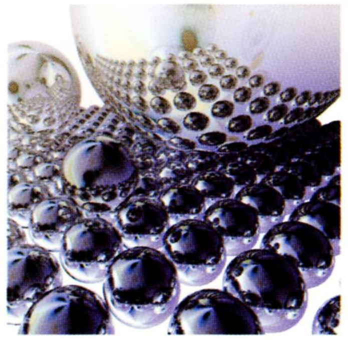
2010

MATERIALS AND STRUCTURES LABORATORY

Since 1934 **TOKYO INSTITUTE OF TECHNOLOGY**

MATERIALS AND STRUCTURES LABORATORY



TOKYO INSTITUTE OF TECHNOLOGY

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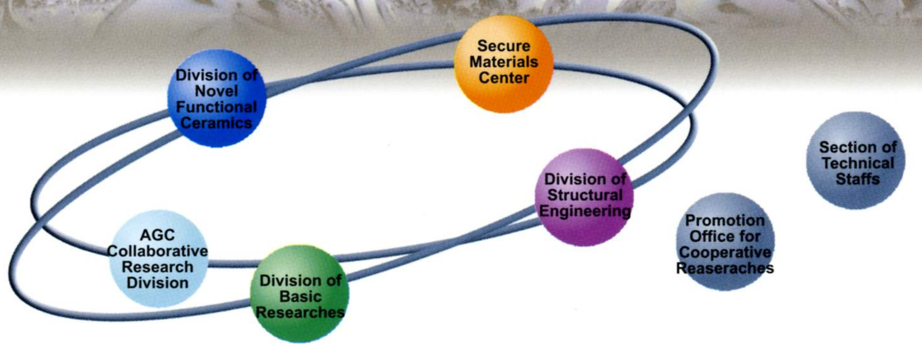
MATERIALS AND STRUCTURES LABORATORY
TOKYO INSTITUTE OF TECHNOLOGY

Kiyoshi Okada

As a core research institute for materials in focused on advanced Ceramics and architectures, Materials and Structures Laboratory Promotes tight collaboration with academics, industries, and public Research sectors worldwide.



Director's address

Our Materials and Structures Laboratory (MSL) is a unique nationwide collaborative research laboratory established at the Tokyo Institute of Technology (Tokyo Tech) in 1996. It is open to researchers from outside the campus who wish to engage in multilateral collaboration and pursue fundamental and applied research on ceramic materials.

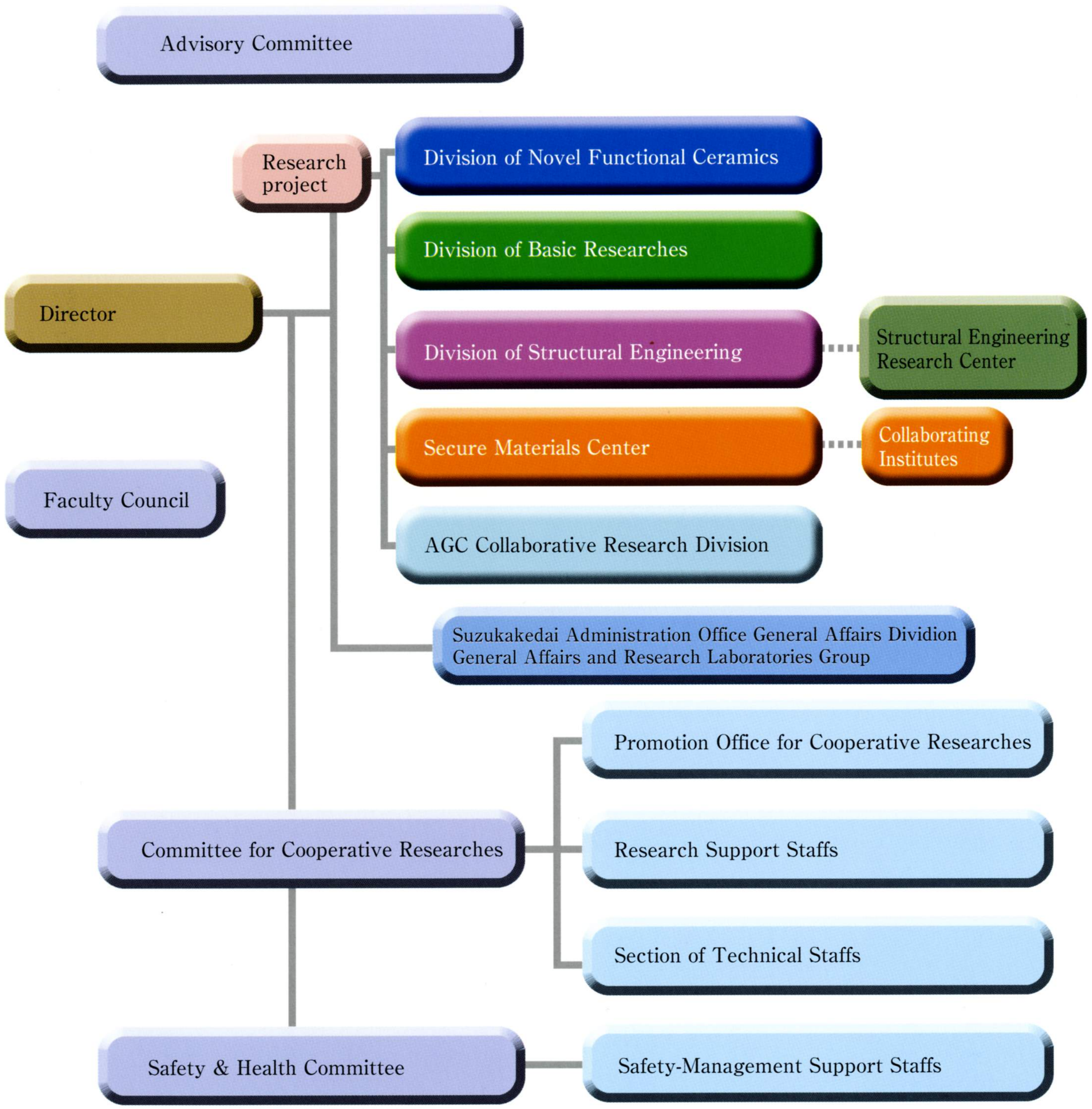
MSL-affiliated researchers are engaged in world-class studies of advanced ceramics, including superfunctional oxides for electronic, photonic and magnetic applications, new high-temperature superconductive iron-based materials and sustainable environmental catalysts based on carbon. MSL is also aiming to create systematic methodologies, applicable to a wide range of materials from fine ceramics, through structural ceramics for giant architectural structures, to composite materials. We are pursuing these goals by studying the relationships between the microstructures of materials at the atomic and electronic scale and the resulting macroscopic material properties. Furthermore, MSL proposes a new concept for future ceramics, namely self-organized materials for human beings. To realize this concept, we are studying “Materials Dynamics” to enable us to control materials and attempt to understand how to change their crystal structures.

The Secure Materials Center (SMC) was established on April 1, 2006, as an affiliated research center with a lifespan of ten years. SMC promotes materials research from the point of view of its sociological effects, to promote the safety and security of human society as well as setting academic criteria. The Structural Engineering Research Center (SERC), which is an affiliate of Tokyo Tech, is supervised mainly by the members of the architectural research group within the MSL laboratory. Its purpose is to develop materials that are designed primarily to benefit the “Human Element” or the end-user.

All the continuing MSL activities are developing from the research concept and ethos of the former Research Laboratory of Engineering Materials (RLEM). This institution includes two major laboratories. The Research Laboratory of Building Materials was established just after the 1923 Great Kanto Earthquake, and focused on the development of building materials for human safety. The Research Laboratory of Ceramic Industry pioneers the development of novel materials by careful and detailed study of complex inorganic materials. This year marks the starting of the six years of the 2nd Mid-Term Objectives and Plan, set up after the change from a national university to a national university corporation. This brought about great changes in the circumstances of the research laboratories attached to the various national universities. However, all the members of the MSL have been able to maintain their cutting edge activities in materials research. It is therefore vital that our laboratory continues to receive strong support from all concerned parties to ensure its ongoing development.

