MANA Progress Report

Facts and Achievements 2015

World Premier International (WPI) Research Center
International Center for Materials Nanoarchitectonics (MANA)

National Institute for Materials Science (NIMS)

Preface

Masakazu Aono
MANA Director-General
NIMS

The International Center for Materials Nanoarchitectonics (MANA) was founded in 2007 as one of the first five centers under the World Premier International Research Center Initiative (WPI Program) of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT). In all the way of this period, MANA has conducted its research on the basis of our own "nanoarchitectonics" concept. All the members of MANA including permanent scientists, postdoctoral researchers, technical and administrative staff and students are happy to see that MANA has become a really world-top-level research center in the field of material science and technology. In fact, until December 2015, MANA has published 3,316 papers in 422 different journals and 118 of them are now among the top 1% most cited papers in the world. Further, MANA has achieved an extremely high score of 2.42 for Elsevier's Field Weighted Citation Impact (FWCI), a new index created to "fairly compare the quality of papers published by research institutions that work in different fields." MANA's papers are printed in journals with an extremely high average Impact Factor (IF) of 6.25 (2015). MANA's scores for these indicators are superior to those of many world-class research institutions.

The MANA Progress Report consists of two booklets named "Facts and Achievements 2015" and "Research Digest 2015." This booklet "Facts and Achievements 2015" serves as a summary to highlight the progress of the MANA project. The other booklet "Research Digest 2015" presents MANA research activities.

wpi

MANA
Nano Revolution
for the Future

NIMS

MANA Progress Report
Facts and Achievements 2015

1. WPI Progress Report: Executive Summary

In June 2016, MANA submitted a WPI Progress Report to the WPI Program Committee. The part entitled *World Premier International Research Center Initiative (WPI) Executive Summary (for Final Evaluation)* is reproduced below.

Host Institution: National Institute for Materials Science (NIMS)
Host Institution Head: Kazuhito Hashimoto
Research Center: International Center for Materials Nanoarchitectonics (MANA)
Center Director: Masakazu Aono

World Premier International Research Center Initiative (WPI) Executive Summary (for Final Evaluation)

A. Progress Report of the WPI Center

I. Summary

In the eight and a half years since it was established, MANA has grown to become one of the world's top research centers in the relevant fields and produced remarkable results in fields ranging from fundamental research to practical applications.

MANA's excellence can be found represented in several key indicators. Among these, A) 118 of MANA's papers are now among the top 1% most cited papers in the world; B) MANA has achieved an extremely high score of 2.42 for Elsevier's Field Weighted Citation Impact (FWCI), a new index created to "fairly compare the quality of papers published by research institutions that work in different fields" (both A and B refer to statistics for papers published between 2008 and 2015); and C) MANA's papers are printed in journals with an extremely high average Impact Factor (IF) of 6.25 (2015). MANA's scores for these indicators are superior to those of many world-class research institutions.

MANA has a unique characteristic compared to other materials science laboratories in the world. Its operations are based on a new concept: a new nanotechnology paradigm called "nanoarchitectonics." This unique concept is the key to MANA's achievement of its striking research results.

In eight and a half years, MANA has accomplished much outstanding research. Some representative examples include a) nanosheet technology and its applications, b) atomic switches and related devices, c) various unimolecular devices, d) highly efficient photocatalysts, e) highly sensitive / parallel molecular sensors (MSS odor sensors, etc.), f) diagnosis and treatment using nanoarchitectonics, g) transmission electron microscopes that can observe electrical, mechanical, and optical properties under high-resolution structural observation, and h) multiple-probe scanning probe microscopes that can measure electrical conductivity at the nanoscopic scale.

Over 50% of the researchers at MANA are non-Japanese, making it the most internationalized research center in Japan. MANA has succeeded in creating an almost perfect environment in that it expeditiously provides administrative and technical support to all MANA researchers, including non-Japanese researchers. MANA can give back to NIMS the obtained knowhow and experience of management an international research center. For example, English-language support for non-Japanese researchers within NIMS as a whole has been greatly improved.

In addition to the WPI program's four pillars, MANA has one extra pillar of its own: the cultivation of young researchers. MANA's systems of independent researchers (approx. 20% of permanent researchers), who pursue their own research topics without belonging to any specific group, and ICYS researchers (approx. 20% of post-doctoral scholars) have attained remarkable achievements.

Since FY 2012, MANA has been defined as one of NIMS's three research arms, and it is becoming a permanent presence within the NIMS research organization. NIMS also provides salaries for approximately 90 permanent staff and otherwise provides comprehensive support for MANA in many ways, something that will continue on into the future.

II. Items

1. Overall Image of our Center

<Vision and background>

When MANA was launched eight and a half years ago, nanotechnology (and the nanoscience on which it is based) was in a state of rapid development and becoming an essential pillar of materials science. It was in this context that we designed MANA with the intention of cultivating a world-class research center that would effectively employ nanotechnology to make powerful advances in the research and development of new materials. We were strongly aware of the common mistake of considering nanotechnology to be a continuation of conventional microtechnology, and moreover that nanotechnology's true power cannot be effectively harnessed unless nanotechnology is properly recognized as being qualitatively different from microtechnology. Thus, we established MANA's guiding vision as "Pioneering a new paradigm of nanotechnology to create a research hub for the best new materials development in the world." In order to concisely express this new technology paradigm, we coined the concept of nanoarchitectonics. This concept is described in more detail in the "Progress Report," but it serves to distinguish MANA's research from other nanotechnology research institutions. We at MANA are pleased to see that the nanoarchitectonics concept has begun to gain approval throughout the world.

<MANA today>

MANA was founded on research in four fields—Nano-Materials, Nano-System, Nano-Power, and Nano-Life—but in FY 2016 it established a new field, Nano-Theory. At present, MANA houses 25 principal investigators, 2 associate principal investigators, 75 permanent researchers, 72 post-doctoral researchers, and 36 students who conduct research in 5 fields. These researchers are supported by 29 administrative and technical staff. The present state of MANA can be summarized by the following five points:

- ★ Achieved world-class research activities
- ★ True international center with over half of researchers being of foreign nationality
- ★ Active fusion research that combines nanotechnology and other fields
- ★ Steadily fulfilling its responsibility to reform its host institution, NIMS
- ★ Training excellent young researchers who work throughout the world

< Future outlook >

Building on eight and a half years of experience and confidence, MANA pursues interdisciplinary, fusion research centered around the fusion of "theoretical research and experimental research," and the fusion of "nanotechnology (nanoarchitectonics) and life science." Our final objective is to develop through innovative technologies new materials that will shake up the world. There is tremendous potential for this goal to be realized.

2. Research Activities

< Remarkable research accomplishments>

As explained above, MANA's research is conducted in five fields (Nano-Materials, Nano-System, Nano-Power, Nano-Life, and Nano-Theory.) Below are the main accomplishments of each field of research.

A) Inventing nanosheet-based new materials: MANA developed and implemented creative nanosheet methods used to create a variety of new materials with novel and useful properties. The next step is to use these methods to create metamaterials and new superconductors.

B) Development of atomic switches and related devices/systems: The atomic switch operated by a completely different principle than traditional semiconductor devices. MANA invented the atomic switch and moved it toward practical application, where it brought innovation to things like AI and IoT. It was also discovered that atomic switches display functionality similar to synapses in the brain, and hence the next step is to create neutral network circuits made out of atomic switches.

C) Best high-efficiency artificial photosynthesis in the world: As an example of this, MANA has succeeded in achieving the artificial photosynthesis of methane. The next step is to use a variety of nanoarchitectonic systems to dramatically improve the efficiency of artificial photosynthesis.

D) High-sensitivity / parallel molecular sensors (membrane-type surface stress sensor (MSS)): MANA developed a molecular sensor that is a hundred times more sensitive than traditional molecular sensors, capable of distinguishing between healthy individuals and cancer patients by analyzing their exhaled breath. MANA is currently researching such applications.

E) Development of a revolutionary method of nanoscale measurement: MANA developed a transmission electron microscopy (TEM) that can measure electrical, mechanical, and optical properties in high resolution. MANA also developed multiple-probe (2/3/4 probes) scanning tunneling microscope (STM), atomic force microscope (AFM), and Kelvin probe force microscope that can measure electrical conductivity at the nanoscopic scale.

<MANA's three Grand Challenge research topics>

MANA has posted three Grand Challenge research topics:

- ★ Artificial brains based on nanoarchitectonics
- ★ Room-temperature superconductivity
- ★ Practical artificial photosynthesis

These are long-term research targets, but interesting results are already being achieved. Themes 1 and 3 were touched upon lightly in sections B and C on the previous page. Theme 2 has seen achievement in attempts to create superconductivity by introducing electrons and holes into insulators and semiconductors using field effects. In these attempts, researchers succeeded in metalizing diamond. Separately, it has been theorized that when heavy atoms such as gold are formed into a two-dimensional buckled honeycomb lattice and an electric field is applied perpendicularly, current will flow along its edge with zero resistance, even at high temperatures up to 600 K. Experiments are underway in an attempt to verify this theory.

<Applications of research achievements>

Most of MANA's fundamental research has led to research into applications conducted in cooperation with a variety of companies including NEC Corporation, Honda Motor Company, Murata Manufacturing Co., and Tokyo Chemical Industry Co. Additionally, MANA researchers applied for a total of 774 patents (541 domestic; 233 international) in the period between October 2007 and December 2015. Meanwhile, MANA registered 581 patents (441 domestic; 140 international) in this same period.

3. Interdisciplinary Research Activities

<Strategic initiatives>

MANA has established the following special funds in order to promote interdisciplinary research that fuses MANA's five fields (Nano-Materials, Nano-System, Nano-Power, Nano-Life, and Nano-Theory).

A) Fusion Research Program
B) Theory-Experiment Fusion Research Program
C) Nano-Life Fusion Research Program
D) Grand Challenge Program
E) Theory-Experiment Pairing (TEP) Program

Research topics were determined through a public submission campaign conducted among young MANA researchers. The final topics were selected by a selection committee.

<Representative achievements>

The following are representative achievements of MANA's interdisciplinary, fusion research.

- Broad-ranging nanosheet technology research; from fundamental research through application
  (Combination of Soft Chemistry, Materials Physics, and Electronic Device Technology)
- Broad-ranging atomic switch research; from fundamental research through application
  (Combination of Electrochemistry, Electronic Device Technology, and Neuroscience)
- Development and practical implementation of highly sensitive / parallel molecular sensors
  (Combination of Science on Animal Olfactory Organs, Nanoarchitectonics, and Medical Diagnosis)
- Development of efficient artificial photosynthetic systems
  (Combination of Photocatalytic Chemistry, Plant Photosynthesis, and Nanoarchitectonics)
- Nanoarchitectonic treatments for cancer and Alzheimer's disease
  (Combination of Medical Science and Nanoarchitectonics)
- Development of new superconductor devices
  (Fusion of theoretical and experimental research)

4. International Research Environment

<International Brain Circulation>

MANA has established satellite labs at research institutions to which external PIs belong. MANA Satellites are currently established overseas at 5 institutions including the University of California Los Angeles (UCLA), the Georgia Institute of Technology, the French National Centre for Scientific Research (CNRS) / Center for Materials Elaboration and Structural Studies (CEMES), the University of Montreal, and University College London (UCL). These satellites both play a role in MANA's research in various fields and are also training grounds for MANA's younger researchers. Furthermore, MANA is visited by large numbers of prominent researchers, young faculty students, and other researchers located both inside and outside of Japan. These numbers are increasing every year.

ICYS researchers are on a tenure track to becoming permanent NIMS research staff, and they are hired during twice annual international application phases. Applications have been received from 1,310 individuals over a period of nine years. 90 were hired and 45 of them were assigned to ICYS-MANA.

Of MANA post-doctoral scholars, 12 have been hired on as permanent NIMS research staff, while 198 have advanced to become researchers at universities and research institutions in Japan and around the world. Further, 27 individuals have been sent to private companies.

One of MANA's missions is to build a network of the world's nanotech research centers, of which MANA is the central hub. MANA has signed MOUs with 56 research institutions from 19 countries with which it engages in research and talent exchange.

<Support system for non-Japanese researchers>

All staff in MANA's Administrative Office speak English and provide comprehensive Japanese-style service to all researchers, regardless of age and nationality. However, we did not simply bring a foreign research environment into Japan; instead, we have built an "international research support system in Japan," where non-Japanese personnel can blend right in.

<Administrative support staff and appropriate support systems>

MANA has succeeded in creating an almost perfect environment in that it expeditiously provides administrative and technical support to all MANA researchers, including non-Japanese researchers. Some representative examples of this environmental support are the bilingualization of documents and communication, livelihood support, technical support, Japanese language classes, and Japanese cultural training.

<Other>

As one method of attracting and cultivating young researchers, MANA's systems of independent researchers (who do not belong to any specific group and pursue research independently) and ICYS researchers have produced great results.

In the interest of cultivating Japanese researchers of an international and interdisciplinary character, MANA encourages young Japanese researchers to take up long work residencies at major research institutions overseas. MANA has also established the YAMATO-MANA Program, the objective of which is to invite excellent young Japanese researchers to MANA and cultivate talent who will lead Japan's future.

5. Organizational Reforms

<Decision-making organization>

The center's Director-General has succeeded in gathering excellent researchers from around the world and building a research culture in which these researchers can work freely and easily while working hard and improving together. The Director-General has displayed strong leadership in his management of the center, including his work setting research policy, streamlining systems and organizations, implementing effective new policies, and distributing research resources. He has created an established global presence for the nanoarchitectonics concept by holding numerous research conferences, publishing special nanoarchitectonics editions of famous journals, distributing online newsletters, and other PR activities. Indeed, there is even happy news that the word "nanoarchitectonics" will be in the next revision to the famous and authoritative Japanese dictionary, *Kojien*.

<Administrative support staff and appropriate support systems>

MANA has succeeded in creating an almost perfect environment in its capacity to expeditiously provide administrative and technical services to all MANA researchers, including non-Japanese researchers.

<WPI program organizational reforms and their ripple effects>

Organizational reforms at MANA

(1) Strongly promoted interdisciplinary research by launching new research programs.
(2) Intensified internationalization at MANA through measures such as promoting bilingual administration and offering research and living support for non-Japanese researchers.
(3) Secured and cultivated young researchers by implementing ICYS, the 3D System, and others.

Ripple effects on the host organization as a whole, etc.

(1) The structure has been put in place to easily spread MANA's organizational reforms to the entirety of NIMS. In the NIMS Mid- to Long-Term Plan (7-year plan), MANA is defined as one of seven core research centers.
(2) Overall English ability at NIMS has been dramatically improved by the implementation of programs to improve the English ability of administrative staff, the translation of important documents and internal announcements into both English and Japanese ("bilingualization"), and other initiatives.
(3) Many excellent young researchers who came of age at MANA have been hired on at NIMS as permanent research staff.
(4) MANA's experience and achievements have spread to NIMS's other research centers: e.g., building design.
(5) Center management offices aspiring to be similar to MANA's Administrative Office have been set up at other NIMS research centers.

<Support from the host institution>

NIMS offers comprehensive support for MANA, providing staff, research funding, and research space to the program, as well as delegating management authority to the Director-General. Since MANA's founding, over 1.4 billion JPY annually has been allocated from NIMS's operational expense grants to pay for research projects and other project expenses necessary to the center's activities.

<Role in the host institution's mid/long term plans, etc.>

In its 3rd five-year plan that began in April 2011, MANA's work in the development of innovative new materials through nanoarchitectonics was recognized as a priority R&D area for NIMS, and MANA was defined as one of NIMS's three research arms: namely, the Nanoscale Materials Division. Further, in NIMS's 4th Mid- to Long-Term Plan (7-year plan), the "International Center for Materials Nanoarchitectonics (MANA)" is explicitly defined as one of NIMS's main research centers. NIMS is also methodically increasing the number of permanent researchers and administrative staff on board at MANA. Thus from April 2011 to March 2016, MANA added 18 permanent staff to its roster, meaning that as of the end of March 2016, MANA had a total of 89 permanent staff.

B. Progress Plan

1. Mid- to Long-term Research Objectives and Strategies Based on the Center's Research Results to Date

<Overview>

After analyzing MANA's research accomplishments over the past eight and a half years, the efficacy of two areas was brought into sharp relief: the fusion of "theoretical research and experimental research," and the fusion of "nanotechnology (nanoarchitectonics) and life science." Therefore, these two fusional areas will be the focus of intensive research in the future.

Additionally, analysis of progress on MANA's three Grand Challenge research themes shows that promising preliminary results are in the process of emerging, and hence this research will also be continued.

<Fusion of theoretical and experimental research>

As stated previously, MANA established in FY 2016 a fifth new field in addition to its four traditional fields of research: Nano-Theory. The Nano-Theory field will constitute a large group of 30 theoretical researchers. This means that approximately one in five MANA researchers will be a theoretical researcher.

Despite the fact that many interesting nanoscopic phenomena are accompanied by excited states, dynamic processes, and many-body effects, contemporary methods of first-principles calculation are not good at handling these elements. To overcome this obstacle, MANA will introduce bold yet appropriate methods of approximation to inspire new developments in theoretical research, which will serve to promote the fusion of theoretical and experimental research. Not only will the field of Nano-Theory serve to fuse theory and experimentation, it will also play a role in promoting interdisciplinary fusion research among MANA's four other fields of research, all of which have experimental research at their core.

<MANA's unique Nano-Life research>

MANA established the Nano-Life field with the aim of opening up a new field that combines MANA's world-best nanotechnology with the life science. One important characteristic of MANA is its environment, in which the best nanotechnology researchers and life science researchers work side-by-side to gain a thorough understanding of each other's fields. This distinctive characteristic of MANA's has recently begun producing remarkable results. In the extension period, MANA will take advantage of these circumstances to completely remodel the Nano-Life field. MANA aims to create new, never-before-seen things and systems by studying the functions of cells, sensory organs, and the brain, incorporating the knowledge gained through this into the best nanoarchitectonics technology. Conversely, MANA will also strongly promote the active utilization of the best nanoarchitectonics technology in Nano-Life research.

<MANA's Grand Challenge>

MANA has laid out three Grand Challenge research targets thus far, and it will continue this work in the future. The outlook for future accomplishments in these areas is quite positive.

Now, MANA is adding a fourth Grand Challenge research target that pertains to the fusion of nanotechnology (nanoarchitectonics) and life science:

★ Super bio-sensing

By combining multiple-probe scanning probe microscopy, ultrasensitive / massively parallel molecular sensors, luminescent nano-particle, nanotubes, and other nanoarchitectonics technology with elements of life science pertaining to cells and biomolecules, we hope to open up a new world of super bio-sensing that is unique to MANA.

2. Management System of the Research Organization

<Research organization management>

In April 2016, one year before the end of the 10-year project period of MANA, the next Mid-Term Plan (7-year plan) starts at NIMS and MANA implements structural reforms based on the following key points: Creating and filling the position of a new deputy director, replacing PIs, establishing the Nano-Theory field, strengthening the Nano-Life field, investing in Grand Challenge research, promoting innovative and challenging research, promoting joint research with universities and private companies, etc.

<Initiatives and planning for organizational reform>

Reforming NIMS: The administrative experience and unique administrative and technical support systems cultivated at MANA will be exported to NIMS.

Internationalizing NIMS and Other Japanese Research Institutions and Universities: NIMS will work to export MANA's research environment to other research institutions and universities outside of NIMS.

Expanding the international network: MANA has grown into a well-known world-class research center that attracts researchers from around the globe. MANA will expand its international network beyond just America, Europe, and other developed countries to include countries that are still developing in terms of R&D, encompassing many countries from all regions of the world. In this way, MANA will fulfill its role as a hub for global nanotechnology R&D and the cultivation of young researchers.

3. Center's Position within the Host Institution, and Measures Taken by Host Institution to Provide Resources to the Center

<Role of the center in the mid/long term outlook of the host institution>

NIMS's next Mid- to Long-Term Plan will be a 7-year plan, and it will begin in April 2016, one year earlier than the conclusion of the initial WPI project implementation period (10 years). Even after the end of the WPI program, MANA will continue to be NIMS's main nanotechnology research center, take in most of NIMS's theoretical researchers, and become an even more solidified international nanotechnology research hub. Specifically, beginning in April 2016 seven research centers will exist within NIMS, and one of those will be MANA. With the theoretical researchers transferring to MANA, the augmented superconductor, and four new hires reinforcing MANA's roster, MANA will grow into a major research center with permanent staff numbering 104—approximately 1/4 of all permanent research staff at NIMS.

<Host institution's action plan for maintaining and developing activities befitting of a world-class research center>

NIMS promises provide MANA with the following research resources, and to continue those basic activities on into the future.

i) Although NIMS declared that it would assign approximately 90 permanent NIMS staff to MANA as permanent employees (including principal investigators, associate principal investigators, group leaders, MANA researchers, independent researchers, and administrative staff), from April 2016 this will be greatly increased to a total of 104 staff.

ii) NIMS will contribute 1.6 billion JPY a year out of its management expenses grant to pay for MANA's research project costs, administrative costs, etc.

After the WPI program concludes, in addition to i) and ii) above, the following policies will be implemented:

iii) Post-doctoral scholars and other fixed-term staff hired using WPI grant funds will be replaced with others hired using external funding.

iv) Programs characteristic of MANA—such as young researcher training programs (ICYS, etc.), symposiums, and outreach activities—will be transferred to and implemented at NIMS.

v) NIMS will implement organizational reforms, scrutinizing and strengthening its own systems with reference to the administrative and technical support that are of especially high quality at MANA.

vi) NIMS is planning to create new open innovation mechanisms that utilize promising research accomplishments at MANA and moves them toward practical applications research. Also a new scheme of internationalization is under designing which enable MANA to develop sustainable international networking with a help of MANA satellites.

2. WPI Program and MANA

The content of Section 2.1 is mostly based on information published on the website of Japan Society for the Promotion of Science (JSPS) in April 2016 (www.jsps.go.jp/english/e-toplevel/) and from the wpi brochure (edition January 2015) that can be downloaded from there (www.jsps.go.jp/j-toplevel/data/wpi.pdf).

2.1 World Premier International Research Center Initiative (WPI)

The World Premier International Research Center Initiative (WPI) was launched in 2007 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in a drive to build within Japan *globally visible* research centers that boast a very high research standard and outstanding research environment, sufficiently attractive to prompt frontline researchers from around the world to want to work in them. These centers are given a high degree of autonomy, allowing them to virtually revolutionize conventional modes of research operation and administration in Japan. Japan Society for the Promotion of Science JSPS is commissioned by MEXT to conduct the program's grant selection and project assessment processes and to perform other administrative functions.

The WPI logo is shown in Fig. 2-1. The emblem of the WPI adopts the motif of a bird, symbolizing the program's driving concept of "upward flight." Undaunted by today's turbulent global climate of twisting and turning winds, the bird flies on steady, azure wings through the sky. In its beak, it carries a seed of new innovation. This radiant dot over the "i" also serves to light the path ahead in pioneering the frontiers of scientific discovery.

Fig. 2-1: WPI logo.

● **Outline of WPI Program**

Competition for securing the world's finest brains has intensified over recent years. For Japanese science and technology to play a leading world role, Japan will need to place itself more within the global flow of outstanding human resources while creating open research platforms that attract such talents and produce outstanding results.

The WPI provides concentrated support for projects to establish and operate research centers that have at their core a group of very high-level investigators. These centers are to create a research environment of a sufficiently high standard to give them a highly visible presence within the global scientific community – that is, to create a vibrant environment that will be strong incentive to frontline researchers around the world to want to come and work at these centers.

The WPI has four basic objectives

- ● advancing leading edge research
- ● creating interdisciplinary domains
- ● establishing international research environments
- ● reforming research organizations

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 the 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

To assist the WPI research centers in carrying out this mandate, the Japanese government provides them with long-term, large-scale financial support.

Long-run financial support from the government

- ●About ¥1.3-1.4 billion annually per center
  (The 3 centers selected in FY2012 each receive up to ¥0.7 billion per year.)
- ● 10-15 years of financial support
- ● Interim evaluation at 5-year intervals

Meaning of “highly visible research cernters.” The WPI holds following vision with regard to the research centers being established.

- ● At least, 10-20 world-class principal investigators
- ● A total of at least 100-200 staff members
- ● At all times, at least 30% of the researchers from overseas

● Selected WPI Programs

The National Institute for Materials Science (NIMS) was one of the original five institutes selected for a WPI grant in FY2007 and later in October of that year, established the International Center for Materials Nanoarchitectonics (MANA). A sixth WPI center was added in FY2010 and 3 more WPI centers were selected in FY2012. The 9 WPI research centers with MANA being the only one not integrated into a university are summarized in Table 2-1 and shown in Fig. 2-2.

In FY2011, the five initial WPI centers that were launched in October 2007 each underwent an interim evaluation by the WPI program committee and entered the second 5 year term of operation in April 2012. In FY2014, the five initial WPI centers each applied for a possible 5-year extension after their initial 10-year supporting period ends in March 2017. The WPI Committee determined that all 5 WPI centers have achieved “World Premier Status” fully meeting the goals of the WPI program. On top of that, the committee concluded that Kavli IPMU from The University of Tokyo is the only WPI center that will receive WPI subsidy for five more years.

● Outline of the 9 WPI Centers

Advanced Institute for Materials Research (AIMR), Tohoku University

AIMR aims to establish a Premier Research Center for materials science, to reform the conventional Japanese system and to construct a visible center. To this end, the institute is assembling excellent researchers in the fields of physics, chemistry, materials science, bioengineering and electronic/mechanical engineering.

Table 2-1: The 9 WPI research centers (as of January 2016).

Host Institution	Center Name (Starting Date)	Center Director	Outline of the Center
Tohoku University	Advanced Institute for Materials Research (AIMR) (Oct 2007)	Motoko KOTANI	Establish a World-Leading Research Organization in Materials Science
The University of Tokyo	Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU) (Oct 2007)	Hitoshi MURAYAMA	Cross-Disciplinary Research Center for Addressing the Origin and Evolution of the Universe
Kyoto University	Institute for Integrated Cell-Material Sciences (iCeMS) (Oct 2007)	Susumu KITAGAWA	Creating a new field of integrated cell-material science in the mesoscopic domain
Osaka University	Immunology Frontier Research Center (IFReC) (Oct 2007)	Shizuo AKIRA	Observation of immune reaction - Unveiling dynamic networks of immunity -
National Institute for Materials Science	International Center for Materials Nanoarchitectonics (MANA) (Oct 2007)	Masakazu AONO	Materials Nanoarchitectonics - New paradigm of materials development -
Kyushu University	International Institute for Carbon-Neutral Energy Research (I^2CNER) (Dec 2010)	Petros SOFRONIS	The Grand Highway for a Carbon-Neutral Energy Fueled World
University of Tsukuba	International Institute for Integrative Sleep Medicine (IIIS) (Dec 2012)	Masashi YANAGISAWA	World-class institute for sleep medicine, aiming to solve the mechanism of sleep/wakefulness by conducting basic to clinical research
Tokyo Institute of Technology	Earth-Life Science Institute (ELSI) (Dec 2012)	Kei HIROSE	Globally-Advanced Interdisciplinary Research Hub for Exploring the Origins of Earth and Life
Nagoya University	Institute of Transformative Bio-Molecules (ITbM) (Dec 2012)	Kenichiro ITAMI	Changing the world with molecules: Synthetic Chemistry and Plant/Animal Biology

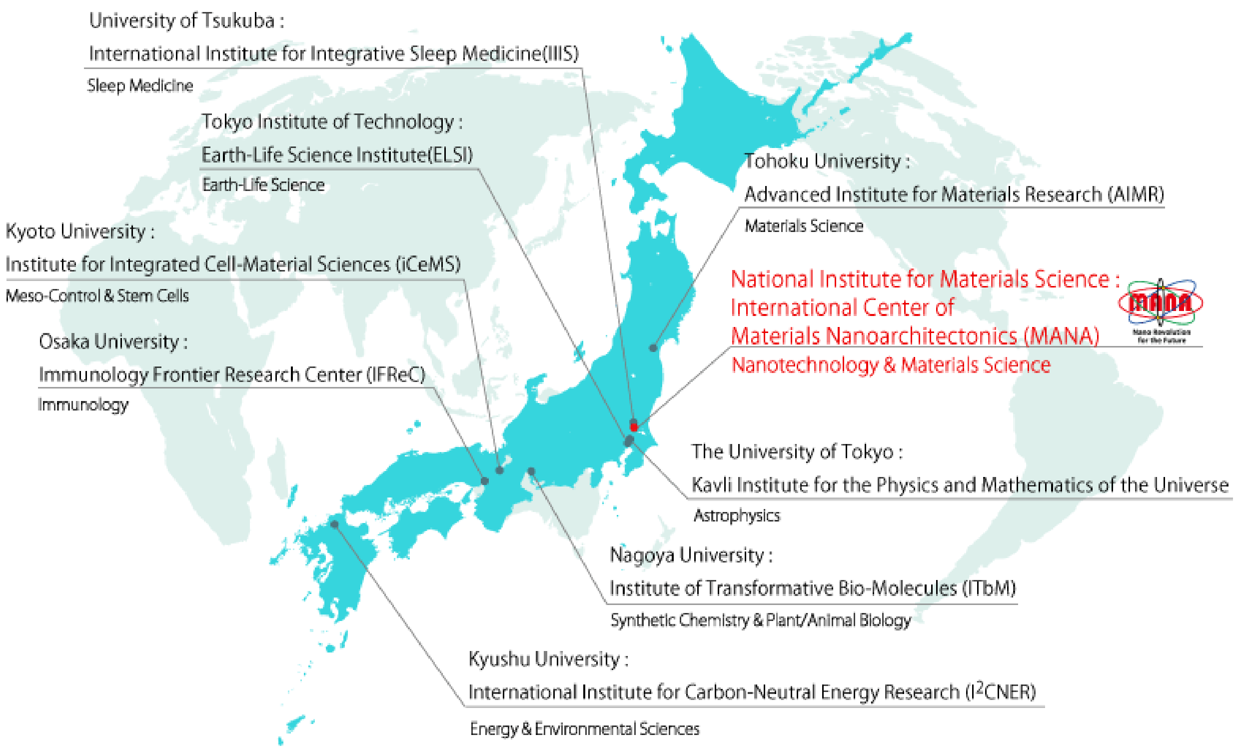


Fig. 2-2: Location of the 9 WPI research centers.

Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU), The University of Tokyo

Establishing a top-level research center visible worldwide for the most urgent issues of basic science such as dark energy, dark matter, and unified theories with a close collaboration of mathematics, physics and astronomy.

Institute for Integrated Cell-Material Sciences (iCeMS), Kyoto University

Our institute seeks to illuminate a chemical basis of cells, creating compounds to control processes in cells such as stem cells (materials for cell control) in addition to sparking cellular processes to create chemical materials (cell-inspired materials), to ultimately establish an integrated cell-material science.

Immunology Frontier Research Center (IFReC), Osaka University

IFReC presents innovative accomplishments in immunology through the interdisciplinary collaboration and participation of world-top immunology and imaging researchers.

International Center for Materials Nanoarchitectonics (MANA), National Institute for Materials Science

MANA aims to create a new paradigm for materials development called "Materials Nanoarchitectonics" and in the field of the managing system focuses on "Melting pot environment," "Fostering young scientists" and "Global Network."

International Institute for Carbon-Neutral Energy Research (I^2CNER), Kyushu University

The mission of the Institute is to contribute to the creation of a sustainable and environmentally friendly society by advancing fundamental science to reduce CO2 emissions and establish a non-fossil based energy carrier system.

International Institute for Integrative Sleep Medicine (IIIS), University of Tsukuba

The mission of IIIS is to be a multidisciplinary, international hub for the research to elucidate the fundamental mechanism of sleep/wakefulness, to develop strategies to regulate sleep, and to contribute to enhancement of world health through the combat with sleep disorders and associated diseases.

Earth-Life Science Institute (ELSI), Tokyo Institute of Technology

ELSI focuses the origins of Earth and life. Both studies are inseparable because life should have originated in unique environment on the early Earth. To accomplish our challenge, we establish a world-leading interdisciplinary research hub by gathering excellent researchers in Earth and planetary sciences, life science, and related fields.

Institute of Transformative Bio-Molecules (ITbM), Nagoya University

The goal of ITbM is to develop innovative functional molecules that make a marked change in the form and nature of biological science and technology (transformative bio-molecules). By merging synthetic chemistry, catalysis chemistry, systems biology, and plant/animal science, which are the strengths of Nagoya University, we aim to create cutting-edge science with potentially significant societal impact.

2.2 MANA, the WPI Research Center at NIMS

● **What is MANA?**

The International Center for Materials Nanoarchitectonics (MANA) was founded in October 2007 as one of the original five centers under the World Premier International research Center Initiative (WPI) of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT). Wining critical acclaim for the research achievements of its first five year term, MANA advanced into its second five year term in April 2012. MANA's Vision and Mission are displayed in Fig. 2-3.

● **What is Nanoarchitectonics?**

Nanotechnology plays an extremely important role in the development of new materials. Yet, nanotechnology tends to be misunderstood as a simple extension of the conventional microtechnology that has demonstrated great effectiveness in micro-fabrication of semiconductor devices - in other words, as a refinement of microtechnology. In fact, however, nanotechnology and microtechnology are qualitatively different. At MANA, we call the new paradigm of nanotechnology, which correctly recognizes this qualitative difference, "nanoarchitectonics."

The distinctive features of nanoarchitectonics can be summarized in the following four key points:

(1) "*Unreliability-tolerant reliability*" - In the world of microtechnology, structures can be constructed according to a design drawing or "blueprint." This is generally not possible in the world of nanotechnology because the world of nanotechnology is far smaller than that of microtechnology. In nanotechnology, thermal and statistical fluctuations become apparent, and at the same time, nanotechnology confronts the limits of the principles of control methods. Therefore, the viewpoint of realizing reliable functions with structures that contain ambiguity is important.

(2) "*From nano-functionality to nanosystem-functionality*" - Nanoscale structures (nanoparts) frequently display interesting new properties, but there are limits to their functionalities, either as individual units or as simple aggregates. Thus, creating completely new functionalities by effectively utilizing interactions among nanoparts of the same type or different types is important.

(3) "*More is different*" - In complex systems that consist of an enormous number of nanoparts, unexpected new functions often emerge in the system as a whole. Therefore, utilizing, and not overlooking, the phenomenon that "quantity changes quality" is another key point.

(4) "*Truth can be described with plain words*" - Finally, it is also necessary to pioneer a new theoretical field, which is capable of handling the three above-mentioned points. In this, it is necessary to construct a theoretical system that not only treats atoms, molecules, electrons, photons, spin, etc. on a first-principles basis, but also consciously introduces "appropriate bold approximation."

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-System, Nano-Power and Nano-Life (Fig. 2-4).

MANA's Vision

Toward a better global future:

Pioneering a new paradigm

in materials development

on the basis of "nanoarchitectonics"

MANA's Mission

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

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

Foster young scientists who battle against innovative research

Construct a world wide network of nanotechnology centers

Fig. 2-3: MANA's Vision and Mission.

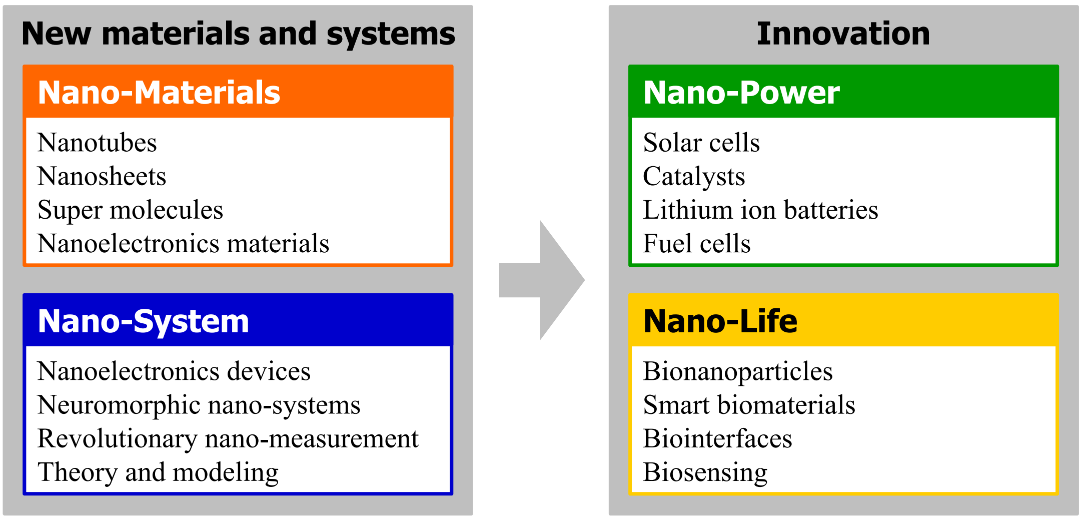


Fig. 2-4: The four research fields of MANA (as of January 2016).

- **Research Objectives of MANA**

Research objectives for each of the four research fields of MANA are as follows.

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.

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’t 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.

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.

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.

● WPI Evaluation of MANA

One Program Director (PD) and nine Program Officers (PO), one for each WPI center, have been assigned by JSPS to conduct the follow-up activities. One deputy PD has been assigned since FY 2013 as well. With the assigned PO as its chair, a working group for each WPI center has been established under the Program Committee. Each group comprises about 5-6 specialists in the subject field. As a rule, about half of them are overseas members. Program Director (PD), Program Officer (PO) and Working Group members for MANA in Fiscal Year 2015 are listed in Table 2-2.

Table 2-2: Program Director (PD), Program Officer (PO) and Working Group members for MANA in Fiscal Year 2015.

Program Director (PD): WPI Program	Toshio Kuroki	Senior Advisor, Research Center for Science Systems, JSPS
Deputy Program Director: WPI Program	Akira Ukawa	Deputy Director, RIKEN Advanced Institute for Computational Science
Program Officer (PO): MANA at NIMS	Gunzi Saito	Professor, Faculty of Agriculture, Meijo University
Working Group Member: MANA at NIMS	Yoshinobu Aoyagi	Senior Researcher, Research Organization of Science and Technology, Ritsumeikan University
Working Group Member: MANA at NIMS	Takehiko Ishiguro	Professor Emeritus, Kyoto University
Working Group Member: MANA at NIMS	Tadashi Matsunaga	President, Tokyo University of Agriculture and Technology
Working Group Member: MANA at NIMS	Hiroshi Katayama-Yoshida	Professor, Graduate school of Engineering Science, Osaka University
Working Group Member: MANA at NIMS	David L. Allara	Distinguished Professor Emeritus of Chemistry and Professor of Materials Science & Engineering Departments of Materials Science & Engineering, Pennsylvania State University, USA
Working Group Member: MANA at NIMS	Klaus von Klitzing	Director, Max Planck Institute for Solid State Research, **Germany, Nobel Prize laureate**

The Evaluation of MANA by the WPI Program Committee consists of an annual 2-day site-visit at MANA and an annual Follow-Up Meeting. Primary Evaluation criteria are the Achievements of Science as well as the Implementation as a WPI Research Center. In FY2011, at the interim evaluation by the WPI Program Committee, MANA received a high score "A" and has entered the second 5 years of operation in April 2012. In FY2014, the 7th MANA Site Visit by the Program Committee members, PD, PO, international WG members, MEXT officials and JSPS secretariats was part of MANA's application for a possible 5-year extension after the initial 10-year supporting period until March 2017. In FY2015, only a short version of site visit was conducted at MANA by PD, PO, MEXT and JSPS.

3. Organization, Members and International Research Environment of MANA

3.1 MANA Organization and Members

● **Organization of MANA**

In order to realize the MANA concept, it is extremely important to establish efficient organizational operation. Fig. 3-1 shows an overview of the MANA organization. The role of MANA members are explained in Table 3-1.

The Director-General of MANA has authority over the center's operation in general. He possesses the authority to allocate Center resources such as budget funds and space. This includes employment and renewal of contracts for researchers and administrative staff members of the MANA center, except for those who are enrolled in the main body of NIMS.

In October 2008, a Chief Operating Officer was assigned to work under the Director-General in order to reduce the burden on the Director-General and to allow for more efficient and speedier Center management. The Administrative Director oversees administrative duties, while the Chief Operating Officer supervises research. In light of the Center's administrative issues, the MANA Executive Meeting was put in place to allow the Director-General, Chief Operating Officer and Administrative Director to confer at any time to make snap decisions on Center management.

In April 2015, the MANA Administrative Director Takahiro Fujita has been promoted to NIMS Vice President. Therefore, in May 2015, the MANA Principal Investigator Tomonobu Nakayama has been appointed as the new MANA Administrative Director.

The MANA Administrative Office has been established with three teams in October 2008 (*Planning Team*, *General Affairs Team*, *Technical Support Team)* and added an *Outreach Team* in April 2010. All staff of the MANA Administration is fluent in English.

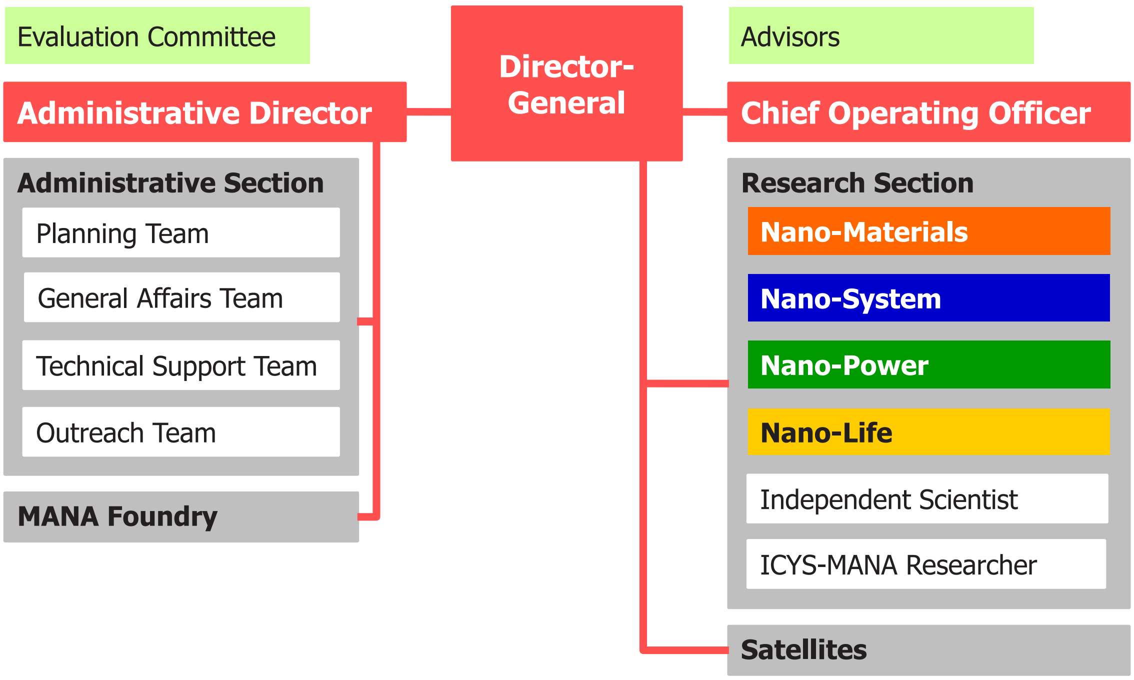


Fig. 3-1: Organization of MANA (as of January 2016).

Table 3-1: MANA members and duties.

Director-General Center oversight	**MANA Independent Scientist** A fixed-term younger researcher who conducts his/her own research independently in the 3D system
Chief Operating Officer Assists the Director-General and supervises research	**ICYS-MANA Researcher** A postdoctoral fellow selected from all over the world by open recruitment. He/she performs his/her research independently while receiving advice from mentors and Principal Investigators
Administrative Director Takes orders from the Director-General and supervises clerical and administrative duties	**MANA Research Associate** A postdoctoral fellow working in a group of a Principal Investigator or MANA Independent Scientist
Principal Investigator (PI) 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	**Graduate Student** A doctor-course student at an institution affiliated with NIMS. He/she participates in research at MANA under the tutelage of a Principal Investigator, MANA Scientist and/or a MANA Independent Scientist
Associate Principal Investigator (API) A young promising scientist, who is expected to perform his/her own research at a level comparable to Principal Investigators	**Research Support Staff** Technicians that support research work
Group Leader A researcher who is leading a research group of a unit headed by one of the Principal Investigators	**Administrative Staff** Staff that supports administrative duties
MANA Scientist A researcher from NIMS who conducts research together with a Principal Investigator	

● **Workforce of MANA**

Table 3-2 shows the workforce of MANA as of January 1, 2016, consisting of 209 researchers and 28 technical and administrative staff. The proportion of foreign researchers is 53.3% from 23 different countries (Table 3-3), showing MANA is now really international. The proportion of female researchers has reached 20.3%.

Appendix 7.1: MANA Top Management
Appendix 7.2: MANA Research Staff

Table 3-2: MANA workforce (as of January 1, 2016).

Position	Number	Non-Japanese	Female
Principal Investigators	18	8	2
Associate Principal Investigators	2	1	0
Group Leaders	11	0	1
MANA Scientists	53	8	8
Independent Scientists	14	3	2
ICYS-MANA Researchers *	10	7	0
MANA Research Associates *	50	41	14
JSPS Fellows *	6	6	1
Junior Researchers #	33	31	12
Technical Staff	11	0	3
Administrative Staff	18	2	17
Total	**226**	**107**	**57**

*: Postdocs #: Graduate Students

Proportion of Foreign Researchers: 53.3% (105/197)
Proportion of Female Researchers: 20.3% (40/197)

Table 3-3: MANA workforce with foreign nationality (as of January 1, 2016).

Region	Country	MANA PI, API	MANA Scientist	Indep. Scientist	ICYS-MANA Researcher	Research Associate	JSPS Fellow	Graduate Student	Staff	Total
Asia	China	2	3	1	2	16	1	22	1	48
	India					13	1			14
	Korea		1			2		3		6
	Vietnam				1	1		1		3
	Nepal		1			1				2
	Indonesia							1		1
	Pakistan							1		1
	Thailand		1							1
Oceania	Australia					1				1
Europe	France	1			2	2				5
	UK	2	1		1		1			5
	Germany					1		1		2
	Russia	1		1						2
	Belgium				1					1
	Finland						1			1
	Greece					1				1
	Rumania					1				1
	Switzerland								1	1
	Ukraine						1			1
Near East	Iran					1	1			2
	Saudi Arabia							1		1
Africa	Egypt					1		1		2
America	USA	2		1						3
	Canada	1	1							2
Total		**9**	**8**	**3**	**7**	**41**	**6**	**31**	**2**	**107**

● **MANA Advisors**

As of January 2016, there are three external intellectuals serving as MANA Advisors (Appendix 7.3). They provide advice on overall Center management and invaluable suggestions on individual research projects. They also cooperate in MANA's outreach activities by serving as lecturers in science seminars geared toward elementary and junior high school students. The late Dr. Rohrer, a MANA advisor, used to attend the MANA International Symposium every year and offer invaluable advice on each of the lectures. In April 2013, MANA appointed two prominent researchers as International Cooperation Advisors (Appendix 7.3). They provide MANA with advice on joint research with overseas research institutes and the formulation of a global nanotech network.

Appendix 7.3: MANA Advisors and International Cooperation Advisors

● **MANA Evaluation Committee**

As of January 2016, the MANA Evaluation Committee is composed of seven external eminent scientists (Appendix 7.4) and is chaired by Prof. Cheetham from the University of Cambridge. Prof. Kazuhito Hashimoto, a member of the MANA Evaluation Committee in 2015, has been appointed as the third NISM President in January 2016. To date, the MANA Evaluation Committee has met four times, once each in 2008, 2010, 2012 and 2015, to evaluate the Center's administration and research activities. The committee provides advice from a different perspective than the WPI Program Committee, and MANA responds to its recommendations by formulating action plans.

Appendix 7.4: MANA Evaluation Committee

3.2 Attractive International Research Environment

MANA is one of the most internationalized research centers in Japan. MANA is firmly advancing the development of an outstanding international research environment in an effort to create a *highly visible research center*.

● Training of Young Scientists

MANA attracts outstanding young researchers from around the world for one reason: They know that if they come to MANA, they will be able to maximize their potential and advance to higher levels of performance. MANA has a very unique training system that helps young researchers find their future paths: the Triple Double (3D) System. The 3D System cultivates global perspective through interdisciplinary research.

Unique Triple Double (3D) System

Under the Triple Double, or 3D, System, researchers have two mentors (*Double Mentor*), are affiliated to two research institutions, (*Double Affiliation*) and conduct research in two fields (*Double Discipline*). This system is highly effective for developing the careers of young researchers and has garnered high acclaim from around the world.

• *Double Mentor*

By working with two world-class researchers, young researchers develop global perspective and add depth to their work.

• *Double Affiliation*

Young researchers develop a strong sense of autonomy and independence by working with multiple institutions.

• *Double Discipline*

Young researchers acquire knowledge in multiple fields to enhance the interdisciplinary nature of their research.

MANA Independent Scientists

MANA hires young researchers who have produced outstanding research achievements as MANA Independent Scientists. MANA uses the *Triple Double (3D)* system to train these future leaders. Independent Scientists are granted "independent" authority over their research. MANA provides these researchers with special support, providing them with an environment in which they can freely pursue independent research projects and opportunities to spend long periods of time at foreign research institutions as well as actively assisting them with interdisciplinary research and assigning them world-class researchers as mentors. Independent Scientists do not merely receive support from MANA. They also actively approach companies and government institutions to secure external research subsidies and must manage their own research funding. In this way, the top-tier research environment at MANA creates research leaders for the world. The "Independence" of Independent Scientists consists of the following:

• *Independent Authority over Research*

Just as the name implies, researchers are given independent discretion over their research. In Japan, there are almost no other research institutes that give this much authority and discretion to researchers in their 30s or early 40s. Thanks to this authority, Independent Scientists can decide their own intention and take action related to their own research themes.

• *Independent Research Budget*

Independent Scientists receive some funding from MANA, but not much. They must approach corporations and federal institutions on their own and take the initiative to acquire their own funding. In this way, they secure funding to enable them to conduct research freely and of their own accord.

• *Independent Action*

Meeting directly with the scientists who set the world standard getting to know them personally and listening to what they have to say might just be the most stimulating thing there is for researchers with future potential. Since the activities of Independent Scientists are very free, it is possible for them to conduct research abroad when and for as long as they require.

ICYS-MANA

With the aim of building an international research environment for young researchers and creating a unique system to guide them, the International Center for Young Scientists (ICYS) was set up by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2003 through the Special Coordination Funds for promoting Science and Technology and the Program for Encouraging the Development of Strategic Research Centers. The mission of ICYS was to gather excellent young researchers from different countries and specializations to a place where they can conduct research autonomously in a melting pot environment where they can stimulate one another and elicit as much of their youthful creativity as possible. This ICYS program received high marks and even after the conclusion of the program in 2007, the principle and system of ICYS continued as the NIMS International Center for Young Scientists.

ICYS is an organization that serves as a tenure-track system leading to permanent researcher positions at NIMS. ICYS is comprised of several subordinate organizations, one of which is ICYS-MANA. Researchers at ICYS are selected twice annually through an international application process. ICYS as a whole has received applications from 1,310 individuals over the past nine years (1,174 of which were non-Japanese individuals [i.e. 89% of the total]). Of these, 90 were hired, and a half of these (45) were assigned to ICYS-MANA.

● **Cutting-edge Research Facilities**

MANA's host institution, NIMS, has equipped itself with research equipment of outstanding quality during its history of more than 40 years, and MANA researchers are allowed to freely use this equipment. Among these facilities are various types of world-class ultra-high-resolution electron microscopes, a dedicated beamline at a synchrotron radiation facility (SPring-8), one of the world's most advanced ultra-high magnetic field generators (10 T), an ultra-high-resolution nuclear magnetic resonance (NMR) spectrometer, and an ultra-high pressurizer device (10-100 GPa). In addition, MANA researchers have access to more than 50 "user facilities" (Fig. 3-2) and can use these with the support of experienced English speaking staff from MANA Technical Support Team (TST). MANA is equipped with equipment like a special electron microscope that can observe electrical, mechanical, thermal, and optical properties under high-resolution structural observation; as well as a multiple-probe scanning probe microscope that can measure electrical conductivity at the nanoscopic scale. MANA also has a photoelectron spectrometer, a Raman spectrometer, a femtosecond laser spectrometer, and many other pieces of high-performance equipment.

In April 2009, MANA established a unique and excellent microfabrication facility called *MANA Foundry* with over 30 facilities for nano-fabrication and characterization to support nanoarchitectonics research (Fig. 3-2). MANA researchers can efficiently achieve the necessary microfabrication within the research center itself. Thirteen support staff are present. The clean room facility in the MANA Foundry consists of eight areas in its 234m^2 floor space: Yellow Room (for drawing and photo lithography), Wet Process Area (for chemical treatment), Etching Area, Film Deposition Area, Nano Measurement Area (for characterization), Nano Analysis Area, Thermal Treatment Area, and Dicing & Wiring Area. MANA Foundry is capable of providing consistent process from test piece fabrication to structural observation and functional verification, including nano-gap electrode pattering by electron beam lithography system on complicated structures such as nano dots, nano wires and nano sheets that are made of various materials like organic, inorganic, magnetic, metal, insulator, superconductor and composite.

Fig. 3-2: User facility managed by MANA Technical Support Team (left) and clean room facility in the MANA Foundry (middle and right).

● **Full Support for Researchers**

Fusion of different fields and cultures creates the possibility of innovation. MANA is pursuing a *melting pot environment* where world-class human resources from diverse fields or specialization and different nationalities and cultures can come together and work *under one roof*. To foster such a melting pot environment more and more, MANA has increased the number of foreigners to over 50% of the MANA researchers. As part of the melting pot activity, researchers from MANA are requested to present their research field at the MANA seminars. When renowned researchers visit MANA, they held seminars to introduce their research projects to stimulate MANA researchers and promote interdisciplinary synergies. In 2015, MANA seminars were conducted with 32 speakers from NIMS and 55 invited renowned researchers from around Japan and the world (total 87 speakers).

Appendix 7.5: MANA Seminars

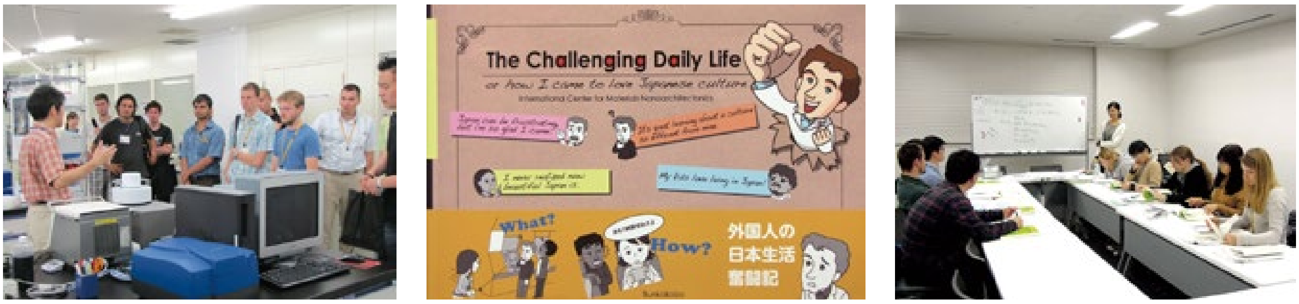


Fig. 3-3: Throughout support for non-Japanese researchers. Lab tour for newly joined researchers (left), a manga comic book with practical tips (middle), and Japanese language class for beginners (right).

All staff in MANA's Administrative Office speak English and provide comprehensive Japanese-style service to all researchers, regardless of age and nationality.

• *Removal of language barriers*

Almost all major guidebooks, documents, intranet services, and other information sources have been translated into both English and Japanese ("bilingualization"). The use of English is thoroughly enforced for all meetings, email contact, etc. In order to assist non-Japanese researchers in obtaining external competitive funding, the center distributes information in English on external funding sources and provides assistance with the application process. Efforts like this to remove language barriers are spreading throughout the entire NIMS organization.

• *Orientation*

At regular intervals, MANA staff provide English language orientation and lab tours for new NIMS researchers (Fig. 3-3). Staff work to ensure that researchers can get started with their work at NIMS as quickly as possible by providing necessary information on work regulations, benefits, supplies procurement, intellectual property, paper publication, research ethics, external funding application, and safety and hygiene, in addition to offering tours of the major research facilities.

• *Livelihood support*

MANA's host organization, NIMS, contracts with the Japan International Science and Technology Exchange Center (JISTEC) to provide livelihood support for non-Japanese researchers. JISTEC handles a wide range of activities, including procedures like residence registration, school enrollment and transfer, opening bank accounts, and moving house. JISTEC also provides a various information relevant to daily living, accompanies individuals to hospitals, and provides support in the event of an accident, in addition to other services.

• *Help to understand Japan*

MANA offers a comic book (Fig. 3-3), well-received by non-Japanese researchers beginning work at MANA, entitled *The Challenging Daily Life*, which offers solutions for problems encountered by non-Japanese researchers conducting research at a Japanese institution. Many directors, managers and research leaders at overseas research institutions have praised this comic book as a "helpful way of eliminating potential barriers faced when young researchers first come to Japan." MANA also offers non-Japanese researchers support including Japanese language classes and Japanese cultural training. Japanese language classes are divided into introductory and beginner levels, and are held in three terms throughout the year. Students hold a speech contest during the final lesson of each term. In 2015, 66 participants attended the Japanese language classes (Fig. 3-3). Japanese culture classes are offered at a pace of roughly once a month. Specialist instructors are invited to give lectures on traditional Japanese culture as shown in Fig. 3-4 and listed in Table 3-4. In 2015, 138 participants joined the Japanese culture classes.

Fig. 3-4: Japanese culture class events at NIMS in 2015. Top from left to right: Kokedama, Paper Cutting Art, Japanese Green Tea and Japanese Drum (Wadaiko). Bottom from left to right: Calligraphy, Pottery, Karate and Origami.

Table 3-4: Schedule of Japanese culture classes in 2015.

1	2015 Jan 30 **Paper Cutting Art** (10 participants)	5	2015 May 30 **Pottery** (9 participants)	9	2015 Sep 25 **Kokedama** (11 participants)
2	2015 Feb 27 **Kumihimo** (7 participants)	6	2015 Jun 26 **Origami** (9 participants)	10	2015 Oct 23 **Seal Engraving** (15 participants)
3	2015 Mar 28 **Cha Kaiseki** (8 participants)	7	2015 Jul 17 **Japanese Green Tea** (19 participants)	11	2015 Nov 20 **Calligraphy** (13 participants)
4	2015 Apr 24 **Karate** (10 participants)	8	2015 Aug 3 & Aug 6 **Japanese Drum (Wadaiko)** (15 participants)	12	2015 Dec 11 **Bath Culture** (12 participants)

• *Technical support*

Members of the Technical Support Team are knowledgeable, proficient in English, and provide great support for all the MANA researchers, especially for non-Japanese researchers. Additionally, the technical support team uses its specialized knowledge to gather and translate information on external funding into English. Especially for non-Japanese researchers, the team provides support of writing applications and reports in Japanese if Japanese documents are really required.

