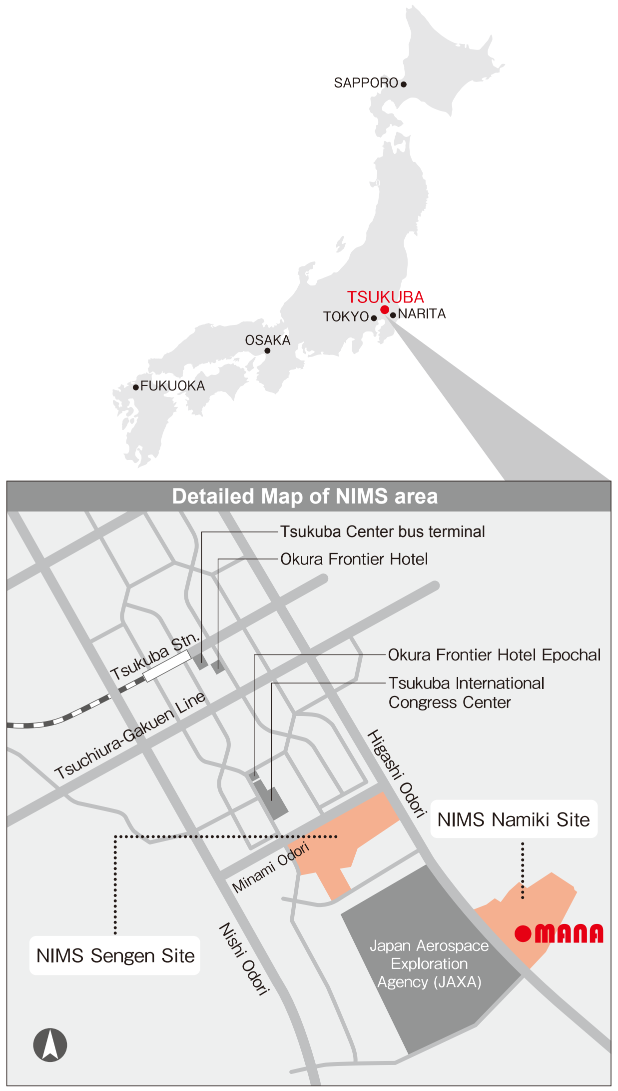

WPI Research Center
International Center for
Materials Nanoarchitectonics
(WPI-MANA)

National Institute for Materials Science

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● The cover STM image "Macroscopic surface-layer superconducting currents were first observed on this surface" by Dr. Takashi UCHIHASHI, MANA Scientist.

2015. 6

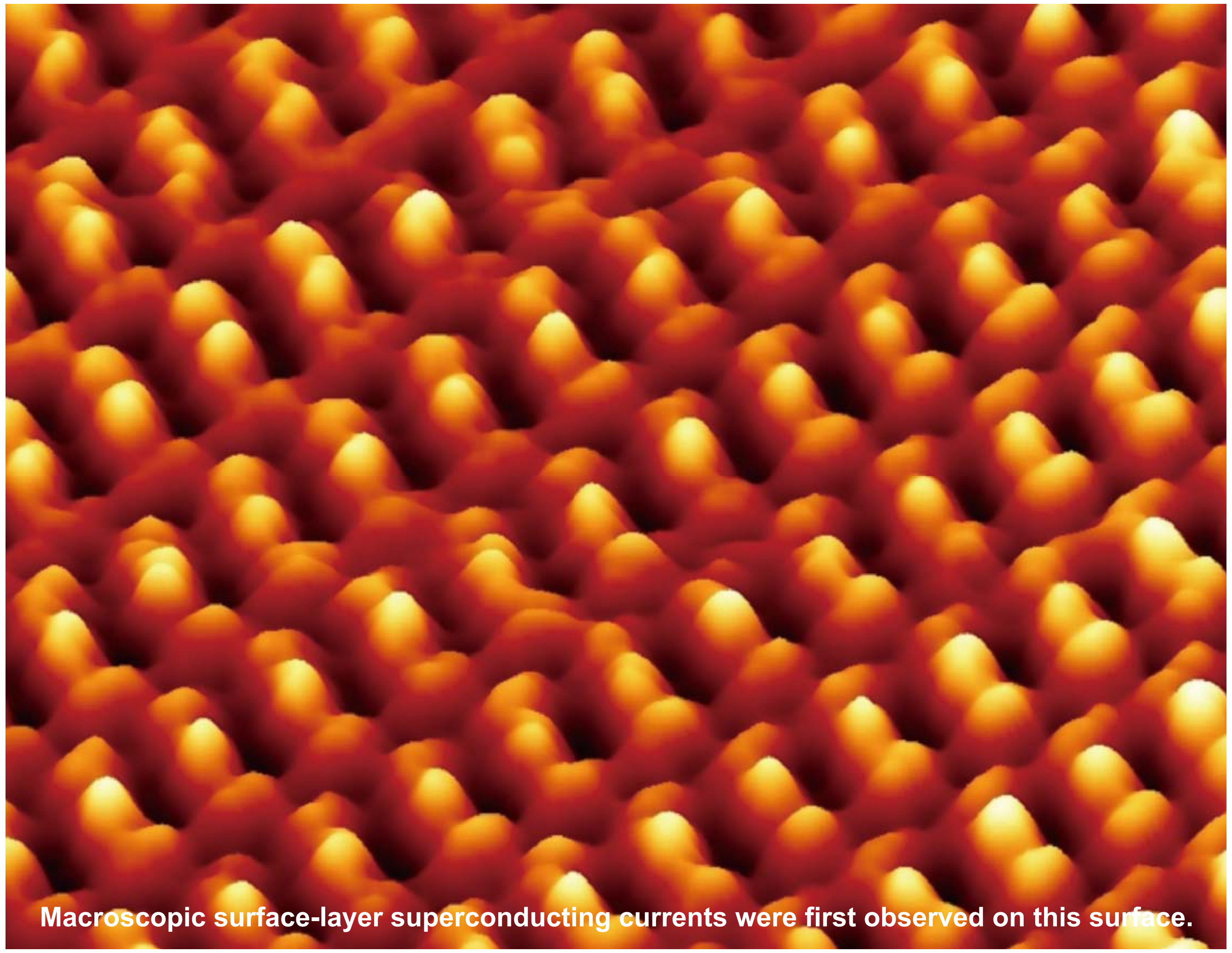
WPI Research Center

International Center for Materials Nanoarchitectonics

MANA

Nanoarchitectonics

Rebuilding of Nanotechnology



Macroscopic surface-layer superconducting currents were first observed on this surface.

Message from the Director-General: What are MANA's goals?

The International Center for Materials Nanoarchitectonics (MANA) was launched in 2007 as one of the first five centers in the World Premier International Research Center Initiative (WPI) sponsored by Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT).* MANA received an excellent evaluation for the results of its first 5-year period and embarked on its second 5-year period in 2012.

If humankind is to continue on a path of sustainable development in the years to come, we must realize a variety of innovative technologies in every field, including the environment, energy, resources, information and communications, medical diagnosis and treatment, and infrastructure, among others. However, many of these innovative technologies cannot be realized if we do not develop appropriate new materials.

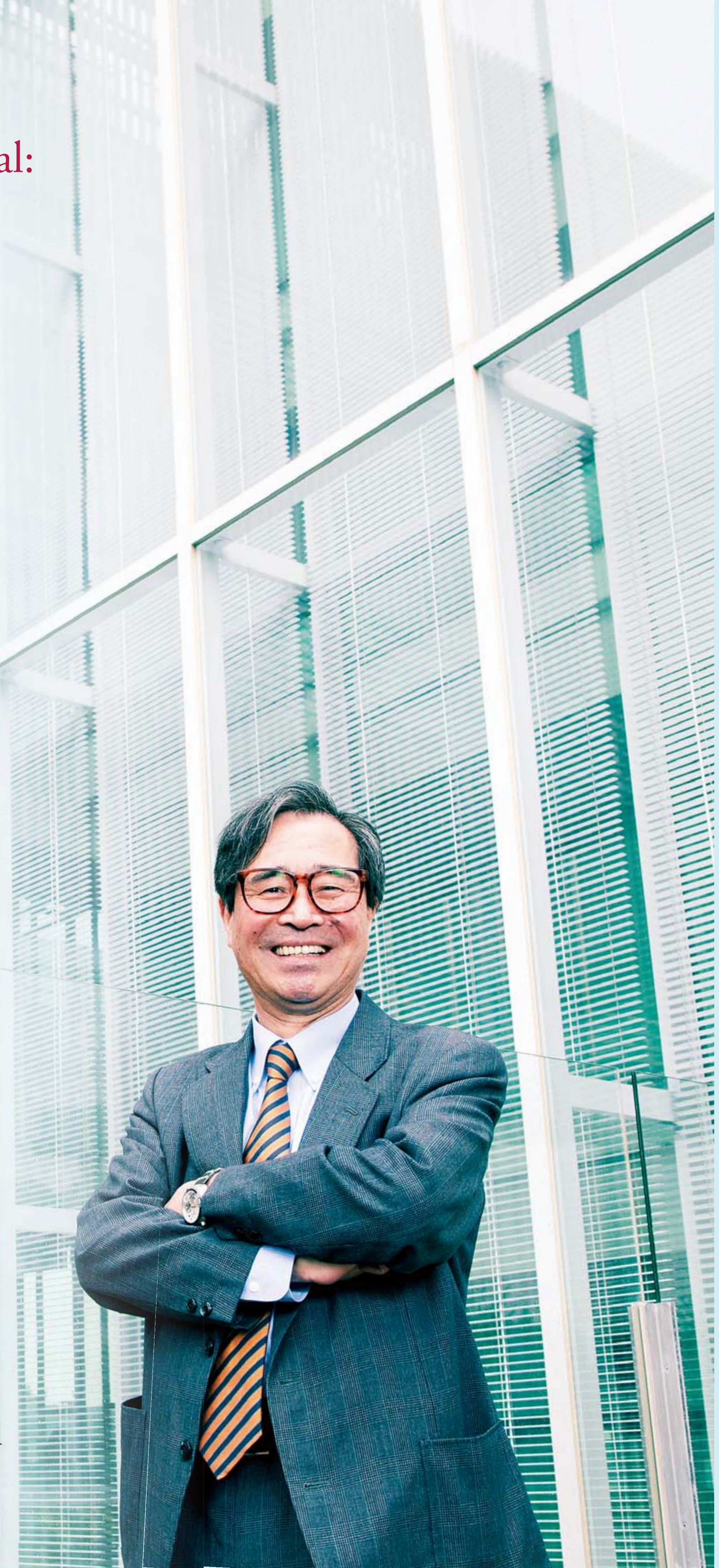
Nanotechnology has made astonishing progress in the last approximately 30 years and has become a key pillar of recent new materials development. Although its position will remain unshaken in the future, MANA believes that conceptual innovation is necessary in order to extract the maximum true value (potentiality) of nanotechnology. We also believe that we should purse this innovation in the direction expressed by "nanoarchitectonics."** This concept of nanoarchitectonics has been refined continuously by MANA researchers and has grown into a concept that is accepted around the world in the last one to two years.