April 2010
Director Kiyoshi Okada

Organization



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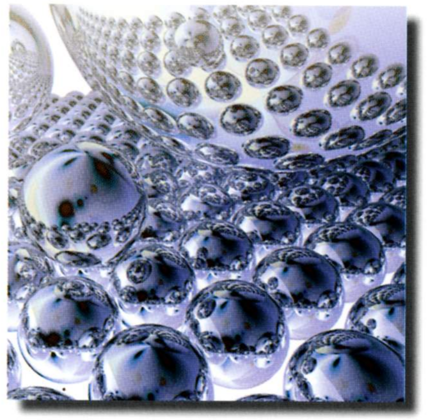

History

- **March. 1934** "Laboratory for building materials" starts as an attached laboratory of Tokyo Institute of Technology
- **January. 1943** "Laboratory of ceramics" starts as an attached laboratory of Tokyo Institute of Technology
- **May. 1949** "Laboratory for building materials" and "Laboratory of ceramics" change to the attachment laboratory of Tokyo Institute of Technology
- **March. 1958** "Laboratory for building materials" and "Laboratory of ceramics" were reorganized to form the "Laboratory of Engineering Materials"
- **May. 1996** "Laboratory of Engineering Materials "was reorgnized to form the "Mateirals and Structures Laboratory (MSL)" as nationwide collaborative research laboratory"

Directory of the Laboratory (April 1, 2010)

MATERIALS AND STRUCTURES LABORATORY
TOKYO INSTITUTE OF TECHNOLOGY

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Professor Hiroshi HASHIDA
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Professor Masahide KATAYAMA
Professor Takuji HAMAMOTO

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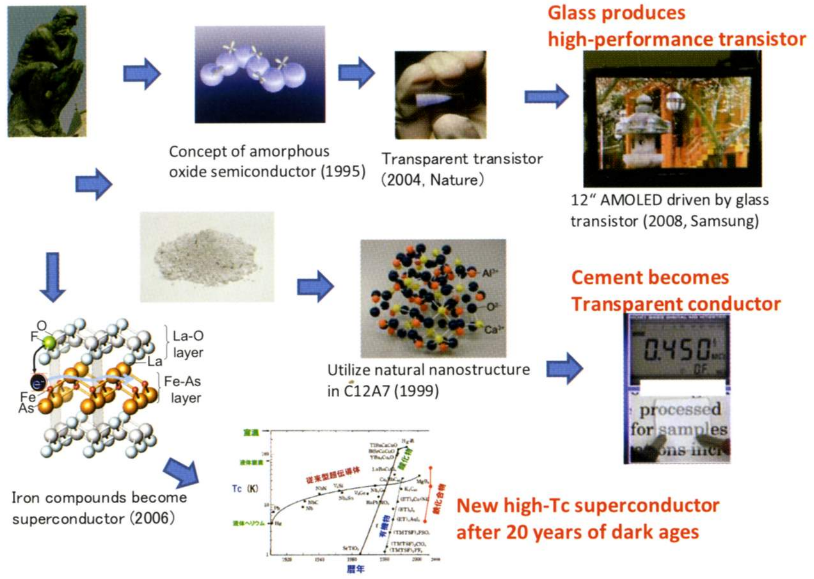
Pu Wuchuan
Thathan Sivakumar
BUN, Kimngun
KADIROVA, Zhukra C.
Luis De Los SantosValladares

Division of Novel Functional Ceramics

Creation of novel functional materials from ubiquitous elements and inorganic materials

Revolution of materials has created new ages. Our aim is to create new materials that drastically improve our society and/or trigger a hot trend in worldwide research. The invention of electro-conductive cement has led to a national initiative "Element Strategy," the realization of high-performance TFTs using amorphous oxide semiconductors facilitates to industrialize next generation flat-panel displays, and the discovery of iron pnictide superconductors rekindled the 2nd fever in superconducting material research.

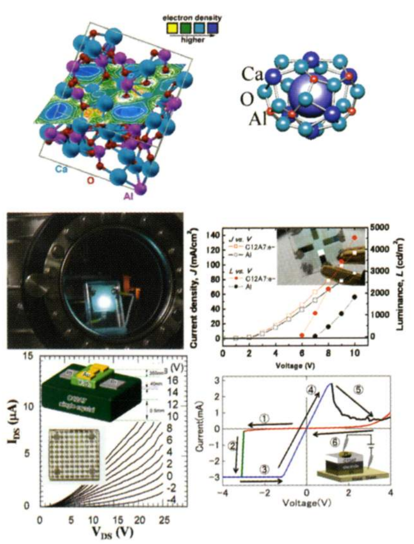
Professor : Hideo Hosono
Assoc. Prof. : Toshio Kamiya
Assist. Prof. : Satoru Matsuishi



'True Nanotechnology' converts traditional oxide materials to novel electronic materials

Hosono-Kamiya Lab

Development of practical electronic devices using novel inorganic materials



Crystal / electronic structures and device applications of C12A7:e⁻

Prototype displays using amorphous oxide TFTs

One prominent example is amorphous oxide semiconductor, which is superior to amorphous silicon and expected for next-generation FPDs and flexible electronic devices.

Search for wide bandgap p-type materials has developed room-temperature operation of blue excitonic LED and oxide p-channel TFTs.

Air-stable inorganic electride C12A7:e^- is a new exotic material that has a very low work function and high electron activity, which can be used for plasma fluorescent, electron emitter, ReRAM etc.

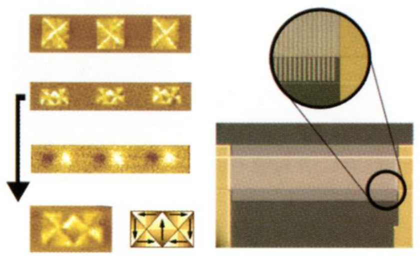
Professor: Hideo Hosono
Assoc. Prof.: Toshio Kamiya
Assist. Prof.: Satoru Matsuishi

Hosono-Kamiya Lab

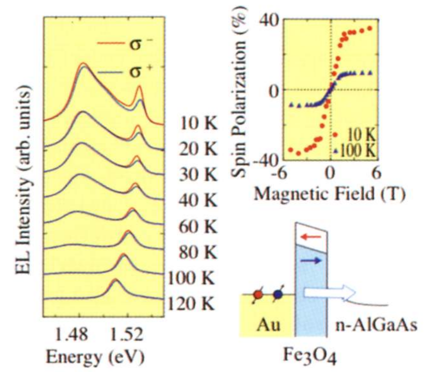
Spintronics and magnetic nanostructures

Our current interest orients towards a full understanding of the basic physics underlying spin injection, detection, and manipulation, with a view to developing a major new direction in electronics - so called spintronics. In order to inject and detect electron spins, we employ a combined optical approach such as optical spin orientation and circular polarization analysis of electroluminescence in ferromagnet /semiconductor heterostructures. Electric manipulation of magnetic domain structures using a ferromagnet /ferroelectrics heterointerface also meets our target. We envisage that spintronics leads to the prospect of a vastly range of design possibilities for electronic devices where magnetic nanostructures has now entered in a very fundamental manner.

Professor: Mitsuru Itoh
Assist. Prof.: Tomoyasu Taniyama
Assist Prof.: Hiroki Taniguchi



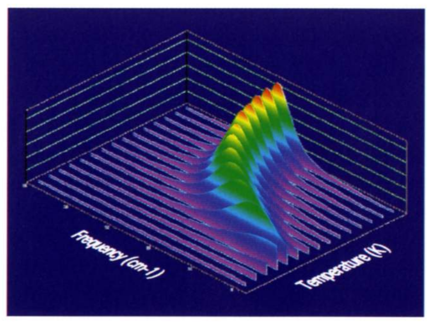
Magnetic domain structures and a typical spin injection micro device.



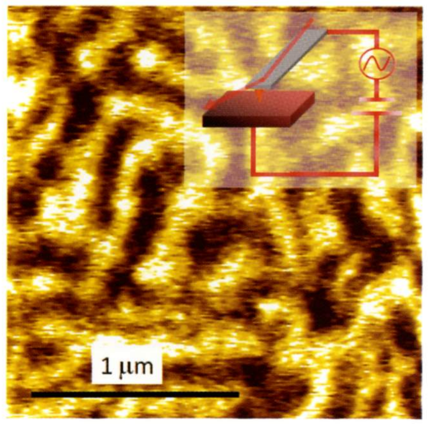
Circularly polarized electroluminescence in a spin injection condition using a ferrimagnetic material/ semiconductor heterostructure.