● **New Research Building**

In October 2008, the entire Nano-Materials and Biomaterials Research Building (13,000 m^2, 5-story) at NIMS Namiki site was allocated to MANA as the MANA Building, the primary space for MANA activities at which all major researchers and equipment were centralized. In March 2012, the new WPI-MANA Building (6,000 m^2, 5-story) was completed and the MANA research environment became even better. The new complex (Fig. 3-5) consists of two units - the WPI-MANA Building and

Fig. 3-5: The new complex consisting of the WPI-MANA Building (top) and NanoGREEN Building (bottom).

the NanoGREEN Building – with the area between the two buildings serving as a free space where researchers can meet and discuss their work. It is a facility for world-class research on environmental and energy materials and nanotechnologies that brings together NIMS and outside researchers and private-sector engineers from Japan and abroad. The new complex is disaster-resistant and equipped with energy-saving and CO_2-reducing technology. Various measures have been taken to create a Melting Pot environment within the building, thereby promoting interdisciplinary research. The building received the rank of S, the highest possible rating, from CASBEE, a tool for assessing and rating the environmental performance of buildings.

The new complex employs the latest technologies, including a photocatalytic glass watering system, solar panels and sun louvers. Temperature, humidity and brightness are all controlled automatically to achieve energy efficiency while ensuring comfort. By linking solar panels, emergency generators and storage batteries into a network, MANA was the first institution in Japan to adopt a microgrid. The microgrid will provide seamless power to key facilities even if power is interrupted during a disaster. Even during long power outages, the solar panels and storage batteries can supply the necessary minimum amount of power. Under normal circumstances when various equipment is in operation, the system has a peak output of 90 kW. It is MANA's forward-looking attempt at developing a zero-energy building (ZEB).

Zero-Energy Buildings (ZEB)
ZEBs are buildings that use energy-saving technology and renewable energy to bring their net energy consumption as close as possible to zero.

4. Research Activities, Output and Achievements

4.1 Research Activities

● **Research Digest 2015**

For an overview of MANA research activities, please refer to yearly published booklet Research Digest (Fig. 4-1), which is part of the MANA Progress Report. Examples of recent research accomplishments of MANA are given in Section 4.3 of this chapter.

Fig. 4-1: Recent issues of the booklet Research Digest.

Table 4-1: Volumes of *MANA Research Highlights* published between FY2011 and FY2015.

Volumes	Fiscal Year
1-2	FY2011
3-6	FY2012
7-13	FY2013
14-21	FY2014
22-24	FY2015

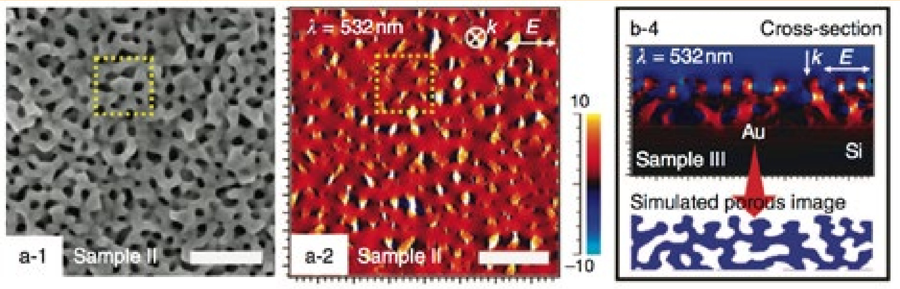
● **MANA Research Highlights**

Since FY2011, the online English newsletter *MANA Research Highlights* has been communicating remarkable MANA research achievements throughout the world. These newsletters are distributed to 2,000 to 3,000 media and science journalists, as well as 2,000 individuals on MANA's mailing list. Especially outstanding research achievements are communicated through the journal Science's third-party e-mail service to approximately 4,000 researchers located around the globe. For reasons including that papers highlighted by this service become the most downloaded, this is a powerful method of publicizing MANA's achievements to the world's scientific community. To date, 24 research accomplishments have been communicated in this way. 24 volumes of *MANA Research Highlights* have been published between FY2011 and FY2015 (Table 4-1). The information is available on the MANA website at www.nims.go.jp/mana/research/index.html . The volumes published in FY2015 are illustrated in Fig. 4-2.

Volume 22 (May 19, 2015)

Holes in gold enhance molecular sensing

Electrochemical techniques produce tuneable porous gold films, where the empty spaces enhance light scattering and sensing signals.



Electromagnetic-field distributions on mesoporous Au films. Scanning electron microscope images (left) and the corresponding Electric-field distributions on mesoporous Au films under 532 nm wavelength excitation.

Publication:
C. Li, O. Dag, T.D. Dao, T. Nagao, Y. Sakamoto, T. Kimura, O. Terasaki, Y. Yamauchi, *Electrochemical synthesis of mesoporous gold films toward mesospace-stimulated optical properties*, Nature Communications **6**, 6608 (2015).
doi: 10.1038/ncomms7608

Volume 23 (February 4, 2016)

Seeding better efficiencies in monocrystalline silicon solar cells

New 'single-seed cast method' for producing high quality monocrystalline solar cells has tremendous potential for the manufacture of low cost, high efficiency silicon solar cells.

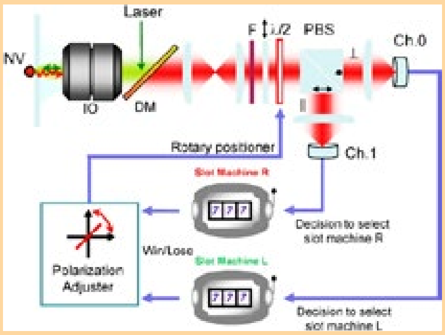
Photograph of the silicon ingot grown with the optimum conditions observed in the current study.

Publication:
Y. Miyamura, H. Harada, K. Jiptner, S. Nakano, B. Gao, K. Kakimoto, K. Nakamura, Y. Ohshita, A. Ogura, S. Sugawara, T. Sekiguchi, *Advantage in solar cell efficiency of high-quality seed cast mono Si ingot*, Applied Physics Express **8**(6), 062301 (2015). doi: 10.7567/APEX.8.062301

Volume 24 (March 18, 2016):

Autonomous Decision-Making by Single Photons

Efficient and adaptive autonomous decision-making has been implemented based on a purely physical mechanism exploiting the quantum nature of photons.



System architecture for single-photon decision maker and schematic diagram of experimental setup.

Publications:
M. Naruse, M. Berthel, A. Drezet, S. Huant, M. Aono, H. Hori, S.J. Kim, *Single-photon decision maker,* Scientific Reports **5**, 13253 (2015).
doi: 10.1038/srep13253

S.J. Kim, M. Aono, E. Nameda, *Efficient decision-making by volume-conserving physical object*, New Journal of Physics **17**, 083023 (2015).
doi: 10.1088/1367-2630/17/8/083023

Fig. 4-2: Volumes 22-24 of the newsletter *MANA Research Highlights*.

● **Advancing Fusion of Various Research Fields**

To encourage precursory, interdisciplinary research across MANA's four fields (Nano-Materials, Nano-System, Nano-Power and Nano-Life), MANA has established the following internal special funds:

- **Fusion Research Program (6 projects, FY2009 – FY2010)**

  This fund was opened to applications from young researchers under the belief that joint research by young researchers from disparate fields is especially important to planting the seeds of new research.

- **Grand Challenge Program (7 projects, FY2011 – FY2012)**

  This program solicited interdisciplinary research proposals that were innovative and "outside the box," in addition to being not necessarily limited to materials research.

- **Nano- Life Fusion Research Program (2 projects, FY2012 – FY2014)**

  Established to promote joint fusion research between Nano-Life researchers and researchers who specialize in other nanotechnology fields.

- **Theory-Experiment Fusion Research Program (10 projects, FY2012 – FY2014 and FY2013 – FY2015)**

  Applications were accepted over a period of two years in an effort to involve more theoretical researchers in MANA to guide and support MANA's experimental research.

● **Grand Challenge Meetings**

In 2011, MANA has started to hold retreat-style *Grand Challenge meetings*. The initial aim of the meeting was to encourage researchers working in different fields at MANA to brainstorm and discuss the kinds of research they aspire to, but the event led some young researchers to propose a Grand Challenge Meeting geared only to young researchers. Some twenty MANA researchers are selected from among those interested in joining this meeting and they engage in free discussions about future grand challenges at MANA at a remote country site for two days. Grand challenge meetings have been held in January 2011 (Miura peninsula), April 2012 (hot spring resort in Nasu) and November 2012 (young researcher's meeting at Miura peninsula). We have observed that these meetings are remarkably useful in triggering fusion research among MANA's scientists in different research specialties. The fourth MANA Grand Challenge Meeting was held in Nasu, Japan, over a 2-day period from February 25 to 26, 2015. Lively presentations and discussions by the participating researchers were held with no research field boundaries. The meeting was a truly significant event that reflected the slogan posted in various places in the MANA Building, "The fruits of your research are proportional to the number of your conversations with others."

The **5th MANA Grand Challenge Meeting** or "The 1st ISSP-MANA Challenge Meeting" was held in Nasu on November 27-28, 2015 (Fig. 4-3). The Institute for Solid State Physics (ISSP) of the University of Tokyo and the International Center for Materials Nanoarchitectonics (MANA) at NIMS are both leading research hubs in the field of materials science and both providing leading research results related to nanoscience and nanotechnology. On the other hand, ISSP is mainly focusing on fundamental nanoscience and MANA on nanoarchitectonics to implement elemental nano functionalities into nanosystems. In this ISSP-MANA Challenge Meeting, potential collaborations between cutting-edge researchers from the two institutions will be dug out by intensive brain-storming discussion throughout the two-day program.

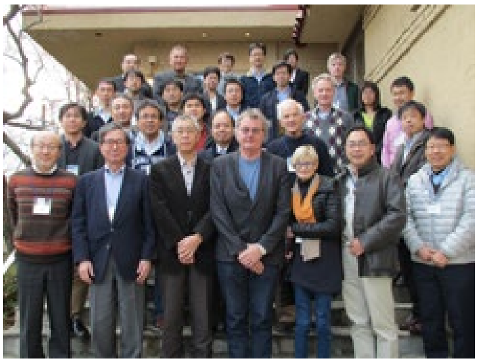


Fig. 4-3: Participants and Brain storming session of the 5th MANA Grand Challenge Meeting in Nasu on November 27-28, 2015.

The **6th MANA Grand Challenge Meeting** or "Energy Forum / TUS – MANA/NIMS Challenge Meeting" was held in two parts at Tokyo University of Science (TUS) on January 8, 2016 and at MANA on January 15, 2016 (Fig. 4-4). The eF/TUS [Energy Forum in Tokyo University of Science] and MANA/NIMS are both questing better solutions for low energy consumption and energy harvesting on the basis of materials science. At present, eF/TUS hosts many TUS researchers from different disciplines

Fig. 4-4: Participants of the 6th MANA Grand Challenge Meeting held at Tokyo University of Science on January 8, 2016 (left) and at MANA on January 15, 2016 (right).

to perform feasibility studies, and MANA/NIMS is developing a variety of materials for solar cells, fuel cells, super capacitor, thermoelectric devices, and so on. Especially MANA is one of the strongest international research hubs in the field of nanoscale science and technology. In this eF/TUS-MANA/NIMS Challenge Meeting, potential cooperation and collaborations between the two institutions will be pursued by intensive brain-storming discussion throughout the two-day program.

● **Invitation of Foreign Researchers**

To ensure that MANA is a research center that attracts all levels of researchers from around the world, MANA uses 2 researcher invitation programs.

NIMS Open Research Institute Program:

This program is run by NIMS and brings together all levels of researchers from young researchers to highly regarded scientists. By March 2016, 178 researchers were invited to MANA by this program.

MANA Short-Term Research Program:

This is an original MANA program that invites faculty members from foreign research institutes who can conduct joint research with MANA researchers. Invitees stay at MANA for 1 to 3 months. By March 2016, 83 researchers from 24 countries have visited MANA within this program.

4.2 Research Output

In the eight and a half years since it was established, MANA has grown to become one of the world's top research centers in the relevant fields and produced remarkable results ranging from fundamental research to practical applications.

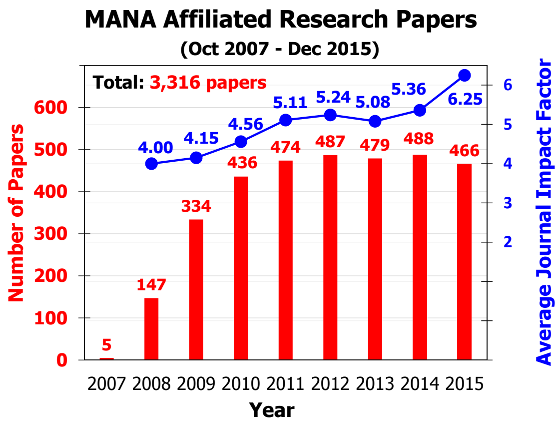


Fig. 4-5: Number of MANA affiliated research papers in English published between October 2007 and December 2015 and average journal impact factor (Source: Web of Science database, as of June 2016).

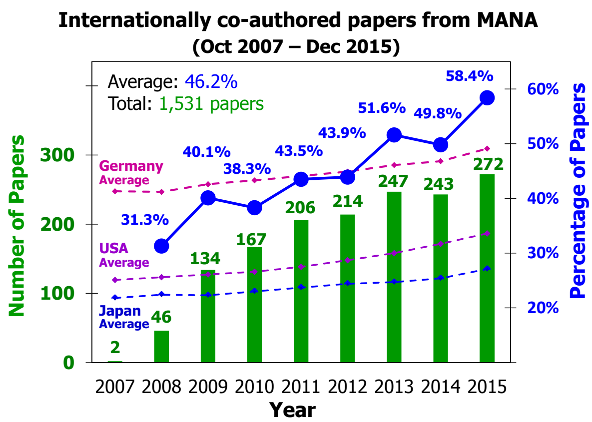


Fig. 4-6: Internationally co-authored papers of MANA published between October 2007 and December 2015. Information based on SCOPUS database. Source of national average: SciVal database, Elsevier B.V., downloaded in May 2016.

Table 4-2: Number of MANA affiliated papers published 2015 in top journals with an impact factor 2015 higher than 8.

Name of journal	Journal impact factor 2015 *	Number of MANA papers 2015
Nature Materials	38.891	1
Nature	38.138	1
Science	34.661	1
Chemical Society Reviews	34.090	1
Progress in Materials Science	31.083	1
Energy & Environmental Science	25.427	2
Accounts of Chemical Research	22.003	3
Advanced Materials	18.960	4
Advances in Physics	18.000	1
Advanced Energy Materials	15.724	2
Nano Letters	13.779	10
ACS Nano	13.334	10
Nano Today	13.157	1
Journal of the American Chemical Society	13.038	6
Angewandte Chemie - International Edition	11.709	11
Nano Energy	11.553	8
Advanced Functional Materials	11.382	8
Nature Communications	11.329	10
Chemistry of Materials	9.407	4
ACS Catalysis	9.307	1
Chemical Science	9.144	1
Materials Horizons	9.095	1
NPG Asia Materials	8.772	3
Journal of Physical Chemistry Letters	8.539	1
Biomaterials	8.387	6
Applied Catalysis B	8.328	2
Small	8.315	4
eLife	8.303	1
Journal of Materials Chemistry A	8.262	16

*: Source: Web of Science database, as of June 2016.

● **Research Papers of MANA**

MANA's excellence can be seen in several key indicators analyzed by Thomson Reuters and Elsevier. Fig. 4-5 shows the number of MANA affiliated research papers in English published between October 2007 and December 2015 together with the average journal impact factor (IF) analyzed by Web of Science data base. The number of MANA papers published per year increased until 2011 and then remained at a high value close to 470 papers per year. Till December 2015, MANA has published a total of 3,316 papers in 422 different journals. The average impact factor (IF) of the journals in which MANA papers were published increased from 4.00 in 2008 to 5.11 in 2011, then remained at an extremely high value slightly above 5 until 2014 and jumped up again to 6.25 in 2015. Of the 466 papers that MANA researchers published in 2015, 121 papers (or 26.0%) appeared in top journals with an impact factor 2015 higher than 8. The top journals are listed in Table 4-2. In other words, the ratio of MANA papers published in such top journals (with impact factor higher than 8) increased from one out of 7 MANA papers (13.9%) in 2014 to one out of 4 MANA papers (26.0%) in 2015. The 466 MANA papers published in 2015 are listed in Appendix 7-6 including *digital object identifier* (doi), *accession number* (WOS), and *electric identifier* (eid).

- The *digital object identifier* (doi) is a unique alphanumeric string assigned by a registration agency (the International doi Foundation) to identify content and provide persistent link to its location on the internet.

- The *accession number* (WOS) is a unique article identifier on Web of Science database.
- The *electric identifier* (eid) is a unique article identifier on SCOPUS database.

Appendix 7.6: MANA Research Papers 2015

MANA researchers actively engage in joint research with other researchers both in Japan and around the world. This is supported by the fact that, of the 3,316 papers released by MANA till December 2015, 46.2% have featured international co-authorship (Fig. 4-6). The number of MANA papers featuring international co-authorship is increasing every year, and such papers accounted for a majority of MANA papers released since 2013. The high rate of international co-authorship of MANA equals that of Germany, which boasts one of the highest rate of international co-authorship in the world. This accomplishment demonstrates that MANA is successfully building an organization in which researchers of different countries can come to cooperate on research.

Essential Science Indicators of Thomson Reuters Web of Science compiles citation-based data sets for gauging performance of publications. *Highly Cited Papers* are ranked in the top 1% by citations for their field and year of publication. Of the total of 3,316 MANA papers, 118 papers (3.6%) are extremely high-profile entering the top 1% in the world by number of citations (source: Web of Science database, as of March 2016). The breakdown of the 118 MANA top 1% papers into Research Fields and Year published is illustrated in Fig. 4-7. MANA top 1% papers appeared in 45 different journals. The journals containing 5 or more MANA top 1% papers are listed in Table 4-3.

Web of Science: 118 highly cited (top 1%) MANA papers

Breakdown into Research Fields:*

Research Field	Percentage
Materials Science	42.4%
Chemistry	42.4%
Physics	12.7%
Pharmacology & Toxicology	1.7%
Engineering	0.8%
Total	**100.0%**

* Classified by Web of Science

Breakdown into Year published:

Year Published	Number of papers
2015	15
2014	14
2013	19
2012	24
2011	14
2010	17
2009	10
2008	5
Total	**118**

Fig. 4-7: Breakdown of the 118 highly cited (top 1%) MANA papers into Research Fields (left) and Year Published (right).

Table 4-3: Journals containing 5 or more highly cited (top 1%) MANA papers.

Name of journal	Journal impact factor 2015 *	Number of MANA top 1% papers
Advanced Materials	18.960	17
Journal of the American Chemical Society	13.038	14
Advanced Functional Materials	11.382	7
Journal of Materials Chemistry A **	8.262	7
Chemical Society Reviews	34.090	5
Chemical Communications	6.567	5

*: Source: Web of Science database, as of March 2016
**: including Journal of Materials Chemistry

Meanwhile, the company Elsevier B.V. has created a new index called the Field Weighted Citation Impact (FWCI) that adjusts the paper citation count by field of research to enable comparisons of the quality of papers released by research institutions in different fields. Fig. 4-8 compares the values of FWCI for MANA and various other institutes and universities in the world. MANA's FWCI of 2.42 is extremely high and means that MANA output is 142% more often cited than expected for the world average (FWCI =1). It is clearly the highest in Japan and reached a level of performance comparable to top-ranked universities in Europe and America.

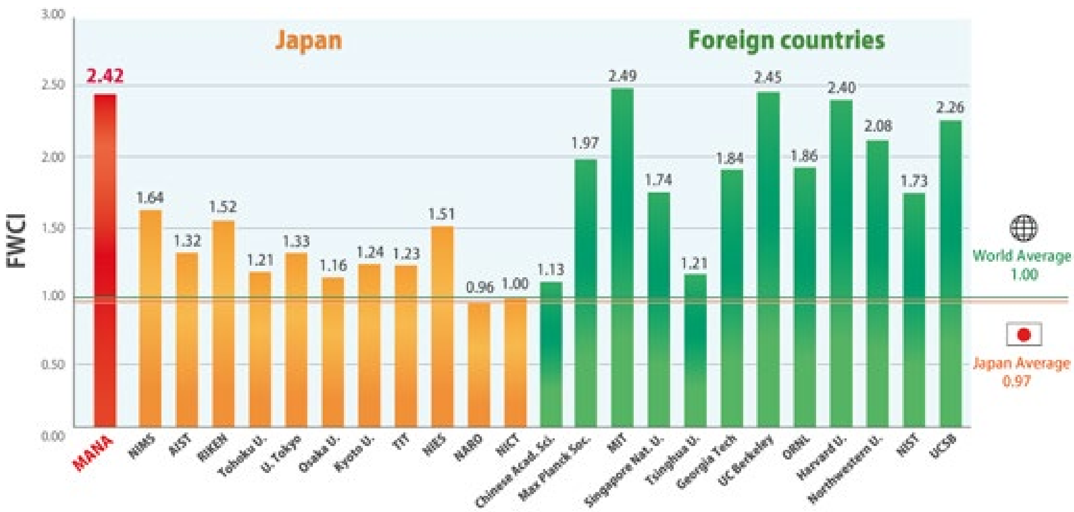


Fig. 4-8: Field Weighted Citation Impact (FWCI) of MANA and other institutions in the world. Source: SciVal database, Elsevier B.V., downloaded in May 2016. FWCIs were calculated for papers published between 2008 and 2015 (8 years).

● **MANA Journal Cover Sheets**

Since the launch of the MANA project in October 2007, MANA scientists have produced many Journal cover sheets of issues that contain their research paper. Different kinds of Journal cover sheets (Journal Front Cover, Journal Inside Front Cover, Journal Back Cover, Journal Inside Back Cover, Journal Frontispiece) related to papers with MANA Affiliation between October 2007 and December 2015 are listed in Appendix 7.7. Some examples from 2015 are shown in Fig. 4-9.

Appendix 7.7: MANA Journal Cover Sheets

Fig. 4-9: Examples of recent journal front covers related to MANA affiliated papers.

● **MANA Patents**

In addition to writing research papers, MANA researchers applied for a total of 774 patents (541 domestic; 233 international) in the period between October 2007 and December 2015. Meanwhile, MANA registered 581 patents (441 domestic; 140 international) in the same period (Fig. 4-10, Table 4-4). A complete list of patent applications and registrations can be found in Appendix 7.8 of this report (for Jan 2013 to Dec 2015) and in Appendix 8.9 of the report *Facts and Achievements 2012* (for Oct 2007 to Dec 2012). A few MANA patent applications were missing in the lists published in the previous Progress Reports. All listed patent applications and patent registrations are or were partly or fully owned by NIMS.

Appendix 7.8: MANA Patents

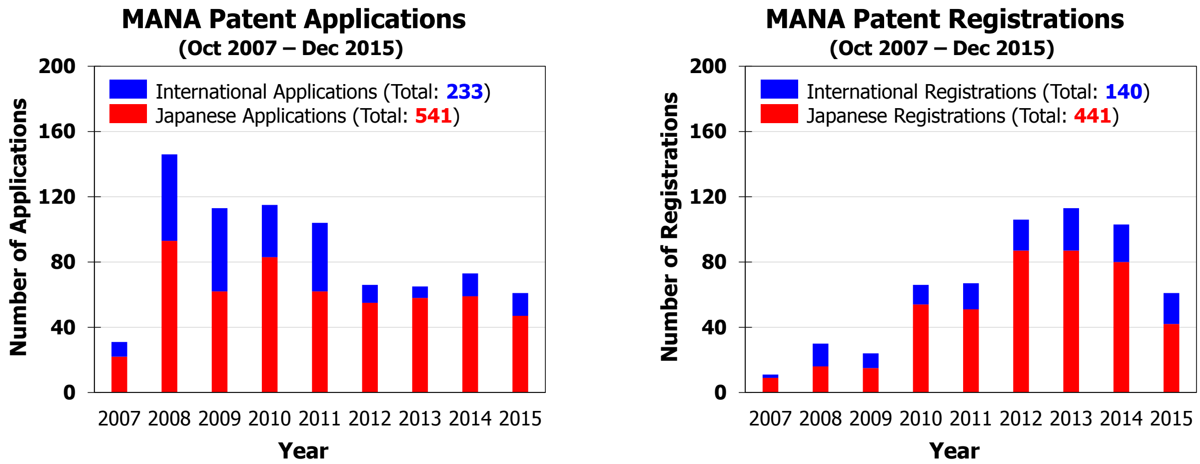


Fig. 4-10: Number of MANA patent applications and registrations between October 2007 and December 2015.

Table 4-4: Number of MANA patent applications and registrations.

	Total Number (2007 Oct – 2015 Dec)	Average Number (per year)
Japanese Patent Applications	541	65.6
Japanese Patent Registrations	441	53.5
International Patent Applications	233	28.2
International Patent Registrations	140	17.0

- **Commendations**

In 2015, MANA's renowned researchers again won several prestigious prizes and awards.

Project Prize at nano tech 2015

The exhibition of research results obtained by MANA Scientist Genki Yoshikawa, entitled *New Sensor Enabling Diagnosis by Breath Analysis and Blood Test with a Cell Phone*, was awarded the Project Prize (Fig. 4-11) at the 14th nano tech International Nanotechnology Exhibition & Conference (nano tech 2015).

Konica Minolta Imaging Science Encouragement Award

MANA Scientist Satoshi Ishii receives the Konica Minolta Imaging Science Encouragement Award FY2014 based on the high evaluation of his research *Development of Ultra-thin Planar Lenses* as a new challenge in optics and imaging science. The award ceremony was held at the Konica Minolta Tokyo Site Hachioji in March 2015.

Japan Institute of Metals and Materials Meritorious Award

MANA Scientist Jin Kawakita received the Japan Institute of Metals and Materials Meritorious Award as an up-and-coming scientist of great promise, having published scientific papers that contribute to developing metallurgy or metal industrial technologies (Fig. 4-11).

Silver Award of the Tanaka Precious Metals' 2014 "Precious Metals Research Grants"

In March 2015, MANA Scientist Mitsuhiro Ebara received the Silver Award of the Tanaka Precious Metals' 2014 "Precious Metals Research Grants". His study Development of New Materials for Treatment of Persistent Cancers Preventing Recurrent and Metastatic Cancer has been highly evaluated as it can contribute to society.

Ando Incentive Prize for the Study of Electronics

The Foundation of ANDO Laboratory decided to award the 28th Ando Incentive Prize (Fig. 4-11) for the Study of Electronics to MANA Scientist Satoshi Ishii. His research *Controlling light diffraction by meta-surfaces* has been highly evaluated as a research that deserves to receive the prize. The Awarding Ceremony was held in July 2015.

Fig. 4-11: Award Ceremonies held in 2015 with researchers from MANA. Left: In January, Independent Scientist Genki Yoshikawa received the Project Prize at nano tech 2015. Middle: In March, MANA Scientist Jin Kawakita won the Japan Institute of Metals and Materials Meritorious Award. Right: In July, MANA Scientist Satoshi Ishii was awarded the Ando Incentive Prize for the Study of Electronics.

German Innovation Award - Gottfried Wagener 2015

Group Leader Yoshitaka Tateyama received the "German Innovation Award - Gottfried Wagener 2015". His research *Theoretical Elucidation of Reaction Mechanism on Electrolyte Interface in Lithium-Ion Battery with Highly-Efficient Use of Supercomputers* has been highly evaluated to win the award.

Japan Society of Coordination Chemistry Contribution Award

MANA Principal Investigator Katsuhiko Ariga received the "Japan Society of Coordination Chemistry Contribution Award". His achievement in *Supermolecules Chemistry at Interfaces* has been highly evaluated as a research that deserves to receive the award.

ISI Highly cited researchers 2015 (Thomson Reuters)

ISI Highly cited researchers 2015 are authors of many highly cited papers produced between 2003 and 2013 in a certain research field in the Thomson Reuters Essential Science Indicators database. Thomson Reuters announced the members of this elite group that contains 5 Principal Investigators from MANA (Fig. 4-12) as follows: Field of *Materials Science*: Kastuhiko Ariga, Yoshio Bando, Zhong Lin Wang and Omar Yaghi. Field of *Chemistry*: Zhong Lin Wang and Omar Yaghi. Field of Physics: Zhong Lin Wang.

