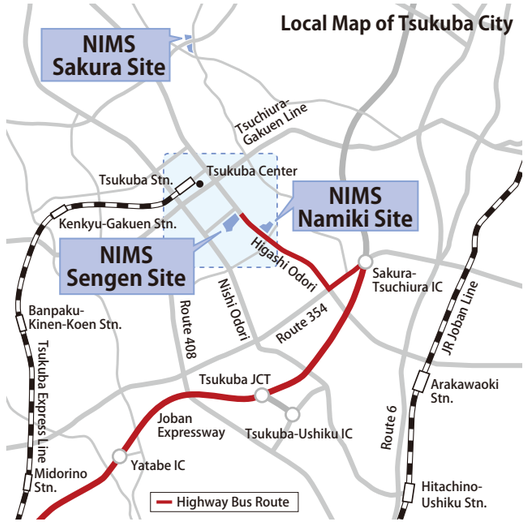
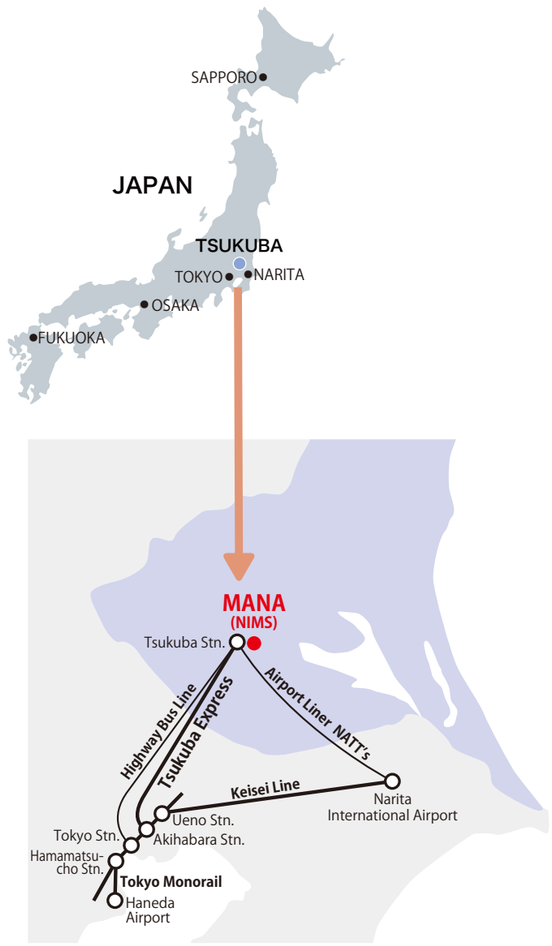
Access to MANA and Contact Information

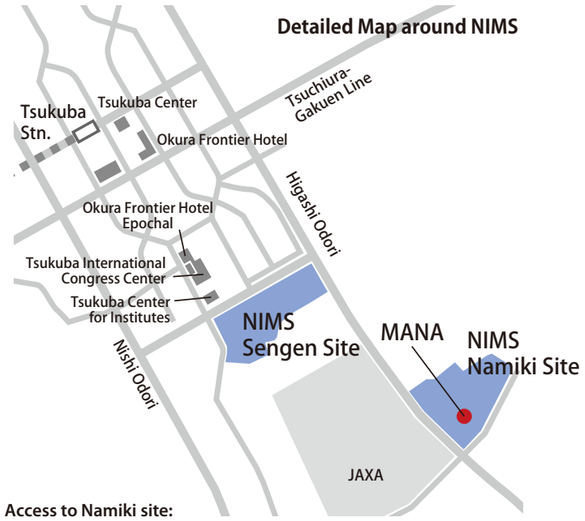
Local Map of Tsukuba City



Map of Japan and Kanto area



Detailed Map around NIMS



Access to Namiki site:

- **By Tsukuba Express Line**
  Get off at Tsukuba Station. Take the bus for "Arakawaoki Station" and get off at "Busshitsu Kenkyujo mae". 1 minute walk.
- **By Highway Bus**
  Take the Highway bus from JR Tokyo Station for "Tsukuba Center" and get off at "Namiki 1-chome". 1 minute walk.
- **By Airport Liner NATT's**
  Take the Airport Liner NATT's from Narita Airport for "Tsuchiura Station" and get off at "Tsukuba Center". Take the bus for "Arakawaoki Station" and get off at "Busshitsu Kenkyujo mae". 1 minute walk.