Ito-Taniyama Lab

Oxide materials tailoring



Temperature dependence of ferroelectric soft mode frequency in ideal displacive type ferroelectric $SrTi^{18}O_3$.



Maze pattern of relaxor ferroelectric surface observed by piezo-force microscope(PFM).

Our major field is Inorganic Solid State Chemistry. The properties of the materials, dielectricity, magnetism, electronic and ionic conduction, optical property and others, depend on their electronic and crystal structures. That is, the design of the new materials with the desired property is a kind of methodologies, how to select the elements from the periodic table and to optimize the structures. So we are accumulating the knowledge of the material design through the deduction and induction for the known and new materials. As a result, we have succeeded in finding new materials more than 100 including superionic conductors, high temperature quantum paraelectrics, ferroelectrics, piezoelectric oxides, spin glasses, and electronic conductors for the past 10 years.

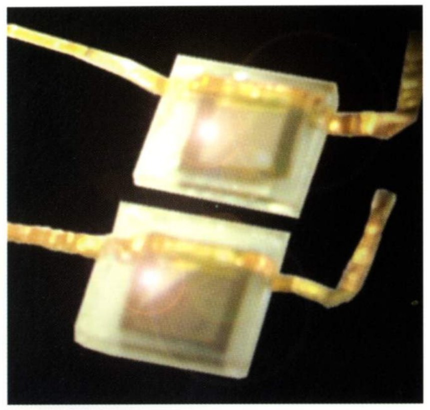
Professor: Mitsuru Itoh
Assoc Prof.: Tomoyasu Taniyama
Assist Prof.: Hiroki Taniguchi

Ito-Taniyama Lab

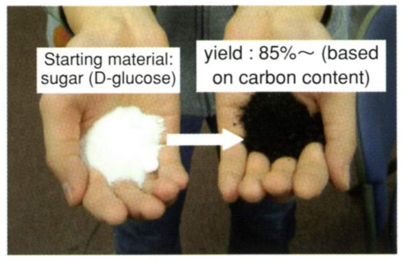
Creation of novel catalysts and materials for the eco-friendly production of energy and chemicals

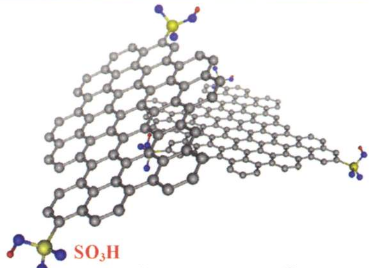
It is essential for our survival to produce chemicals and energy with small environmental load. We have been trying to create materials and catalysts for the eco-friendly production of chemicals and energy. Our "sugar catalyst" -which is composed of nanographen sheets- exhibits remarkable catalytic performance for the production of biofuels and various industrially important chemicals. We have also found that pyrolysis of abundant and inexpensive organic compounds results in a novel n-type semiconductor and have been constructing a new solar cell based on the material.

Professor: Michikazu Hara
Assist Prof.: Kiyotaka Nakajima
Assist Prof.: Masaaki Kitano



Novel solar cell system based on a n-type carbon semiconductor





"sugar catalyst"

An amorphous carbon consisting of nanosized graphene sheets (1-2 nm) with large amounts of SO_3H groups

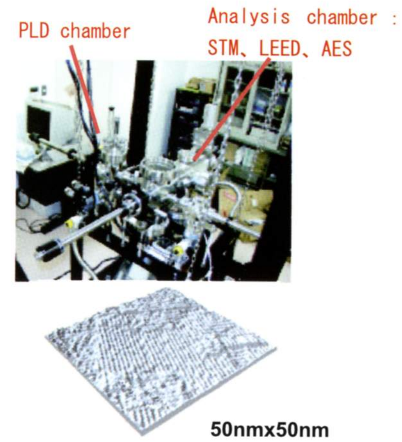
Hara Lab

Nano-engineering of surface and interface in ceramics

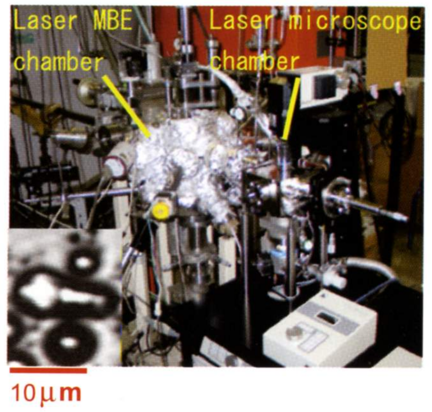
Studies on super functional oxide nano materials and devices as well as new material processing in vacuum utilizing ceramics solid-liquid interface are going on in this laboratory. Laser molecular beam epitaxy (MBE) for high-quality oxide thin films and surface analyses with STM/AFM, LEED/AES and XPS for their characterizations are the key technologies in our laboratory. Currently, our effort is focused on such topics as follows.

1) Laser MBE growth of oxide films: Flux-mediated epitaxy for real oxide single crystal films
2) Field effect chemical devices: oxide electronics and photocatalysis in TiO_2-based wide-gap oxides.
3) Surface chemistry of transition metal oxides: exploration of new low dimensional nano structures and properties of ceramics.

Assoc. Prof.: Yuji Matsumoto



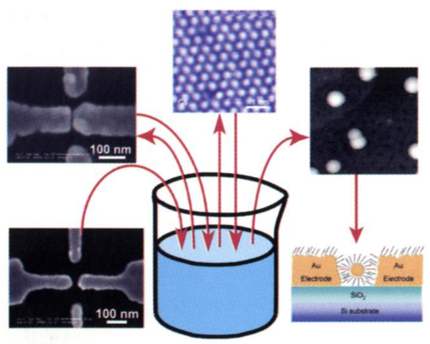
In situ PLD-STM system equiped with LEED/AES for studies on oxide surface nano-structures. The atomic struture of an anatase TiO_2 (1x4) film surface was investigated by STM.



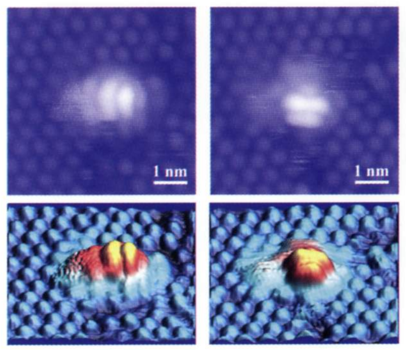
In situ PLD-laser microscope system for studies on solid-liquid interface in vacuum. The inset is a real-time imaging of BiOx liquid droplets by the laser microscope

Matsumoto Lab

Molecular devices and nanoparticle devices by utilizing bottom-up processes



"Bottom-up electronics" enables us to fabricate molecular devices and nanoparticle devices by self-assemble processes.



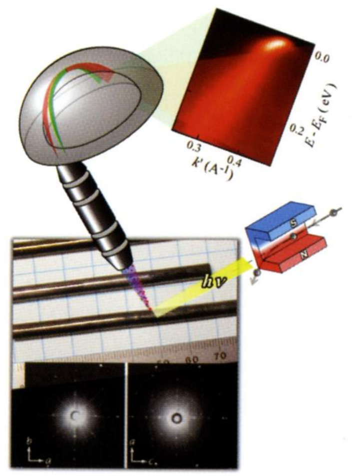
Smallest switch (1 nm) by endohedral metallofullerene observed by molecular resolution STM.

Bottom-up electronics enables us to fabricate single-electron devices and molecular devices with high sub-nm precision by simply dipping a sample into a beaker. To establish these devices, we control the tunneling probability between nanogap electrodes and the Coulomb island of a nanoparticle or a functional molecule by selecting a suitable molecular structure. Both molecular-resolution images and the electrical properties of the Coulomb island have been obtained by scanning tunneling microscopy (STM) and scanning tunneling spectroscopy (STS), respectively. We have also demonstrated Coulomb blockade phenomena of a Au nanoparticle and a functional molecule by molecular-resolution STM and STS, and introduce established the bottom-up processes toward the realization of solid-state single-electron devices and molecular devices by utilizing the results obtained by STM and STS.