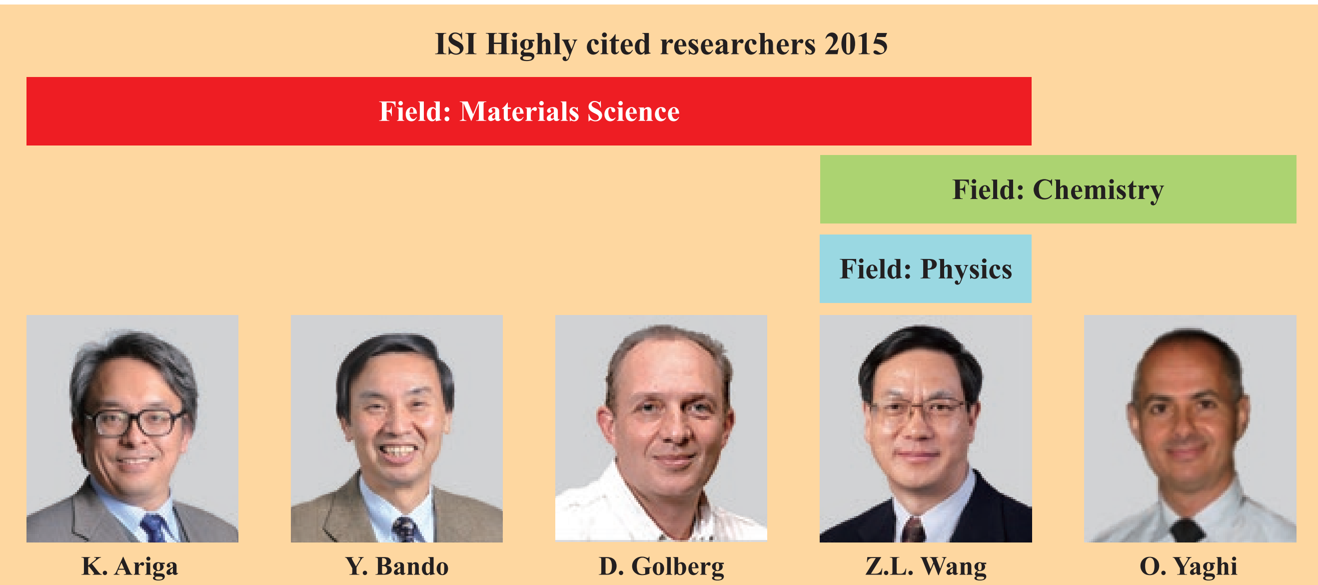


Fig. 4-12: 5 MANA Principal Investigators were selected as *ISI Highly cited researchers 2015* in the fields of Materials Science, Chemistry and Physics.

Urgel Archambault Prize 2015

Prof. Françoise M. Winnik, MANA Satellite Principal Investigator at University of Montreal, Canada, received the "Urgel Archambault Prize 2015" for physics, mathematics, computer science and engineering from the Association Canadienne Française pour l'Avancement des Sciences (ACFAS), a non-profit organization contributing to the advancement of science in Quebec and the Canadian Francophony. The award to Prof. Winnik is a tremendous validation of her ingenious work to combine fundamental and applied research in areas such as medical imaging, gene therapy and nanomedicine (Fig. 4-13).

15th Japan DDS (Drug Delivery System) Society NAGAI Award

Prof. Yukio Nagasaki, MANA Satellite Principal Investigator at University of Tsukuba, received the "15th Japan DDS (Drug Delivery System) Society NAGAI Award" (Fig. 4-13). He has been highly evaluated to win the award for his contribution on *Design of Novel Redox Polymers for Anti-oxidative Nanotherapeutics*.

37th Japanese Society for Biomaterials Scientific Incentive Award

MANA Scientist Mitsuhiro Ebara received the "37th Japanese Society for Biomaterials Scientific Incentive Award" (Fig. 4-13). He has been highly evaluated to win the award for his research on *Design of Shape-Memory Biomaterial for Cell Mechanobiology Application*.

Japan Society of Applied Physics (JSAP) Young Scientist Presentation Award

In December 2015, MANA Research Associate Mahito Yamamoto has been selected to receive the 39th Japan Society of Applied Physics (JSAP) Young Scientist Presentation Award from JSAP. His presentation entitled *Thickness-controlled oxidation of atomically thin* WSe_2 was highly evaluated as a research study that merits this prestigious award.

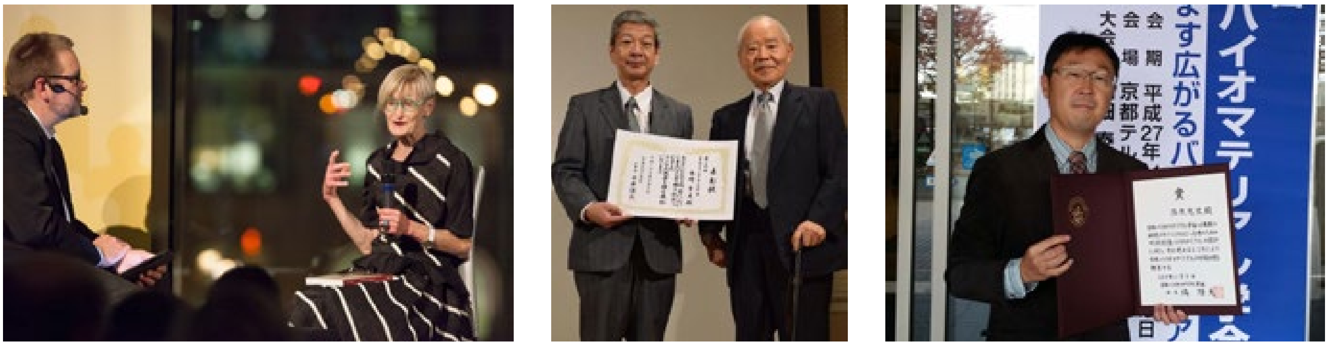


Fig. 4-13: Award Ceremonies held in November 2015 with researchers from MANA. Left: MANA Satellite PI, Prof. Françoise M. Winnik, received the Urgel Archambault Prize. Middle: MANA Satellite PI, Prof. Yukio Nagasaki, won the 15th Japan DDS (Drug Delivery System) Society NAGAI Award. Right: MANA Scientist Mitsuhiro Ebara obtained the "37th Japanese Society for Biomaterials Scientific Incentive Award".

4.3 Research Achievements

In June 2016, MANA submitted a WPI Progress Report to the WPI Program Committee. The content of this section has been reproduced from chapter 2.1 of this report.

● Remarkable Research Results from MANA

MANA was established for the purpose of establishing a new nanotechnology paradigm based on the concept of nanoarchitectonics, and to bring about innovation in new materials development through this paradigm. These objectives are steadily being accomplished. In reality, a number of concepts based on nanoarchitectonics have emerged from MANA's research, including soft chemical nanoarchitectonics, interface nanoarchitectonics, neuromorphic nanoarchitectonics, topological nanoarchitectonics, and in-vivo nanoarchitectonics. Research based on these topics is steadily progressing. Below is a summary of 20 selected research achievements from MANA between October 2007 and March 2016. These accomplishments fall into three broad categories: *Creation of New Research Fields*, *Fusion of Interdisciplinary Research Fields*, and *Other Remarkable Research Results*. Each category is divided into three subcategories.

Creation of New Research Fields	Research Results
★ Nanosheet-based New Horizon for Novel Materials Creation	[1], [2]
★ Atomic Switch and Related Prospective Devices and Systems	[3], [4]
★ Molecular-scale Site-designated Chemical Nanoarchitectonics	[5], [6]
Fusion of Interdisciplinary Research Fields	
★ Nanoarchitectonics-inspired Nano-Life Science	[7], [8]
★ Nano-Life Science-inspired Nanoarchitectonics	[9], [10]
★ Theory-Experiment 'Cross-linkage' for Exploring Novel Nanoscale Materials and Systems	[11], [12]
Other Remarkable Research Results	
★ Innovative Nanoscale Devices and Systems	[13], [14], [15]
★ Innovative Nanoscale Characterization Methodologies	[16], [17]
★ Nanoarchitectonics Related to Sustainable Energy and Environment	[18], [19], [20]

Creation of New Research Fields refers to MANA-conceived original research that is in the process of spreading throughout the world. This includes the creation of various new materials through nanosheet technology, research on atomic switches and resulting devices, and research on nanoarchitectonic chemistry that approaches the realization of mono-molecular devices.

Fusion of Interdisciplinary Research Fields refers to Nano-Life research that draws on MANA's advanced nanoarchitectonics, nanoarchitectonics research that draws on Nano-Life research (i.e., the reverse), and research that closely intertwines and fuses theory and experiment.

Other Remarkable Research Results contains various other remarkable achievements that do not fall under either of the categories above.

Creation of New Fields of Research

★ Nanosheet-based Breakthroughs for Creating Novel Materials

[1] Production of functional nanosheets through exfoliation of layered crystals via massive swelling

Representative researcher: T. Sasaki

We have developed a variety of oxide and hydroxide nanosheets via inducing enormous swelling of layered crystals in liquid phase. The highly swollen crystals can be gently disintegrated into high-quality unilamellar nanosheets in high yield, which is difficult to attain by other delamination procedures. This process has been applied to various layered crystals synthesized in a designed composition and structure to produce a range of nanosheets exhibiting unique and useful properties. The nanosheets thus obtained have been effectively utilized as building blocks for "2D Nanosheet Nanoarchitectonics" to tailor functional nanostructured materials and nanodevices.

We found the amazing phenomena that platy microcrystals of layered metal oxides underwent accordion-like swelling in various amine solutions (Fig. 4-14). The interlayer galleries evenly expanded up to 100 times beyond original spacing via penetration of a very large volume the aqueous solution. The resulting unique "aquacrystals" could be totally delaminated into large-sized nanosheets.

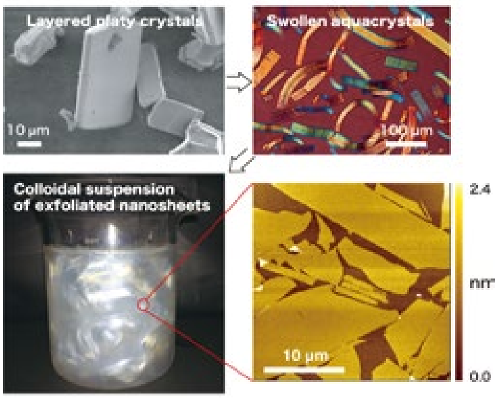


Fig. 4-14: Platy microcrystals of a layered titanate (top left), their swollen "aqua- crystals" (top right) and exfoliated nanosheets (bottom).

References:

[1]-1 F. Geng, R. Ma, A. Nakamura, K. Akatsuka, Y. Ebina, Y. Yamauchi, N. Miyamoto, Y. Tateyama, T. Sasaki, *Unusually stable ~100-fold reversible and instantaneous swelling of inorganic layered materials*, Nature Communications **4**, 1632 (2013).
doi: 10.1038/ncomms2641

[1]-2 F.X. Geng, R.Z. Ma, Y. Ebina, Y. Yamauchi, N. Miyamoto, T. Sasaki, *Gigantic Swelling of Inorganic Layered Materials: A Bridge to Molecularly Thin Two-Dimensional Nanosheets*, Journal of the American Chemical Society **136**(14), 5491 (2014).
doi: 10.1021/ja501587y

[2] Super-high-k oxide nanosheets: New 2D materials and devices beyond graphene

Representative researchers: M. Osada, T. Sasaki

We have discovered high-k oxide nanosheets, an important material platform for ultra-scale electronics and post-graphene technology. Newly developed nanosheets (Ti_2NbO_7, $(Ca,Sr)_2Nb_3O_{10}$) exhibited the highest permittivity (ε_r = 210~320) ever realized in all known dielectrics in the ultrathin region (< 10 nm). Our results offer a route to new 2D devices beyond graphene.

2D materials are now considered to be excellent candidates for future electronic applications. High-k oxide nanosheets are of major technological importance for establishing the thinnest and highest-k nanodielectrics (Fig. 4-15) that cannot be achieved in graphene and other materials. Notably, all-nanosheet capacitors exceeded textbook limits, opening a route to new capacitors and energy storage devices. A layer-by-layer engineering using high-k oxide nanosheets enabled us to design new 2D devices such as nanosheet FETs, artificial ferroelectrics, multiferroics, etc. Graphene is only the tip of the iceberg, and we are now opening up a new era of "post-graphene technology."

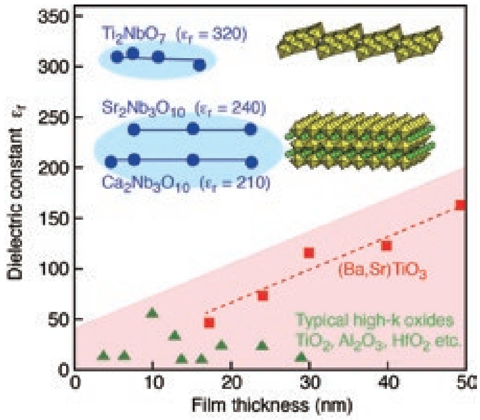


Fig. 4-15: Dielectric properties of high-k oxide nanosheets and various oxide dielectrics.

References:

[2]-1 M. Osada, T. Sasaki, *Two-Dimensional Dielectric Nanosheets: Novel Nanoelectronics From Nanocrystal Building Blocks*, Advanced Materials **24**(2), 210 (2012). doi: 10.1002/adma.201103241

[2]-2 C.X. Wang, M. Osada, Y. Ebina, B.W. Li, K. Akatsuka, K. Fukuda, W. Sugimoto, R.Z. Ma, T. Sasaki, *All-Nanosheet Ultrathin Capacitors Assembled Layer-by-Layer via Solution-Based Processes*, ACS Nano **8**(3), 2658 (2014). doi: 10.1021/nn406367p

★ Atomic Switch and Related Prospective Devices and Systems

[3] Atomic switch: Novel on/off switching characteristics and unique synaptic-like behaviors

Representative researchers: K. Terabe, T. Tsuruoka, M. Aono

We have developed the novel switching device, which is better than conventional semiconductor devices such as DRAM and Flash memory, in terms of simple structure, lower energy consumption, etc. It is almost a commercial reality for the field-programmable gate arrays (FPGAs) in collaboration with NEC Corp. The unique operating mechanisms of the atomic switch, i.e., movement of atoms/ions associated with their redox reaction processes in solids under potential applications, have enabled the further development of various novel devices, such as "volatile/nonvolatile three-terminal atom transistor," "on-demand function-selectable atomic switch," and '"synapse-like atomic switch junction."

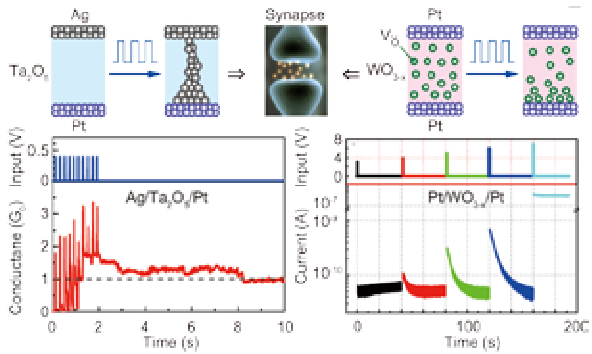


Fig. 4-16: Atomic switch junctions work as inorganic synapses in systems of $Ag/Ta_2O_5/Pt$ with metal ion migration (left) and $Pt/WO_{3-x}/Pt$ with oxygen vacancy migration (right).

The synapse-like atomic switch junctions emulate two modes of plasticity of biological synapses in the human brain, i.e., short-term plasticity (STP) and long-term potentiation (LTP), utilizing the structural stability of electron-conducting paths. Depending on the input strength and repetition frequency, the junctions exhibit the transition between the STP and LTP modes. This function can be realized using cation (metal ion) or anion (oxygen vacancy) migrations in various electrolyte systems, as shown in Fig. 4-16. The results encourage us to develop conceptually new artificial neuromorphic computing systems that do not require any pre-programming.

References:

[3]-1 T. Ohno, T. Hasegawa, T. Tsuruoka, K. Terabe, J.K. Gimzewski, M. Aono, *Short-term plasticity and long-term potentiation mimicked in single inorganic synapses,* Nature Materials **10**(8), 591 (2011). doi: 10.1038/NMAT3054

[3]-2 R. Yang, K. Terabe, G. Liu, T. Tsuruoka, T. Hasegawa, J.K. Gimzewski, M. Aono, *On-Demand Nanodevice with Electrical and Neuromorphic Multifunction Realized by Local Ion Migration*, ACS Nano **6**(11), 9515 (2012). doi: 10.1021/nn302510e

[4] Networks of atomic switches for neuromorphic computation

Representative researchers: J. Gimzewski, A. Stieg, M. Aono

We have developed unique neuromorphic devices, known as atomic switch networks (ASN), comprised of highly interconnected (~10^9/cm^2) atomic switch interfaces which retain the synaptic properties of their component elements and *generate a class of emergent behaviors known to underlie biological cognition. The utility of ASN devices in reservoir computing, a biologically inspired framework known to demonstrate unparalleled efficiency in real-time performance of complex tasks, has been demonstrated through performance of various benchmark machine- learning tasks including the parity-n test, NARMA-10 test and the T-maze. ASN devices hold great promise as a scalable hardware platform for signal processing and computation capable of overcoming modern operational limits in the RC paradigm.*

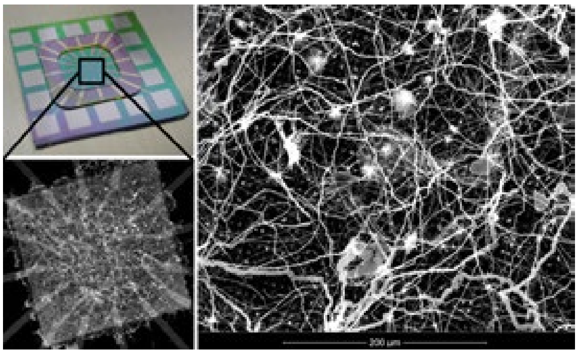


Fig. 4-17: The ASN device (upper left) is comprised of atomic switch junctions located at the crossing points of self-organized nanowire network. A look inside the ASN (lower left) reveals a highly interconnected neuromorphic architecture (right).

The mammalian brain exceeds modern computers in performing complex tasks such as associative memory, pattern recognition, or prediction as a result of the radically divergent physical structures and operating mechanisms. Drawing inspiration from the cortical neuropil, millions of atomic switches have been incorporated into a densely interconnected network of conductive nanowires, as shown in Fig. 4-17, through the nanoarchitectonics concept of self- organization. By combining concepts of computational neuroscience and machine learning with those of self-organization in complex nanoscale materials, these results lay a foundation for the creation of next-generation cognitive technologies.

References:

[4]-1 A.V. Avizienis, H.O. Sillin, C. Martin-Olmos, H.H. Shieh, M. Aono, A.Z. Stieg, J.K. Gimzewski, *Neuromorphic Atomic Switch Networks*, Plos One **7**(8), e42772 (2012). doi: 10.1371/journal.pone.0042772

[4]-2 A.Z. Stieg, A.V. Avizienis, H.O. Sillin, C. Martin-Olmos, M. Aono, J.K. Gimzewski, *Emergent Criticality in Complex Turing B-Type Atomic Switch Networks*, Advanced Materials **24**(2), 286 (2012). doi: 10.1002/adma.201103053

[4]-3 H.O. Sillin, R. Aguilera, H.H. Shieh, A.V. Avizienis, M. Aono, A.Z. Stieg, J.K. Gimzewski, *A theoretical and experimental study of neuromorphic atomic switch networks for reservoir computing*, Nanotechnology **24**(38), 384004 (2013). doi: 10.1088/0957-4484/24/38/384004

★ Molecular-scale Site-designated Chemical Nanoarchitectonics

[5] Electrical wiring of single molecules via conductive molecular chains

Representative researchers: Y. Okawa, C. Joachim, M. Aono

Though single-molecule electronics has been widely investigated for a long time, the fabrication of practical single-molecule circuits remains challenging because of the lack of viable methods for wiring each molecule. To solve this problem, we have developed a novel method for single molecular wiring. Using a nanoscale-controlled chain polymerization on a molecular layer, we have succeeded in connecting single conductive polymer chains to single functional molecules via covalent bonds. We are investigating the electrical transport properties of the fabricated single molecule devices. These studies will be an important step in advancing the development of single-molecule electronic circuitry.

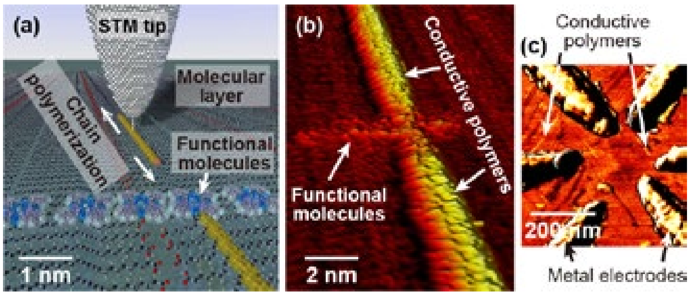


Fig. 4-18: Schematic illustration (a) and STM image (b) of chemical soldering. Chain polymerization is initiated with the STM tip. Two conductive polymer chains are connected to a single functional molecule (phthalocyanine). (c) Atomic force microscopy image of conductive polymer chains fabricated between metal electrodes on a hexagonal boron nitride substrate.

Fig. 4-18a illustrates the wiring procedure, which we call "chemical soldering". Stimulation with a tip of scanning tunneling microscope (STM) on a molecular layer of diacetylene compound can initiate chain polymerization of diacetylene molecules, and the reactive front edge of the chain forms a covalent bond with the adsorbed functional molecule. We have demonstrated that two polydiacetylene chains are connected to a single phthalocyanine molecule (Fig. 4-18b). We are investigating the electrical transport properties of the fabricated single molecule devices on insulating substrates (Fig. 4-18c).

References:

[5]-1 Y. Okawa, S.K. Mandal, C. Hu, Y. Tateyama, S. Goedecker, S. Tsukamoto, T. Hasegawa, J.K. Gimzewski, M. Aono, *Chemical Wiring and Soldering toward All-Molecule Electronic Circuitry,* Journal of the American Chemical Society **133**(21), 8227 (2011). doi: 10.1021/ja111673x

[5]-2 Y. Okawa, M. Akai-Kasaya, Y. Kuwahara, S.K. Mandal, M. Aono, *Controlled chain polymerisation and chemical soldering for single-molecule electronics,* Nanoscale **4**(10), 3013 (2012). doi: 10.1039/C2NR30245D

[6] Controlling bound and unbound states of molecules (C_{60}) reversibly at designated sites

Representative researchers: T. Nakayama, M. Nakaya, M. Aono

Toward a realization of ultrahigh-density data storage using single-molecule manipulation with a scanning tunneling microscope (STM), a long-standing problem was how to achieve reversible and repeatable control of a molecular bit to represent 0 and 1. We solved this problem by controlling bound and unbound states of C_{60} molecules at room temperature and demonstrated bit operations at a bit density of 190 Tbits/in^2.

In a thin film of fullerene C_{60} molecules, single-molecule-level chemical reaction between C_{60} molecules was controlled using an STM tip. We found that negative and positive ionization of a designated C_{60} molecule perfectly trigger polymerization and deploymerization reactions of a designated C_{60} molecule with an adjacent molecule in the film, respectively. With this method, an ultra-dense data storage was demonstrated (Fig. 4-19).

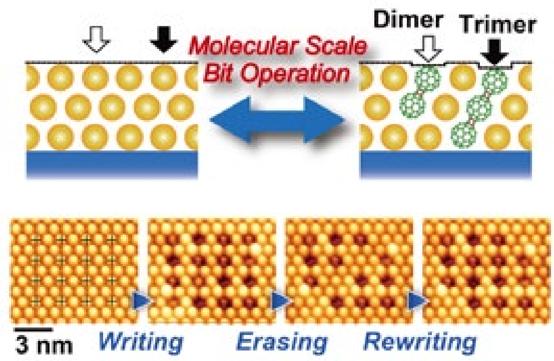


Fig. 4-19: (Upper) Schematic illustration of local and reversible control of bound and unbound states of C_{60} molecules. (Lower) A series of STM images showing single-molecule-level bit operation.

References:

[6]-1 M. Nakaya, S. Tsukamoto, Y. Kuwahara, M. Aono, and T. Nakayama, *Molecular scale control of unbound and bound C_{60} for topochemical ultradense data storage in an ultrathin C_{60} film*, Advanced Materials **22**(14)**,** 1622 (2010). doi: 10.1002/adma.200902960

[6]-2 M. Nakaya, M. Aono, T. Nakayama, *Molecular-Scale Size Tuning of Covalently Bound Assembly of C_{60} Molecules*, ACS Nano **5**(10), 7830 (2011). doi: 10.1021/nn201869g

Fusion of Interdisciplinary Research Fields

★ Nanoarchitectonics-inspired Nano-Life Science

[7] Nanoarchitectonic smart nanofibers for cancer and kidney disease therapy

Representative researcher: M. Ebara

We have developed a smart anticancer nanofiber capable of simultaneously performing thermotherapy and chemotherapy for treating malignant tumors. By tailoring the nanoarchitectures of polymer networks in the fiber, we demonstrated simultaneous heat generation and drug release in response to alternating magnetic field (AMF). Only a 5-10 min application of AMF can successfully induce cancer apoptosis both in vitro and in vivo studies.

The nanofiber is composed of a chemi- cally-crosslinkable temperature-responsive polymer with an anti-cancer drug and magnetic nano-particles, which serve as a trigger of drug release and a source of heat, respectively (Fig. 4-20a). Both in vitro and in vivo studies show that the majority of tumor cells died in only a 5-10 min application of AMF by double effects of heat and drug (Fig. 4-20b). We believe that the development of a manipulative material is considered to lead not only to improving the survival rate of cancer patients but also to providing minimally invasive treatment methods in combination with endoscopic surgery.

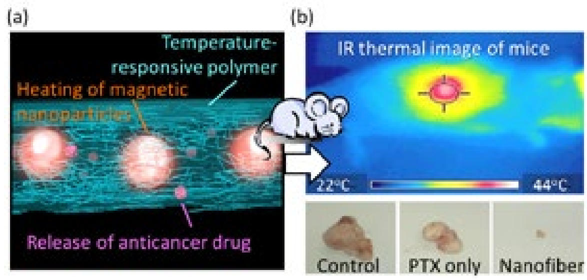


Fig. 4-20: Schematic illustration of smart nanofiber. (b) In vivo studies show that AMF application induces heat generation in mice (top) and the size of tumors were successfully reduced by implantation of the smart nanofiber via double effects of heat and drug (bottom).

References:

[7]-1 Y.J. Kim, M. Ebara, T. Aoyagi, *A Smart Nanofiber Web That Captures and Releases Cells*, Angewandte Chemie – International Edition **51**(42), 10537 (2012). doi: 10.1002/anie.201204139

[7]-2 Y.J. Kim, M. Ebara, T. Aoyagi, *A Smart Hyperthermia Nanofiber with Switchable Drug Release for Inducing Cancer Apoptosis*, Advanced Functional Materials **23**(46), 5753 (2013). doi: 10.1002/adfm.201300746

[8] Nano- and micro-structured biomaterials for cell function controlling and tissue engineering

Representative researchers: G. Chen, N. Kawazoe

Nano- and micro-structured biomaterials play an important role in tissue engineering to control stem cell functions and to guide the regeneration of new tissues and organs. We have developed a series of functional biomaterials that mimicked the nano-structured microenvironments surrounding cells in vivo. The biomaterials showed specific controlling on the differentiation of stem cells and promotive effects on tissue regeneration.

One type of the biomaterials is surface functionalized nanomaterials. Gold nanoparticles having various geometries were synthesized and functionalized with different functional groups. Surface functionalized gold nanoparticles showed different effects on the osteogenic differentiation of human bone marrow-derived mesenchymal stem cells depending on their surface properties (4-21). Another type of biomaterials is porous scaffolds with micropatterned pore structures and biological molecules. The scaffolds were prepared by a unique ice template method and their micropatterned structures could be easily controlled by designing the templates. The scaffolds promoted formation of highly aligned and multi-layered muscle bundle tissues. The scaffolds have been used for regeneration of cartilage, skin, bone and muscle tissues. The functional biomaterials have been shown useful for stem cell research and tissue engineering.

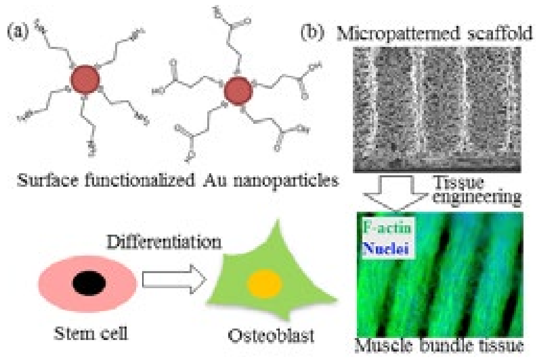


Fig. 4-21: Surface functionalized gold nanoparticles and their effects on osteogenic differentiation of mesenchymal stem cells (a) and micropatterned collagen porous scaffold and its application for regeneration of skeletal muscle tissue (b).

References:

[8]-1 H.H. Oh, Y.G. Ko, H. Lu, N. Kawazoe, G. Chen, *Preparation of Porous Collagen Scaffolds with Micropatterned Structures*, Advanced Materials **24**(31), 4311 (2012). doi: 10.1002/adma.201200237

[8]-2 J.J. Li, N. Kawazoe, G.P. Chen, *Gold nanoparticles with different charge and moiety induce differential cell response on mesenchymal stem cell osteogenesis*, Biomaterials **54**, 226 (2015). doi: 10.1016/j.biomaterials.2015.03.001

★ Nano-Life Science-inspired Nanoarchitectonics

[9] Ultrasensitive and ultraparallel molecular sensing for mobile olfaction and other various Applications

Representative researcher: G. Yoshikawa

We have developed a novel molecular sensor, which researchers had been trying to realize for 20 years all over the world. We named the new sensor "Membrane-type Surface stress Sensor (MSS)", which is based on the comprehensive optimization of materials science, mechanics, crystallography, and electronics, investigated together with Dr. Heinrich Rohrer (Nobel Prize Winner in Physics 1986). In contrast to the %-order improvements in sensitivity by conventional approaches, the MSS achieved more than 100 times higher sensitivity in addition to superior performance in all practical aspects. The MSS is expected to contribute to various fields; medicine, security, and environmental research.

We fabricated MSS chips in collaboration with EPFL, Switzerland, and demonstrated the possibility for non-invasive breath analysis in collaboration with University of Basel, Switzerland (Fig. 4-22a). While the MSS provides a practical sensing element as shown in Fig. 4-22b, a consumer sensor system requires further optimization and nanoarchitectonic integration of lots of components ranging from various hardware to software including big-data analysis with cloud computing. To integrate the cutting-edge technologies, we launched an industry-government-academia joint research framework: the MSS Alliance. Through this framework, we aim to establish basic technologies for practical mobile olfaction toward safe, healthy, and peaceful life.