The outstanding research achievements which MANA produced during its first 5-year period were not simply the result of setting our course toward the unique concept of "nanoarchitectonics." These achievements were possible because we also made committed efforts to realize internationality, as evidenced by the fact that more than half of our researchers are from other countries, train young scientists, support interdisciplinary "fusion" research, and communicate our research achievements to the world.

As we go forward, MANA will strive to be a global leader in new materials research. To achieve this goal, we request the warm support of all our colleagues and friends.

* Since 2007, a total of nine WPI centers have been established to date (see p. 4).
** For a detailed explanation of nanoarchitectonics, see p. 5.

Masakazu Aono, Director-General



Our Vision

Toward a better global future:
Pioneering a new paradigm
in materials development
using nanoarchitectonics concept

Our Mission

Develop ground-breaking new materials
on the basis of the nanoarchitectonics concept

Create a “melting pot” where top-level
researchers gather from around the world

Secure young scientists and
foster their confidence
to battle toward challenging targets

Construct a world wide network
of nanotechnology centers

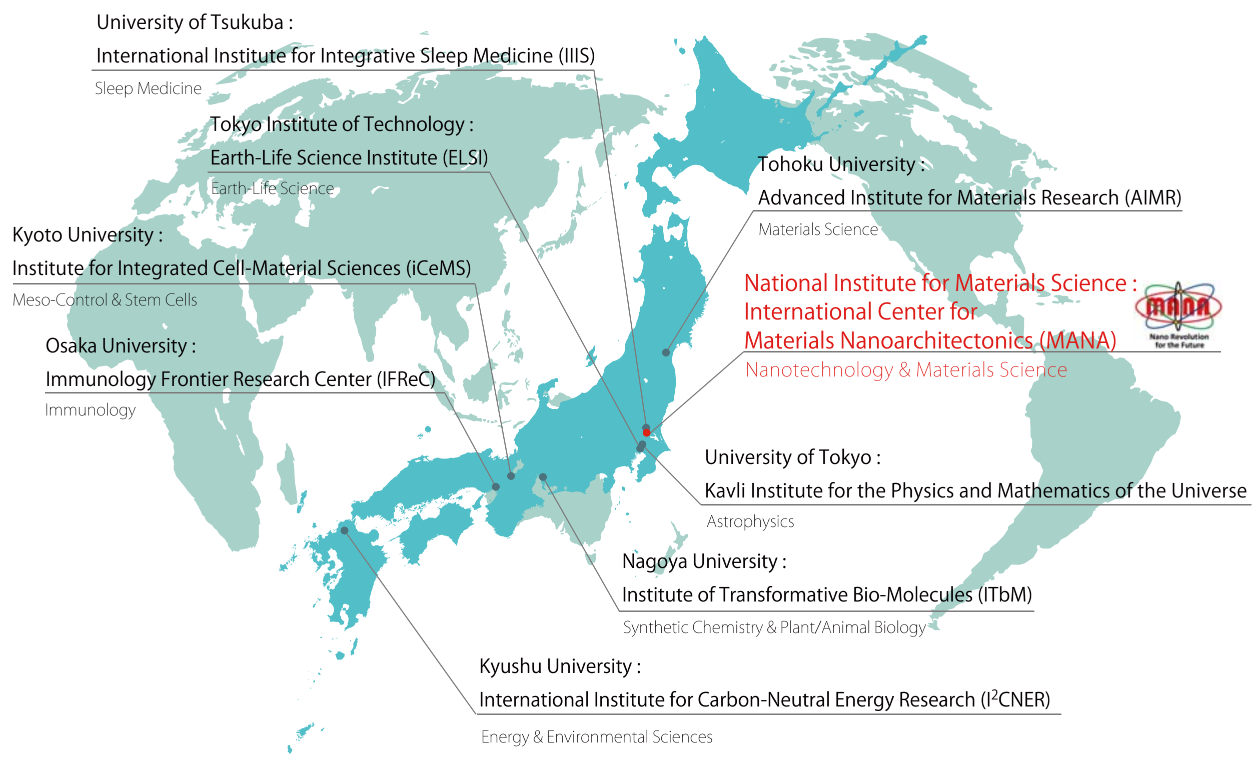
World Premier International Research Center Initiative

In 2007, Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) inaugurated the World Premier International Research Center Initiative (WPI) in order to further enhance Japan's position as one of the world's leading science and technology powers.

In recent years, competition for outstanding "brainpower" has becomes increasingly intense around the world, and Japan must also participate in the global circulation of mobile human resources.

The aim of the WPI program is to create several research centers in Japan which boast the highest levels in both research content and the research environment in order to attract the world's top-level researchers. These research centers must satisfy four necessary conditions: "World's highest level of research," "Creation of fusion-type research in interdisciplinary domains," "International research environment," and "Positive stance toward reform of the research organization." To date, a total of nine WPI research centers have been selected. Each of these centers is now developing its own ambitious research program.

WPI research centers, the highest peaks where the world's top researchers gather.



NANOARCHITECTONICS

What is nanoarchitectonics?

Nanotechnology plays a key role in the development of new materials. Nanotechnology tends to be perceived mistakenly as an extension of the microtechnology that has proven so effective in the microfabrication of semiconductor devices, in other words, as an extension that further refines conventional miniaturization techniques. However, nanotechnology is qualitatively different from microtechnology. The new paradigm of nanotechnology, which correctly understands this qualitative difference, is what we call "nanoarchitectonics."

Nanoarchitectonics has the following four essential characteristics:

1) In the world of microtechnology, structures can be fabricated according to a "blueprint," but this is generally difficult in the nanotechnology world. This is due to thermal or statistical fluctuations and the theoretical limits of control techniques. For this reason, the important question is "how to create materials or systems with useful, reliable functions from nanostructures that contain ambiguity ('nanoparts')."

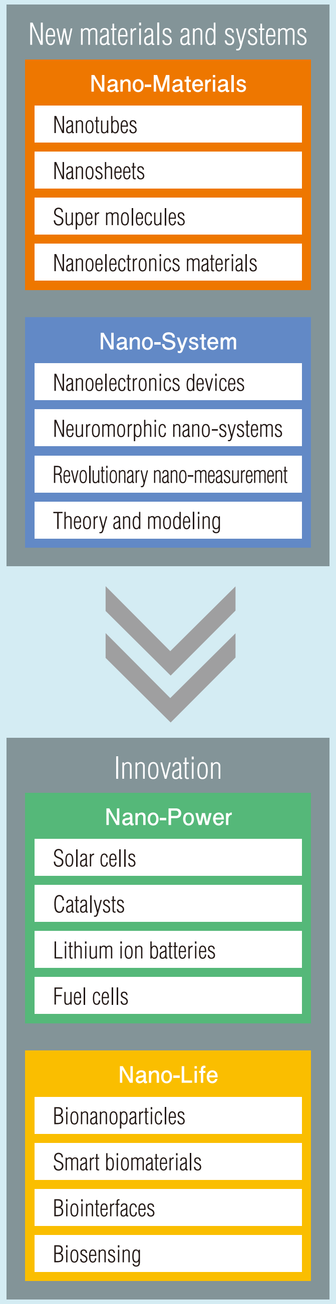
2) Nanoscale structures frequently exhibit extremely interesting new properties. However, "nanoparts" made up of those structures do not necessarily display useful functions, either independently or in simple aggregates. Here, the key is effectively inducing organic interactions between the same or different "nanoparts," and thereby creating completely new material functions; in other words, a paradigm shift "from construction of structures to organization of interactions."

3) In complex systems consisting of an enormous number of nanoscale "nanoparts," new and unexpected functions often emerge in the system as whole. In nanoarchitectonics, researchers must not overlook the phenomenon that "quantity changes quality."