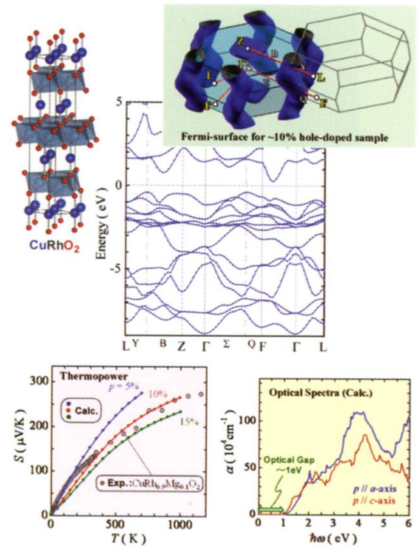
Professor : Yutaka Majima
Assist Prof. : Yasuo Azuma
Assist Prof. : Norio Okabayashi

Majima Lab

Explorations into super-functions in ceramic materials



Growth of high-quality large single crystals of ceramic materials by a FZ technique, followed by direct observations of their electronic structures using ARPES.



Nano-simulations of electronic properties (band dispersion, Fermi-surface, thermoelectric power, optical spectra, etc.) of ceramic materials by means of first principles calculations.

Our goal is to understand, to utilize, and to create "super functions" in ceramic materials (e.g., high-T_c superconductivity in layered copper oxides). For these ends, we are extending our expertise to full aspects of approaches in materials science; (1) syntheses: preparations of samples with precisely controlled compositions / non-stoichiometry, and growth of large high-quality single-crystals, (2) measurements: state-of-the-art techniques of quantum observations such as electronic states by angle-resolved photoemission spectroscopy and phonon states by inelastic x-ray scattering, and (3) theoretical analyses/predictions: nano-simulations based on first principles calculations.

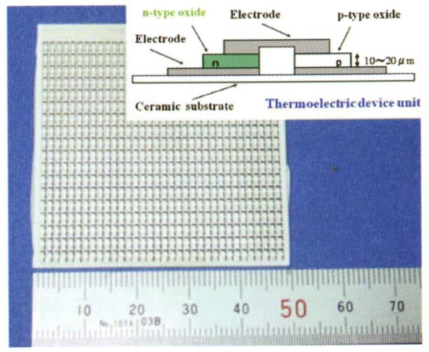
Assoc. Prof.: Takao Sasagawa

Sasagawa Lab

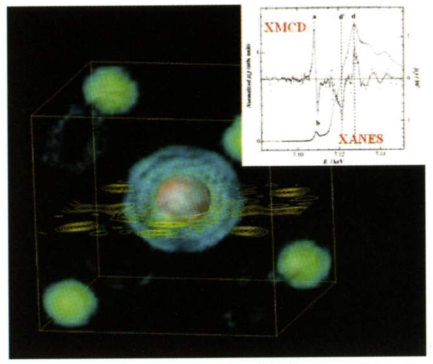
Behavior of electrons and synchrotron X-rays

Our study is central to understanding the behavior of electrons in the crystalline solid and examining the relationship between the crystal structure and physical property in materials. In addition to our laboratory's facilities, we have been instrumental in developing BL-6C beamline at the Photon Factory. Our approach is to study the electronic and magnetic states in oxide materials, magnetic structures through the magnetic resonant scattering, theoretical electronic structures through the first-principles calculations, crystal structures with charge ordering and fluctuation, new methodologies for utilizing synchrotron X-rays and neutrons, new materials for cutting-edge thermoelectric devices, and the earth and space materials under extreme conditions.

Professor: Satoshi Sasaki
Assist Prof.: Maki Okube



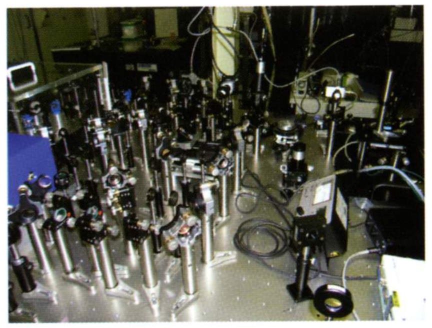
Integrated-circuit module of oxide thermoelectric devices by imprinting on the ceramic substrate.



Theoretical electron-density distribution of Fe_3O_4 and X-ray magnetic circular dichroism of $NiFe_2O_4$.

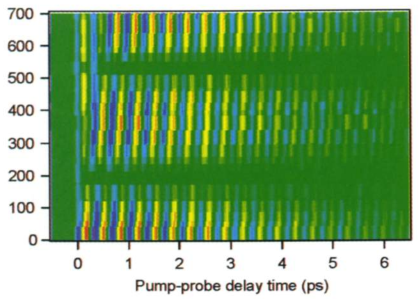
Sasaki Lab

Ultrafast dynamics and coherent control in condensed matter


Femtosecond time-resolved optical measurement system

Dynamics of electrons, phonons and elementary excitations, which dominate physical properties of materials, occurs within a short time scale faster than nanoseconds. We investigate ultrafast dynamics of carriers, spins, phonons and other quasi-particles in picosecond and femtosecond time scales using ultrafast time-resolved optical spectroscopy and X-ray diffraction. Macroscopic quantum states of phonons such as coherent and squeezed states have been extensively studied on semiconductors, superconductors, and ferroelectric materials. We also perform a coherent control of quantum states in a condensed matter to optically control physical properties using precisely controlled femtosecond laser pulses and study the quantum decoherence.

Assoc. Prof.: Kazutaka Nakamura



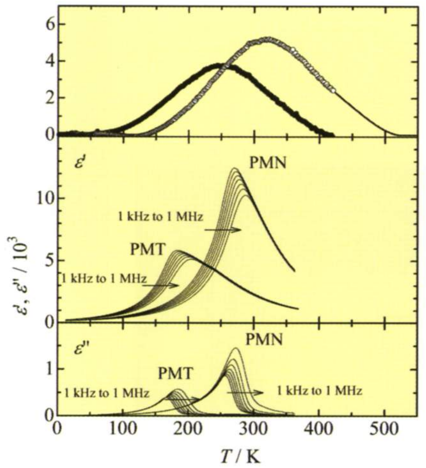
Optical control of coherent optical phonons in bismuth

Nakamura Lab

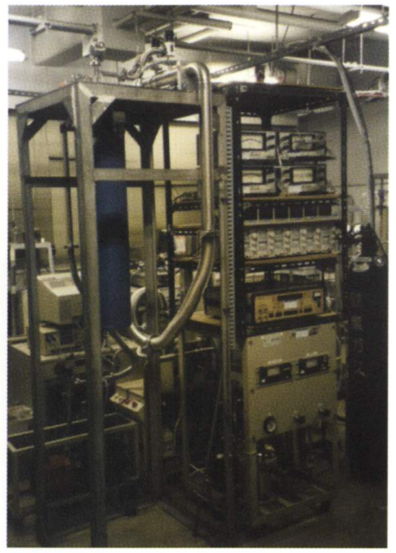
Elucidation of phase transitions and function of materials

The elucidation of the mechanism of phase transitions in various kinds of materials is required as the phase transition affects the functionality of the material. We are especially trying to understand the effect of crystal imperfection to the phase transition behavior. The effects of impurities to the magnetic phase transition and the magnetism in frustrated spin systems, the limited particle size effects to ferroelectric substance and molecular crystals, and the pinning effects in incommensurate phase transitions are studied. The possibility to control the phase transition behavior by nano-structure controlling is examined.

Assoc. Prof.: Hitoshi Kawaji

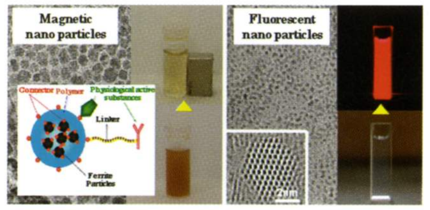


Excess heat capacity and dielectric constant anomaly due to the formation of polar nano region in relaxors


High precision adiabatic calorimeter

Kawaji Lab

Advanced solution processes for functional ceramics



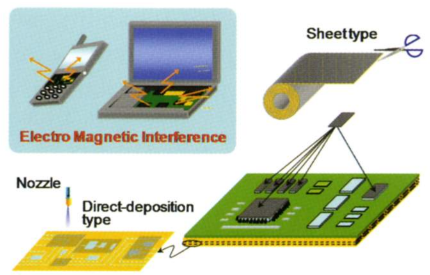
Nano-particles having magnetic and fluorescent properties applicable for bio beads.