WPI Research Center
International Center for Materials Nanoarchitectonics (MANA)

National Institute for Materials Science

International Center for Materials Nanoarchitectonics
1-1 Namiki, Tsukuba, Ibaraki, 305-0044
TEL : +81-(0)29-860-4709 FAX : +81-(0)29-860-4706
E-mail : mana@nims.go.jp

http://www.nims.go.jp/mana/

MANA Building

2010-09

WPI Research Center

MANA

International Center for Materials Nanoarchitectonics

Towards a World-Top Level Fundamental Research Center in Nanotechnology and Materials Science

Prof. **Masakazu Aono**
MANA Director-General

Pioneering a New Paradigm

The International Center for Materials Nanoarchitectonics (MANA) was established as one of the five research centers selected as part of the World Premier International (WPI) Research Center Initiative, launched by Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2007 (*). I am pleased to report that in the three years since its inception, MANA has achieved steady progress and I would like to take this opportunity to express my sincere gratitude to all parties who have supported and contributed to its success.

The creation of a sustainable society remains one of the most important challenges mankind faces in the modern age. The realization of such a society will require technological innovation in a wide range of fields including the environmental, energy, resources, IT and communications, diagnostic and medical sectors. More importantly, however, advances in each of these disciplines will depend to a large extent on the development of new materials. Historically, advances in materials sciences have always paved the way for technological innovation with the resulting technologies functioning as the driving force that breaks through existing barriers.

Following remarkable development over the last two decades, the field of nanotechnology has come to play a central role in modern day materials development and it is widely expected to remain a key pillar of materials sciences in the future. However, if we view nanotechnology as just another significant milestone in approaches toward materials development, we lose a valuable opportunity to leverage its true potential. Nanotechnology should really be considered an entirely new branch of technology that has brought about a paradigm shift in conventional materials development. At MANA, this new discipline is referred to as "Nanoarchitectonics" and we are striving to promote and explore this field.

Perhaps the most remarkable insight thus far gained through nanotechnology is that "interesting new functions seem to appear once material is reduced to nanoscale dimensions." However, the mere incorporation of these single properties into materials development will not bring about substantial innovation in the science. Of more importance are the various new cooperative functions that originate as the result of the mutual interactions nanoscale structural units exert with each other. Properly understanding the cooperative functions and systematically using them could likely spark a transformation in materials development. We must advise caution though, as the conventional manufacturing approach of making and assembling parts in accordance with a particular design (valid for macro-scales to micron scales) cannot necessarily be transferred to nanoscale operations. Specific manipulation of nanoscale structural units, comprised of atoms and molecules, is not simply a matter of using the appropriate tools or techniques but is dependent on a range of other factors such as statistical and thermal fluctuations and thus not always absolutely achievable. Incorporating these structural ambiguities and deficiencies into design decisions, Nanoarchitectonics constitutes a new branch of technology that will prompt the development of new materials by exploring new essential tools and techniques to create materials with revolutionary properties based on the organization of cooperative functions.

To promote and effectively use Nanoarchitectonics as an independent discipline, MANA has established four research areas consisting of Nano-Materials, Nano-Systems, Nano-Green, and Nano-Bio, with the scope of research extending from fundamental to applied levels. The Center has also succeeded in creating an international environment with over half of its research body comprised of foreigners and is actively trying to attract competent human resources from all over the world. MANA is also dedicated to the training of young scholars in an effort to contribute to the next generation of researchers.

In closing, I would like to once again request your continued support for our activities.

(*) A sixth research center was added in Kyushu University in 2010.

Aiming to Be Highly Visible Research Center

The WPI Program has four basic objectives: advancing leading edge research, creating interdisciplinary domains, establishing international research environments and reforming research organizations.