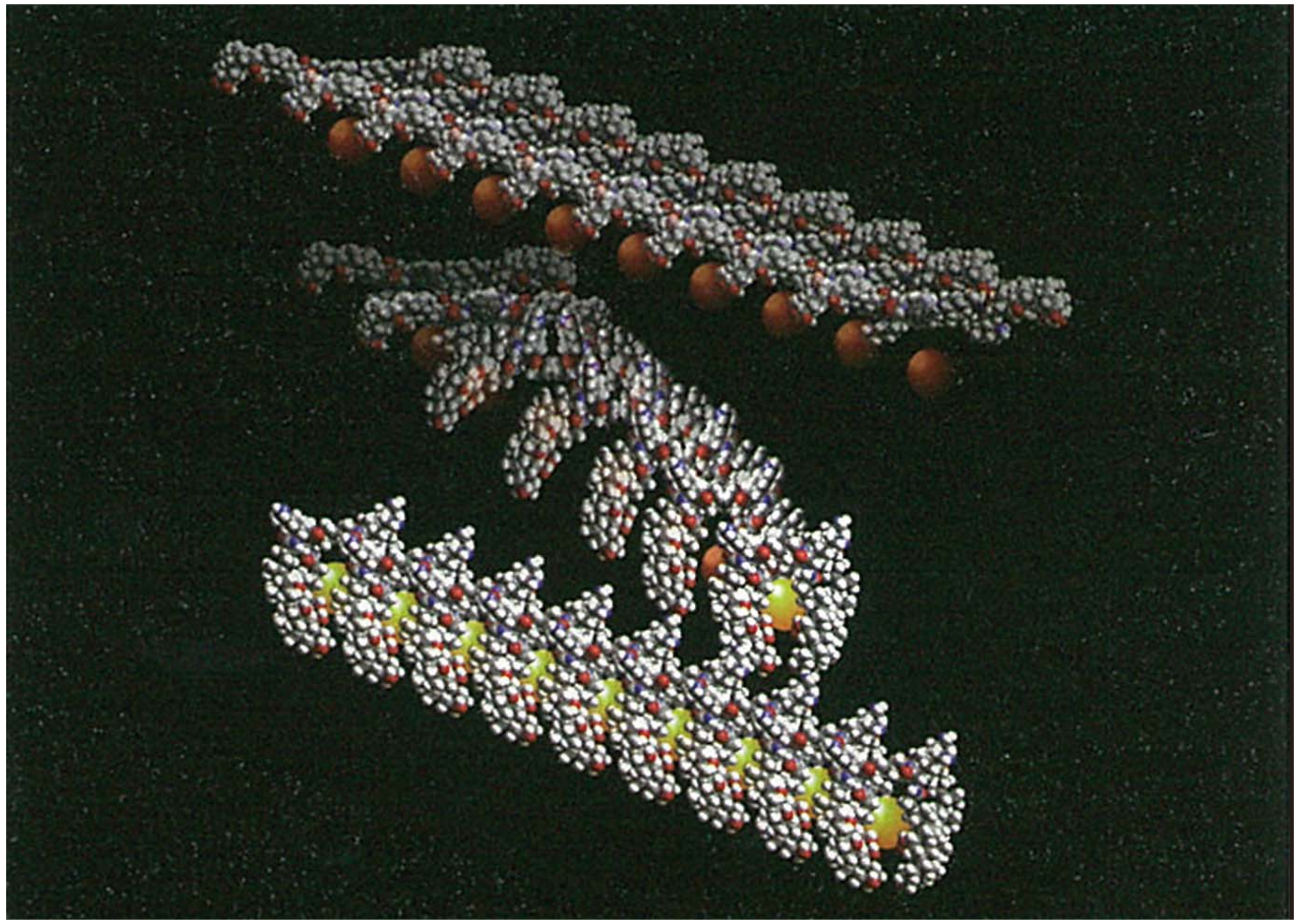
4) It is necessary to pioneer a new theoretical field that can convincingly explain the above three points. This should not be limited only first principles calculations of atoms, molecules, electrons, photons, spins, and the like, but perhaps must also introduce appropriate bold new approximations. This should be called "nanotheory."

Based on this paradigm of nanoarchitectonics, MANA is engaged in a full range of research, from basic to applied, in four research fields, "Nano-Materials" "Nano-Systems" "Nano-Power" and "Nano-Life" fields.

Four Research Fields of MANA



Nano-Materials

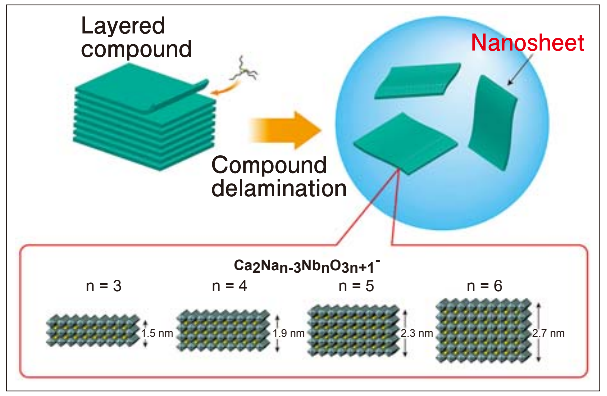


Synthesis of New Nanoscale Materials and their Artificial Organization for Design of Advanced Functionalities

MANA researchers are engaged in research with the aim of creating new nanomaterials such as nanotubes, nanorods, nanosheets, etc. by utilizing original synthesis techniques, beginning with soft chemistry, supramolecular chemistry, and combinatorial techniques. In this work, we are strongly aware not only of size and shape at the nanometer order, but also precise control of the composition and structure of materials. From this perspective, we aim to discover new physical properties and phenomena and greatly enhance functions under the guiding principle of discovery and exploration of new nanomaterials. In elucidating physical properties, we actively use cutting-edge nanocharacterization techniques such as an advanced TEM system combined with STM and AFM, etc. We are also developing chemical nanotechnology, which enables artificial construction of high-order nanostructured materials by arrangement and integration of nanomaterials obtained in this manner at the nano level by chemical processes and hybridization with other materials, with the goal of creating new functions and new technologies that are greatly superior to the existing ones.

Theme 1 Creation of Nanoscale Materials with a Designed Composition and Structure

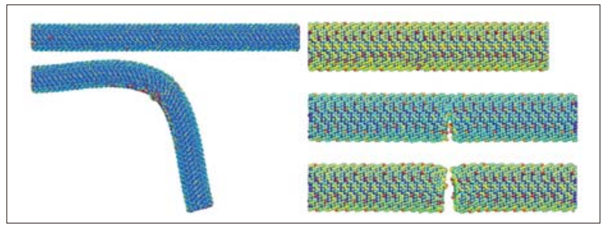
We synthesize 1-dimensional nanomaterials such as nanotubes, nanorods, etc. by using chemical vapor deposition (CVD) and other vapor phase processes. As examples of this research, we have achieved large-scale synthesis of short diameter boron nitride (BN) nanotubes by using new catalysts, and synthesis of silicon (Si) and germanium (Ge) nanorods by regioselective doping of the central and fringe areas. Application of these materials as fillers for polymers and as high mobility transistor materials, etc. is expected. MANA is also studying synthesis of 2-dimensional nanosheets with a wide range of material systems by utilizing the unique soft chemistry process of exfoliation of single layers from layered compounds. For example, we successfully synthesized a perovskite type niobium oxide nanosheet with thickness controlled continuously at a 0.4nm unit. This is considered to be a promising material as an excellent dielectric function block. MANA researchers have also created other new nanomaterials, including BN nanosheets with thicknesses of 2-5nm by a newly-developed chemical blowing process, and transition metal hydroxide nanocones by a uniform precipitation process under a surfactant (this was the first such nanomaterial using a non-carbon system).



Soft-chemical exfoliation process to produce perovskite type oxide nanosheets.

Theme 2 Measuring the Performance of Nanomaterials

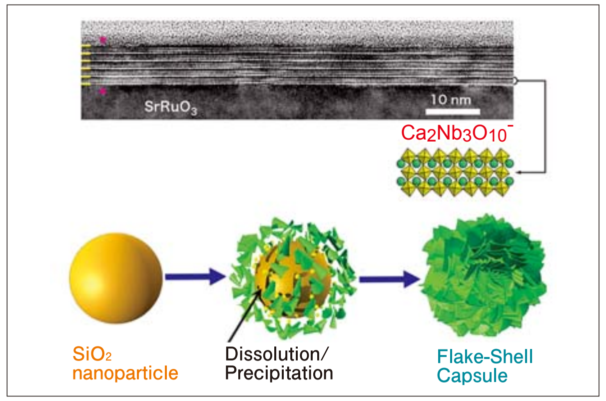
The properties of nanomaterials are controlled by their microstructures, for example, shape, defects, etc. MANA developed piezo specimen holder incorporating the functions of a scanning tunneling microscope and an atomic probe microscope in a high performance electron microscope, and uses this instrument for in-*situ* measurements of the electrical and mechanical properties of various types of nanomaterials. This technique revealed that BN nanotubes have a large Young's modulus comparable to that of diamond.



Fracture process of Si nanowires observed in a TEM.