There are functional ceramics which can exhibit very attractive properties such as magnetic, dielectric, luminescent, and (photo) catalytic ones. Most of these functional ceramics are prepared by high temperature process causing a large environmental load and that restrict their chances for the applications. Our group is investigating a development of a novel low temperature process named "Soft Solution Process," to fabricate various functional ceramic films, powders and patterning, and to realize their practical applications.

The representative research topics are listed below;

1) Development of novel solution processes, such as ink-jet, spin-spray, and high-frequency induction heating.
2) Ferrite films and patterning applicable for conducted noise suppressors in GHz range.
3) Fabrication of bioactive ceramic layer on bulk metallic glass surface by Electrochemical Hydrothermal method and application for implant materials.
4) Functional nano particles having magnetic and fluorescent properties and their biomedical applications.

Assoc. Prof.: Nobuhiro Matsushita



Ferrite plated films applicable for conducted noise suppressor in GHz range.

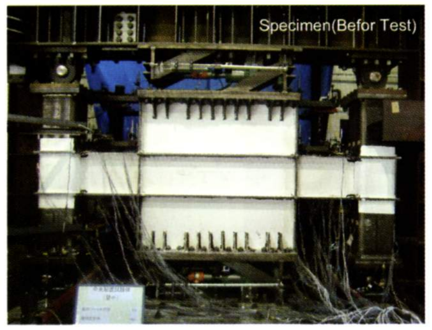
Matsushita Lab

Division of Structural Engineering
(Structural Engineering Research Center)

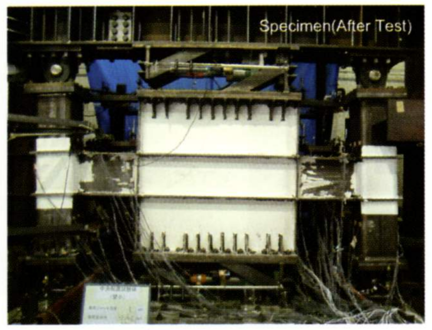
Damage contralled seismic design for building structures

Lessons learned from the Northridge earthquake in the US 1994 and Hyogoken-Nanbu earthquake in Japan 1995 told us the great importance of damage controlled seismic design for the civil and building structures. The objectives of our research are that, 1) to develop the methodology of damage controlled seismic design for building structures; 2) to develop various effective devices of passive energy dissipation systems, such as hysteretic dampers, viscoelastic dampers, etc.; 3) to develop intelligent dynamic analysis systems for damage controlled seismic structures. Our researchers are based on the theory derivation, computer analysis, and experiments.

Professor: Akira Wada
Assist. Prof.: Shoichi Kishiki



Dynamic test of viscoelastic dampers



Dynamic test of steel beam-end connections

Wada Lab

Study on passively-controlled building and base-isolated building

The use of various dampers that absorb seismic energy and reduce building sway/damage is addressed. The above figure shows the full-scale specimen of a 5-story building with dampers which we tested using the world's largest shake-table at E-Defense. The new technology is also applied to houses. There are 24 million houses in Japan, and half of them are recognized to be seismically deficient. The left figure shows a portion of a 2-story wooden house, and house damper units which we have developed, patented, and commercialized. Other topics are: building base-isolation, steel structure, and pounding of adjacent buildings during an earthquake.

Professor: Kazuhiko Kasai
Assist. Prof. : Kazuhiro Matsuda

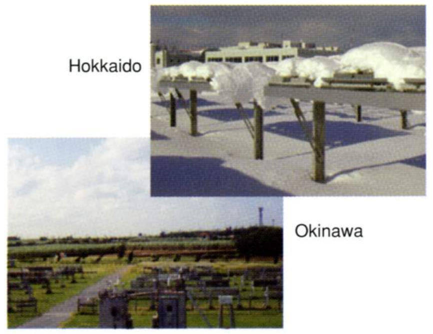

Development and Test for Wooden House with Passive Control System


Full-scale Test of 5-story Building with Dampers Using World's Largest Shake-table at E-Defense

Kasai Lab

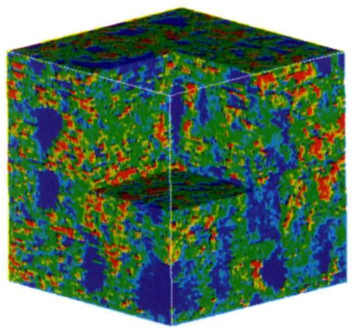
Toward sustainable building

Hokkaido



Okinawa

Outdoor exposure test of building materials


Pore distribution in cement paste obtained through newly developed Ga intrusion technique

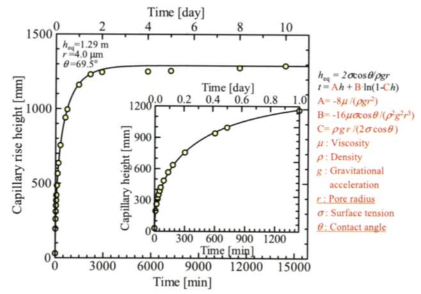
The properties and long-term performance of materials and components for sustainable buildings are mainly investigated here. As they are closely related to weather, we focus, in particular, on deterioration of performance of them by weather. methods to eraluate then and how to improve their service lite.

Durability of concrete, which occupies a significant part of substance of buildings, directly affects their life. We also study the properties of concrete relating to durability such as pore structure of cement paste, permeability of concrete, and carbonation of it.

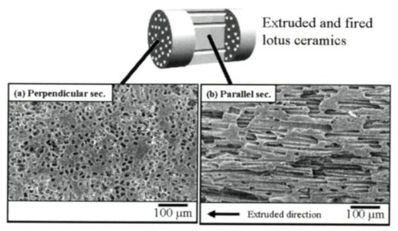
Professor: Kyoji Tanaka

Tanaka Lab

Functional ceramics for water-based energy-saving technology



Excellent capillary rising ability of the lotus ceramics.



SEM micrograph of "lotus ceramics" with controlled macropores.

A wide variety of porous ceramic materials can be prepared and their different pore structures provide the special internal spaces required for reaction with various adsorbates. Our group has developed a new process for producing porous ceramics containing micropores (< 2 nm in size), mesopores (2-50 nm) or macropores (>50 nm), for various applications in which their characteristic properties are exploited. Microporous ceramics act as highly functional vapor adsorbents showing micropore filling phenomena that may make them useful as chemical heat pump materials. Mesoporous ceramics have the potential to control humidity by exploiting their capillary condensation-evaporation hysteresis properties. Macroporous ceramics have potential applications as passive cooling materials for counteracting heat island effect because of their high capillary lift ability (>1 m). In addition, ceramics with hydrophilic and hydrophobic properties can also be produced, in which various oxide nanosheets are used as surface coating materials. Thus, our main interests are in a variety of functional ceramics for water-based energy-saving technology.

Professor: Kiyoshi Okada
Assist Prof.: Kenichi Katumata

Okada Lab

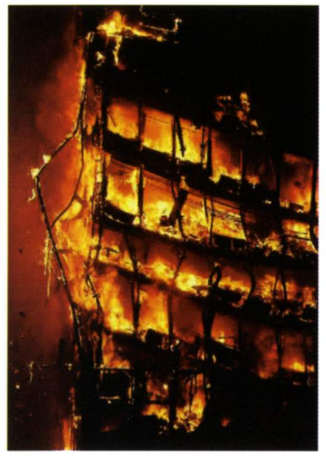
Clarify the characteristics of building construction materials at high temperatures

In a fire, it has the possibility that damage due to the deterioration of the material and the thermal stress, occurs in the framework of the structure.

To predict the behavior of the structure and it's damage during a fire, it is important to make clear the mechanical properties of steel and concrete materials at high temperatures. In this Laboratory, it has being studied about the mechanical properties, especially the stress-strain relationship and creep-strain in the temperatures ranges from 20 to 800℃. In addition, in order to the verification of validity of these data, test results of structural members, such as column, beam, a high strength bolt friction joints, are compared with the numerical analysis result.