Host institution	WPI research center	Research fields
Tohoku University	Advanced Institute for Materials Research (AIMR)	Materials Science
University of Tokyo	Institute for the Physics and Mathematics of the Universe (IPMU)	Astrophysics
Kyoto University	Institute for Integrated Cell-Material Sciences (iCeMS)	Meso-Control Stem Cells
Osaka University	Immunology Frontier Research Center (IFReC)	Immunology
National Institute for Materials Science	**International Center for Materials Nanoarchitectonics (MANA)**	**Nanotechnology & Materials Science**
Kyushu University	Carbon-Neutral Research Institute (Selected in 2010)	Environmental & Energy Sciences

To achieve these objectives, WPI research centers are required to tackle the following challenges:

■ Critical mass of outstanding researchers

- Bringing together top-level researchers within a host research institution
- Inviting top-notch researchers from around the world

■ Attractive research and living environment of top international standard

- Strong leadership by center director
- English as the primary language
- Rigorous system for evaluating research and system of merit-based compensation
- Strong support function
- Facilities and equipment appropriate for a top world-level research center
- Housing and support for child education and daily living

Science: leading-edge research
Globalization: international research environments
Reform: research organizations
Fusion: interdisciplinary domains

Prof. **Sukekatsu Ushioda**
NIMS President

The National Institute for Materials Science (NIMS) was the only independent administrative institution to be selected for a grant by the World Premier International Research Center (WPI) Initiative in 2007 and later in October of that year, established the International Center for Materials Nanoarchitectonics (MANA). The WPI Initiative selects members on the basis of their ability to attract leading researchers from across the globe and bring together a wide range of researchers including young scholars, postdoctoral associates and graduate students in an environment that should possess a certain level of "global visibility."

Apart from featuring world-class leading-edge research facilities, NIMS also hosts one of the best international research environments in Japan. Building on this environment, MANA is promoting the development of new materials and devices that will contribute to the realization of a sustainable society under its flagship research field of "Materials Nanoarchitectonics."

In its role as host institution, NIMS fully supports the research activities undertaken by MANA and looks forward to seeing MANA develop into a world-class leading research center in the nanotechnology and materials fields, distinguished both by reputation and achievements.

Research

Mission and Research Target

Research Target of MANA

By converging the five key technologies of Materials Nano-architectonics, the center focuses on the four researchfields, Nano-materials, Nano-system, Nano-green and Nano-bio, to develop novel materials and systems at the nanometer scale and create epoch-making innovations in materials science and technology and contributes to the development of various new technologies necessary for the realization of sustainable society.

Nanoarchi tectonics

- Controlled Self Organization
- Field-induced Materials Control
- Chemical Nanomanipulation
- Atom/Molecule Novel Manipulation
- Theoretical Mode ling & Designing

CONVER GENCE

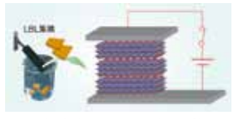
Mission of MANA

- To promote interdisciplinary research by materials nanoarchitectonics
- To serve as a "Melting Pot" where top-level researchers gather from around the world
- To secure and cultivate outstanding, innovative young scientists
- To construct a network of nanotechnology centers throughout the world

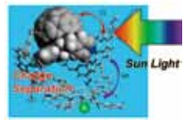
New Materials & System

Nano-Materials •Nanotubes •Nanosheets •Supermolecules •Nanoparticle

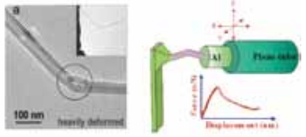
Utilizing unique synthetic techniques developed in NIMS, e. g., soft-chemical processes, the Nanomaterials field systematically explores and creates new nanoscale materials (e.g., nanotubes, nanowires, nanosheets, nanoparticles etc.) based on a wide range of organic to inorganic materials, and aims to unravel new and enhanced properties in them. Furthermore, these newly developed nanomaterials are assembled via chemical manipulation and alignment control by external fields to design/tailor highly organized nanostructures. Through these strategies, revolutionary electronic, magnetic, optical and chemical functionalities will be developed to contribute the progress of electronics and the solution of energy /environment issues.