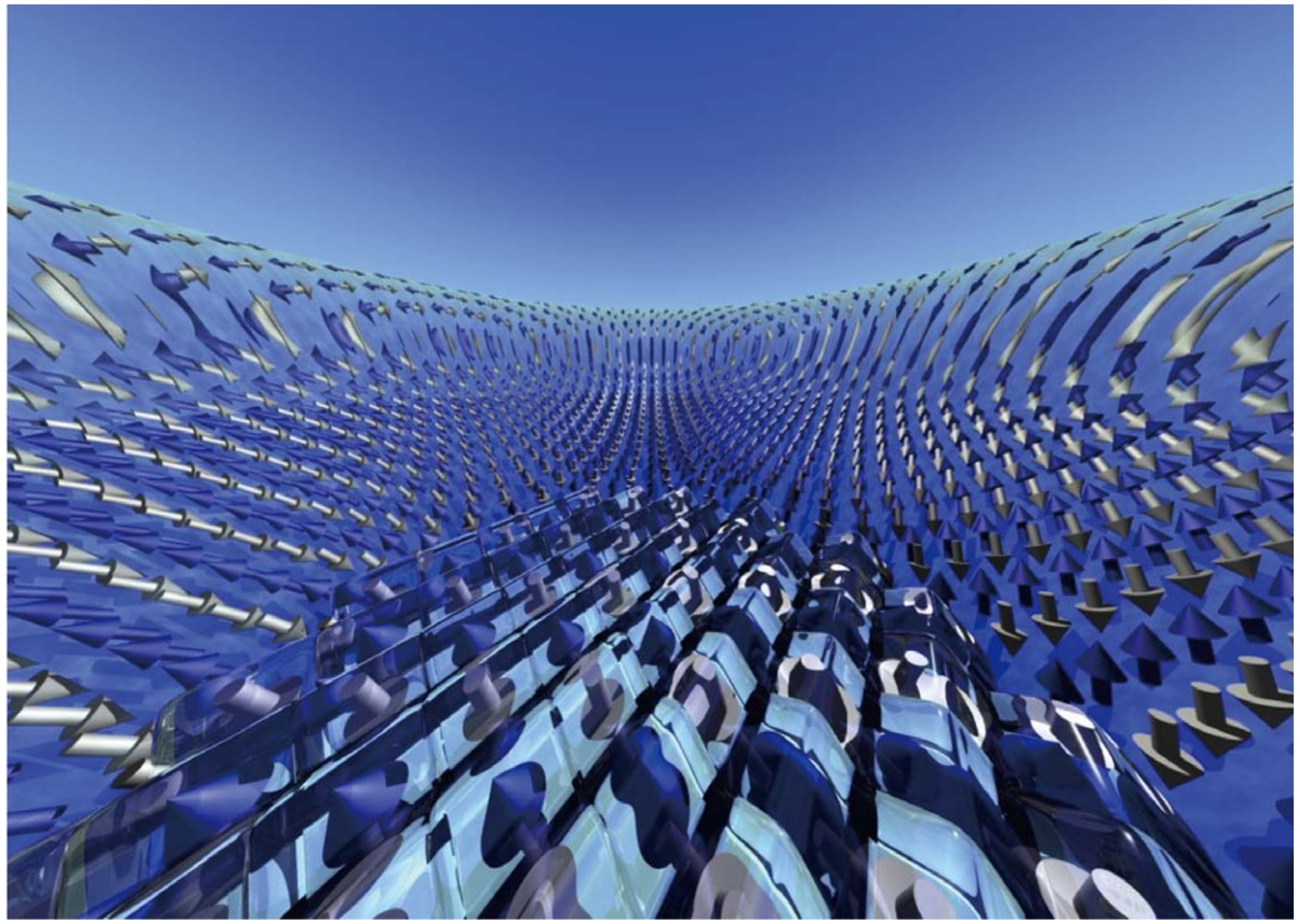
Theme 3 Development of New Functional Materials via Controlled Assembly and Hybridization of Nanoscale Materials

A third aim of research in the Nano-Materials Field is to create high-order functions that cannot be obtained with single substances by various integration techniques, utilizing the nanomaterials obtained by the research described above as building blocks, and by hybridization of those nanomaterials with other materials. For example, we found that an artificial superlattice, which was constructed by layer-by-layer assembly of perovskite type oxide nanosheets using a solution-based process, displays an extremely high dielectric function and ferroelectric property. As other examples, a hybrid material which is transparent and has excellent heat radiation and mechanical properties can be obtained by dispersing BN nanotubes in a polymer matrix, and a unique hollow capsule can be induced by controlling the dissolution-regrowth reaction to create a shell of silica flakes. As this "silica flake-shell capsule" displays controlled drug release behavior sustained over an extended time, development is continuing, envisioning practical application of these research results.



A multilayer film of $Ca_2Nb_3O_{10}$ nanosheets (top) and a micro-capsule of SiO_2 flakes (Bottom).

Nano-System



The Quest for Novel Nanosyststems to Go Beyond Common Sense of Today and Lead the Information Processing Revolution of Tomorrow

The aims of the MANA Nano-System Field are to discover new functions which appear as a result of the mutual interaction of nanostructures that individually have interesting properties, and to systematically investigate their use in nanosystems. Concretely, we are engaged in basic research on phenomena such as atomic transport, molecular reaction processes, charge transport, spin transport, plasmon excitation, superconductivity, etc. in nanoscale materials, and in the development of a wide range of devices utilizing those phenomena, including atomic switches, artificial synapses, molecular devices, qubits (quantum bits) in which quantum interference can not be destroyed, neural network-like network circuits, next-generation CMOS devices, ultra-high sensitivity, super parallel-type molecular sensors, etc. Because we give high priority to the development of new nanoscale characterization methods, we developed a multi-probe scanning probe microscope and other characterization instruments. We are also actively engaged in interdisciplinary and fusion research with other research fields in MANA.

Theme 1 Creating Nanodevices for an IT Revolution

The current generation of computers, which support today's information processing needs, are constructed by using von Neumann type algorithm architecture in CMOS devices. However, both the limits of integration of CMOS devices and the inherent bottleneck of calculation speed in the von Neumann architecture are now forcing radical changes in computer technology. To realize those changes, the Nano-System Field is carrying out research with the aims of realizing a gigantic network of devices that are reversible for input signals, i.e., functioning like the synapses of the human neural network, and establishing a quantum processing method that enables massively parallel processing.

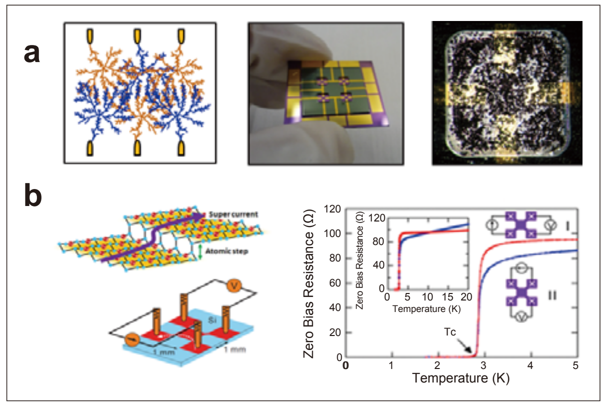


Fig. 1 a) Formation of a gigantic network of plastic devices to input signals, like synapses of the human neural network. b) Observation of surface superconductivity which is expected to enable novel qubits for quantum computing.

Theme 2 Research based on Nano-System Theory

We proactively engage in theoretical research with the aim of discovering nanodevices with new functions. For example, as illustrated in Fig. 2 a), we demonstrated that stable quantum calculation, in which quantum interference can hardly be disturbed, is possible by organizing a structure comprising three layers, i.e., superconductor / semiconductor (including an element with large spin-orbit interaction) / magnetic body (insulator). Furthermore, as shown in Fig. 2 b), assuming this device can be made with an element that displays large spin-orbit interaction, we devised a 2-dimensional structure that enables a current to flow with zero electrical resistance at room temperature and higher temperatures. (Note: this phenomenon would not be called superconductivity.)

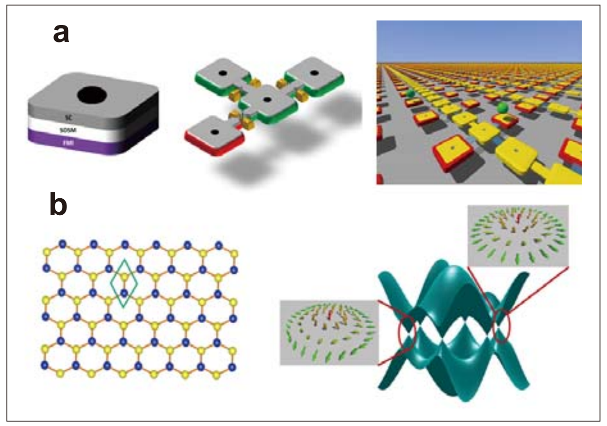


Fig. 2 a) Qubits which enable stable quantum calculation in which quantum interference can hardly be disturbed, and assemblies of those qubits. b) A 2-dimensional structure that enables a current to flow with zero electrical resistance.

Theme 3 Development of New Nanoscale Evaluation Methods

We are also developing new nanoscale measurement methods. As a representative example, we developed the world's first multi-probe scanning probe microscope which makes it possible to measure electrical conduction at the nanoscale. We also devised a thin film type sensor and realized a sensor that enables super parallel identification of molecules contained in gases and liquids with ultra-high sensitivity (more than 2 orders higher than a similar conventional method) by integrating multiple units of the developed sensor (Fig. 3).