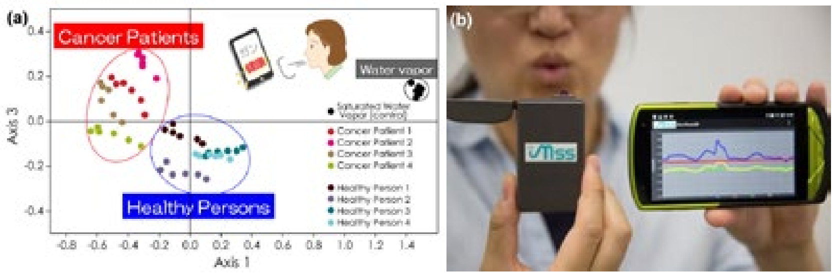


Fig. 4-22: Experimental results of breath analysis using an array of MSS which could distinguish the breath of cancer patients from that of healthy people in a double blind trial. (b) A prototype of a mobile sensing device based on the MSS technology.

References:

[9]-1 G. Yoshikawa, T. Akiyama, S. Gautsch, P. Vettiger, H. Rohrer, *Nanomechanical Membrane-type Surface Stress Sensor,* Nano Letters **11**(3), 1044 (2011). doi: 10.1021/nl103901a

[9]-2 G. Yoshikawa, F. Loizeau, C.J.Y. Lee, T. Akiyama, K. Shiba, S. Gautsch, T. Nakayama, P. Vettiger, N.F. de Rooij, M. Aono, *Double-Side-Coated Nanomechanical Membrane-Type Surface Stress Sensor (MSS) for One-Chip–One-Channel Setup*, Langmuir **29**(24), 7551 (2013). doi: 10.1021/la3046719

[10] Progress in high-efficiency artificial photosynthesis

Representative researcher: J. Ye

We have been conducting a series of pioneering works for challenging a high-efficiency artificial photosynthesis, which offers a potential solution for global warming and energy shortage issues. A new material Ag_3PO_4 *with the world's* *highest quantum efficiency in photocatalytic water oxidation has been developed. Sophisticated control of surface/ interface structure has enabled efficienct light harvesting, charge separation, and gas diffusion/conversion, making a big step towards realization of a high-efficiency artificial photosynthesis.*

Here we demonstrate a new strategy inspired by nature's far red-to-NIR responsive architectures. The system is constructed by controlled assembly of light-harvesting plasmonic nanoantennas (Au nanorods) onto a typical $BiVO_4$ photocatalytic unit with butterfly wings' 3D micro/nanoarchitectures (Fig. 4-23). It's found that the unique structure can significantly enhance solar light harvesting including far red-to-NIR, and increase electric-field amplitude of localized surface plasmon, which promotes the rate of electron-hole pair formation, thus substantially reinforcing photocatalysis.

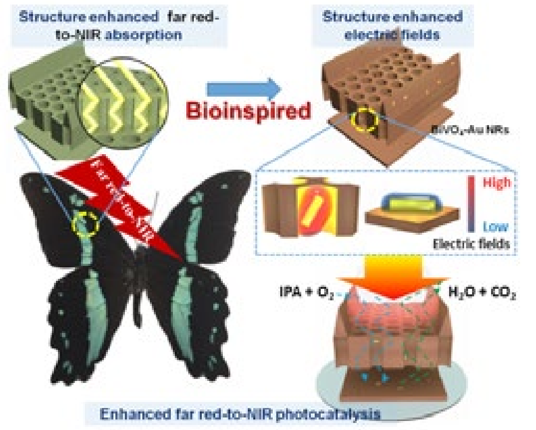


Fig. 4-23: Schematic illustration of the concept of structure-enhanced bio-inspired far red-to-NIR highly responsive photocatalytic system.

References:

[10]-1 R.Y. Yan, M. Chen, H. Zhou, T. Liu, X.W. Tang, K. Zhang, H.X. Zhu, J.H. Ye, D. Zhang, T.X. Fan, *Bio-inspired Plasmonic Nanoarchitectured Hybrid System Towards Enhanced Far Red-to-Near Infrared Solar Photocatalysis*, Scientific Reports **6**, 20001 (2016). doi: 10.1038/srep20001

[10]-2 Z.G. Yi, J. Ye, N. Kikugawa, T. Kako, S. Ouyang, H. Stuart-Williams, H. Yang, J. Cao, W. Luo, Z. Li, Y. Liu, R.L. Withers, *An orthophosphate semiconductor with photooxidation properties under visible-light irradiation*, Nature Materials **9**(7), 559 (2010). doi: 10.1038/nmat2780

★ Theory-Experiment *Cross-linkage* for Exploring Novel Nanoscale Materials Systems

[11] Topological matter nanoarchitectonics for novel quantum devices

Representative researchers: X. Hu, T. Uchihashi

Because the uncertainty of quantum system becomes prominent, the functions of nano devices are hard to realize through design in a way similar to those in the macroscopic worlds. In order to develop a new design principle for advanced nanoquantum devices, we are exploiting the topology of various systems, which links bulk to surface and nano to macro as a quantum holography principle. A brand-new approach coined "topological nanoarchitectonics" is emerging.

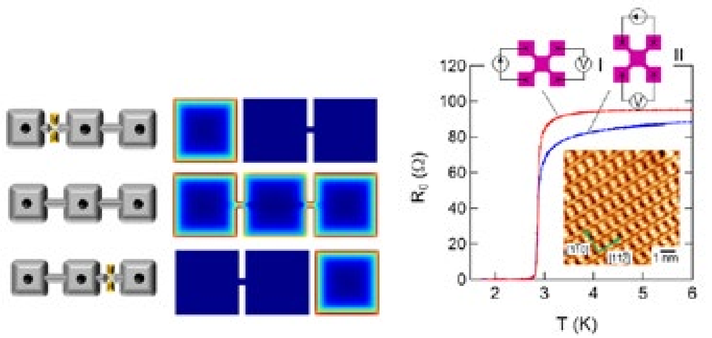


Fig. 4-24: (Left) Basic blocks for manipulating MFs. Connections among TSs are pinched off by voltages at the junctions, which results in hopping of MFs. (Right) Temperature dependence of zero bias resistance of the Si(111)-(√7×√3)-In reconstruction. Inset shows the STM image of sample surface.

At the interface between topological and trivial gapped states, a stable surface state should appear. In a topological superconductor (TS), zero-energy Majorana fermions (MFs) appear at vortex cores and the sample edge, which are equivalent to their antiparticles, whereas in a topological insulator (TI) the edge state can carry zero-resistance current. We have designed nanoquantum devices for generating and manipulating MFs, exploiting the property that MFs appear only when 2D TSs enclose an odd-number of vortices (Fig. 4-24). We demonstrate that charge-neutral MFs can be moved by switching on and off point-like gate voltages. We show that the non-Abelian quantum statistics are generated by exchanging positions of MFs, useful for decoherence-free qubits and quantum computation. In order to realize the TS state experimentally, we are working on an atomically thin superconductor on semiconductor surface with the Rashba effect and self-assembling of magnetic molecules. We demonstrate the surface superconductivity by direct transport measurements (Fig. 4-24) for the first time in the world. The desirable influence of the self-assembled magnetic molecules on the superconducting properties has also been clarified, and the presence of Josephson vortices was revealed by an intimate collaboration between theory and experiment. We have also revealed a checkerboard-type pattern in the spin-resolved density of states of MF at the vortex core as a function of energy and distance from the center of vortex. This feature can be detected by the spin-polarized STM/STS technique and serves as the evidence of MF.

References:

[11]-1 T. Uchihashi, P. Mishra, M. Aono, T. Nakayama, *Macroscopic Superconducting Current through a Silicon Surface Reconstruction with Indium Adatoms: Si(111)-(√7×√3)-In,* Physical Review Letters **107**(20), 207001 (2011). doi: 10.1103/PhysRevLett.107.207001

[11]-2 S. Yoshizawa, H. Kim, T. Kawakami, Y. Nagai, T. Nakayama, X. Hu, Y. Hasegawa, T. Uchihashi, *Imaging Josephson Vortices on the Surface Superconductor Si(111)-(root 7 x root 3)-In using a Scanning Tunneling Microscope*, Physical Review Letters **113**(24), 247004 (2014). doi: 10.1103/PhysRevLett.113.247004
[11]-3 T. Kawakami, X. Hu, *Evolution of Density of States and a Spin-Resolved Checkerboard-Type Pattern Associated with the Majorana Bound State*, Physical Review Letters **115**(17), 177001 (2015). doi: 10.1103/PhysRevLett.115.177001

[12] Large-scale First-principles calculations and experiments for the design of nanoscale devices

Representative researchers: T. Miyazaki, D.R. Bowler, N. Fukata

To enable first-principles electronic structure calculations using density functional theory (DFT) to be performed on systems which correspond to practical nanoscale devices and materials, we have developed a world-leading linear-scaling DFT code: CONQUEST. While it is very difficult to treat systems containing more than a few thousand atoms using standard DFT implementations, with CONQUEST we can treat systems with more than a million atoms. Using the CONQUEST, we have conducted a collaborative theory-experiment research on Si/Ge core-shell nanowires.

CONQUEST can perform robust and accurate electronic structure calculations, including structure relaxations or molecular dynamics on very large systems, which cannot be treated by standard DFT techniques. The code is exceptionally efficient on massively parallel computers like the K computer. We have performed DFT calculations on three-dimensional Ge nano-islands grown on Si(001) substrates, to study the growth mechanism at the atomic scale, treating all the atoms (Fig. 4-25 top). We have also calculated the atomic and electronic structures of Si/Ge core-shell nanowires (Fig. 4-25 bottom). Based on the calculated results, we synthesized Ge/Si core-shell nanowires and found conclusive evidence of the hole gas accumulation in the core-shell nanowires.

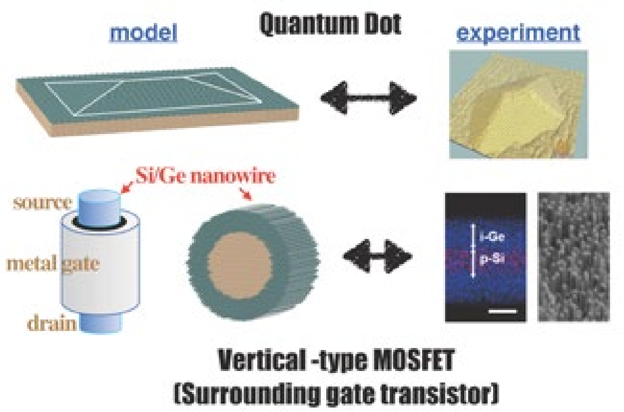


Fig. 4-25: (Top) Optimized structure of Ge nano-island on Si(001) substrate calculated using CONQUEST, and experimental structure. (Bottom) Atomic models of Si/Ge core-shell nanowire, along with TEM and SEM measurements and schematic of how nanowires can be used in transistors.

References:

[12]-1 M. Arita, D.R. Bowler, T. Miyazaki, *Stable and Efficient Linear Scaling First-Principles Molecular Dynamics for 10000+Atoms*, Journal of Chemical Theory and Computation **10**(12), 5419 (2014). doi: 10.1021/ct500847y
[12]-2 N. Fukata, M. Yu, W. Jevasuwan, T. Takei, Y. Bando, W. Wu, Z.L. Wang, *Clear Experimental Demonstration of Hole Gas Accumulation in Ge/Si Core–Shell Nanowires*, ACS Nano **9**(12), 12182 (2015). doi: 10.1021/acsnano.5b05394

Other Remarkable Research Results

★ Innovative Nanoscale Devices and Systems

[13] Novel concepts for developing thermoelectric materials and systems for first wide scale Applications

Representative researcher: T. Mori

The conventional tradeoffs in th ermoelectric properties have been long-time barriers to achieving high performance. We have demonstrated new concepts to overcome these. Proposing magnetic semiconductors to achieve high power factors, fabricating thermoelectric nanosheets with phonon selective scattering, achieving excellent p, n control through atomic occupancy variance, we approach breakthrough to the first wide-scale applications.

We have discovered that magnetic semiconductors like carrier-doped chalcopyrite can have enhanced thermoelectric properties (Fig. 4-26 top). We are further developing this concept with a view to develop compatible or even "2 in 1" solid-state power sources for stand-alone or wearable spintronics devices of the future. Nanosheets of thermoelectric materials were also synthesized achieving phonon selective scattering and enhanced properties (Fig. 4-26 bottom). Hierarchical assembly

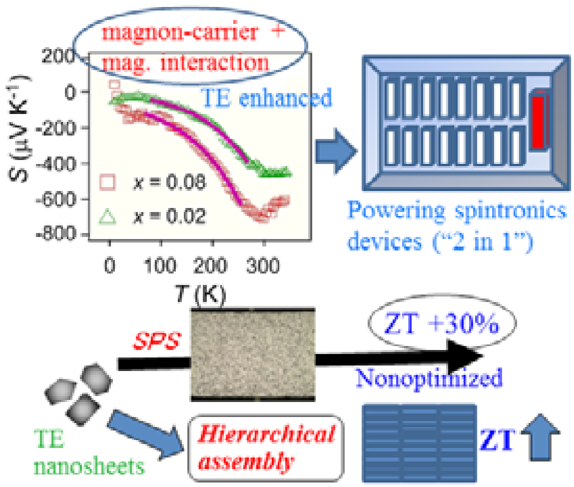


Fig. 4-26: Thermoelectric enhancement through (Top) magnetic semiconductors and (Bottom) nanosheets.

of nanosheets are expected to lead to large enhancements and nanoscale modules and devices.

References:

[13]-1 C. Nethravathi, C.R. Rajamathi, M. Rajamathi, R. Maki, T. Mori, D. Golberg, Y. Bando, *Synthesis and thermoelectric behaviour of copper telluride nanosheets*, Journal of Materials Chemistry A **2**(4), 985 (2014). doi: 10.1039/c3ta12877f

[13]-2 R. Ang, A.U. Khan, N. Tsujii, K. Takai, R. Nakamura, T. Mori, *Thermoelectricity Generation and Electron-Magnon Scattering in a Natural Chalcopyrite Mineral from a Deep-Sea Hydrothermal Vent*, Angewandte Chemie - International Edition **54**(44), 12909 (2015). doi: 10.1002/anie.201505517

[14] Silicon-doped metal oxide thin film transistor for next generation power-saving flat display

Representative researcher: K. Tsukagoshi

We realized a promising material for oxide thin film transistor (TFT) to produce a next generation power-saving flat display. Our Si-doped metal oxide TFT (SiM-O$_x$TFT) behaves as a very stable and high-performance TFT with highly suppressed off-state current (Fig. 4-27).

As for pixel swithing TFT in the flat panel display, amorphous silicon or poly-silicon film has been customerily used. But because of serious large off-state current in the current TFTs, a new TFT is strongly desired to realize a low-power consumption system. Furthermore, higher mobility of TFT than the amorphous silicon is needed to present high resolution contents. Amorphous metal oxide thin-film transistor (α-O$_x$TFT) is a possible candidate as the post silicon TFTs. Although the InGaZnO film is one of the candidates of the α-O$_x$TFT, however, the InGaZnO is very unstable film in actual production. The electric property of the film is a very sensitive to oxygen absorption or desorption at the bonding sites adjacent to Zn atoms.

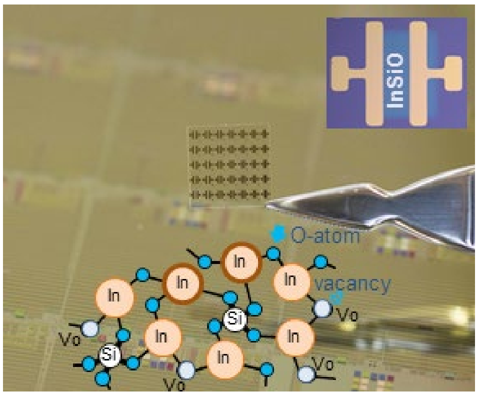


Fig. 4-27: Photo images of the InSiO-O$_x$TFTs on glass substrate. Schematic of vacancy (VO) suppression by incorporating SiO_2.

References:

[14]-1 S. Aikawa, T. Nabatame, K. Tsukagoshi, *Effects of dopants in InO$_x$-based amorphous oxide semiconductors for thin-film transistor applications*, Applied Physics Letters **103**(17), 172105 (2013). doi: 10.1063/1.4822175

[14]-2 S. Aikawa, N. Mitoma, T. Kizu, T. Nabatame, T. Tsukagoshi, *Suppression of excess oxygen for environmentally stable amorphous In-Si-O thin-film transistors*, Applied Physics Letters **106**(19), 192103 (2015). doi: 10.1063/1.4921054

[15] Multi-functional electron tunneling devices with molecular quantum dots

Representative researchers: Y. Wakayama, R. Hayakawa

Precise control of electron tunneling is critical for power-saving electronic devices. Our purpose is to develop electron tunneling devices by taking advantages of organic molecules as quantum dots. A variety of molecular functions are integrated into a Si-based architecture, aiming to bridge a gap between fundamental quantum effect and practical device engineering.

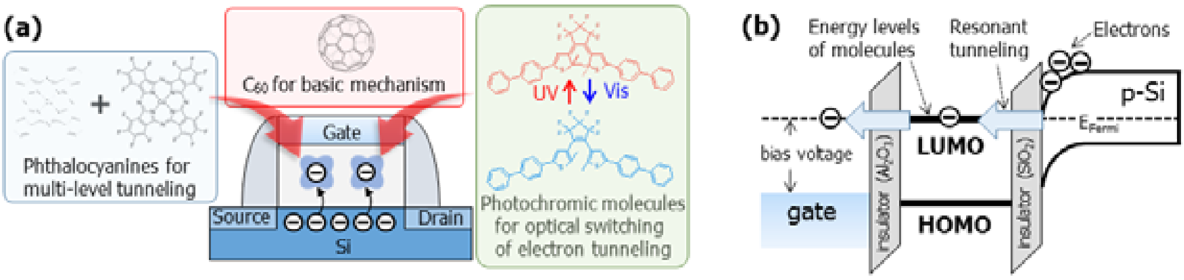


Fig. 4-28: (a) Device and molecular structures. (b) Energy-level diagram, showing resonant tunneling.

Fullerene (C_{60}) molecules were embedded in a double-tunneling junction consisting of Au/Al_2O_3/C_{60}/SiO_2 multi-layers on Si substrates (Fig. 4-28a). Staircases in current-voltage curves were observed, which can be attributed to resonant tunneling through the empty and occupied energy levels of the molecule as drawn in Fig. 4-28b. These results indicate that the tunneling properties can be tuned precisely by designing molecular structure. We applied this mechanism to various functionalities: multi-level tunneling by using multiple phthalocyanines and optical switching by using photochromic molecules. Importantly, our device configuration is compatible with the conventional MOS-FET and, therefore, these results demonstrate the potential of practical use of molecules for the tunneling devices.

References:

[15]-1 R. Hayakawa, N. Hiroshiba, T. Chikyow, Y. Wakayama, *Single-Electron Tunneling through Molecular Quantum Dots in a Metal-Insulator-Semiconductor Structure,* Advanced Functional Materials **21**(15), 2933 (2011). doi: 10.1002/adfm.201100220

★ Innovative Nanoscale Characterization Methodologies

[16] Multiple-probe scanning probe microscopes (STM, AFM, KFM): Development and application

Representative researchers: T. Nakayama, M. Aono

Novel properties which will come from materials nanoarchitectonics must be characterized with innovative instruments and methodologies. Therefore, we developed multiple-probe scanning probe microscopes (MP-SPMs) and realized unique and indispensable nanoscale electrical measurements.

MP-SPMs have individually-driven 2 to 4 probes for identifying a nanostructure of interest and also for performing multiprobe electrical measurements of it. For example, the length of electron mean-free-path of a SWCNT on SiO_2 was measured to be about 500 nm at room temperature (Fig. 4-29). MP-STM was converted into multiple-probe atomic force microscope (MP-AFM) using newly developed tuning fork sensor, and non- contact potential mapping via Kelvin force microscopy (KFM) was implemented in MP-AFM. These allow our MP-SPM system to handle nanostructures on insulating substrates.

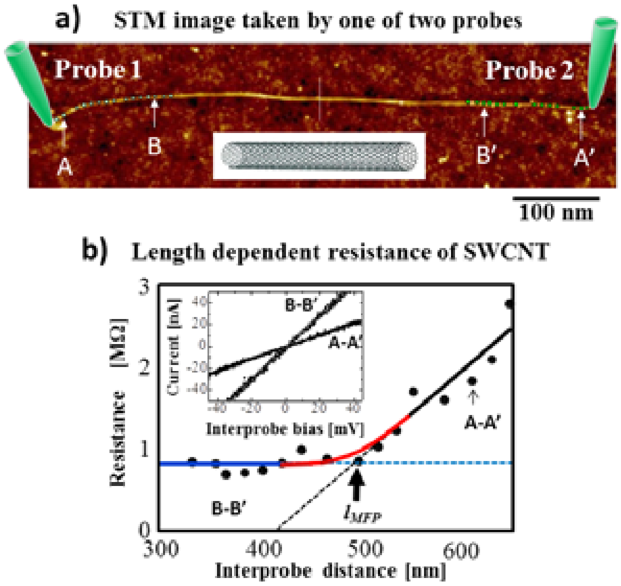


Fig. 4-29: (a) STM image of a SWCNT placed on a SiO_2/Si substrate. Two probes of the STM in contact with the SWCNT are schematically shown. (b) Length dependent resistance of a SWCNT. I-V curves measured between two probes are shown in the inset.

Reference:

[16]-1 T. Nakayama, O. Kubo, Y. Shingaya, S. Higuchi, T. Hasegawa, C.S. Jiang, T. Okuda, Y. Kuwahara, K. Takami, M. Aono, *Development and Application of Multiple-Probe Scanning Probe Microscopes*, Advanced Materials **24**(13), 1675 (2012). doi: 10.1002/adma.201200257

[17] Novel electrical, mechanical, thermal, optoelectronic and luminescence properties of nanomaterials studied by *in situ* TEM

Representative researchers: D. Golberg, Y. Bando

We have developed revolutionary methods of in situ transmission electron microscopy (TEM) which allow us to measure true properties of nanomaterials, while in-tandem getting the deepest insights into their atomic structures. Designed TEM techniques combining the capabilities of a high-resolution TEM instrument and either an atomic force sensor, or a scanning tunneling microscopy probe, or a laser beam, have become the powerful tools for our study of more than fifty chemical nanosystems shaped in diverse morphologies, e.g. tubes, wires, sheets and particles. The key point of our experiments is that all measurements have been conducted on an individual nanostructure level under the highest spatial, temporal and energy resolution peculiar to TEM, and thus can directly be linked to morphological, structural and chemical peculiarities of a given nanomaterial.

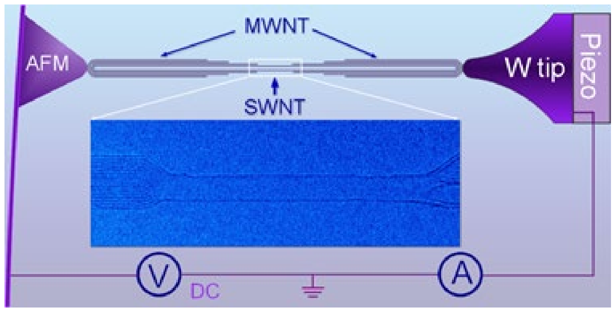


Fig. 4-30: Schematics of a single-walled C (SWNT) unravelling from the multi-walled C (MWNT) nanotube using Joule heating followed by its direct tensile strength measurement under stretching in a high-resolution TEM.

For example, we succeeded for the first time in the world to measure the tensile strength on individual single-walled and multi-walled C and BN nanotubes (NTs), Fig. 4-30. The tubes were placed within a force-sensor microdevice inside a high-resolution TEM and their mechanics were then investigated in real-time by correlating the measured strength and Young's moduli, and types, and sites of NT structural defects under atomic resolution. The huge strength values of ~100 and ~33 GPa were determined for the defect-free C and BN NTs, respectively.

References:

[17]-1 M.S. Wang, D. Golberg, Y. Bando, *Tensile tests on individual single-walled carbon nanotubes: linking nanotube strength with its defects*, Advanced Materials **22**(36), 4071 (2010). doi: 10.1002/adma.201001463

[17]-2 X.L. Wei, M.S. Wang, Y. Bando, D. Golberg, *Tensile tests on individual multiwalled boron nitride nanotubes*, Advanced Materials **22**(43), 4895 (2010). doi: 10.1002/adma.201001829

★ Nanoarchitectonics Related to Sustainable Energy and Environment

[18] Metallic nanoporous materials for next-generation high-performance electrocatalysts

Representative researcher: Y. Yamauchi

Platinum (Pt) and gold (Au) have long been regarded as useful catalysts in fuel cells. However, the high cost of these metals, together with the limited reserves in nature, has been shown to be the major bottleneck for commercial applications. We have developed novel nanoporous metals with highly electrocatalytic activity.

In view of the strong social demand for the reduced use of rare metals, there have been heightened calls for the development of a technology for securing high functionality with low use of Pt and Au by producing porous structures with larger surface areas (Fig. 4-31). Our group has focused on fine controls of compositions and morphologies which are important factors for design of porous metals. We have developed a route to nanoporous metal films by a simple electrodeposition method in an aqueous surfactant solution. The atomic crystallinity is coherently extending in the pore walls, providing a large number of atomic steps and defect sites, which are very active sites in methanol oxidation reaction and oxygen reduction reaction. As a result, the electrochemical performance is dramatically enhanced, compared to commercially available catalysts.

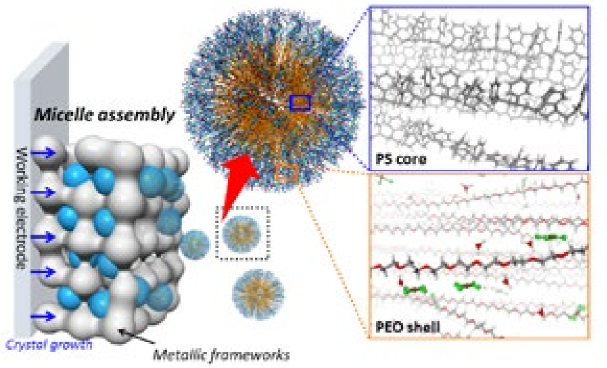


Fig. 4-31: Electrochemical approach for preparation of nanoporous metals.

References:

[18]-1 C. Li, O. Dag, T.D. Dao, T. Nagao, Y. Sakamoto, T. Kimura, O. Terasaki, Y. Yamauchi, *Electrochemical synthesis of mesoporous gold films toward mesospace-stimulated optical properties*, Nature Communications **6**, 6608 (2015). doi: 10.1038/ncomms7608

[18]-2 Y.Q. Li, B.P. Bastakoti, V. Malgras, C.L. Li, J. Tang, J.H. Kim, Y. Yamauchi, *Polymeric Micelle Assembly for the Smart Synthesis of Mesoporous Platinum Nanospheres with Tunable Pore Sizes*, Angewandte Chemie - International Edition **54**(38), 11073 (2015). doi: 10.1002/anie.201505232

[19] Subnanometer-scale molecular manipulation by submeter-scale macroscopic motion: a paradigm shift to functional conformer science

Representative researcher: K. Ariga

We have developed a novel methodology to rationally manipulate functional molecules including molecular machines embedded at movable interface by macroscopic mechanical motions. In attempts with molecular pliers as model machines at the air-water interface, closing and opening motions of the pliers were estimated and simulated by density functional theory and molecular dynamics calculation, which were further compared with macroscopic mechanical energies of the interface by thermodynamic calculation. The obtained results indicated highly efficient conversion of the mechanical energy in tens of centimeter-scale motion into subnanometer-scale modulations of the molecular pliers (Fig. 4-32).

This finding can be generalized as molecular manipulation to rationally create intermediate molecular conformers that can be adapted to target functions. For example, mechanical manipulations of the synthesized molecular receptor at the air-water interface can realize switchable chiral discriminations of amino acids upon pressure modulation. Another receptor at the interface was mechanically optimized to be capable of discriminating thymine and uracil that cannot be distibguished by naturally occurring DNA and RNA. Molecular functions exceeding biomolecules can be created through conformational modulation of functional molecules, which is regarded as a paradigm shift of synthetic approaches for functional molecules to functional conformer science.

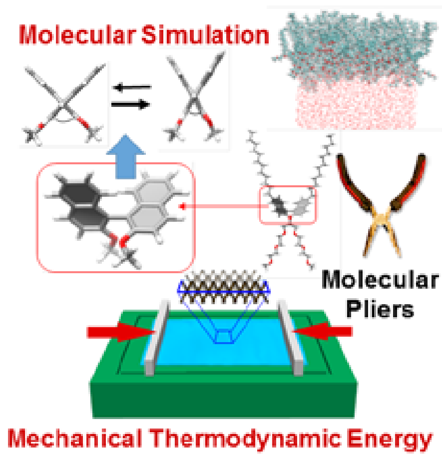


Fig. 4-32: Mechanochemical control of molecular structures.