High-dielectric nanosheet film



Supramolecules that generate electricity from sun light

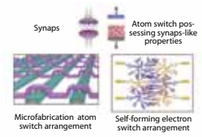


Mechanical Properties of Boron Nitride Nanotubes Measured inside TEM

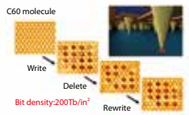
Nano-System •Nanobrain •Quantum information •Nano-superconductor •Advanced modeling

The Nano-systems field not only explores new nanoscale materials that exhibit superior nano properties but also investigates new cooperative function that are generated as a result of the mutual interactions that nano structural units exert with each other and tries to develop nanosystems that organize these cooperative properties. Over the near term, the research will likely continue to focus on technological innovation in the fields of information processing and environmental monitoring. In the domain of information processing, the field aims to push the boundaries of conventional CMOS devices through development of new nanodevices, as well as create new information processing systems or quantum information processing systems that can learn from and even outperform neural networks. In the domain of environmental monitoring, the field is developing new methodologies that will enable detection of several hundred different types of particles in the environment, including gasses, liquids and biological materials, and new techniques that will enable monomolecular sensitivity to the same types of particles as well as spatial resolution measured in nanometers.

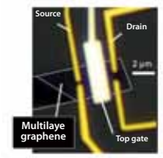
Computational circuit for new algorithm



Monomolecular level ultrahigh density memory

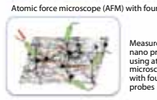


Graphene-based field effect transistor (FET)



Scanning probe microscope with multiple probes

Atomic force microscope (AFM) with four nano probes



Measurement of nano properties using atomic force microscope (AFM) with four nano probes

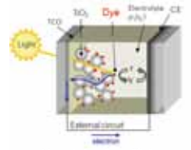
Innovation

Nano-Green •Fuel cells •Solar cells •Catalyst •Li ion battery

In order to establish the fundamentals for a renewable energy system with the sun as the primary energy source, which is required for the sustainable-society, the Nano-Green Field carries out research on the construction of efficient interfacial energy conversion processes by arranging atoms and molecules on surfaces in a controlled manner, i.e., Surface Nanoarchitectonics. Theoretical design and advanced material synthesis techniques with high precision are being utilized to develop highly efficient photo catalysts for water splitting, dye-sensitized solar cells, and catalysts for fuel cells and photo electrolysis of water. In addition solid-state Li-ion batteries with a high power density and micro-solid oxide fuel cells will be realized.

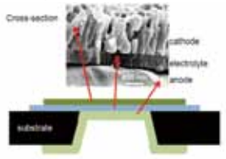
Highly efficient solar energy conversion

Photocatalyst material that exhibits remarkable oxidation power under visible light irradiation. Silver Phosphate (Ag_3Po_4)

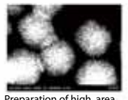


Novel dye for efficient dye-sensitized solar cell

Micro-solid oxide fuel cell by pulsed laser deposition



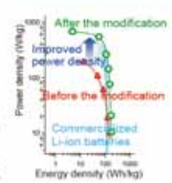
Efficient catalysts for fuel cell and photoelectrochemistry



Preparation of high area catalyst of dendrite shape

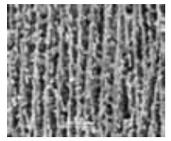
Efficient hydrogen evolution catalyst

All solid state Li ion battery with high power density

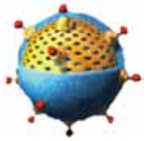


Nano-Bio •Bionanoparticle •Biomaterials •Biointerfaces

Using fundamental technologies based on new materials that actively interact with cells or living organisms, bio-compatible materials, and minimum invasive sensing, the Nano-bio field conducts research on target-oriented drug delivery systems, new pharmaceutical systems that combine imaging functionality with therapeutic efficacy, and materials therapy, in which the type materials used enhances the benefits gained from a particular therapy. In addition, it also conducts research in artificial organs or treatment systems that use high-efficiency cell culture matrixes, which control cell differentiation, and composite materials that restore biofunctions, with the goal of developing medical regenerative technologies that draw on new materials.

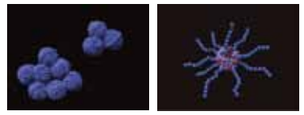


Restoration of hard and soft tissue nano composite material

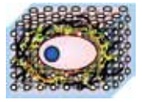


Smart particle used in material therapy

Drug-eluting stent



Target-oriented drug carrier



Artificial matrix that controls stem cell functions

Attractive Research Environment

MANA Cafe : Venue for mutual communication and research integration

Full support for researchers of all nationalities

Origami class organized for foreign researchers

MANA Foundry
Both sides mask aligner (left), Spattering machine (right)

Melting Pot

Multinational researchers from different fields and with different cultural backgrounds all gather at MANA to create a melting pot environment. Diverse research fields come together in the melting pot to breed new research seeds for innovation.