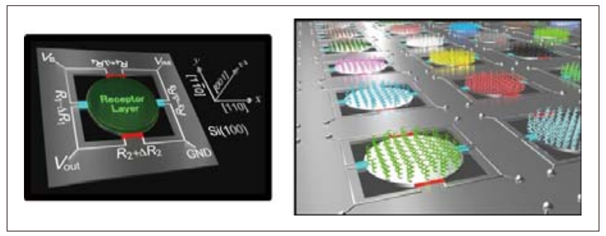
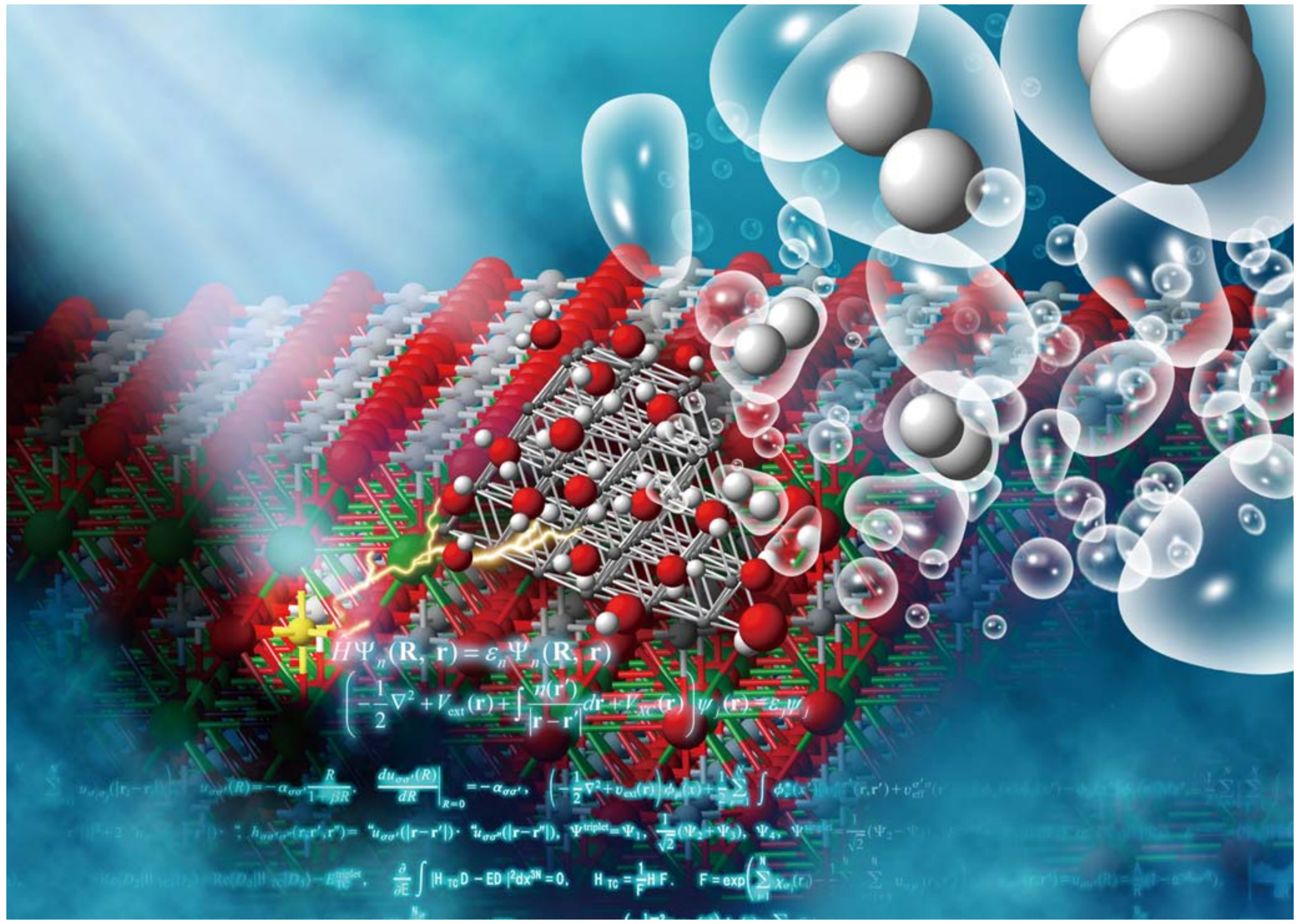


Fig. 3 New ultra-high sensitivity molecular sensor that enables super parallel analysis and identification of molecules in gases and liquids.

Nano-Power

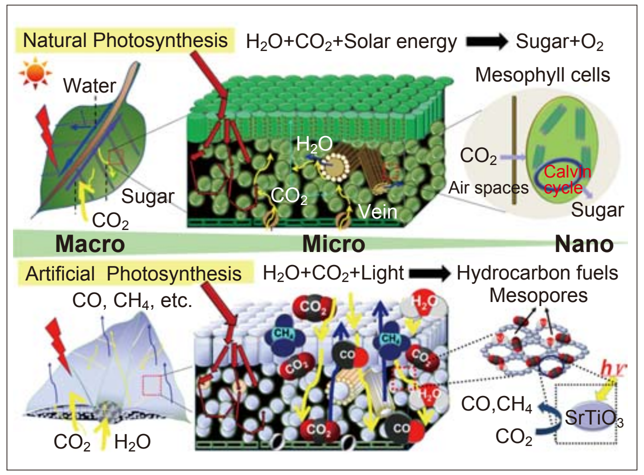


High Efficiency Material and Energy Conversion Systems for a Sustainable Society

The key to efficient use of solar energy is the arrangement of the molecules responsible for various functions such as electron transport and reactions. Efficient ion transport and electron transport play key roles in the storage, transportation, and extraction of energy, for example, in secondary cells (rechargeable batteries) and fuel cells. For this reason, control of interfacial atoms and molecules is indispensable. The arrangement of atoms and molecules at the catalyst surface is also a crucial key for achieving high selectivity and high efficiency in catalysts that are essential for resource-saving and energy-saving chemical processes. In short, the scientific basis for realizing a sustainable society is designing the interfacial atomic/molecular arrangement corresponding to the purpose and realizing the actual arrangement as designed, in other words, "interfacial nanoarchitectonics." Based on this concept of interfacial nanoarchitectonics, researchers in the Nano-Power Field are engaged in research and development of systems for high efficiency matter-energy conversion by free manipulation of atoms and molecules and control of nanostructures.

Theme 1 Learning from Natural Photosynthesis

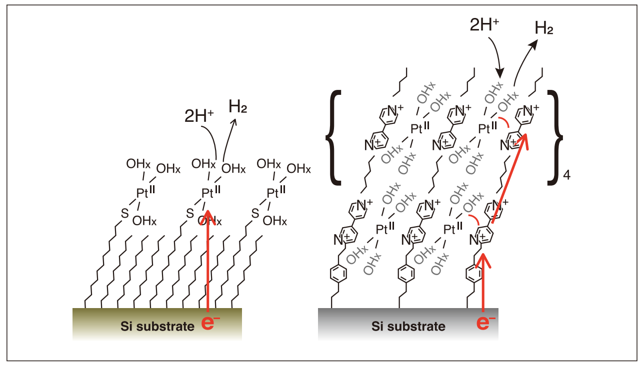
Realizing an "artificial photosynthesis system" for conversion and storage of the energy of light, which can synthesize renewable hydrocarbon chemical resources from water and CO_2 gas by using solar energy, is one of the ultimate dreams of humankind. Taking on the challenge of new nano-photocatalysts, we are engaged in research and development on novel hybrid oxide semiconductor photocatalyst materials and applied research on chemical reduction and recycling of CO_2 by utilizing those materials. In the natural world, the photosynthesis reaction was created in the process of the evolution of life. The natural process is extremely sophisticated and boasts quantum efficiency approaching 100%. One effective approach for realizing efficient artificial photosynthesis is considered to be construction of an "artificial photosynthesis system (APS)" that mimics the key structural elements and functions of photosynthesis in plants. In this research, we promoted efficient harvesting of light and adsorption, diffusion, and conversion of CO_2 gas by synthesizing a $SrTiO_3$ photocatalyst using the leaf of the cherry tree as a template, and constructing a multilayered structure that imitated the leaf from nanometer to millimeter scale. This dramatically improves conversion efficiency of CO_2 to methane.



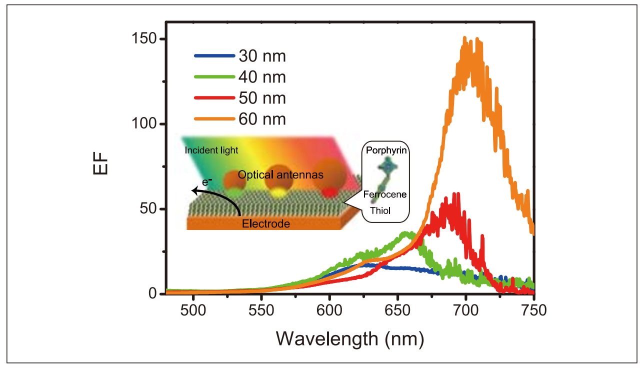
Schematic illustration and comparison of the key processes in natural photosynthetic system (NPS) and artificial photosynthetic system (APS). Main processes are : light harvesting, gas adsorption, gas diffusion, and gas conversation.

Theme 2 Highly Efficient Energy Conversion by Arranging Nanoparticles and Molecules on Solid Surface in Order

Interconversion of light, electricity, and chemical energy in photovoltaic cells, photocatalysts, secondary cells, fuel cells, and similar devices has attracted considerable attention. The key to achieving higher efficiency in all these processes is the construction of interfaces, particularly the interfaces between solids and solutions. Using interfacial nanoarchitectonics, we improved and realized high efficiency photoelectrochemical hydrogen formation and reduction of CO_2 by arranging a molecular layer, which is responsible for electron transfer and a metal complex molecule, which catalyzes the chemical reaction, on the surface of a photoexcitable semiconductor. We also improved and realized light utilization efficiency in the near infrared region by arranging gold nanoparticles as antennas on a molecular layer which is arranged on a metal surface and enables photoinduced electron transfer. In other work, we are developing a scanning probe microscope, ultra-high speed laser spectroscopy, synchrotron radiation measurement method, and other techniques for solid-liquid interfacial systems. We have successfully analyzed structures with spatial resolution of 1nm (one-billionth of a meter) and measured electron transfer rates with temporal resolution of 0.1 psec (one-10 trillionth of a second).