References:

[19]-1 D. Ishikawa, T. Mori, Y. Yonamine, W. Nakanishi, D.L. Cheung, J.P. Hill, K. Ariga, *Mechanochemical Tuning of the Binaphthyl Conformation at the Air-Water Interface*, Angewandte Chemie - International Edition **54**(31), 8988 (2015). doi: 10.1002/anie.201503363

[19]-2 K. Ariga, T. Mori, S. Ishihara, K. Kawakami, J.P. Hill, *Bridging the Difference to the Billionth-of-a-Meter Length Scale: How to Operate Nanoscopic Machines and Nanomaterials by Using Macroscopic Actions*, Chemistry of Materials **26**(1), 519 (2014). doi: 10.1021/cm401999f

[20] Highly-efficient plasmonic systems for molecular sensing and energy conversion

Representative researcher: T. Nagao

Plasmonics and metamaterial are the new emerging paradigms for materials science which enable us to control the light in nano-space. We can tailor remarkable functionality such as extraordinary signal enhancement of molecules, enhanced photocatalytic reaction, and smart solar power harvesting. We focus ourselves on manipulating infrared (IR) light waves for the applications in molecular sensing and environmental monitoring. We also develop various light harvesting plasmonic materials and nanostructures for solar thermal energy conversion and solar photoelectric transfer.

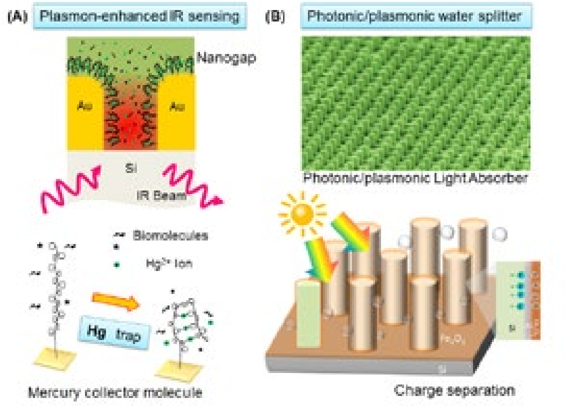


Fig. 4-33: (A) Schematic illustration of mercury sensing by infrared (IR) plasmon. (B) An example of photonic/plasmonic lattice for efficient solar-light harvesting and charge separation aiming at water splitting.

Fig. 4-33A shows an example for the selective monitoring of the presence of mercury ions (Hg^{2+}) dissolved in environmental water by plasmon-enhanced infrared (IR) vibrational spectroscopy. From natural water from Lake Kasumigaura (Ibaraki Prefecture, Japan), direct detection of Hg^{2+} with a concentration as low as 37 ppt was demonstrated, indicating the high potential of this simple method. We also develop photonic and plasmonic nanostructure array with high solar absorption power for realizing highly efficient solar photothermal converter as well as solar photoelectric charge separator for energy applications (Fig. 4-33B).

References:

[20]-1 C.V. Hoang, M. Oyama, O. Saito, M. Aono, T. Nagao, *Monitoring the Presence of Ionic Mercury in Environmental Water by Plasmon-Enhanced Infrared Spectroscopy*, Scientific Reports **3**, 1175 (2013). doi: 10.1038/srep01175

[20]-2 K. Chen, B.B. Rajeeva, Z.L. Wu, M. Rukavina, T.D. Dao, S. Ishii, M. Aono, T. Nagao, Y.B. Zheng, *Moire Nanosphere Lithography*, ACS Nano **9**(6), 6031 (2015). doi: 10.1021/acsnano.5b00978

5. Global Nanotechnology Network

5.1 MANA Satellite Network

Six out of the 20 MANA Principal Investigators (PIs) and Associate Principal Investigators (APIs) are visiting researchers from external research institutes. MANA has satellite laboratories at research institutions to which PIs and APIs are affiliated. As of January 2016, there are six MANA satellite laboratories, two in Europe, one in Japan and three in USA/Canada (Figs. 5-1, 5-2). In March 2015, the MANA satellite laboratory of Prof. Hideaki Takayanagi at Tokyo University of Science has been closed.

Researchers at the Satellites and MANA carry out joint research in nanoarchitectonics through frequent mutual visits and e-mail communications. In addition, the Satellites play a crucial role in training young researchers. MANA aims to serve as a global network hub for nanotechnology. The satellite laboratories promote innovative research as front-line bases of the global network and are an irreplaceable presence for MANA. To date, research at the MANA satellites has yielded 348 MANA affiliated papers (Fig. 5-3) or 10.5% of the total of 3,316 MANA papers. Many of these papers appeared in journals with a high impact, including Nature Materials, Nature Nanotechnology and Advanced Materials. From this viewpoint as well, the Satellites are making an important contribution to MANA's research results.

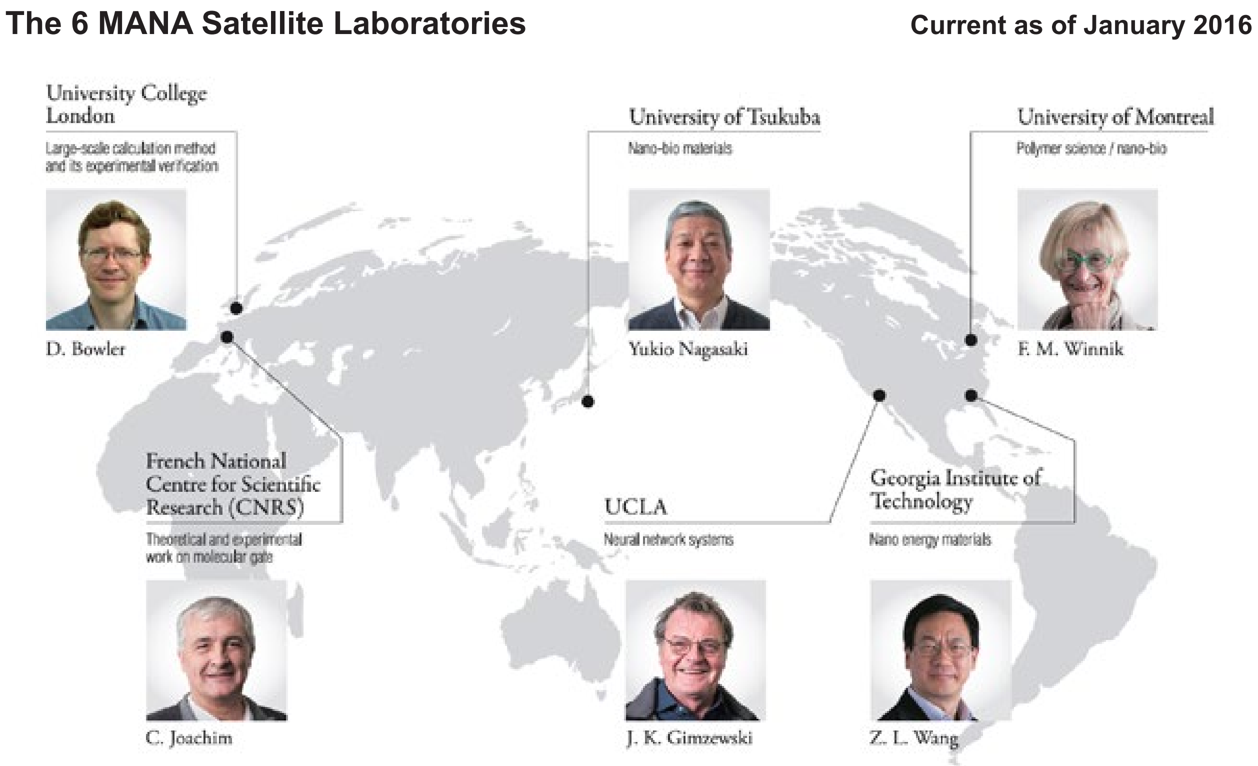


Fig. 5-1: The six MANA satellite laboratories.

UCLA
USA

CNRS
France

UCL
UK

University of Tsukuba
Japan

Georgia Tech
USA

UdeM
Canada

Fig. 5-2: Location of the six MANA satellite laboratories. Top row from left to right: University of California Los Angeles, UCLA, (USA); CEMES/CNRS, Toulouse (France); University College London, UCL (UK). Bottom row from left to right: University of Tsukuba (Japan); Georgia Institute of Technology, GIT (USA); University of Montreal, UdeM (Canada).

● **Prof. James K. Gimzewski** of UCLA is a renowned nanotechnology researcher who received a Feynman Prize in 1997. At MANA, he is conducting Nano-System research on neural networks that is aiming at a creation of artificial brain. Until FY2015 Prof. Gimzewski has visited MANA 31 times and resided at MANA for a total of 362 days, and in this time he has engaged in joint research projects on new neurocomputer circuits that utilize the learning capabilities of atomic switches. Between 2008 and 2015, he has published 63 papers through MANA. Prof. Gimzewski's research is frequently covered by NHK television programs, namely the January 2010 program *Proposal for the Future* and the February 2012 program *Nano Revolution: How Atoms Will Change Our Lives*. He also works hard on training and education for young researchers, graduate students, and young administrative staff by receiving post-doctoral scholars dispatched by MANA to UCLA, contributing greatly to the management of Nanotechnology Students' Summer School, and accepting MANA office staff as interns, among other efforts.

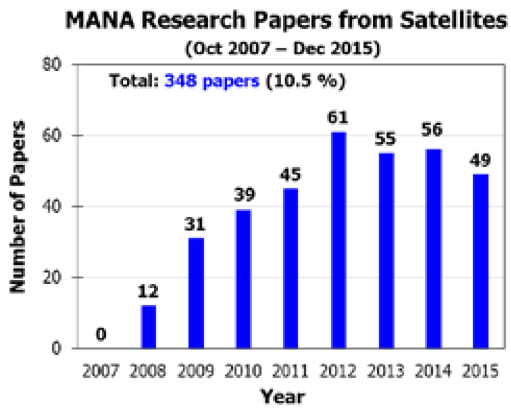


Fig. 5-3: MANA affiliated research papers from satellites.

● **Prof. Zhong Lin Wang** of the Georgia Institute of Technology is a highly active researcher whose papers, as of May 2016, have been cited over 90,000 times and have an H-index of 142. At MANA, he works in the Nano-Materials field and conducts research on photonic structures inspired by biological systems and nanogenerators that harvest mechanical energy. Prof. Wang is also he mentor of group leader Dr. Fukuta, who has visited the Georgia Institute of Technology 15 times for a total of 29 weeks to engage in joint research on nano-devices. The results of this research have been printed in the journal ACS Nano. There is also an exchange of personnel that takes place, as for example Prof. Wang's post-doctoral scholars later become Dr. Fukuta's post-doctoral scholars. Prof. Wang's work at the MANA Satellite has prompted Japanese companies to inquire about possible collaborations.

● **Prof. Françoise M. Winnik** of the University of Montreal is a world-renowned researcher in the fields of polymer chemistry, interface and colloid science, and nanoscience. She serves as the Executive Editor of Langmuir, the journal of the American Chemical Society. At MANA, Prof. Winnik works in the Nano-Life field and engages in a wide range of research, primarily focusing on the synthesis of new biocompatible polymers but also including various other interdisciplinary fusion research that utilizes nanotubes and nanoparticle materials developed by MANA researchers in other fields. Prof. Winnik operates labs at both MANA and the University of Montreal, but she is focused entirely on her MANA research with zero teaching obligations at the University of Montreal. In the past 5 years, she has spent 765 days at MANA and published 30 MANA papers.

● **Prof. Yukio Nagasaki** from Graduate School of Pure and Applied Sciences, University of Tsukuba, is working on polymers and biomaterials science. During last 30 years, he engaged in materials science especially in the field of biology, pharmaceutics and medical science. At MANA, Prof. Nagasaki works in the Nano-Life field and conducts research on biointerface, drug delivery system and nanomedicine. He published more than 200 scientific papers (including 107 MANA papers). Prof. Nagasaki serves as Handling Editor of Biomaterials, Elsevier, and Associate Editor of Bulletin of Chemical Society, Japan. Further, he is working as a members of executive committee of Polymer Society, Japan, The Japan Society of Drug Delivery System, Japanese Society of Biomaterials, and Society for Free Radical Research, Japan. Prof. Nagasaki received the excellent Ph.D. thesis award from Inoue Foundation of Science in 1989, Young Researcher Award from Polymer Society, Japan in 1993, SPSJ Mitsubishi Chemical Award from Polymer Society, Japan in 2010, the Award of The Japanese for Ulcer Society (2014), the Award of Japanese Society for Biomaterials (2014) and the Nagai Award from The Japan Society of Drug Delivery System (2015).

● **Prof. David Bowler** from University College London is a computational physicist who models nanostructures of semiconductors, particularly on surfaces, and develops new techniques. He has two key strands in his research: close collaboration with experimental groups, and development of novel electronic structure methods. He has driven the development of the world-leading linear scaling DFT code, CONQUEST, in close collaboration with Dr. Tsuyoshi Miyazaki in NIMS. One third of his published papers have been written in direct collaboration with experiment, where the focus of both techniques leads to a synergy, giving an insight that is greater than the sum of the parts. At MANA he works in the Nano-Power field, where he combines the two parts of his research, using CONQUEST to model the structure and properties of core-shell nanowires fabricated by Dr. Naoki Fukata. Since the MANA satellite at UCL has been opened 3 years ago, Prof. David Bowler has visited MANA 6 times and published 10 papers on the research conducted in MANA.

● **Prof. Christian Joachim** from CNRS-CEMES is a world-renowned computational scientist who won the Feynman Prize in 1997 and 2005. At MANA, he works in the Nano-System field and performs research on the design, manufacture, and atomic manipulation of nanocircuits, in addition to working on the theory of surface electron interconnection. Until March 2016, Prof. Christian Joachim has visited MANA 17 times for a total of 131 days. He actively engages in joint research with MANA researchers and has released 48 papers through MANA (this includes many papers printed in *Nature Nanotechnology* and other top-tier journals). At CEMES, Dr. Joachim hosted a workshop focused on uniting computational scientists with experimental scientists in October 2009, and a Japan-France workshop on Nano-Materials in November 2010. Prof. Christian Joachim announced to organize a molecule concept nano-car race in 2016 at the CNRS MANA satellite in France. Teams from several countries, including MANA from Japan, will try this world smallest, most difficult and scientific car race.

The nanocar race at the CNRS MANA satellite

Dr. Christian Joachim (Principal Investigator, MANA satellite at CNRS)

The molecule-car race (The nanocar race)

The first-ever international race of molecule–cars (nano-cars) will be at the Toulouse MANA Satellite (France) in October 2016. It was first announced in 2013 [1] but it took almost 3 years for Toulouse MANA to find support and sponsorships for this competition. All details about the race, the name of Toulouse 11 scientists and engineers forming the technical team for the race organization, the 6 officially selected teams and the actual list of sponsors can be found on its website [2]. To register for the first edition of this molecule Grand Prix in Toulouse, a team had to deliver to the Toulouse organizers until May 2016 the following information:

(a) The details of its institution (academic, public, private)
(b) The design of its molecule-vehicle including the delivery of the xyz file coordinates of the corresponding atomic structure
(c) The propulsion mode, preferably by tunneling inelastic effects
(d) The evaporation conditions of the molecule-vehicles
(e) If possible a first UHV-STM image of the molecule-vehicle
(f) The name and nationality of the LT-UHV-STM driver having performed (e).

1894 2016

Fig. 5-4: The official poster of the 1894 first ever automobile car race organized in France by "Le Petit Journal", a famous French newspaper at that time and the official poster of the first ever molecule-vehicle car race organized at the Toulouse MANA satellite for October 2016.

This information was used to select the 5 teams accepted to race and to organize training sessions to learn the driving conditions on the Toulouse MANA Satellite LT-UHV-4 STM which will be the workhorse for the competition [3]. The first ever "macroscopic" automobile race was organized in France in July 1894 between Paris and Rouen. 102 teams registered, 21 effectively started the race and 17 arrived in Rouen about 7 hours later (Fig. 5.4). For the October 2016 molecular scale automobile race, 9 teams have expressed their interest to participate, one team abandoned and 6 were selected by the organizers. It is expected to have a better success rate at the arrival for this first ever nano-car race than for the macroscopic 1894 one.

Preparation of the track

In October 2016, the molecule-car of a given registered team will have at its disposal a track prepared on a small portion of the same Au(111) surface. The surface will be maintained at very low temperature that is 4.3 K and in UHV conditions during the competition. The race itself will last no more than 2 days and 1 night including the time needed to prepare almost identical in length tracks for the competitors. The cleaning and the imaging of a given track will be realized by each team independently, in parallel and certified by an independent Track Commissioner before the official starting of the race on the 14th of October at 10:00 in the morning. If a competitor is judged too long for preparing its own track, it will be allowed to be helped for this

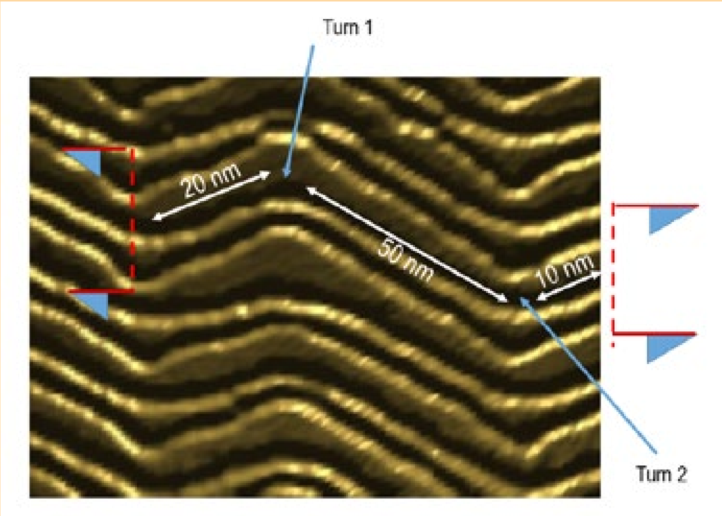


Fig. 5-5: Image LT-UHV-STM of a 36.5 nm x 48.6 nm portion of the Au(111) surface with its native herringbone reconstruction. The measured corrugation is 0.026 nm. Each driver is free to choose the separation, kept throughout the race, between two rafters to fit the width of its molecule-car. The race track per team is determined before the start of the race in consultation with the Track Commissioner and of the other team's drivers. One example of a possible circuit from left to right is presented on the STM image with a first straight line of 20 nm long, a first curve, a long straight line of 50 nm long, a second corner and finally a second straight 20 nm long before the arrival line (only a 10 nm portion was imaged). The width of the track selected here is 6 nm in average. Image recorded on one STM tip of the LT-UHV 4 STM installed in Pico-Lab CEMES-CNRS in Toulouse, where the machine molecule-car race will take place. Conditions: I = 300 pA and V = 200 mV.

first edition by the other registered teams. If this preparation is still too long as judged by the Track Commissioner, this team will be disqualified. This preparation step is about 6 hours maximum.

On this Au(111) surface, the track per competitor will beneficiate from the native zig zag Au(111) herringbone surface reconstruction (Fig. 5-5). Such a reconstruction is producing long and linear portions of a track terminated generally both ways by about 45° slight turns. This will make the circuit for the race a succession of linear portions and turns leading for example to a simple 90 nm long circuit with a track width of about 6 nm on the fcc part of the Au(111) reconstructed surface. The first training have demonstrated a speed of 5 nm per hour including the STM imaging time and without counting the few accidents along the drive. In 1894, the Peugeot car official winner of the race had driven 126 km between Paris and Rouen in less than 7 h.

At once, 4 different molecule-cars will compete at the same time and in parallel on the same Au(111) surface using the unique LT-UHV 4 STM instrument constructed on purpose by *ScientaOmicron* for the Toulouse MANA Satellite. It is basically four LT-UHV-STM miniature scanner of very high stability able to scan the surface in parallel [3]. Since more than 4 teams have registered for this first edition, it will be done playoff races determined by lot taking into account the results of the training sessions and certainly the attendance to them. Tungsten tips for the tracks cleaning and for the race itself will be fabricated by the teams on a specific set up available in Toulouse and this normally two weeks before the starting of the race. There are 28 storage positions available on the UHV carrousel around the tracks but only one UHV tip reshaping equipment accessible on line. All the tips required for the competition will be stored on this UHV carrousel the night before the starting of the competition. No tip change is allowed during the race.

How to propel and drive a nanocar?

For this first edition, all molecule-vehicles chemical structure are accepted as soon as they have a minimum of hundred atoms (Fig. 5-6). They must be quite small in lateral width to be able to fit on the track width chosen by a given team and to be imaged at relatively low voltage (< 500 mV) and current (> 1 pA). It is preferable to register a molecule-vehicle with 4 wheels, a chassis and an embarked molecular motor that is a molecule-car. The mechanical manipulation of a molecule-car [4] is only allowed for reaching the starting line on the Au(111) surface marked for example by the last turn before the 20 nm short track on Fig. 5-5. However, this should not be the mode of propulsion during the race itself.

In 1894, the propulsion modes were very diverse: steam, petrol, hydraulic, air compressor, gravity, gasoline and pedals. The required propulsion mode for this first edition of the molecule-car race is inelastic electron tunneling effects [5]: the tunneling current passing through a molecule-car is mainly an elastic phenomenon in nature. But less than 0.01% of the tunneling electrons are releasing vibrational energy to the molecule-car when quantum mechanically transferred through it. This energy is normally redistributed inside the molecule-car and depending of its design, part of this energy can be used by the molecule-car to move on the surface, generally by steps of 0.3 nm to 0.6 nm on an Au(111) surface [5].

If no molecule-vehicle is able to be driven by tunneling electronic inelastic effects i.e. without any mechanical interactions between the

Fig. 5-6: A photography of the macroscopic models of 6 of the 8 molecule-vehicles which candidate for the first international molecule-car race. Each molecule-car was 3D printed with a 50'000'000 enlargement using the exact atomic scale coordinates of the chemical structure of the molecule-car provided by the teams to the Toulouse MANA satellite organizers. For example the 4 wheels drive dark blue top left molecule-car is now measuring 130 mm 3D printed and is 2.8 nm in reality.

molecule and the end tip apex during the race itself, the organizers have the right for this first edition to lower the rule and tolerate a molecule-vehicle driven in a mechanical pushing mode. But one fundamental interest of the race is exactly to learn the nano-architectronics rules to design a molecule-car for its internal mechanical machinery to function driven by inelastic tunneling and in the future light effects. Such an understanding is very important in general for designing single molecule motors [6] with a real motive power or molecule-latch to input binary data on atomic scale circuitries [7].

The winner?

The molecule-car passing first through the arrival line will be declared the winner of the first international molecule-car race by the race Director. The prize will be a very good dinner for the winning team in the best two stars restaurant in Toulouse.

References:

[1] C. Joachim, G. Rapenne, ACS Nano **7**(1), 11 (2013).
[2] http://www.cemes.fr/Molecule-car-Race
[3] J.S. Yang, D. Sordes, M. Kolmer, D. Martrou, C. Joachim, Eur. Phys. J. Appl. Phys. **73**(1), 10702 (2016).
[4] T.A. Jung, R.R. Schlitter, J.K. Gimzewski, H. Tang, C. Joachim, Science **271**, 181 (1996).
[5] A. Nickel, R. Ohmann, J. Meyer, M. Grisolia, C. Joachim, F. Moresco, G. Cuniberti, ACS Nano **7**(1), 191 (2013).
[6] P. Mishra, J.P. Hill, S. Vijayaraghavan, W. Van Rossom, S. Yoshizawa, M. Grisola, J. Echeverria, T. Ono, K. Ariga, T. Nakayama, C. Joachim, T. Uchihashi, Nano Lett. **15**(7), 4793 (2015).
[7] O.A. Neucheva, F. Ample, C. Joachim, J. Phys. Chem. C **117**(49), 26040 (2013).

5.2 International Nanotechnology Research Network

MANA signs Memoranda of Understanding (MOUs) with universities and research institutes around the globe in order to promote the creation of an international nanotechnology research network by way of joint research projects. A MOU agreement is valid for 5 years and can be renewed if both institutes agree. Between the launch in October 2007 and March 2016, MANA has concluded MOUs with 56 different institutions from 19 countries (Appendix 7.9, Table 5-1). 3 MOUs were renewed and 1 MOU was replaced. As of March 31, 2016, 29 MOUs are valid, 30 have expired and 1 has been replaced. Photos of recent MANA MOU signing ceremonies in Australia are shown in Fig. 5-7.

Appendix 7.9: International Cooperation

Fig. 5.7: MANA MOU Signing Ceremonies in Australia with University of Wollongong (September 2015, left) and University of Sydney (February 2016, right). Photos from left to right: Prof. Masakazu Aono (MANA Director-General) and Prof. Joe Chicharo (Deputy-Vice Chancellor, Academic, University of Wollongong). Prof. Thomas Maschmeyer (AINST Director), Prof. Tomonobu Nakayama (MANA Administrative Director) and Prof. Zdenka Kuncic (AINST Director, Community and Research).

Table 5-1: MANA MOUs with 56 different institutions from 19 countries. The number of MANA MOUs valid on March 31, 2016, is shown in parenthesis.

Region	Number of MOUs
Europa	22 (9)
Asia	19 (10)
North America	8 (5)
Australia	4 (4)
South America	2 (1)
Middle East	1 (0)
Total	56 (29)

5.3 Partnership with Foreign and Domestic Universities

Since MANA is a part of a public research center and not a university, we strive to collaborate with foreign and domestic universities. In 2015, MANA continued to hold workshops and symposia with the aim of promoting research exchange and boosting MANA's name recognition in order to scout for talent. In addition, MANA accepted 2 technical trainees from Qatar for half a year.

● List of Workshops and Joint Symposia held in 2015

Jul 29, 2015

The 6th NIMS/MANA-Waseda University International Symposium

On July 29, 2015, the 6th NIMS/MANA-Waseda University International Symposium was held at Waseda University with 10 lectures, 12 student presentations and 15 poster presentations. NIMS (National Institute for Materials Science) and Waseda University launched the joint graduate school and had the first Joint symposium at Waseda University in 2009. The symposium focuses on research in wide range fields, including new ceramics, inorganic materials, semiconductors, biomaterials, polymer materials, and metallic crystals.

Jul 29-30, 2015

International Symposium on Nanoarchitectonics for Mechanobiology

On July 29-30, 2015, the International Symposium on Nanoarchitectonics for Mechanobiology was held at MANA (Fig. 5-8). The 2-day event with about 120 participants featured three plenary lectures from Dr. Viola Vogel (ETH), Dr. Toshihiro Akake (Foundation for Advancement of International Science, FAIS) and Dr. Yasuhiro Sawada (National Rehabilitation Center for Persons with Disabilities), invited talks by 11 distinguished scientists from Japan and other countries, 9 MANA research presentations and 37 poster presentations. The spirited discussions and exchanges of ideas at this symposium strongly highlighted the importance of the interdisciplinary fields of materials science and mechanobiology.

Oct 15-16, 2015

MANA-RSC Symposium: Materials for Energy Generation and Storage

On October 15-16, 2015, MANA and the Royal Society of Chemistry (RSC) held the MANA-RSC Symposium at MANA (Fig. 5-8) with assistance from the University of Tsukuba and the National Institute of Advanced Industrial Science and Technology (AIST). At the event, 14 presentations by researchers involved with energy research including Prof. Fraser Armstrong (University of Oxford), and 38 poster presentations from young scientists were shown. Participants totaled more than 130 people, and one third of them were from outside of NIMS.

Fig. 5-8: Participants of the International Symposium on Nanoarchitectonics for Mechanobiology (left) and the MANA-RSC Symposium (right).

● Trainees from Qatar Complete Training at MANA

On May 28, 2015, NIMS held a ceremony marking the completion of training by trainees from Qatar, who had attended training at NIMS since December 2014 and recently completed the 6 month training period. NIMS received technical trainees from the Qatar Environment & Energy Research Institute (QEERI) based on a comprehensive cooperation agreement which was concluded between Qatar Foundation (QF) and NIMS in April 2014. Among seven trainees, MANA received Mr. Granim Al-Kubaisi and Mr. Rakan Al-Marri (Fig. 5-9), who studied the operation of analysis measurement and observation devices and other topics. Exchange between the two organizations are expected to contribute to friendship between Qatar and Japan.

Fig. 5-9: Trainees from Qatar at MANA: Mr. Ghanim Al-Kubaisi (left) and Mr. Rakan Al-Marri (right).

● Programs for Attracting Junior Researchers to MANA

NIMS Graduate Schools

NIMS operates the NIMS Graduate Schools having concluded agreements with selected Japanese universities, and graduate students are taught advanced research by NIMS researchers on the frontlines of their fields. In Fiscal Year 2015, 23 scientists at MANA are teaching in the NIMS Graduate Schools (Table 5-2). Students in the NIMS Graduate Schools who possess especially outstanding skills are appointed as junior researchers and are paid a salary for their contribution to NIMS research. In FY2015, there are 36 junior researchers working at MANA, of which 34 are foreigners and 13 are females. In September 2009, the graduate school at University of Tsukuba established a Master's curriculum in which students can take all of their required credits in English. The objective is to attract outstanding foreign students from the Master's program to the NIMS Graduate Schools.

Table 5-2: Number of MANA members at the NIMS Graduate Schools in FY2015.

School	No. of Faculties	No. of Students
University of Tsukuba	10	17
Hokkaido University	6	7
Waseda University	5	10
Kyushu University	2	2

International Cooperative Graduate Program

Within the International Cooperative Graduate Program overseas doctorial students from renowned universities around the globe spend several months to one year at NIMS researching under the supervision of NIMS researchers. By March 2016, MANA brought in 57 students within this program from 12 different universities (Fig. 5-10): Flinders University (Australia), Xian Jiatong University (China), Charles University and the University of Pardubice (Czech Republic), Budapest University of Technology and Economics (Hungary), Anna University and Jawaharlal Nehru Centre for Advanced Scientific Research (India), Yonsei University (Korea), Universiti Teknologi Malaysia (Malaysia), Warsaw University of Technology (Poland), Lomonosov Moscow State University (Russia) and National Taiwan University (Taiwan).