Environment in which Researchers can Focus on Research

MANA employs experienced staff who are fluent in English and has a wide variety of administrative support systems in place to ensure that researchers of all nationalities can focus on their research without difficulty.
The official language of MANA is English. Seminars and meetings are held in English, and all email communication, intranet content, research plans and administration documentation are in English, thus allowing all researchers—foreign nationals and Japanese alike—to devote themselves to their research.

Thorough Support for Foreign Researchers

MANA provides thorough assistance to foreign researchers for matters such as registration procedures, finding housing, and emergencies to get them established in Japan. MANA also offers regular Japanese culture and Japanese language classes for foreign researchers.
There are also public accommodation facilities nearby for foreign researchers who work at MANA, making for an ideal environment.

Cutting-Edge Research Facilities

MANA researchers have full access to the world's most advanced, high-performance research facilities at NIMS. MANA is home to the MANA Foundry, a collection of top-class equipment that provides the backup for nanoarchitectonics research ranging from nano-fabrication to nano-characterization.
In addition to the Foundry, MANA houses a large amount of shared equipments and employs experienced technicians to provide maintenance and support.

MANA's Unique Training of Human Resources

Fostering Young Researchers

Young researchers at MANA are encouraged to work under the tutelage of external non-NIMS mentors, some of whom are stationed overseas. Young researchers typically have 2 mentors (Double-mentor), are affiliated to 2 research institutions, (Double-affiliation) and research in 2 fields (Double-discipline). This is called the 3D, or Triple Doubles System.
Many young researchers spend some time of the year working with their overseas mentors. This encourages them to undertake discipline-integrated research and serves to cultivate a global perspective in them.

Short-Term Research Programs

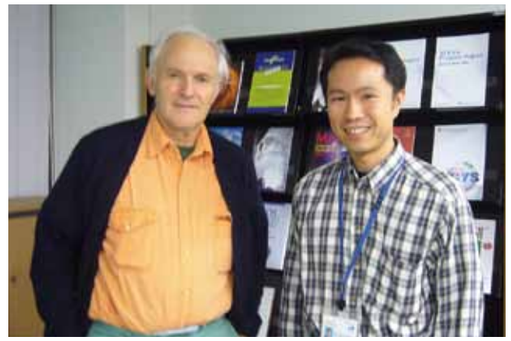
MANA conducts Short-Term Research Program in an effort to promote more efficient joint research efforts. Under these programs, tenured young researchers from overseas universities or research institutes are invited to the Center for a period of 1-3 months. This short-term stay not only promotes more efficient joint research but allows MANA to build strong alliances with research institutes around the world.
Moreover, the promotion of joint research with the world's leading researchers creates an international spirit and enhances creativity among MANA's young scholars.

Summer School

MANA also co-hosts a rotating Summer School with the University of Cambridge and UCLA as part of an educational program for graduate students.

Disseminating MANA to the World

Thus far, a total of 19 young researchers have advanced their careers following their stay at MANA, and are either working as permanent researcher at NIMS or have taken up professor or associate professor positions in 10 different countries, thereby playing a role on the global stage.



Professor Kroto, winner of the Nobel Prize in Chemistry, advises a young researcher

One of MANA's young researchers fully engaged in an experiment with Prof. Ramanath who was visiting from the US.

New Research Building

The construction of a new MANA building will start in FY 2010. The building is designed so that scientists of different fields can gather together and interact freely with each other. The building is also designed to achieve the country's highest level of energy efficiency and environment-friendliness through the installation of solar panels on the roof and LED array lighting on the ceilings among other approaches.

Architectural illustration of the new building

Activities of MANA

MANA International Symposium 2010 (March)

Workshop on "Materials Nanoarchitectonics for Sustainable Development" in Hakone

International Symposium

Every year MANA hosts renowned researchers from around the globe for 3 days of presentations and disucussions with MANA's own researchers. More than 300 researchers participate in the active discussions every year.