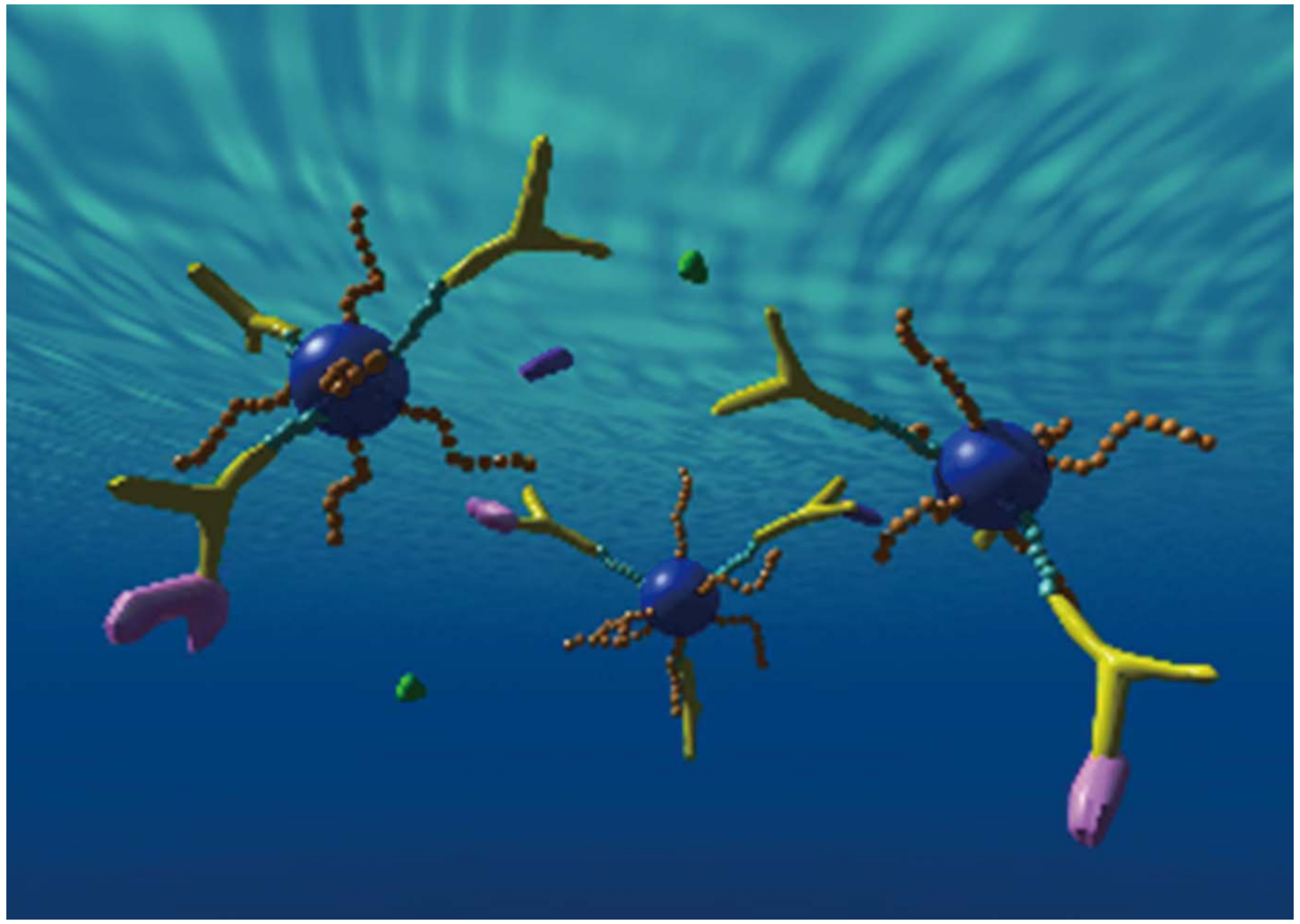


Surface confined molecular catalysts for photoelectrochemical hydrogen evolution at Si electrode.



Size dependent photocurrent enhancement factor as a function of wavelength at optical antenna (gold nanoparticle) – molecule (porphyrin-ferrocene-thiol linked molecule) hybrid system on gold electrode.

Nano-Life

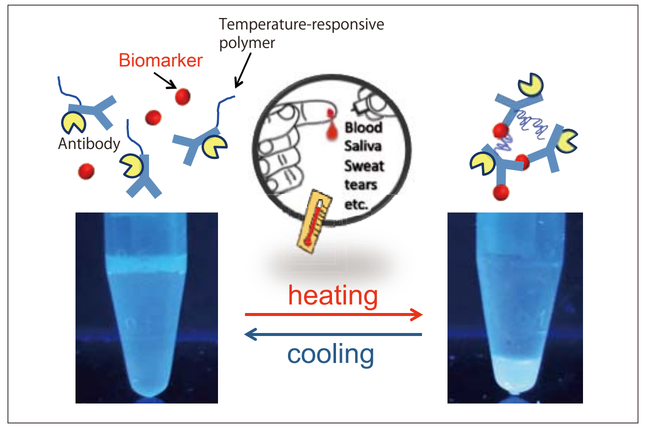


Nano-Biological Functional Materials Realizes Material Therapy

Our aim is to create novel biomaterials that realize "materials therapy" for safe and secure advanced medical treatment. Materials therapy is an approach in which diagnosis and treatment of diseases are performed using materials, and the materials themselves demonstrate effects precisely like those of drugs. Although cells are the smallest unit in the human body, cells can be organized by cell groups and the adhesive proteins, etc. that support them, which then form organs that can perform complex functions. In this process, the homeostasis of the body is maintained by communications between biomolecules. In the MANA Nano-Life Field, we are developing new biomaterials that control biofunctions at the nano level by using nanoarchitectonics. In particular, we are carrying out research linked to clinical treatment by combining the two focuses of "Diagnosis/prevention" and "Treatment" of disease. These technologies can be expected to greatly reduce the time and cost of conventional treatment methods, and to lead to new therapeutic technologies that can also be applied to high urgency diseases.

Theme 1 Nanomaterials for Early Diagnosis and Preventions of Diseases

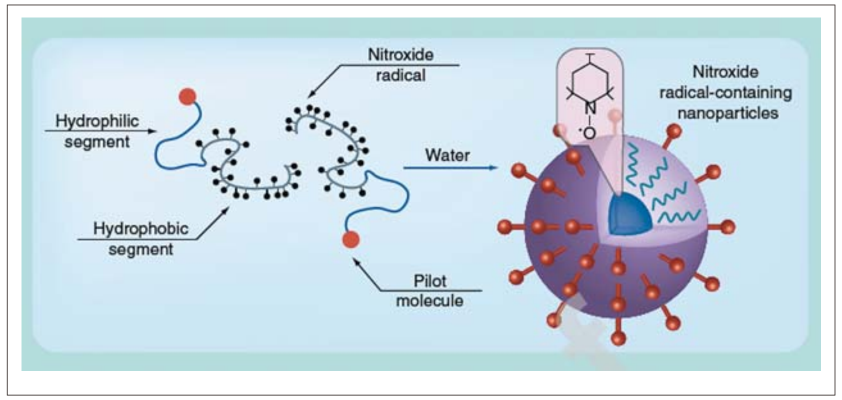
Many lives can be saved by early diagnosis and proper treatment of cancers and infectious diseases. We are developing early diagnosis systems with the aims of high sensitivity, low cost, and simplicity. Concretely, we designed a "nano-linker," which links antibodies and enzymes by using a smart polymer with a size of several 10nm. After antigens that exist in minute amounts in the blood are captured by antibodies, this nano-linker is structurally changed by external stimulus, and its signal is amplified by hundreds of times, enabling early diagnosis. We are also developing a high sensitivity imaging technology for lesions in the body by using various functional nanoparticles that mimic the nano-interfaces in the body. We evaluate the safety of new nanoparticle that we fabricate by using sensor cells which respond to trace amounts of cytotoxicity, and we are also involved in basic research that will contribute to medical treatments, focusing on issues such as metastasis of cancer cells and construction of the neural network by a cell arrangement technique utilizing photoresponsive molecules.



A hybrid of antibody, enzyme, and temperature-responsive polymer enables to purify and enrich target biomarkers only by heating.

Theme 2 Nanomaterials for Treatment of Diseases

Our aim is to apply biomaterials with new functions to the treatment of diseases by skillfully utilizing the nanostructures and hierarchical structures, and the functional interactions of the body. To efficiently regenerate living tissues, we developed a biomimesis type scaffold material that mimics the extracellular matrix surrounding cells in the living body, and we are promoting application to tissue regeneration and regenerative medicine using this scaffold material. We also fabricated redox nanoparticles as reactive oxygen scavengers by precise design and skillful self-assembly of polymers. Because these nanoparticles do not hinder energy production in normal cells, but can effectively remove reactive oxygen in the vicinity of diseased cells, high expectations are placed on this nanomaterial as a new nano-medicine that can be used to treat cerebral infarction (stroke) and myocardial infarction (heart attack). We also propose various medical devices that utilize nanoarchitectonics, such as artificial bone and stents using the nanostructures and nano-interfaces of the body, drug delivery systems, DNA vaccines, adhesives, and others, with the aim of clinical application.



Self-assembled nanoparticle carrying specific functions improves therapeutic efficiency, retaining low side effect.

"MANA", an International Brand Attracting Researchers from Around the World

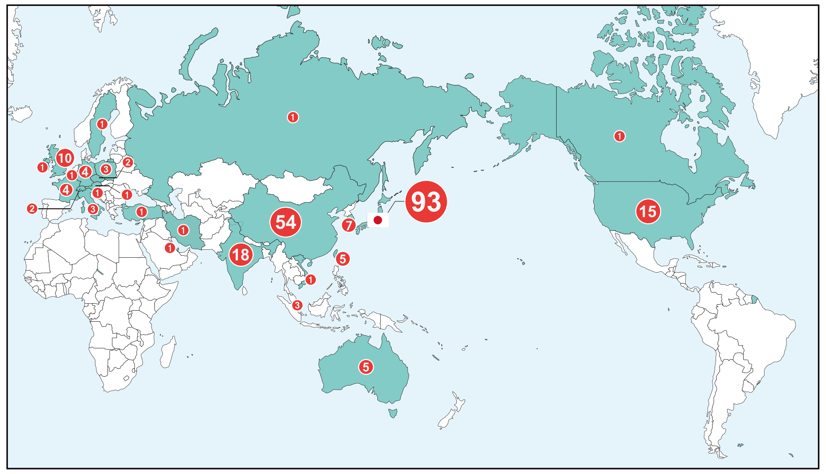
The International Center for Materials Nanoarchitectonics (MANA), which was launched in 2007, already boasts many impressive achievements in its 7 year history, beginning with the training of world-class researchers, and is steadily evolving toward its next phase.