Assoc. Prof.: Takeo Abe

Compression test on cross-section of the column at high temperatures (500 degrees Celsius)

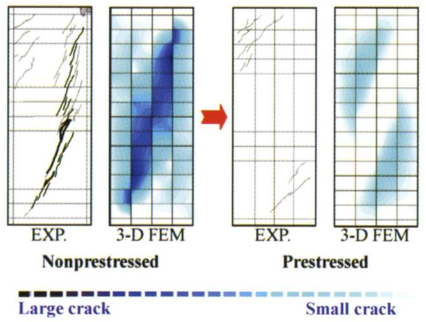


Windsor Building Fire at Madrid in Spain (Associated Press)

Abe Lab

Crack behaviors in concrete structures

Deterioration of RC building in the coast of a bay



Improvement of durability of RC column by transverse prestressing

As earthquake-resistant design of reinforced concrete (RC) buildings is making the transition to performance-evaluation design from technical-specification design, it is necessary not only to gather information on maximum shear carrying capacity relevant to safe performance, but also to evaluate subsequent operating performance and durable performance for continuous use, based on the damage to a building after an earthquake. In RC buildings, crack width is treated as a measure of damage evaluation in many cases, and plays an important role in the verification of damage limits. In our laboratory, the mechanical properties of cracks in RC building have been examined in detail, and the effects of crack behaviors on the structural performance have been investigated experimentally and analytically from the viewpoint of serviceability, durability and safety.

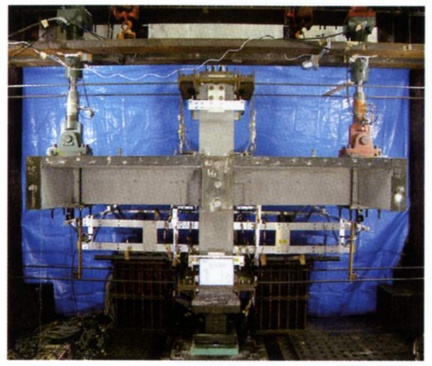
Assoc. Prof.: Yasuji Shinohara

Shinohara Lab

Protection of concrete and timber buildings against disturbance

Main research project is the solution of mechanical behavior and the establishment of safety of concrete composite structures and timber structures. Study on damage controlled Precast-Prestressed concrete structures with P/C mild-press-joint is carried out in order to clarify the mechanical behavior and to establish of design method. The research subject also includes experimental study on mechanical behavior of floor framing with opening, experimental study and establishment of design method of wooden frames with velocity-dependent dampers or deformation-dependent dampers, and experimental study on moment resisting timber structures. Estimation method of moment and rotation angle relationships of moment resisting joint is proposed.

Assoc. Prof.: Hiroyasu Sakta

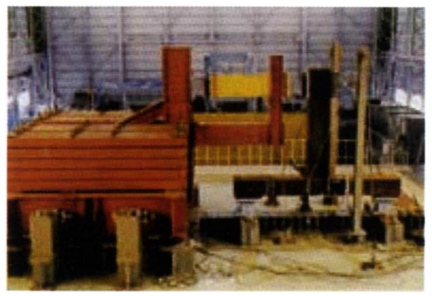


Experiment on Mechanical Behavior of Cruciform Frame with Floor Slab Constructed using PC-Mild-Press Joint Method

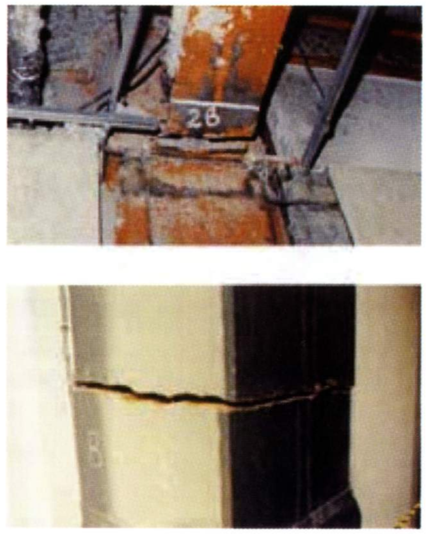
Experiment on Shear Behavior of Thick Structural Plywood Sheeted Floor Framing with Opening

Sakata Lab

Estination of ultimate earthquake resistance of steel buildings



Full Scale Shaking Table Test of Beam-to-Column Connection



Brittle Fracture in Kobe Earthquake

It is very important to evaluate the ultimate earthquake resistance of building structures to prevent the fatale damage on building and civil structures under earthquake. In our laboratory, to clarify the ultimate earthquake resistance of building structure, following theme is studied. 1) Inelastic response analysis of multi-story steel moment flames based on the realistic behavior of members. 2) Dynamic loading test on the full scale structural element made by the material of the various performance. 3) Estimation of earthquake resistance of the moment resistant steel frames under the past fatal earthquake.

Assoc. Prof.: Satoshi Yamada

Yamada Lab

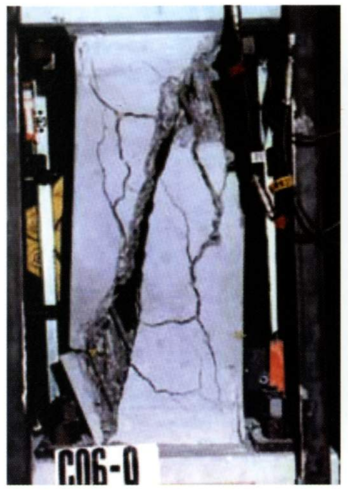
Secure Materials Center

For safe and secure buildings

This group is concerned with the basic behavior of reinforced concrete members to make the reinforced concrete building proof against the strong earthquake and durable. It has been definitely shown by Hanshin-Awaji Earthquake Disaster in 1995 that knowing the function of building remained after shock. We have to explain the behavior of the building during earthquake and the process of failure.

Strong earthquakes bring out the tremendous explosions at gasholders or powder plants. In order to protect human against those explosions, it is necessary to study the damage of a structure from them.

Professor: Shizuo Hayashi
Assist Prof. : Yo Hibino

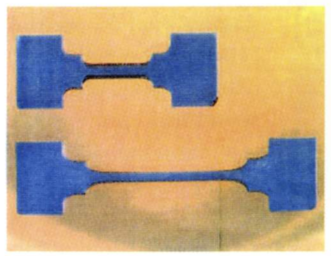


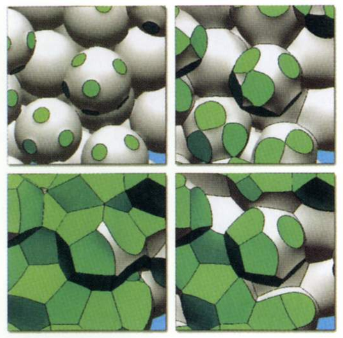
Experimental result


Damage from earthquake

Hayashi (s) Lab

Towards an architectural design of secure materials


Finding of ceramics superplastiicity in a silicon-nitride based composite (Nature 1990)


Sintering simulation in three dimensions (3D) (2006)

Most ceramics are hard, chemically inert, and refractory, then, they are used for a multitude of applications, e.g., energy, transportation, production, and construction systems. On the other hand, they are brittle in nature, and their strength is limited by microscopic defects. We aim to develop technology for increased reliability of ceramics, which will be key components for realizing safe and secure systems. The ductile ceramics is still a dream, but, the finding of ceramics superplasticity brought about a unique net-shape manufacturing method for future ceramic industry. The main challenges are to provide basis for developing highly efficient superplastic forming of toughened ceramics. Furthermore, we are developing modeling and simulation technology to make more reliable ceramic components by controlling microstructural heterogeneity during sintering.