MANA Seminars

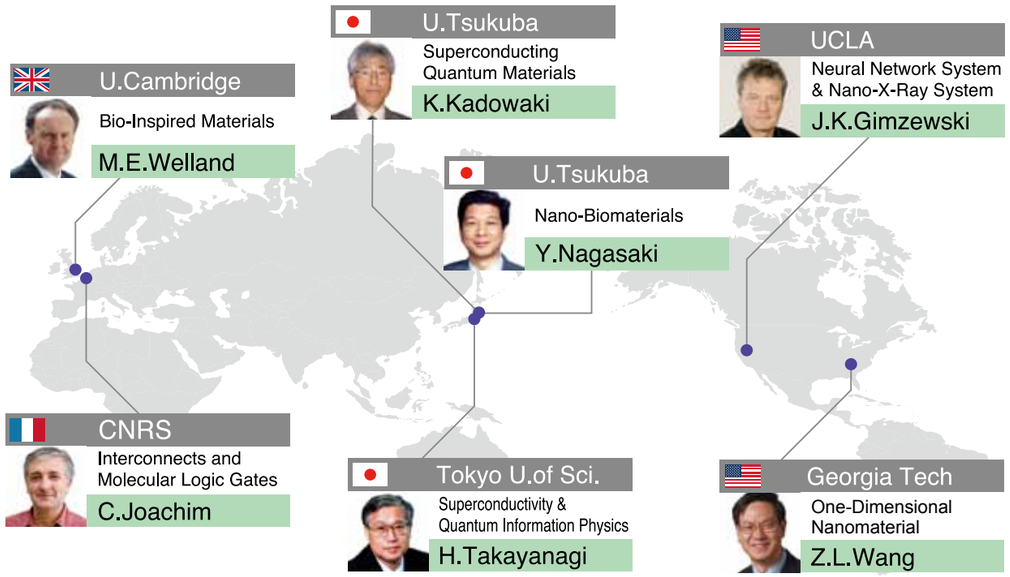
The purpose of the weekly-held MANA Seminars is to provide a venue for interdisciplinary exchange and network building. Both MANA-affiliated researchers and visiting scholars attend the Seminars and present and discuss on the latest research topics.

Workshop

MANA operates workshops with Satellites and other partner research organizations throughout Japan and across the globe. The aim of these workshops is to promote research exchange, make MANA known and develop networks.

Satellites

The MANA research body is comprised of 28 principal researchers of which seven are visiting scholars from external research institutes. To further promote research efficiency, visiting researchers set up a satellite MANA lab at their home institution. So far, a total of six MANA satellite labs have been established across the globe. In addition to serving as a platform for joint research, these labs also function as forward bases in MANAs strategy to expand its global reach and form a nanotech network.



Striving to Implement Resolute Organizational Reforms

Director-General

M. Aono

Chief Operating Officer

Y. Bando

Administrative Director

T. Fujita

Advisors:

Advisors, such as Nobel Prize Winners and world prominent researchers, provide advice and guidance to MANA scientists and researchers.

Nobel Prize in Physics (1986)

Prof. Heinrich Rohrer

Nobel Prize in Chemistry (1996)

Prof. Sir. Harry Kroto
Florida State Unieversity

Prof. C.N.R. Rao
Honorary President of the Jawaharlal Nehru Centre for Advanced Scientific Research

Prof. Galen D. Stucky
University of California Santa Barbara

Prof. Teruo Kishi
Former NIMS President

Evaluation Committee Members:

Evaluation Committee Members provide MANA with their critical comments and expert recommendations on the operation and research strategy of the MANA project.

Chair

A. Cheetham
U. Cambridge

T. Aida
U. Tokyo

M. Endo
Shinshu U.

H. Hahn
Karlsruhe

K. Hashimoto
U. Tokyo

Y. Nishi
Stanford U.

M. Rühle
Max-Planck

R. Ruoff
U. Texas

L. Schlapbach
EMPA

K. Tanaka
JST

NIMS

MANA's host institution, the National Institute for Materials Science (NIMS), conducts research and development on new materials under its slogan of "Nanotechnology Driven Materials Science for Sustainability".
As MANA's host, NIMS provides the maximum level of support to ensure that MANA becomes a world-class research center.

Members

MANA Principal Investigators (PI)

Principal Investigators are internationally known world-top class scientists, who take the main role to achieve the MANA research targets and serve as mentors for younger researchers.
MANA has selected Principal Investigators from NIMS and other domestic and overseas institutes.