Global Career Advancement

MANA is always aware of its role as a platform for successful career advancement for young researchers.

We particularly wish to provide a place where researchers can build even more outstanding human resources and play an active role in their next workplace. To achieve this, we make the maximum possible effort to create a world-class research environment by providing a full complement of the world's most advanced research equipment, eliminating language barriers, and providing support for administrative work.

As examples of career advancement, in the past 7and half years, 11 MANA alumni made successful carrier move to the National Institute for Materials Science (NIMS), and 227 to positions at universities and research institutes in Japan and other countries. By sending out researchers from MANA to higher positions at domestic and international research centers, we are also expanding the network of nanotechnology researchers with MANA as its hub.



Destinations of MANA postdoc alumni (unit: number of people).

Unique Triple Double (3D) System

MANA has created a unique system for training young scientists that we call the "Triple Double (3D)" system. Each young researcher at MANA is encouraged to have two mentors, one who is a scientist at NIMS, and the other from outside NIMS (particularly a mentor from another country). Young MANA researchers have 2 mentors (Double Mentor), do research spanning 2 fields of specialization (Double Discipline), and are affiliated with 2 institutions (Double Affiliation). The "Triple Double" system takes its name from these "3 Ds."

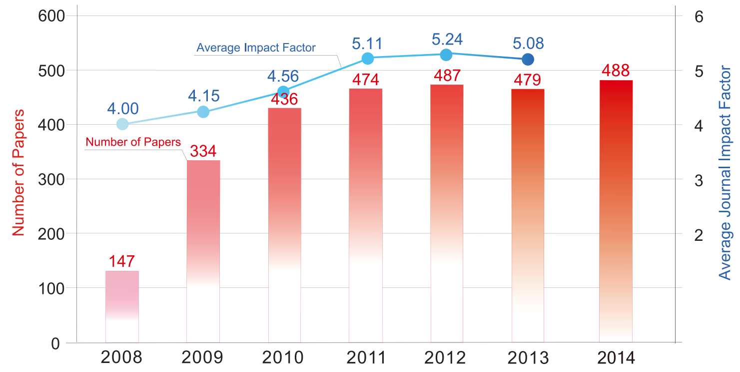
By having young researchers work at research institutes in other countries, carry out research with the world's top scientists, and do interdisciplinary and fusion type research, MANA is training a new generation of scientists with an international vision and interdisciplinary capabilities.

Sir H. W. Kroto, Nobel Laureate in Chemistry 1996, encourages MANA's young researchers.

Research Results Attracting the World's Attention

In 2013, MANA researchers published 479 papers, and the average impact factor of the journals that carried those papers was 5.08. The high quality of research at MANA is clear from these results.

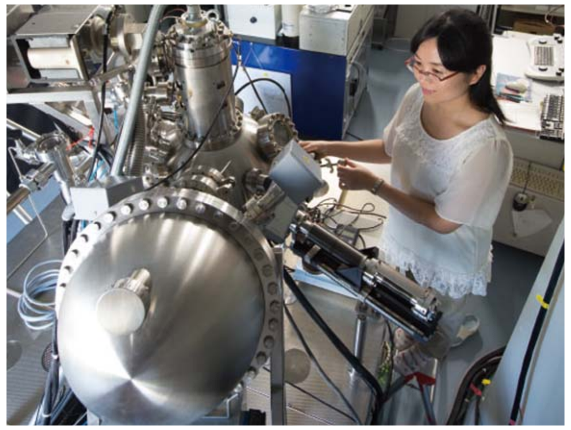
In addition, a number of prestigious scientific journals, beginning with Advanced Materials (Wiley) and Langmuir (American Chemical Society) have devoted special issues to "nanoarchitectonics."



Number of MANA affiliated Papers, Average Impact Factor

Cutting-edge Research Facilities

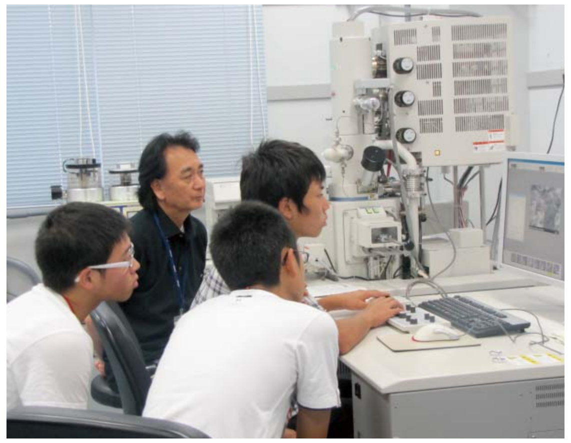
Researchers have the opportunity to use some of the world's most advanced, highest performance research equipments at MANA's host institution, the National Institute for Materials Science (NIMS). MANA also has an independent "MANA Foundry," which boasts capabilities from nanofabrication to characterization for diverse types of materials. In addition, MANA researchers have access to more than 50 "user facilities" and can use these with the support of experienced technical staff.



UHV (uitra-high vacuum) low energy electron microscope.

Diverse Outreach Activities

MANA uses a diverse range of science communication activities. In addition to "open house" events, in which we open our facilities to the general public, and science camps for high school students, we also publish the public relations magazine CONVERGENCE and exhibit at science and technology events. We also post news about outstanding research results at MANA from time to time in the online English-language newsletter MANA Research Highlights to inform leading research institutions, the media, and science journalists in Japan and other countries of recent developments at MANA.



SEM operation experience in Summer camp.

Melting Pot Environment of Different Scientific Fields, Cultures, and Nationalities

Fusion of different fields and cultures creates the possibility of innovation. At MANA, we are pursuing a "melting pot environment" where world-class human resources from diverse fields of specialization and different nationalities and cultures can come together and work "under one roof." This is fostering a rich international perspective and giving birth to new ideas and original, creative research.

Cosmopolitan Research Environment

Because more than half of all MANA researchers come from countries other than Japan, we are actively working to create an environment where wide-ranging exchanges among Japanese and international researchers are possible. The WPI-MANA Building, which was completed in the spring of 2012, was designed so that researchers in many fields can share the same space by removing the walls of offices on each floor to form single large rooms. We also made transparency a priority in laboratories by using glass-paneled corridor walls and doors throughout the new building so that researchers who come and go outside labs can see the experiments in progress inside.

Labs with glass-paneled walls to encourage transparency.

A unique feature of the new WPI-MANA Building: Glass-paneled spaces for communication between researchers on each floor of the Atrium.

Full Support for Researchers

MANA has created an environment where researchers can devote their full attention to their research, regardless of nationality, by adopting English as a common language and assigning experienced staff to act as secretaries providing administrative support to researchers. We give warm-hearted assistance to researchers with foreign nationalities as they start their new lives in Japan, and we offer Japanese language classes and "experience" classes so newcomers can learn more about Japanese culture and deepen their understanding of Japan.

Laboratory tour in English for new researchers.

Advisors and Committee Members

Advisors

Advisors including Nobel Laureates and prominent researchers provide valuable advice to MANA scientists, drawing on their extensive experience.

Sir H. W. Kroto
Professor, Florida State University
Nobel Laureate in Chemistry(1996)

C. N. R. Rao
Honorary President, Jawaharlal Nehru Centre for Advanced Scientific Research

T. Kishi
Former President, National Institute for Materials Science

International Cooperation Advisors

International cooperation advisors including prominent researchers provide MANA with advice on joint research with overseas research institutes and the formulation of a global nano-tech network.

Sir M. Welland
Professor, University of Cambridge

L. Schlapbach
Former CEO, Swiss Federal Laboratories for Materials Testing and Research

Evaluation Committee Members

Evaluation committee members provide MANA with their critical comments and expert recommendations on the operation and research strategy of MANA projects.