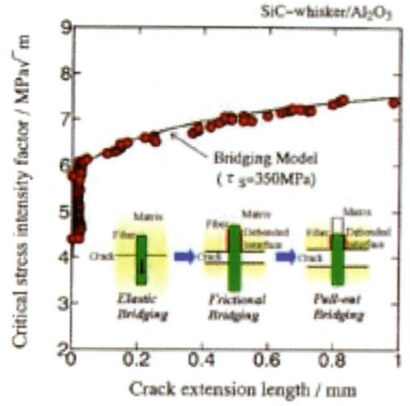
Professor: Fumihiro Wakai
Assoc. Prof.: Takashi Akatsu
Assist Prof. : Yutaka Shinoda

Wakai-Akatsu Lab

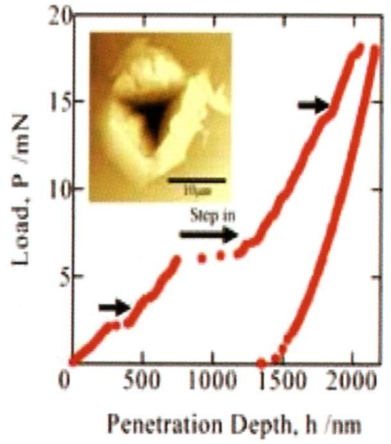
Research on secure materials from a viewpoint of a locally concentrated stress field

The fracture and plastic deformation of ceramics substantially progress from a local phenomenon that should be observed in the same scale as the microstructure of the material. The aim of our research project is to know how we can develop ceramics with high strength and toughness through the study of local fracture and deformation behavior at a crack tip or under an indentation with nano or submicron scale. We have developed a technique to evaluate the local mechanical properties of materials, which is widely applicable for advanced materials such as MEMS parts or thin films.

Professor: Fumihiro Wakai
Assoc. Prof.: Takashi Akatsu
Assist Prof. : Yutaka Shinoda



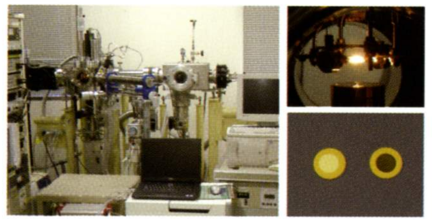
R-curve behavior of whisker reinforced ceramic composite (Dots:experimental values, Solid line:estimation of a crack face bridging model.)

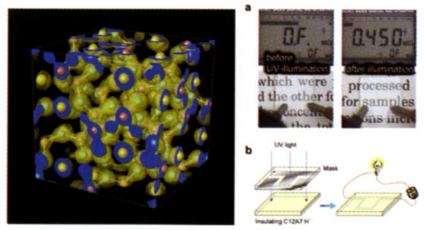


Nanoindentation on a highly oriented pyrolytic graphite and the AFM image of a residual impression.

Wakai-Akatsu Lab

Ceramics that control active ions and radicals


The experimental apparatus for the evaluation of oxygen radical emission (left). An incandescent emission source and a quadrupole mass spectrometer (upper right). Oxidation of a silver film on a quartz-crystal microbalance (lower right).


The cage structure of C12A7 revealed by the synchrotron X-ray diffractmetry (left). A C12A7 thin film before and after ultraviolet light illumination (right a). Patterning of 'invisible' electronic circuit (right b).

Certain metal oxide ceramics can act as mediums that generate, store and transport ions and free radicals in unusual states. We aim at understanding their physical and chemical properties and developing these properties to new functional materials and devices. For example, we found hydride (H^-) ion is stabilized in the cage of $12CaO \cdot 7Al_2O_3$ (C12A7) crystal with a nanoporous structure. A light illumination converts it to a transparent electronic conductor. This is a first discovery of an electronic conductivity in light-metal oxides. We also found that incandescently-heated zirconia ceramics intensely emits atomic oxygen into vacuum. This phenomenon serves as an efficient oxygen radical source.

Assoc. Prof.: Katsuro Hayashi

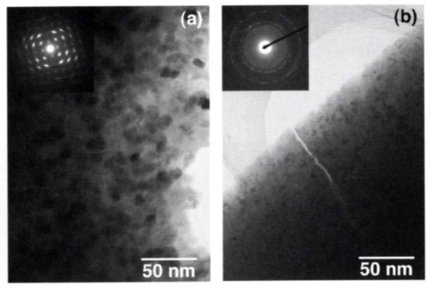
Hayashi (k) Lab

Functional fragmentation controlled by phase transitions

Intrinsically, every material has limitation in strength even though materials researchers have devoted considerable effort to develop strong structural materials. By changing the way of thinking, we are proposing new concept, so called “functional fragmentation”, in which materials themselves fragment to save our lives. Development of new structural materials with designed fragmentation is our future goal. To realize such a function, phase transitions and/or chemical reactions induced by temperature or pressure should play an important role, because such a phase changes can be regarded as intelligent active function against external conditions. As basic investigations, shock-induced phase transitions and chemical reactions are explored from microscopic level, and then application to new safe structural materials will be examined.

Assoc. Prof.: Toshiyuki Atou

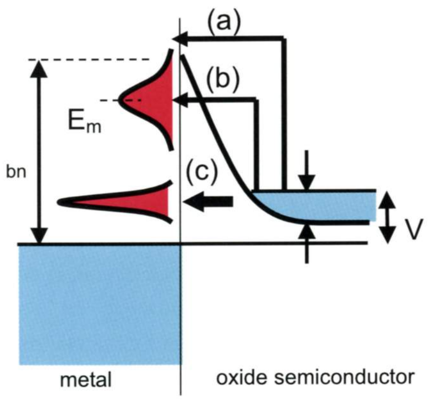
Two-stage light gas gun can generate a velocity up to 4 km/s.



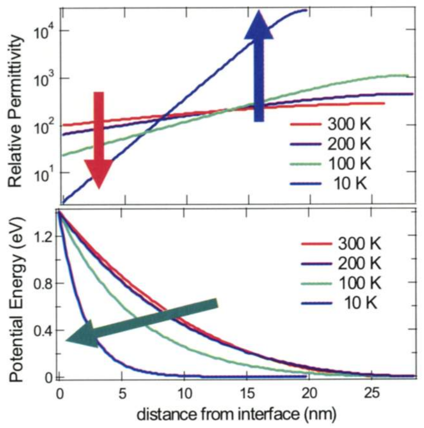
Shock compressed mullet ceramics indicate peculiar nano structure (a) and microscopic decomposition to alumina and silica (b).

Atou Lab

New functionalities at oxide surfaces and interfaces



Schematic potential profile at the interface between metal and n-type $SrTiO_3$. In addition to the thermionic emission (a), thermally-assisted (b) and direct (c) tunneling can contribute to the junction transport when the barrier is thin enough.



Relative permittivity (top) and potential energy (bottom) at the interface between metal and n-type $SrTiO_3$. Relative permittivity strongly depends on the distance from the interface.

Phenomena characteristic of semiconductor interfaces have given rise not only to electronic devices but also to new research areas including quantum Hall effect. We study oxide interfaces in order to develop new functionalities and to find novel electronic structures by high-precision thin film growth, transport and junction characteristics measurements and photoemission spectroscopy, utilizing a large difference between bulk and interface electronic states in oxides. Our goal is to develop artificial electronic states which are useful for device application as well as for scientific research.

Assoc. Prof.:Tomofumi Susaki

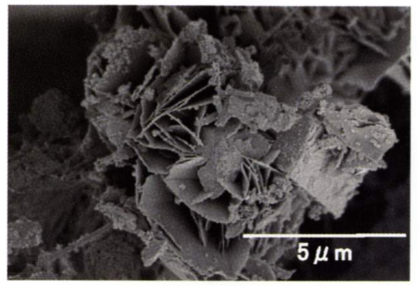
Susaki Lab

Collaborating Institutes

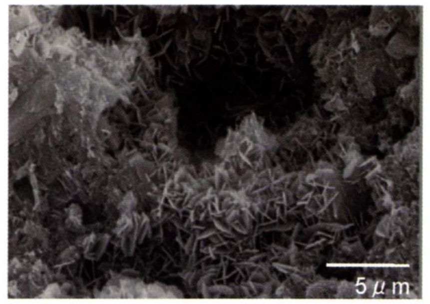
Construction Chemistry

We work on the following themes to solve a lot of problems related to the construction technology from a chemical side. We cover studies of basic research for developments of cement based new materials, new application methods of cement based materials, long-term durability of cement based materials, composite of polymer and inorganic materials, hydrothermal synthesis of building materials, rheology of concentrated suspensions, dispersion mechanisms of polymer dispersants. We also cover studies of fundamental research for the use of industrial waste products in cement raw materials and cement concrete mineral admixtures.