Flinders University (Australia)
Xian Jiaotong University (China)
Charles University (Czech Republic)
University of Pardubice (Czech Republic)
Budapest Univ. Techn. Economics (Hungary)
Anna University (India)
Jawaharlal Nehru Center (India)
Yonsei University (Korea)
Universiti Teknologi Malaysia (Malaysia)
Warsaw University of Technology (Poland)
Moscow State University (Russia)
National Taiwan University (Taiwan)

Fig. 5-10: The 12 universities from where MANA has accepted doctorial students within the International Cooperative Graduate Program.

Internship Program

NIMS established an internship system to proactively accept students from universities throughout Japan and the world which have not concluded agreements with NIMS and provide them with opportunities to partake in materials and nanotechnology research. By March 2016, MANA has accepted 405 interns, of which 322 have been foreigners. MANA has welcomed 33 US students from the NSF's National Nanotechnology Infrastructure Network (NNIN) Research Experience for Undergraduates (REU) Program.

5.4 Global Career Advancement

MANA is always aware of its role as a platform for successful career advancement for young researchers. MANA's policy is not merely to gather young researchers from throughout the world and cultivate them into excellent researchers. Rather, MANA seeks to endow these researchers with a thorough understanding of Japan such that they can advance their careers in countries throughout the world. Till the end of FY2015, 255 MANA's young researchers have "graduated" MANA. 12 of them were selected for permanent research positions at NIMS and 99 became faculty members (professor, associate professor and so on) of universities both inside and outside Japan. Also, 99 have advanced in their careers to become researchers at universities and research institutions, and 27 have moved to private companies. 35% of those who made research at MANA found employment within Japan, and the remaining 65% found positions in the world, primarily in Asia (Fig. 5-11).

Fig. 5-11: Destinations of the 255 MANA postdoc alumni between October 2007 and March 2016.

Examples of career advancement of MANA Alumni:

- Assistant Professor, Temple University, USA
- Professor, ETZ Zurich, Switzerland
- Research Group Leader, Max Planck Institute for Intelligent Systems, Germany
- Associate Professor, Uppsala University, Sweden
- Associate Professor, University of Bristol, UK
- Assistant Professor, University of Nora Gorica, Slovenia
- Assistant Professor, King Faisal University, Saudi Arabia
- Professor, Fudan University, China
- Professor, Nanjing University of Science and Technology, China
- Professor, Korea Institute of Energy Research, Korea
- Lecturer, Nanyang Technological University, Singapore
- Professor, University of South Australia, Australia

Dr. Xaosheng Fang (2008-2011) and Dr. Tianyou Zhai (2010-2013) both worked for 3 years as ICYS-MANA researchers. Their research at MANA was so successful that in 2015 these two ICYS-MANA alumni were selected as *ISI Highly cited researchers* in field of Materials Science. *ISI Highly cited researchers 2015* are authors of many highly cited papers produced between 2003 and 2013 in a certain research field in the Thomson Reuters Essential Science Indicators database. Dr. Xaosheng Fang currently works as Professor at Fudan University, China, and Dr. Tianyou Zhai as a Professor at Huazhong University of Science and Technology, China.

6. Enhancement of National and International Recognition

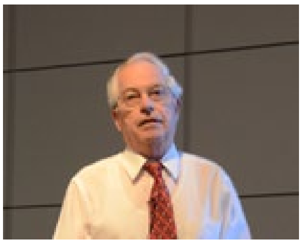
6.1 MANA International Symposium

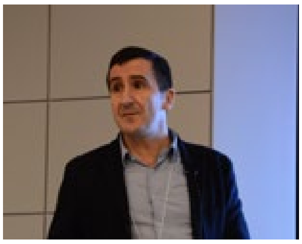
The MANA International Symposium is held each year to present research achievements at MANA to the Japanese and international scientific communities. The 9th MANA International Symposium 2016 was held at Epochal Tsukuba in Tsukuba City, Japan over a 3-day period from March 9 (Wednesday) to March 11 (Friday), 2016 (Figs. 6-1 to 6-5). The symposium featured 3 Special Lectures Prof. Jean-Marie Lehn (Nobel Laureate in Chemistry 1987, France), Prof. Pedro Miguel Echenique (President, Donostia International Physics Center, Spain) and Prof. Rainer Waser (Electronic Materials Research Laboratory, Germany). 18 distinguished scientists from Japan and other countries had invited talks. Research results at MANA and NIMS were announced in a total of 15 oral presentations and 102 poster presentations, and 7 young scientists who made excellent poster presentations won the MANA International Symposium 2016 Poster Award. The Symposium attracted 411 participants from 24 countries over the 3-day period, with lively question-and-answer sessions and exchanges of ideas.

Fig. 6-1: The 9th MANA International Symposium in March 2016.

Prof. Echenique **Prof. Lehn** **Prof. Waser**

Fig. 6-2: Special lectures by Prof. Pedro Miguel Echenique (President, Donostia International Physics Center, Spain), Prof. Jean-Marie Lehn (Nobel Laureate in Chemistry 1987, France) and Prof. Rainer Waser (Electronic Materials Research Laboratory, Germany).


Prof. Frei


Prof. Diez Muiño


Prof. Ishihara


Prof. Yuasa


Prof. Weitering


Prof. Jung


Prof. Itami


Prof. Kato


Prof. von Löhneysen


Prof. Hanaguri


Prof. Ishitani


Prof. Banerjee


Prof. Funakubo


Prof. McGrath


Prof. Ishihara


Prof. Harada


Prof. Mikos


Prof. Tanaka

Fig. 6-3: Invited lectures at the 9th MANA International Symposium by renowned scientists from outside MANA. Top row from left to right: Prof. Heinz Frei (Lawrence Berkeley National Laboratory, USA), Prof. Ricardo Diez Muiño (Donostia International Physics Center, Spain), Prof. Tatsumi Ishihara (WPI-I^{2}CNER, Kyushu University, Japan) and Prof. Shinji Yuasa (Spintronics Research Center, AIST, Japan). Second row from left to right: Prof. Hanno H. Weitering (University of Tennessee, USA), Prof. Thomas A. Jung (Paul Scherrer Institute, Switzerland), Prof. Kenichiro Itami (WPI-ITbM, Nagoya University, Japan) and Prof. Takashi Kato (University of Tokyo, Japan). Third row from left to right: Prof. Hilbert von Löhneysen (Karlsruhe Institute of Technology, Germany), Prof. Tetsuo Hanaguri (RIKEN, Japan), Prof. Osamu Ishitani (Tokyo Institute of Technology, Japan) and Prof. Kaustav Banerjee (UC Santa Barbara, USA). Fourth row from left to right: Prof. Hiroshi Funakubo (Tokyo Institute of Technology, Japan), Prof. Kathryn M. McGrath (MacDiarmid Institute, New Zealand), Prof. Kazuhiko Ishihara (University of Tokyo, Japan) and Prof. Yoshie Harada (WPI-iCeMS, Kyoto University, Japan). Fifth row from left to right: Prof. Antonios G. Mikos (Rice University, USA) and Motomu Tanaka (Heidelberg University, Germany and WPI-iCeMS, Kyoto University, Japan).

Prof. Hashimoto | **Mr. Watanabe** | **Prof. Kuroki** | **Prof. Saito**

Fig. 6-4: From left to right: Opening address by Prof. Kazuhito Hashimoto (President, NIMS) and subsequent greeting addresses by Mr. Masami Watanabe (Director, Basic Research Promotion Division, MEXT), Prof. Toshio Kuroki (Director, WPI Program) and Prof. Gunzi Saito (WPI Program Officer of MANA).

Fig. 6-5: Outline of MANA by Prof. Masakazu Aono (Director-General, MANA, left), audience and at the Poster Award Ceremony (right).

6.2 MANA Website

The official English MANA website (www.nims.go.jp/mana/) was launched in February 2008 and is continuously being improved. It provides an overview of MANA, introduces researchers, research projects and output, and informs about events and recent news. In February 2011, the new Japanese MANA website (www.nims.go.jp/mana/jp/index.html) was launched. To further improve the content, both English and Japanese MANA websites have been renewed in FY2013 and again in FY2014. Since January 2015, a responsive web design of the MANA website is being used, which enables easy browsing with a wide range of devices including smartphones.

6.3 MANA Newsletter

Since its founding, MANA has published the newsletter CONVERGENCE three times annually in Japanese and English, for a total of 22 issues until end of FY2015. Every issue features updates on the center's activities as well as interviews with famous, Nobel-class researchers (Fig. 6-6). This newsletter, which is intended for researchers throughout the world, is currently distributed to 1,650 domestic addresses and 1,800 international addresses.

MANA Newsletter CONVERGENCE

No. 18
October 2014

Prof. Teruo KISHI

No. 19
February 2015

Don EIGLER, Stan WILLIAMS, Masa AONO

No. 20
June 2015

Prof. Yoshio NISHI

No. 21
October 2015

Prof. Yasuhiko ARAKAWA

No. 22
February 2016

Prof. Leo ESAKI

Fig. 6-6: Recent issues of the MANA newsletter CONVERGENCE.

6.4 Outreach Activities

As a result of MANA's outreach activities, the nanoarchitectonics concept has begun to spread. For example, the E-MRS Fall meeting held in September 2014 featured a "nanoarchitectonics" session. MANA has also actively pursued outreach oriented toward the general public. To nurture interest in science among young students, MANA has held events such as the MANA Science Cafe, joint symposiums, summer camps, and "science school" events for elementary and junior high school students featuring Nobel Prize winners (Prof. H. Rohrer, Prof. H. Kroto, etc.). MANA also creates online videos that explain its research achievements in an easy-to-understand way. MANA has also released general introductory books on its research, such as *Nanoarchitectonics: A Revolution in Materials Science* (2014) and *The Nanotech Handbook for Future Scientists* (2015). Moreover, due to the success of this outreach work, "nanoarchitectonics" will be now listed in the famous and authoritative *Kojien* Japanese dictionary, and is becoming increasingly widely known.

Since 2014, MANA has organized "Tsukuba Action Project (T-ACT): Science Communication Training," which is based on a collaboration between the University of Tsukuba and MANA. Graduate and undergraduate students participate in MANA outreach activities, including interviews with scientists and communication at scientific events. In 2015, MANA continued to participate in domestic and international outreach events (Figs. 6-7, 6-8).

Fig. 6-7: MANA Clean room tour (left) and Smart Polymer Rangers show (middle) at NIMS Open House. Scientific lecture of Dr. Mitsuhiro Ebara for Junior High School students (right).

● **Scientific Lecture for General Citizens**

On January 15, 2015, MANA Principal Investigator Katsuhiko Ariga gave a lecture for general citizens at the Mitaka Network University, which is a public-academic--university-government regional network. This lecture was part of a course planned by "Science Communication," an incorporated nonprofit organization that provides information on topics related to science and technology in response to requests from citizens' groups. Principal Investigator Ariga's lecture was entitled "New Nanotech – Hand-made, hand-operated nanotechnology and new materials" and introduced innovative nanotechnologies that can be manipulated simply by the human hand, even though they are leading-edge science and technology.

● **NIMS Open House 2015**

NIMS Open House 2015 was held on April 15 and 19 at NIMS in Tsukuba. MANA participated in the event at NIMS Namiki site on April 15 and at NIMS Sengen site on April 19. At Namiki site, MANA organized a clean room tour (Fig. 6-7) and presented a simulation experience of multiple probe STM measurement and other demonstrations of advanced technology. At Sengen site, the MANA exhibited "smart polymers," that can be utilized as a biomaterial and presented a Smart Polymer science show (Fig. 6-7). This exhibit was part of the "Tsukuba Action Project (T-ACT): Science Communication Training." University students who participated in T-ACT explained the expected behavior of smart polymers in the human body in a children-friendly show featuring a group of heroes called the "Smart Polymer Rangers."

● **Scientific Lectures for Junior High School Students**

MANA cooperated with Tsukuba Scientific Lectures, which are events where scientists in Tsukuba visit a school in the city and give a special lecture, organized by the Tsukuba City Board of Education. On June 18, and October 1, 2015, Dr. Mitsuhiro Ebara and his colleagues delivered a series of lectures about "smart polymers" to students of Namiki Junior High School Science Club (Fig. 6-7). On July 22 and August 18, 2015, the students visited MANA to participate in scientific experiments with cutting-edge research facilities. The students presented the results of their study with MANA researchers at the Tsukuba Science Festival end of October 2015.

● **Scientific Lecture for High School Students**

On June 25, 2015, MANA Scientist Jin Kawakita gave a lecture at the Hikawa High School, which has been assigned as a one of the Super Science High Schools (SSHs). To foster excellent human resources in science and technology, high schools assigned as Super Science High Schools by the Japanese Ministry MEXT work on special class lessons and distinctive collaborative project studies with universities and research institutions. Dr. Kawakita's lecture entitled "Material Research and Chemistry" was held as a part of SSHs activities. He introduced most advanced material science to the students.

Fig. 6-8: Left, middle: Participants of Nanotechnology Student's Summer School. Right: Smart Polymer Rangers at the Tsukuba Science Festival.

● **Nanotechnology Students' Summer School 2015**

Over a 5 day period from June 29 to July 3, 2015, MANA held the Nanotechnology Students' Summer School. A total of 25 students in the first half or second half of their doctoral courses participated from Japan, Canada, the United States, Australia and France (Fig. 6-8). In each group, the participants proposed and presented nanotechnology contributing to modern society based on "nanoarchitectonics." This was a very substantial summer school, in which participants practiced group tasks and learned fundamentals and mental attitudes of research through a fusion of different fields, going beyond the barriers of different backgrounds and cultures.

● **Tsukuba Science Festival 2015**

From October 31 to November 1, 2015, MANA participated in the "Tsukuba Science Festival 2015" held at Tsukuba Capio and exhibited "smart polymers," a material that can be used for the diagnosis and medical treatment of diseases. The Smart Polymer science show (Fig. 6-8) was also shown. Members of the Namiki Junior High School science club and University of Tsukuba students lended a hand as well. Tsukuba Science Festival is a science exchange event which provides "hands-on" learning experiences for members of the general public, and is organized by Tsukuba City and the Tsukuba City Board of Education. In 2015, 56 organizations from Tsukuba, such as schools and research institutes, participated in the event with 18,000 visitors.

● **University of Tsukuba "Sohosai" Festival 2015**

MANA opened an exhibition booth as one of the "Tsukuba Research Introductions" at the "Sohosai" festival held at the University of Tsukuba on November 7-8, 2015. "Tsukuba Research Introductions" is a project where research institutes in Tsukuba and University of Tsukuba present content of research and research outcome. The MANA booth presented the remarkable research outcome "Membrane-type Surface stress Sensor: MSS" of Dr. Genki Yoshikawa (MANA Independent Scientist) and introduced the "NIMS Joint Graduate School Program" for students who plan to enter graduate school in the near future.

6.5 Media Coverage

MANA continues to be featured in Japanese newspaper articles and in Japanese television.

Between October 2007 and March 2016, in the first 8 1/2 years of the MANA project, 472 press releases about MANA appeared in Japanese newspapers (Fig. 6-9). This corresponds to an average number of press releases of 57.2 per year. To encourage foreign researchers to issue press releases, NIMS has setup a support system.

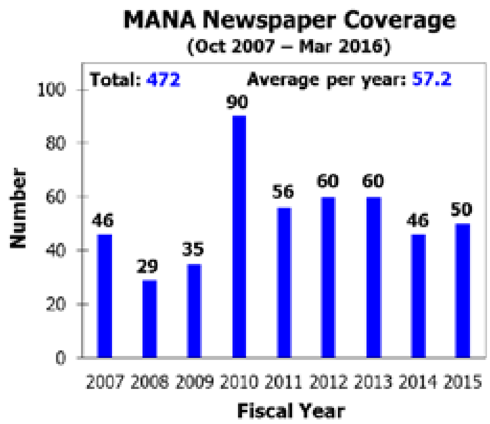


Fig. 6-9: Number of press releases from MANA published in Japanese newspapers.

In FY2015, research of Dr. Mitsuhiro Ebara (MANA Scientist), Dr. Tetsushi Taguchi (MANA Scientist) and Dr. Genki Yoshikawa (Independent Scientist) has been featured in Japanese television as summarized in Table 6-1 and illustrated in Fig. 6-10. Dr. Ebara uses smart polymers as a biomaterial for cancer treatment and dialysis. Dr. Taguchi has developed a novel surgical adhesive with potential for biomedical applications in the field of cardiovascular and thoracic surgery. Dr. Yoshikawa presents his newly developed miniaturized platform "Membrane-type Surface stress Sensor (MSS)" for detection of target molecules in various fields as medicine, environment, food, cosmetics and security.

Table 6-1: Research of MANA featured in Japanese television in FY 2015.

Mitsuhiro Ebara (MANA Scientist)	
2015 Aug 7	NHK Ibaraki, news
2015 Aug 8	NHK, news
2016 Mar 13	TBS, documentary
Tetsushi Taguchi (MANA Scientist)	
2016 Feb 18	NHK Ibaraki, news

Genki Yoshikawa (Indep. Scientist)	
2015 Sep 29	Nittere CS news
2015 Oct 17	NHK, news
2015 Oct 20	Fuji TV documentary
2016 Jan 10	NHK, news
2016 Jan 27	NHK Ibaraki, news

Fig. 6-10: Top row: Research of MANA featured in Japanese television news. Dr. Ebara in *NHK Ohayo Nippon* (Good morning Japan, left) and in *NHK Iba6* (right). Bottom row: Research of MANA featured in Japanese television documentaries. Dr. Ebara in TBS *Yume no Tobira* (A door opened to dreams, left) and Dr. Yoshikawa in Fuji TV *News no kimo* (Essential news, right).

6.6 Visitors to MANA

There are several kinds of short-time visitors to MANA.

(a) Researchers visiting MANA for scientific discussion, to give a seminar or to attend a workshop or symposium
(b) Researchers or students invited to MANA for short-time research activities
(c) MANA visit of Satellite Principal Investigators, MANA Advisors and Evaluation Committee members
(d) General Visitors (excluding categories (a), (b), (c))

In FY2011 (April 2011 – March 2012), the number of visitors to MANA decreased in the wake of the nuclear power plant incident after the Great East Japan Earthquake in March 2011. But it seems that this so-called *Japan allergy* has disappeared almost entirely and, as shown in Table 6-2, we observe a strong increase of visitors to MANA since FY2012. The 796 visitors in FY2015 came from all over the world: Europe (120), America (70), Asia (581), including (443) from Japan, and other regions (25). In 2015, MANA visitors included higher-ranked scientists (Fig. 6-11) and students (Fig. 6-12) from foreign universities.

Table 6-2: Number of short-time visitors to MANA.

Fiscal Year	Total of Visitors (a), (b), (c), (d)	General Visitors (d)
FY2015	796	159
FY2014	757	218
FY2013	715	146
FY2012	565	284
FY2011	248	108
FY2010	315	147

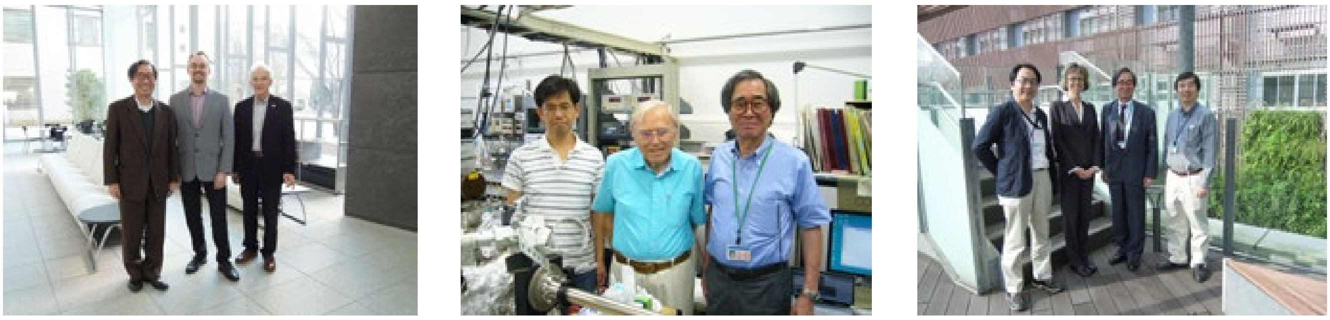


Fig. 6-11: MANA visit of scientists in 2015. Left: Prof. Peter Thostrup from Aarhus University, Denmark on March 2. Middle: Prof. Ernst Bauer from Arizona State University, USA, on July 13. Right: Prof. Dr. Zdenka Kuncic from the University of Sydney, Australia, on October 29.

Fig. 6-12: MANA visit of students in 2015. Left: La Trobe University, Melbourne, Australia, on February 3. Right: University of Twente, Netherlands, on July 28.

6.7 MANA Scientific Art Pictures

In November 2011, MANA Director-General Masakazu Aono has started a call to submit scientific art pictures. After a second call in October 2012, and a third call in November 2015, MANA has received over 100 scientific art pictures (Fig. 6-13), which are being used to decorate empty walls in the MANA Building and the new WPI-MANA Building. MANA scientific art pictures are being used often at NIMS and MANA in promotion videos, original goods, brochures, websites, greeting cards and exhibitions.

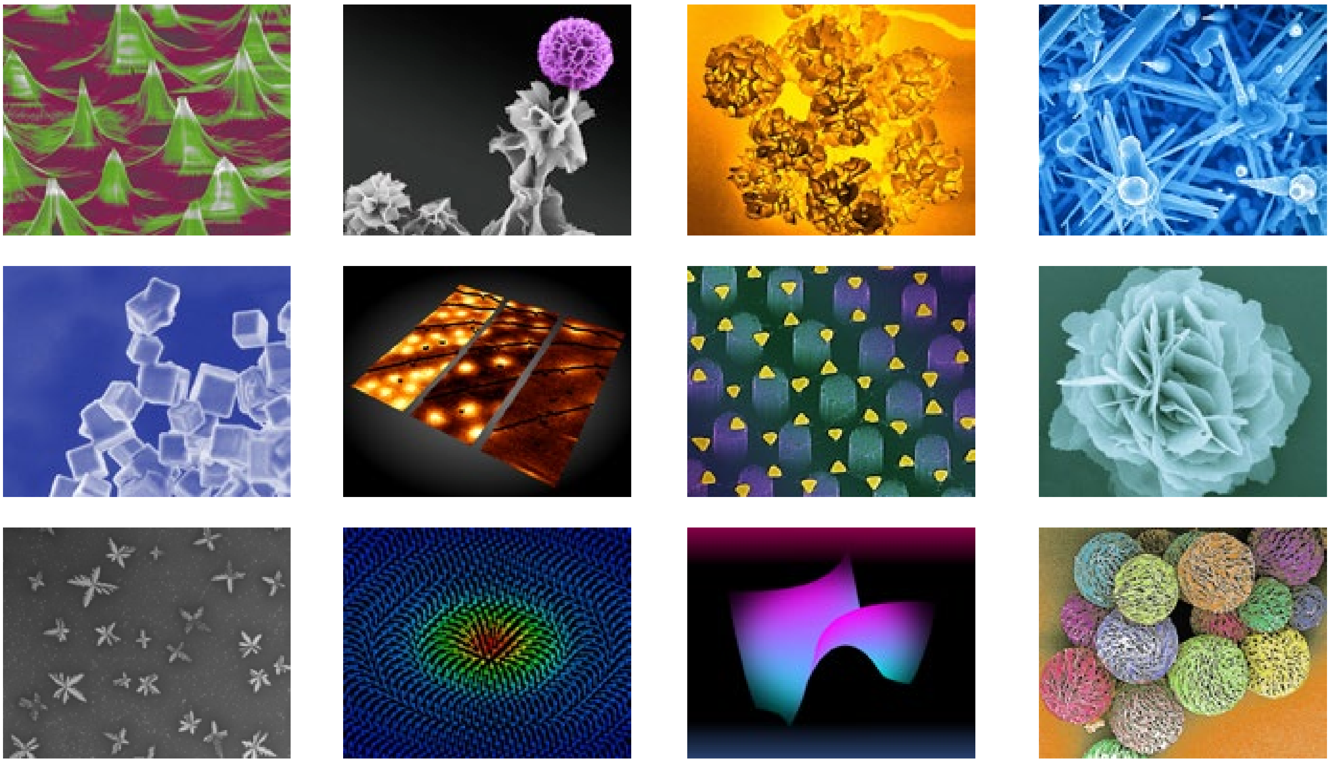


Fig. 6-13: Examples of MANA scientific art pictures from the third call.

Up to date, 3 times MANA art pictures have received the Award for Excellence at the “Beauty in Science and Technology Panel Exhibition” held as part of the Science and Technology Week organized by the Japan Science and Technology Agency (JST). The 3 award winning art pictures from MANA are shown in Fig. 6-14 and photos of the award ceremonies in Fig. 6-15.

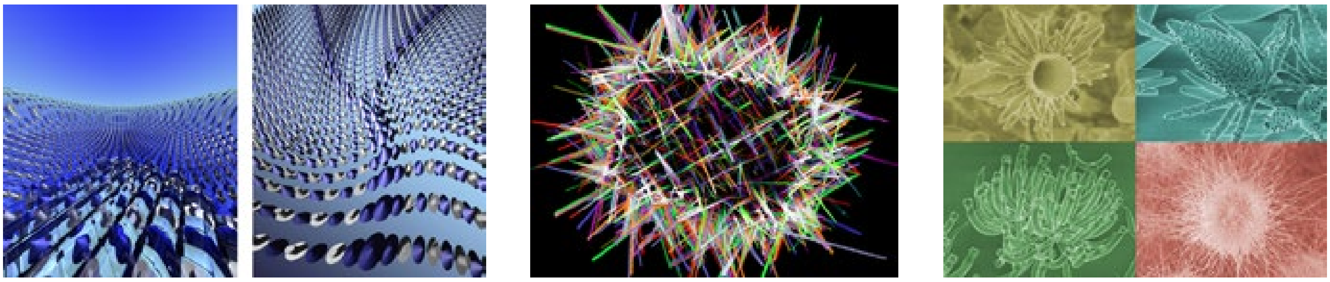


Fig. 6-14: The 3 award winning art pictures from MANA. Left: Title: *Strange behavior of electrons in solid material (Frozen electrons, Separation of magnetic waves)*, Exhibition: April 2012. Award Ceremony: April 2013. Middle: Title: *Rainbow Cube*, Exhibition: April 2013. Award Ceremony: April 2014. Right: Title: *Nano Flower in full bloom*, Exhibition: April 2015. Award Ceremony: April 2016.

Fig. 6-15: Award Ceremonies in 2013 (Masanori Kohno), 2014 (Jonathan Hill and Lok Kumar Shrestha) and 2016 (Amir Pakdel).

6.8 MANA History

The MANA history between September 2007 and March 2016 can be found in Appendix 7.10.