A. K. Cheetham
Professor, University of Cambridge
Chair

T. Aida
Professor, University of Tokyo

M. Endo
Professor, Shinshu University

H. Hahn
Professor, Karlsruhe Institute of Technology

K. Hashimoto
Professor, University of Tokyo

Y. Nishi
Professor, Stanford University

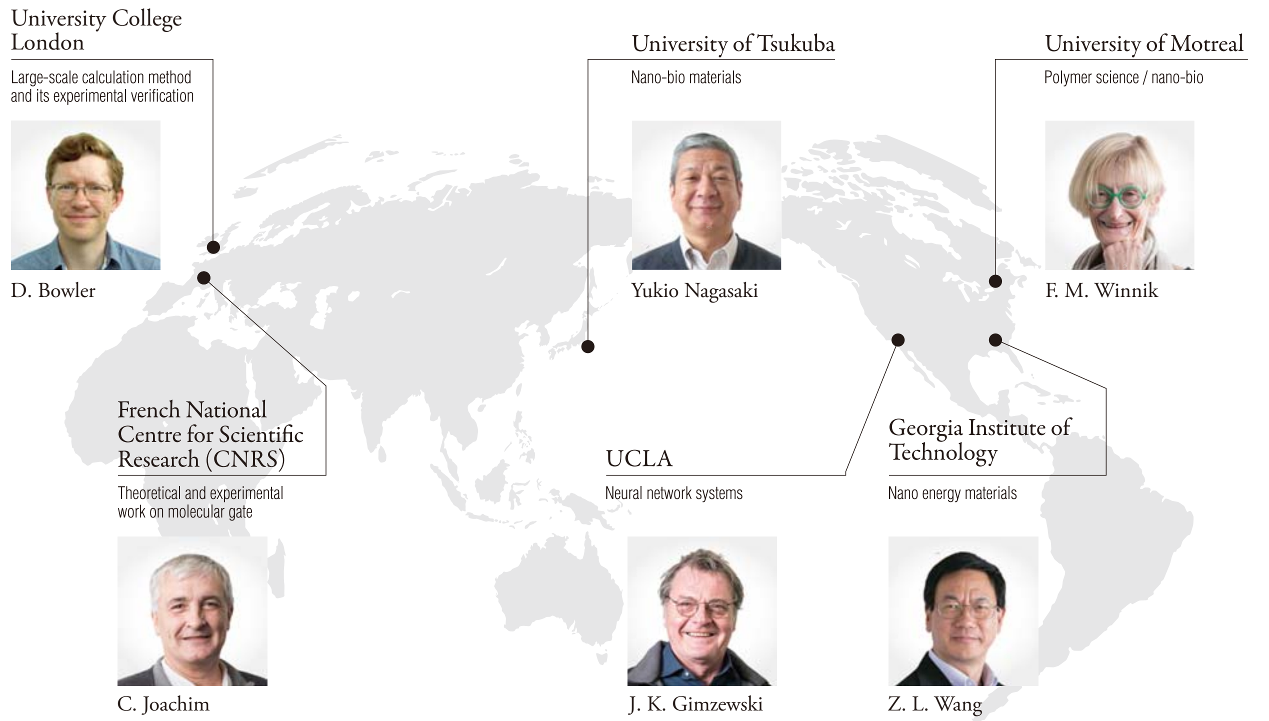
R. S. Ruoff
Professor, Ulsan National Institute of Science and Technology

J. P. Spatz
Director
Max Planck Institute for Intelligent Systems

Satellite Network

One third of MANA Principle Investigators (PIs) are visiting researchers from external research institutes. MANA has satellite laboratories at research institutions to which PIs are affiliated. The satellite laboratories speedily and rationally facilitate joint research and also play a crucial role in training young researchers.

MANA aims to serve as a global network hub for nano-technology. The satellite laboratories located in six research institutes, promote innovative research as front-line bases of the global network.



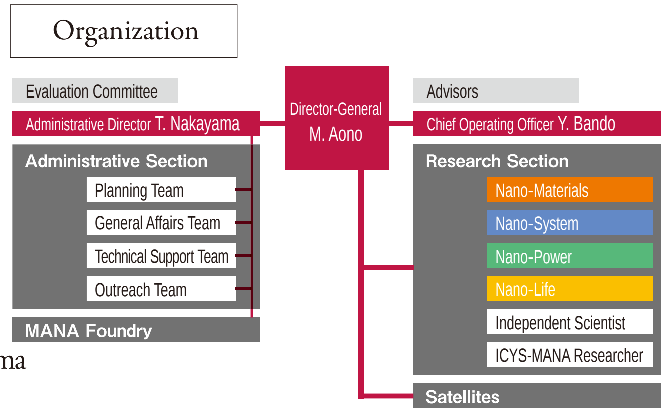
Members

Director-General

Masakazu Aono — Director-General

Yoshio Bando — Chief Operating Officer

Tomonobu Nakayama — Administrative Director



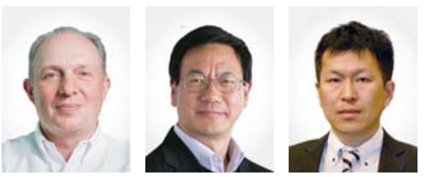
Principal Investigators (PI) and Associate Principal Investigators (API)

* Field Coordinator
** Satellite *** API

A Principal Investigator is an internationally known world top-class scientist who plays leading roles in achieving MANA research targets and in fostering younger researchers through mentoring.
Principal Investigators are selected from NIMS and other domestic and overseas institutes. An Associate Principal Investigator is a promising young scientist, who is expected to perform his/her own research at a level comparable to Principal Investigators.

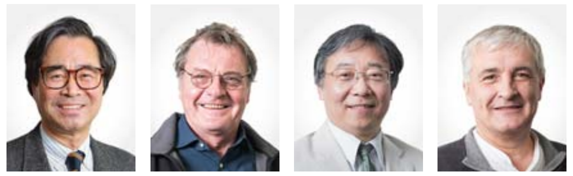
Nano-Materials 7PIs

T. Sasaki* NIMS · K. Ariga NIMS · Y. Bando NIMS · T. Chikyow NIMS



D. Golberg NIMS · Z. L. Wang** Georgia Tech · M. Osada*** NIMS

Nano-System 5PIs



M. Aono* NIMS · J. K. Gimzewski** UCLA · X. Hu NIMS · C. Joachim** CNRS

K. Tsukagoshi NIMS

Nano-Power 5PIs

J. Ye* NIMS · K. Takada NIMS · K. Uosaki NIMS · O. Yaghi UC Berkley · D. Bowler** *** UCL

Nano-Life 3PIs

G. Chen* NIMS · Y. Nagasaki** Univ. Tsukuba · F. M. Winnik** Univ. Montreal

MANA Workforce (as of May 2015)

Out of 201 researchers at MANA, 108 (53.7 percent) are foreign nationalities hailing from 24 countries.

Position	Principal Investigators	Associate Principal Investigators	Group Leaders	Faculty Scientists	Postdoctoral Researchers	Junior Researchers	Administrative Staffs and Technical Staffs	Total
Number	18	2	11	68	68	34	32	233
Non-Japanese	8	1	0	12	55	32	1	109
Female	2	0	1	11	16	12	20	62

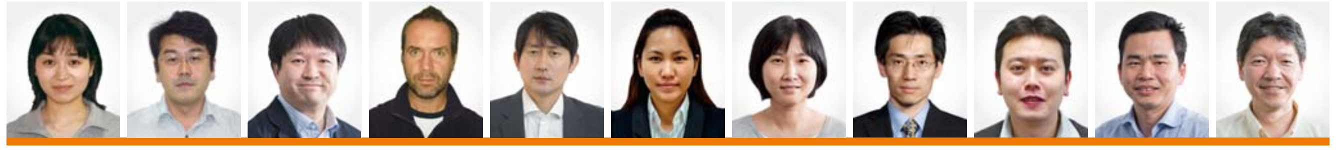
Group Leaders

In units led by Principal Investigators, Group Leaders serve as the leaders of research groups.

N. Fukata · T. Mori · T. Sekiguchi · T. Nagao · K. Terabe · Y. Tateyama · N. Hanagata · M. Kikuchi · H. Kobayashi · A. Taniguchi · A. Yamamoto

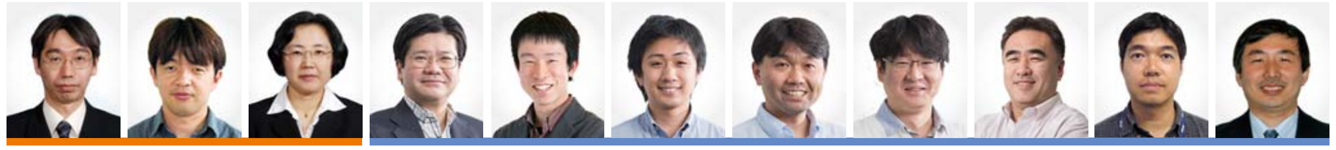
MANA Scientists

NIMS scientists who carry out research with Principal Investigators.



J. Chen · Y. Ebina · M. Goto · J. Hill · Y. Ide · W. Jevasuwan · Q. Ji · J. Kawakita · N. Kawamoto · R. Ma · M. Mitome

T. Nagata · T. Nakane · W. Nakanishi · I. Ohkubo · N. Sakai · L. K. Shrestha · R. Souda · D. Tang · T. Taniguchi · Y. Wakayama · R. Wu



S. Yagyu · Y. Yamashita · M. Yoshitake · H. Arakawa · S. Ishii · T. Kawakami · M. Kohno · S. Kim · K. Nagaoka · S. Nakaharai · Y. Okawa

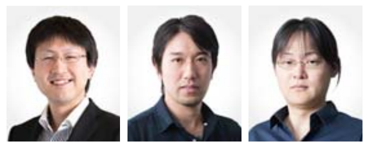
M. Sakurai · Y. Shingaya · T. Tsuruoka · T. Uchihashi · I. Hamada · H. Kino · H. Noguchi · T. Ohnishi · K. Sakaushi · K. Tashiro · M. Ebara

S. Hiromoto · Y. Kaizuka · C. Kataoka · K. Kawakami · N. Kawazoe · T. Naganuma · Y. Suetsugu · T. Taguchi · T. Yamazaki · C. Yoshikawa

Independent Scientists

Young age-limited NIMS researchers who are assigned to MANA on a full-time basis.
Independent Scientists carry out their own research independently under MANA's 3D system.

R. Arafune · A. Belik · R. Hayakawa · J. Henzie · T. Konoike · T. Minari · S. Moriyama · J. Nakanishi · T. Nakanishi · L. Sang · N. Shirahata



S. Tominaka · Y. Yamauchi · G. Yoshikawa

ICYS-MANA Researchers

Post-doctoral researchers selected from countries around the world under an open application system.
Carry out their own research independently based on advice from Mentors and Principal Investigators.

S. Dutta · A. Fiori · K. Jiptner · Y. Kotsuchibashi · H. T. Ngo · T. C. Nguyen · G. Rydzek · K. Shiba · X. Wang · X. Wang · H. H. Yeung