Professor: Etsuo Sakai



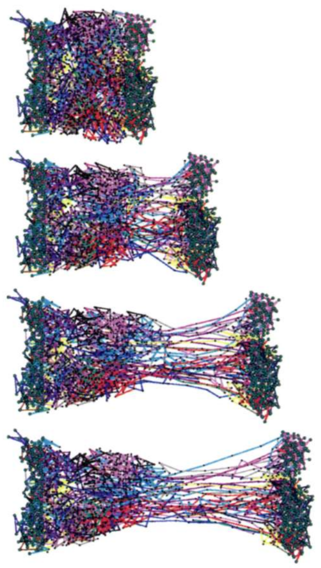
Reaction products in $2CaO \cdot Al_2O_3$ Glass-$CaSO_4$ systems



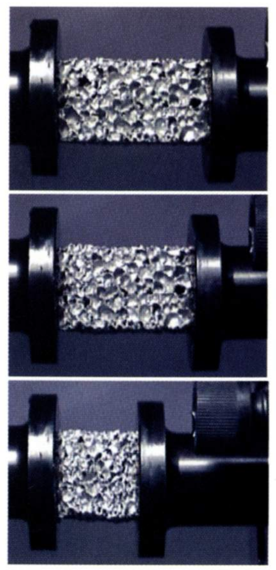
Low temperature hydrothermal synthesis of Tobermorite by using of γ-Ca_2SiO_4

Sakai Lab

Mechanics of Materials for Safety and Security, and toward Comfort Life



Deformation Behavior Simulation of Polymers with Molecular Chain Network Model



Observation of Deformation Behavior of Aluminum Foam under Compression

Realization and development of strong, sustainable and reliable materials and structures are everlasting subject for human beings. They are directly related to recent national issue: ***anzen*** and anshin (security and peace of mind). In order to achieve ***anzen***, ***anshin*** and hence comfortable human life, we are working on analysis, simulation, measurement and evaluation in the fields around Mechanics of Materials. Recent research topics are widely spread as follows: mechanical modeling and evaluation of adhesion and debonding of material interfaces, simulation of polymer deformation with molecular chain model, wavelet analysis of elastic stress waves, development of ultrasonic non-destructive evaluation technique, advancement of stress/strain measurement techniques by inverse analysis, evaluation and improvement of mechanical reliabilities of electronic materials and products, and others.

Professor: Kikuo Kishimoto

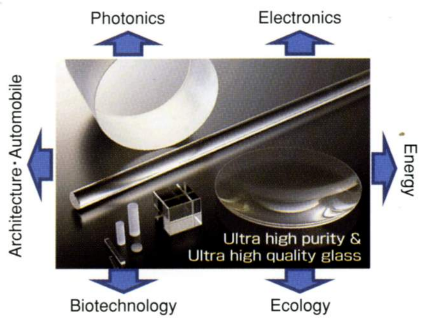
Kishimoto Lab

AGC Collaborative Research Division

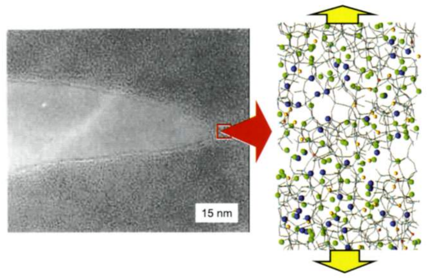
Aiming to create new functional glasses and inorganic materials

Although glass has been used as daily necessities in various fields for a long time, its importance is recently increasing in cutting-edge fields, such as photonics, electronics, energy, etc. Traditionally, glass is made from ubiquitous and environment friendly materials which are abundantly available on the earth. However, since glass is in a nonequilibrium state and has a disordered structure, its essence is still unknown and a lot of unknown functions are expected to be hidden in glass. We study on the relationship between glass structures and properties, and create new functional glasses by designing novel structures and new ceramics made by using the glasses, aiming at creation of useful materials for the society.

Professor: Setsuro Ito
Assist. Prof.: Jiang Li



Development of new functions of glass by controlling composition & structure



Fracture behavior of glass at the crack tip
-Clarifying fracture mechanism & Preventing glass fracture-

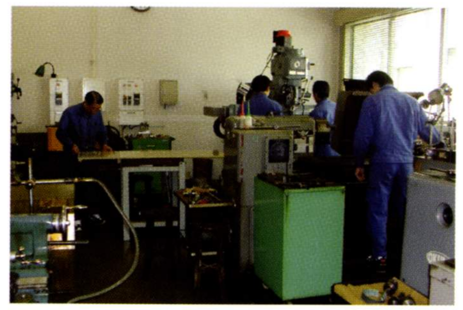
Ito (s) Lab

Promotion Office for Cooperative Researches

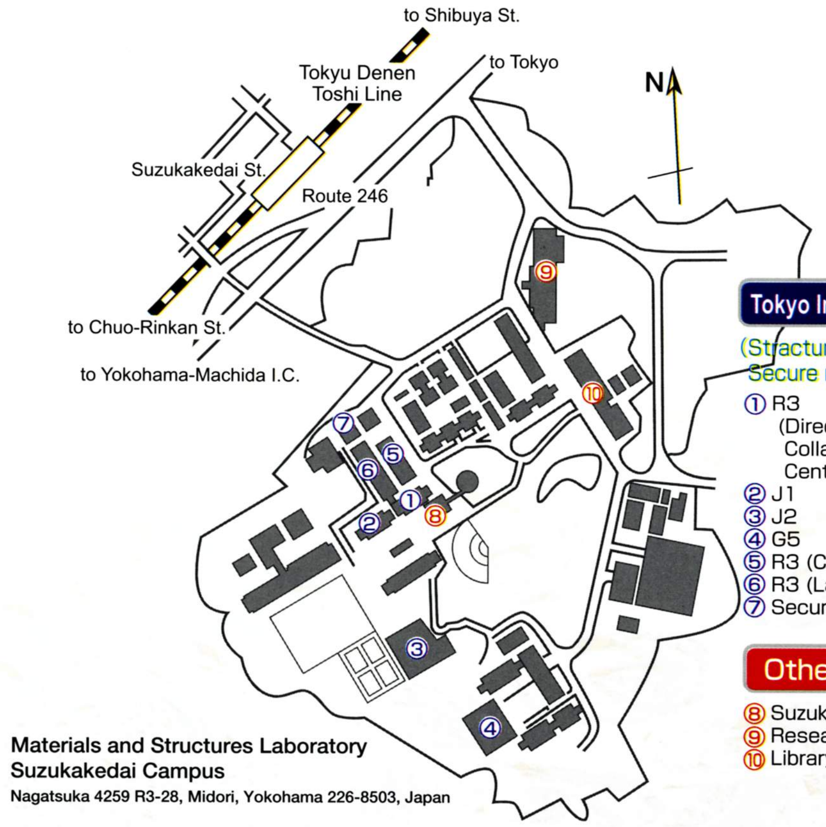
MSL is promoting collaborative research with the researchers in the Universities, Governmental and/or industrial research organizations in Japan as well as overseas utilizing facilities and/or data in MSL.. The collaborative researches are categorized as "General research" , "Specified research" and "Workshops to be held in MSL". In 2009, we promoted 81 project including more than 680 researchers. The dead line for application will be in the middle of February in every year.
E-mail:suishin@msl.titech.ac.jp

Section of Technical Staffs

Research Administrator



The section of technical staffs supports research activities of the laboratory technically. It has a machine shop and the staffs assist sub technical consulting to develop experimental equipments and manufacturing them. Moreover, the sample measurement with equipments for collaborate research. It has the staffs assist maintenance of experimental equipments and management assistance to research activities are supported widely.



Tokyo Institute of Technology

(Stractural Enginnering Research Center, Secure materials Center)

① R3 (Director Office · MSL Administration Office · Collaborative Promotion Office · Center for Materials Design)
② J1
③ J2
④ G5
⑤ R3 (Creative Research Laboratory)
⑥ R3 (Laboratory · Technical Room)
⑦ Secure materials Center Special Laboratory

Othes

⑧ Suzukake Hall
⑨ Research Administration Office
⑩ Library