Nano-Materials Field

T. Sasaki* NIMS
K. Ariga NIMS
Y. Bando NIMS
D. Golberg NIMS
K. Hono NIMS
K. Kitamura NIMS
N. Ohashi NIMS
Y. Sakka NIMS
Z. L. Wang*** GIT

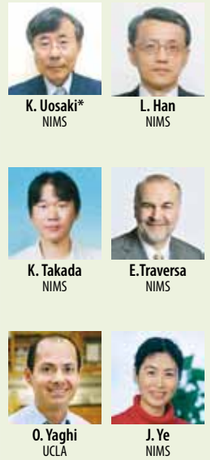
9PIs

Nano-System Field

M. Aono* NIMS
D. Fujita NIMS
J. Gimzewski** UCLA
T. Hasegawa NIMS
X.Hu NIMS
C. Joachim*** CNRS
K. Kadowaki*** Univ. Tsukuba
T. Nakayama NIMS
H. Takayanagi*** Tokyo Univ. Sci.
K.Tsukagoshi NIMS
M. Welland** U. Cambridge

11PIs

Nano-Green Field



K. Uosaki* NIMS
L. Han NIMS
K. Takada NIMS
E.Traversa NIMS
O. Yaghi UCLA
J. Ye NIMS

6PIs

Nano-Bio Field

T. Aoyagi* NIMS
Y. Nagasaki*** Univ. Tsukuba

2PIs

* Field Coordinator ** Satellite Co-Director *** Satellite PI

MANA Workforce

As of September 2010, 107 of MANA 191 researcher, or 56%, are foreign nations hailing form 18 different coutries.

As of September 2010

Position	Number	Non-Japanese	Female
Principal Investigator (NIMS)	21	5	1
Principal Investigator (Satellite)	7	4	0
MANA Scientist	44	7	5
MANA Independent Scientist	14	3	1
ICYS-MANA Researcher	16	10	1
MANA Research Associate	63	56	19
Graduate Student	26	22	6
Administrative Staff and Technical Staff	35	1	21
Total	226	108	54

Proportion of foreign researchers : 56%

MANA Scientists

MANA Scientists are researchers from NIMS, who perform MANA research together with Principal Investigators.

H. Arakawa G. Chen M. Ebara Y. Ebina E.Fabbri J. Hill S. Hiromoto A. Islam C. Kataoka K. Kawakami N. Kawamoto N. Kawazoe
M. Kikuchi M. Kohno O. Kubo R. Ma N. Maruyama T. Minari M. Mitome T. Mori T. Naganuma K. Nagaoka H. Noguchi T. Ohnishi
Y. Okawa M. Osada T. Ozawa D.Pergolesi M. Sakurai N. Satoh Y. Shingaya R. Souda Y. Suetsugu T. Taguchi A. Taniguchi K. Tashiro
K. Terabe S. Tominaka T. Tsuruoka T. Uchihashi A. Yamamoto T. Yamazaki M. Yanagida C. Zhi

MANA Independent Scientists

MANA Independent Scientists are younger researchers from NIMS, who work full-time at MANA and can perform their own research independently in the 3D system (page 6).

R. Arafune A. Belik N. Fukata M. Higuchi S. Moriyama T. Nagao J. Nakanishi Y. Tateyama S. Tsuda L. Vayssieres
A. Vinu K. Wakabayashi Y. Yamauchi C. Yoshikawa

ICYS-MANA Researchers (Postdocs)

ICYS-MANA Researchers are postdoctoral fellows selected from all over the world by open recruitment. ICYS-MANA researchers perform their own research independently by receiving advice from mentors and MANA Principal Investigators.

X. Fang U. Gautum F. Hajjaj R. Hayakawa M. Imura M. Lee T. Shibata L. Shrestha P. Srinivasu Y. Tsujimoto
H. Ueki J. Wi J. Williams G. Yoshikawa T. Zhai Y. Zhang

MANA Research Associates (Postdocs)

MANA Research Associates are post-doctoral fellows employed by Principal Investigators or MANA Independent Scientists.

Graduate Students

Graduate Students are doctor-course students, who are employed by MANA as part-time researchers.