Appendix 7.10: MANA History

Appendix 7.1: MANA Top Management

MANA Top Management (3):

Current as of January 2016

Masakazu AONO
Director-General

Yoshio BANDO
Chief Operating Officer

Tomonobu NAKAYAMA
Administrative Director

Appendix 7.2: MANA Research Staff

MANA Principal Investigators (18):

Current as of January 1, 2016

Nano-Materials Field (6)

Coordinator

Takayoshi SASAKI
NIMS

Katsuhiko ARIGA
NIMS

Yoshio BANDO
NIMS

Toyohiro CHIKYOW
NIMS

Dmitri GOLBERG
NIMS

Zhong Lin WANG
Georgia Tech (Satellite)

Nano-Power Field (4)

Coordinator

Jinhua YE
NIMS

Kazunori TAKADA
NIMS

Kohei UOSAKI
NIMS

Omar YAGHI
UC Berkeley

Nano-System Field (5)

Coordinator

Masakazu AONO
NIMS

James K. GIMZEWSKI
UCLA (Satellite)

Xiao HU
NIMS

Christian JOACHIM
CNRS (Satellite)

Kazuhito TSUKAGOSHI
NIMS

Nano-Life Field (3)

Coordinator

Guoping CHEN
NIMS

Yukio NAGASAKI
Univ. Tsukuba (Satellite)

Françoise M. WINNIK
Univ. Montreal (Satellite)

Associate PIs (2), Group Leaders (11), MANA Scientists (53): Current as of January 1, 2016

Nano-Materials Field (28)


Minoru OSADA (Associate PI)


Naoki FUKATA (Group Leader)


Takao MORI (Group Leader)


Takashi SEKIGUCHI (Group Leader)


Jun CHEN


Yasuo EBINA


Masahiro GOTO


Jonathan HILL


Yusuke IDE


Wipakorn JEVASUWAN


Jin KAWAKITA


Naoyuki KAWAMOTO


Renzhi MA

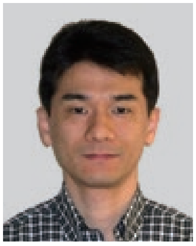

Masanori MITOME


Takahiro NAGATA


Takayuki NAKANE


Waka NAKANISHI


Isao OHKUBO


Nobuyuki SAKAI


Lok Kumar SHRESTHA


Ryutaro SOUDA


Daiming TANG


Takaaki TANIGUCHI


Yutaka WAKAYAMA


Rudder WU


Shinjiro YAGYU


Yoshiyuki YAMASHITA


Michiko YOSHITAKE

Nano-Power Field (8)


David BOWLER (Associate PI)


Yoshitaka TATEYAMA (Group Leader)


Ikutaro HAMADA


Hiori KINO


Hidenori NOGUCHI


Tsuyoshi OHNISHI


Ken SAKAUSHI


Kentaro TASHIRO

Nano-System Field (14)


Tadaaki NAGAO (Group Leader)


Kazuya TERABE (Group Leader)


Hideo ARAKAWA


Satoshi ISHII


Takuto KAWAKAMI


Song-Ju KIM


Masanori KOHNO


Katsumi NAGAOKA


Shu NAKAHARAI


Yuji OKAWA


Makoto SAKURAI


Yoshitaka SHINGAYA


Tohru TSURUOKA


Takashi UCHIHASHI

Nano-Life Field (16)


Nobutaka HANAGATA (Group Leader)


Masanori KIKUCHI (Group Leader)


Hisatoshi KOBAYASHI (Group Leader)


Akiyoshi TANIGUCHI (Group Leader)


Akiko YAMAMOTO (Group Leader)


Mitsuhiro EBARA


Sachiko HIROMOTO


Yoshihisa KAIZUKA


Chiho KATAOKA


Kohsaku KAWAKAMI


Naoki KAWAZOE


Tamaki NAGANUMA


Yasushi SUETSUGU


Tetsushi TAGUCHI


Tomohiko YAMAZAKI


Chiaki YOSHIKAWA

MANA Independent Scientists (14):

Current as of January 1, 2016

MANA Independent Scientists


Ryuichi
ARAFUNE


Alexei A.
BELIK


Ryoma
HAYAKAWA


Joel
HENZIE


Takako
KONOIKE


Takeo
MINARI


Satoshi
MORIYAMA


Jun
NAKANISHI


Takashi
NAKANISHI


Liwen
SANG


Naoto
SHIRAHATA


Satoshi
TOMINAKA


Yusuke
YAMAUCHI


Genki
YOSHIKAWA

ICYS-MANA Researchers (10):

Current as of January 1, 2016

ICYS-MANA Researchers


Alexandre
FIORI


Yohei
KOTSUCHIBASHI


Huynh Thien
NGO

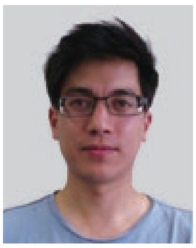

Tanh Cuong
NGUYEN


Gaulthier
RYDZEK


Kota
SHIBA


Xi
WANG


Xuebin
WANG


Hamish Hei-Man
YEUNG


Shunsuke
YOSHIZAWA

MANA Research Associates (50):

Current as of January 1, 2016

Nano-Materials Field (24)


Partha BAIRI, India


Ovidiu CRETU, Romania


Dominic GERLACH, Germany


Avijit GHOSH, India


Xiangfen JIANG, China

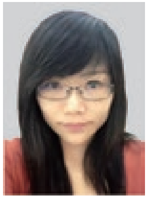

Shangbin JIN, China


Hyung Jun KIM, Korea


Hirokazu KOMATSU, Japan


Jieun KOO, Korea

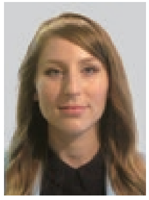

Cuiling LI, China


Jia LIU, China


Satofumi MARUYAMA, Japan


Asahiko MATSUDA, Japan


Kosuke MINAMI, Japan


Kathrine Elizabeth MOORE, Australia


Bhawani NARAJAN, India


Malay PRAMANIK, India


Rahul Raghunath SALUNKHE, India


Qunhong WENG, China


Jinghua WU, China


Pan XIONG, China


Tomoe YAYAMA, Japan


Ke Xiong ZHANG, China


Yang ZHANG, China

Nano-Power Field (10)


Purnandhu BOSE, India


Hung Cuong DINH, Vietnam


Maryam JAHAN, Iran


Huimin LIU, China


Xianguang MENG, China


Junais MOKKATH, India


Koichi OKADA, Japan


Hongpan RONG, China


Saurabh SRIVASTAVA, India


Huabin ZHANG, China

Nano-System Field (11)


Chanchal CHAKRABORTY
India


Kai CHEN
China


Rekha GOSWAMI
Nepal

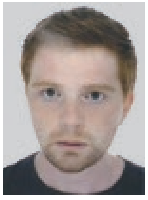

Rintaro HIGUCHI
Japan


Gaku IMAMURA
Japan


Karthik KRISHNAN
India


Ming LI
China

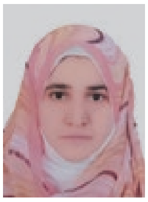

Xu-Ying LIU
China


Cedric Romuald MANNEQUIN
France


Elisseos VERVENIOTIS
Greece


Mahito YAMAMOTO
Japan

Nano-Life Field (5)


Shimaa ABDELALEEM
Egypt


Gregory BEAUNE
France


Sourov CHANDRA
India


Sharmy Saimon MANO
India

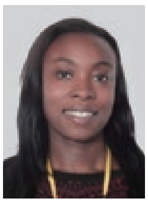

Usharani NAGARAJAN
India

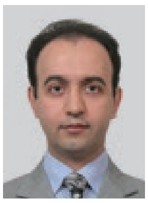
JSPS Fellows (6):

Current as of January 1, 2016

Nano-Materials Field (6)


Mikhailo CHUNDAK
Ukraine


Geraldine ECHUE
UK


Amir PAKDEL
Iran


Thiyagu SUBRAMANI
India


Tommi Paavo TYNELL
Finland


Zhongli WANG
China

Appendix 7.3: MANA Advisors and International Cooperation Advisors

MANA Advisors (3):

Current as of January 2016

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

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

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

Teruo Kishi
Former President,
National Institute for
Materials Science
Japan

MANA International Cooperation Advisors (2):

Current as of January 2016

International Cooperation Advisors including prominent researchers provide MANA with advice on joint research with overseas research institutes and the formation of a global nanotech network.

Sir Mark E. Welland
Professor,
University of Cambridge
UK

Louis Schlapbach
Former CEO,
Swiss Federal Laboratories for
Materials Testing and Research
Switzerland

Appendix 7.4: MANA Evaluation Committee

MANA Evaluation Committee Members (7):

Current as of January 2016

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

Chair

Anthony K. Cheetham
Professor,
University of Cambridge,
UK

Takuzo Aida
Professor,
University of Tokyo,
Japan

Morinobu Endo
Professor,
Shinshu University,
Japan

Horst Hahn
Professor,
Karlsruhe Institute
of Technology,
Germany

Yoshio Nishi
Professor,
Stanford University,
USA

Rodney S. Ruoff
Professor,
University of Texas,
USA

Joachim P. Spatz
Professor,
Max Planck Institute for
Intelligent Systems,
Germany

Appendix 7.5: MANA Seminars

List of MANA Seminars (January – December 2015):

No.	Seminar
1	2015 Jan 13 *Polymeric Nanoparticles for multidrug resistance and heterogeneity in solid tumor* **Prof. You Han Bae** University of Utah, **USA**
2	2015 Jan 26 *Progress in laser processing of PDMS and metallization* **Prof. Petar Asenov Atanasov** Bulgarian Academy of Sciences, **Bulgaria**
3	2015 Jan 26 *Noble metallic nanostructures: preparation, properties, application in SERS and biophotonics* **Prof. Petar Asenov Atanasov** Bulgarian Academy of Sciences, **Bulgaria**
4	2015 Jan 28 *Development of New Functionalization Methods of Carbon Nanotubes and Graphene* **Dr. Stéphane Campidelli** Laboratoire d'Innovation en Chimie des Surfaces et Nanoscience, CEA Saclay, **France**
5	2015 Jan 29 *Development of Narrow Band Gap Semiconductor with a Deep Valence Band as Efficient Visible Light Photocatalyst* **Prof. Jun Lin** Renmin University of China, **China**
6	2015 Jan 29 *Boronic Acids: Recognition, Sensing and Assembly* **Prof. Tony David James** University of Bath, **UK**
7	2015 Feb 16 *Frontier of Quantum Molecular Spintronics Based on Single-Molecule Magnets: Who is greater, Nomo or Ichiro?* **Prof. Masahiro Yamashita** Tohoku University (JST CREST), **Japan**
8	2015 Feb 17 *Perovskite Solar Cell Research Using a Surface Science Approach* **Prof. Yabing Qi** Okinawa Institute of Science and Technology Graduate University, **Japan**
9	2015 Feb 17 *Graphene for high sensitivity sensing* **Prof. Hongwei Zhu** Tsinghua University, **China**
10	2015 Feb 24 *Electrochemical Integration of Organic and Inorganic Materials towards a fully Solution-Processed Device* **Prof. Mao Li** Chinese Academy of Science, **China**
11	2015 Mar 2 *Catalytic model systems studied by high-resolution, video-rate Scanning Tunneling Microscopy* **Prof. Peter Thostrup** Aarhus University, **Denmark**
12	2015 Mar 2 *Functionalization of Organic Salts in Crystalline State by Supramolecular Approach* **Prof. Norimitsu Tohnai** Osaka University, **Japan**
13	2015 Mar 17 *Quantum chemistry meets density matrix renormalization group theory: Theory and application to π-conjugated system* **Prof. Yuki Kurashige** Institute for Molecular Science (IMS), **Japan**
14	2015 Mar 18 *Atomically Precise Clusters of Noble Metals* **Prof. Thalappil Pradeep** Indian Institute of Technology Madras, **India**
15	2015 Mar 20 *Advances in the characterization of nanoporous materials with hierarchical pore structure* **Prof. Matthias Thommes** University of Edinburgh and Quantachrome Instruments, **UK**
16	2015 Mar 25 *Plasmonic array to shape the emission* **Dr. Shunsuke Murai** Kyoto University (JST PRESTO), **Japan**
17	2015 Mar 30 *Beyond Journal Publication: Communicating Science To The Public* **Dr. A. Maureen Rouhi** Chemical & Engineering News Asia, American Chemical Society, **USA**
18	2015 Apr 7 *A new tool for material and energy research – standing wave photoemission in near ambient pressures* **Dr. Slavomír Nemšák** Helmholtz Zentrum Berlin, **Germany**
19	2015 Apr 8 *Electron transport calculation method based on real-space formalism* **Prof. Tomoya Ono** University of Tsukuba (JST PRESTO), **Japan**
20	2015 Apr 10 *Projects of Theory-Experiment Fusion Research Fund – Accomplishment Reports* **Dr. Kazuhito Tsukagoshi** (MANA Principal Investigator) **Dr. Jinhua Ye** (MANA Principal Investigator) **Dr. Naoki Fukata** (Group Leader) **Dr. Xiao Hu** (MANA Principal Investigator) **Dr. Jun Nakanishi** (Independent Scientist) **Prof. Françoise Winnik** (MANA Principal Investigator) **Dr. Mitsuhiro Ebara** (MANA Scientist) MANA, NIMS, **Japan**
21	2015 Apr 28 *Macromolecular Engineering at Interfaces: New concept and biomedical applications* **Dr. Fouzia Boulmedais** Institut Charles Sadron, **France**
22	2015 May 1 *Prospects for Nanowires: From Nano-materials to Nano-Devices* **Prof. Harry E. Ruda** University of Toronto, **Canada**

23	2015 May 18 *Defects in two-dimensional materials: their production under irradiation, evolution and properties* **Prof. Arkady V. Krasheninnikov** Aalto University, **Finland**
24	2015 May 22 *Determination of electronic transport properties for low-speed electrons* **Dr. Bo Da** ICYS-Sengen Researcher, NIMS, **Japan**
25	2015 May 22 *Stabilized Diamond Schottky Diodes for Power Electronic* **Dr. Alexandre Fiori** ICYS-MANA Researcher, NIMS, **Japan**
26	2015 May 29 *Noncovalent and Reversible Covalent Interactions: Fundamental Studies and New Applications* **Prof. Mark S. Taylor** University of Toronto, **Canada**
27	2015 Jun 2 *Multifunctional plasmonic nanocomposites* **Dr. Mihaela Koleva** Bulgarian Academy of Sciences, **Bulgaria**
28	2015 Jun 5 *Properties of dilute-N GaAs quantum structures for application in Intermediate Band Solar Cell research* **Dr. Martin Elborg** ICYS-Sengen Researcher, NIMS, **Japan**
29	2015 Jun 5 *Organic and hybrid organicinorganic photovoltaics: from understanding key loss mechanisms to developing new approaches* **Dr. James W. Ryan** ICYS-GREEN Researcher, NIMS, **Japan**
30	2015 Jun 11 *Nanoparticles and (drinking) water: How can we detect them?* **Dr. Patrick Bäuerlein** KWR Watercycle Research Institute, **The Netherlands**
31	2015 Jun 11 *The Search for Genomes to Accelerate the Discovery of High Temperature Alloys* **Prof. Jason Ryan Hattrick-Simpers** University of South Carolina, **USA**
32	2015 Jun 16 *Study of TiO_2 based Materials for the Superior Photocatalytic Properties* **Dr. Hua Xu** Tianjin University, **China**
33	2015 Jun 19 *Dual-emitting nanostructures* **Prof. Karuna Kar Nanda** Indian Institute of Science, **India**
34	2015 Jun 19 *Is polyaniline underrated?* **Dr. Gaulthier Rydzek** ICYS-MANA Researcher, NIMS, **Japan**
35	2015 Jun 19 *State-selected gas/surface reaction: methane dissociation on platinum surface* **Dr. Hirokazu Ueta** ICYS-Sengen Researcher, NIMS, **Japan**
36	2015 Jul 2 *Tunable graphene-based platform on optics, photonics and photovoltaics* **Prof. Chun-Wei Chen** National Taiwan University, **Taiwan**
37	2015 Jul 3 *Electronic properties of graphene hybrid materials from first-principles calculations* **Dr. Thanh Cuong Nguyen** ICYS-MANA Researcher, NIMS, **Japan**
38	2015 Jul 3 *Development and Mechanistic Elucidation of Stimuli-Responsive π-Electron Systems* **Dr. Kazuhiko Nagura** ICYS-Sengen Researcher, NIMS, **Japan**
39	2015 Jul 6 *Design of functionalized of carbon-based nanomaterials and their applications* **Dr. Alberto Bianco** CNRS, **France**
40	2015 Jul 9 *Implantable Optical Biosensors--Materials for Next-Generation Personal Monitoring* **Prof. Mike Mc Shane** Texas A&M University, **USA**
41	2015 Jul 10 *Mössbauer Spectroscopy of Multiferroic Oxides* **Dr. Alexey Sobolev** Lomonosov Moscow State University, **Russia**
42	2015 Jul 17 *First-Principles Study of Hydrogen Bonded Molecular Conductor κ-H_3(Cat-EDTTTF/ST)$_2$: Electronic Structure and Role of the Hydrogen Bonds* **Dr. Takao Tsumuraya** ICYS-Namiki Researcher, NIMS, **Japan**
43	2015 Jul 17 *Challenges in Bulk Si Crystal Growth for PV Application: Focus on Dislocations* **Dr. Karolin Jiptner** ICYS-MANA Researcher, NIMS, **Japan**
44	2015 Jul 27 *Materials in 2-dimension and beyond: 10 years after graphene* **Prof. Philip Kim** Harvard University, **USA**
45	2015 Aug 3 *Novel development of very high brightness and high spin-polarized LEEM and application to spintronics thin film materials* **Prof. Takanori Koshikawa** Osaka Electro-Communication University, **Japan**
46	2015 Aug 4 *Biodegradable elastomers as ink for 3D printing* **Prof. Shan-hui Hsu** National Taiwan University, **Taiwan**
47	2015 Aug 5 *Quantitative Analysis of Digital STM Lithography* **Dr. James Owen** Zyvex Labs LLC, **USA**
48	2015 Aug 6 *Design topological states in non-Dirac fermion systems* **Prof. Zhi Wang** Sun Yat-Sen University, **China**
49	2015 Aug 6 *Josephson Effect in Majorana Junctions* **Prof. Qifeng Liang** University of Shao Xing, **China**
50	2015 Aug 25 *Functional Materials Synthesized by On-Surface Chemistry* **Prof. Dimas G. de Oteyza** Donostia International Physics Center, **Spain**

51	2015 Sep 1 *Sputtering preparation of metal nanoclusters provide fluorescence* **Prof. Tetsu Yonezawa** Hokkaido University, **Japan**
52	2015 Sep 4 *Construction of Non-Metallated Multiporphyrinoids using Easily Metallated Copper Ion as Catalyst: Synthetic Self-Torture* **Dr. Thien H. Ngo** ICYS-MANA Researcher, NIMS, **Japan**
53	2015 Sep 4 *Insulator on diamond for electronic devices: from capacitor to logic inverter* **Dr. Jiangwei Liu** ICYS-Namiki Researcher, NIMS, **Japan**
54	2015 Sep 8 *Intelligent Nanophotonic Architecture: Decision Making and More* **Dr. Makoto Naruse** National Institute of Information and Communications Technology, **Japan** **Dr. Song-Ju Kim** NIMS, **Japan**
55	2015 Sep 15 *Career Options and Job Resources for Scientists* **Dr. Tianna Hicklin** Custom Publishing Office, Science, AAAS, **USA**
56	2015 Sep 16 *Multilayer Nanocoatings Capable of Separating Gases, Killing Bacteria and Stopping Fire* **Prof. Jaime Grunlan** Texas A&M University, **USA**
57	2015 Sep 16 *Polymeric Biomaterials for Next Generation Medical Devices and Tissue Engineering Scaffolds* **Prof. Melissa Grunlan** Texas A&M University, **USA**
58	2015 Sep 18 *Stimuli-Responsive Naphthalenediimide-Based π-Systems:Structural Dynamics and Electronic Properties* **Dr. Atsuro Takai** ICYS-Sengen Researcher, NIMS, **Japan**
59	2015 Sep 18 *3D Graphene and Boron Nitride Nanosheets: Chemical-Blowing Synthesis and Applications* **Dr. Xuebin Wang** ICYS-MANA Researcher, NIMS, **Japan**
60	2015 Sep 28 *Non-Conventional Polymers for Energy Generation and Energy Storage* **Prof. Patrick Theato** University of Hamburg, **Germany**
61	2015 Sep 30 *Adsorption on open nanopores: nanoconfinement effect and Sorption by Elastic Layer-structured MOFs: gate phenomenon* **Prof. Hirofumi Kanoh** Chiba University, **Japan**
62	2015 Oct 2 *Development and Applications of large-scale first-principles DFT calculation methods for complicated systems* **Dr. Ayako Nakata** ICYS-Namiki Researcher, NIMS, **Japan**
63	2015 Oct 2 *More from MOFs: Making, Melting and aMazing Mechanics* **Dr. Hamish Hei-man Yeung** ICYS-MANA Researcher, NIMS, **Japan**
64	2015 Oct 8 *Non-enzymatic DNA Nanotechnology* **Prof. Amanda V. Ellis** Flinders University, **Australia**
65	2015 Oct 8 *Wavefunction Engineering in Graphene Systems* **Dr. Adelina Ilie** University of Bath, **UK**
66	2015 Oct 16 *Ic(B,T,• tour* **Dr. Yasuyuki Miyoshi** ICYS-Sengen Researcher, NIMS, **Japan**
67	2015 Oct 16 *Scanning tunneling microscopy study of superconducting vortices in atomic-layer indium* **Dr. Shunsuke Yoshizawa** ICYS-MANA Researcher, NIMS, **Japan**
68	2015 Oct 19 *Plasmonic Properties of Coupled Gold Nanostructures* **Prof. Li Shuzhou** Nanyang Technological University, **Singapore**
69	2015 Oct 21 *Multiple proton-coupled electron transfer in electrocatalysis* **Prof. Marcus Koper** Leiden University, **The Netherlands**
70	2015 Nov 6 *ATLAS-TFET: Toward Green Transistors and Sensors* **Prof. Kaustav Banerjee** University of California Santa Barbara (UCSB), **USA**
71	2015 Nov 6 *How do functional nanoparticles contribute to nanomechanical sensing?* **Dr. Kota Shiba** ICYS-MANA Researcher, NIMS, **Japan**
72	2015 Nov 6 *Multi-responsive water soluble porphyrins* **Dr. Jan Labuta** ICYS-Sengen Researcher, NIMS, **Japan**
73	2015 Nov 13 *Chromonic liquid crystals: selfassembled building blocks for bottom-up preparation of nanostructured solids* **Dr. Carlos Rodriguez Abreu** International Iberian Nanotechnology Laboratory, **Portugal**
74	2015 Nov 20 *Development of soluble catalyst for ORR/OER in aprotic Li−air batteries* **Dr. Shoichi Matsuda** ICYS-GREEN Researcher, NIMS, **Japan**
75	2015 Nov 20 *Smart Polymers: Nanoparticle-Kit for Diagnosis, Therapy, and Everyone* **Dr. Yohei Kotsuchibashi** ICYS-MANA Researcher, NIMS, **Japan**
76	2015 Nov 24 *Functional On-Surface Supramolecular Architectures* **Prof. Thomas Andreas Jung** Paul Scherrer Institute (PSI), **Switzerland**

77	2015 Nov 25 *Fibrinolysis: an alternative way to defensive strategies for antithrombotic materials* **Prof. Hong Chen** Soochow University, **China**	79	2015 Dec 4 *Advanced Binder-Free Anodes for Ultrafast Energy Storage* **Dr. Xi Wang** ICYS-MANA Researcher, NIMS, **Japan**
78	2015 Nov 30 *Carbon materials-based energy and biomedical sciences* **Prof. Toyoko Imae** National Taiwan University of Science and Technology, **Taiwan**	80	2015 Dec 4 *Multifunctional Shape Memory Alloys via Nanoscale Phase Transformation* **Dr. Aslan A. Palcheghloo** ICYS-Sengen Researcher, NIMS, **Japan**

Appendix 7.6: MANA Research Papers 2015

List of MANA affiliated research papers in English published 2015 in scientific journals (466 papers):

1	S.A. Abdellatef, R. Tange, T. Sato, A. Ohi, T. Nabatame, A. Taniguchi, *Nanostructures Control the Hepatocellular Responses to a Cytotoxic Agent "Cisplatin"*, Biomed Research International **2015**, 925319 (2015). doi: 10.1155/2015/925319 WOS:000358549700001 2-s2.0-84938149705
2	M.P. Adhikari, R. Adhikari, R.G. Shrestha, R. Rajendran, L. Adhikari, P. Bairi, R.R. Pradhananga, L.K. Shrestha, K. Ariga, *Nanoporous Activated Carbons Derived from Agro-Waste Corncob for Enhanced Electrochemical and Sensing Performance*, Bulletin of the Chemical Society of Japan **88**(8), 1108 (2015). doi: 10.1246/bcsj.20150092 WOS:000359513200014 2-s2.0-84940199334
3	Y. Agawa, H. Tanaka, S. Torisu, S. Endo, A. Tsujimoto, N. Gonche, V. Malgras, A. Aldalbahi, S.M. Alshehri, Y. Kamachi, C.L. Li, Y. Yamauchi, *Preparation of a platinum electrocatalyst by coaxial pulse arc plasma deposition*, Science and Technology of Advanced Materials **16**(2), 024804 (2015). doi: 10.1088/1468-6996/16/2/024804 WOS:000353641100007 2-s2.0-84928675239
4	S. Aikawa, N. Mitoma, T. Kizu, T. Nabatame, T. Tsukagoshi, *Suppression of excess oxygen for environmentally stable amorphous In-Si-O thin-film transistors*, Applied Physics Letters **106**(19), 192103 (2015). doi: 10.1063/1.4921054 WOS:000355008100016 2-s2.0-84929338235
5	J. Aimi, M. Komura, T. Iyoda, A. Saeki, S. Seki, M. Takeuchi, T. Nakanishi, *Synthesis and self-assembly of phthalocyanine-tethered block copolymers*, Journal of Materials Chemistry C **3**(11), 2484, (2015). doi: 10.1039/c4tc02778g WOS:000350984200007 2-s2.0-84924282176
6	M. Akamatsu, T. Mori, K. Okamoto, H, Komatsu, K. Kumagai, S. Shiratori, M. Tamaura, T. Nabeshima, H. Sakai, M. Abe, J.P. Hill, K. Ariga, *Detection of Ethanol in Alcoholic Beverages or Vapor Phase Using Fluorescent Molecules Embedded in a Nanofibrous Polymer*, ACS Applied Materials & Interfaces **7**(11), 6189 (2015). doi: 10.1021/acsami.5b00289 WOS:000351972400024 2-s2.0-84925745876
7	B. Al Otaibi, S.Z. Fan, D.F. Wang, J.H. Ye, Z.T. Mi, *Wafer-Level Artificial Photosynthesis for CO_2 Reduction into CH_4 and CO Using GaN Nanowires*, ACS Catalysis **5**(9), 5342 (2015). doi: 10.1021/acscatal.5b00776 WOS:000361089700042 2-s2.0-84940984923
8	J.X. An, X.Y. Liu, P. Linse, A. Dedinaite, F.M. Winnik, P.M. Claesson, *Tethered Poly(2-isopropyl-2-oxazoline) Chains: Temperature Effects on Layer Structure and Interactions Probed by AFM Experiments and Modeling*, Langmuir **31**(10), 3039 (2015). doi: 10.1021/la504653w WOS:000351327300013 2-s2.0-84925004133
9	R. Ang, A.U. Khan, N. Tsujii, K. Takai, R. Nakamura, T. Mori, *Thermoelectricity Generation and Electron-Magnon Scattering in a Natural Chalcopyrite Mineral from a Deep-Sea Hydrothermal Vent*, Angewandte Chemie - International Edition **54**(44), 12909 (2015). doi: 10.1002/anie.201505517 WOS:000363423900009 2-s2.0-84945461550
10	R. Ang, Z.C. Wang, C.L. Chen, J. Tang, N. Liu, Y. Liu, W.J. Lu, Y.P. Sun, T. Mori, Y. Ikuhara, *Atomistic origin of an ordered superstructure induced superconductivity in layered chalcogenides*, Nature Communications **6**, 6091 (2015). doi: 10.1038/ncomms7091 WOS:000348831300018 2-s2.0-84923098090

11 M. Aono, *I'm with Rohrer-sensei even now*, e-Journal of Surface Science and Nanotechnology **13**(6), 263 (2015).
doi: 10.1380/ejssnt.2015.263
WOS: -
2-s2.0-84939170986

12 M. Aono, S. Kasai, S.J. Kim, M. Wakabayashi, H. Miwa, M. Naruse, *Amoeba-inspired nanoarchitectonic computing implemented using electrical Brownian ratchets*, Nanotechnology **26**(23), 234001 (2015).
doi: 10.1088/0957-4484/26/23/234001
WOS:000354899200001
2-s2.0-84930011360

13 K. Ariga, Q.M. Ji, W. Nakanishi, J.P. Hill, *Thin Film Nanoarchitectonics*, Journal of Inorganic and Organometallic Polymers and Materials **25**(3), 466 (2015).
doi: 10.1007/s10904-015-0179-4
WOS:000353468400015
2-s2.0-84922496174

14 K. Ariga, Q. Ji, W. Nakanishi, J.P. Hill, M. Aono, *Nanoarchitectonics: a new materials horizon for nanotechnology*, Materials Horizons **2**(4), 406 (2015).
doi: 10.1039/c5mh00012b
WOS:000356611500003
2-s2.0-84941348801

15 V.E. Babicheva, M.Y. Shalaginov, S. Ishii, A. Boltasseva, A.V. Kildishev, *Long-range plasmonic waveguides with hyperbolic cladding*, Optics Express **23**(24), 31109 (2015).
doi: 10.1364/OE.23.031109
WOS:000366614100083
2-s2.0-84959410415

16 V.E. Babicheva, E. Viktoriia, M.Y. Shalaginov, S. Ishii, A. Boltasseva, A.V. Kildishev, *Finite-width plasmonic waveguides with hyperbolic multilayer cladding*, Optics Express **23**(8), 9681 (2015).
doi: 10.1364/OE.23.009681
WOS:000353299300013
2-s2.0-84938248234

17 N. Bakhtiari, S. Azizian, S.M. Alshehri, N.L. Torad, V. Malgras, Y. Yamauchi, *Study on adsorption of copper ion from aqueous solution by MOF-derived nanoporous carbon*, Microporous and Mesoporous Materials **217**, 173 (2015).
doi: 10.1016/j.micromeso.2015.06.022
WOS:000360596100023
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Appendix 7.7: MANA Journal Cover Sheets

Journal cover sheets related to MANA affiliated papers (October 2007 – December 2015):

	Journal name *Type of cover sheet*	Year	Volume	Issue	doi number (of related paper)
1	Physics Today *Journal Front Cover*	2008	61	12	10.1063/1.3047660
2	Advanced Functional Materials *Journal Front Cover*	2009	19	15	10.1002/adfm.200900295
3	Advanced Functional Materials *Journal Inside Front Cover*	2009	19	12	10.1002/adfm.200801435
4	Advanced Materials *Journal Inside Front Cover*	2009	21	20	10.1002/adma.200802441
5	Advanced Materials *Journal Inside Front Cover*	2009	21	44	10.1002/adma.200901321
6	Journal of Materials Chemistry *Journal Front Cover*	2009	19	3	10.1039/b808320g
7	Journal of Materials Chemistry *Journal Inside Front Cover*	2009	19	25	10.1039/B903791H
8	Journal of Nanoscience and Nanotechnology *Journal Front Cover*	2009	9	1	10.1166/jnn.2009.J076
9	Journal of Porphyrins and Phthalocyanines *Journal Front Cover*	2009	13	1	10.1142/S1088424609000061
10	Physical Chemistry Chemical Physics *Journal Inside Front Cover*	2009	11	29	10.1039/B822802G
11	Soft Matter *Journal Back Cover*	2009	5	19	10.1039/B909397D
12	Solid State Physics (in Japanese) *Journal Front Cover*	2009	44	2	(not available)
13	Advanced Functional Materials *Journal Front Cover*	2010	20	3	10.1002/adfm.200901878
14	Journal of Materials Chemistry *Journal Front Cover*	2010	20	32	10.1039/C0JM01013H
15	Materials Transactions *Journal Front Cover*	2010	51	11	10.2320/matertrans.M2010192
16	Nanoscale *Journal Inside Front Cover*	2010	2	2	10.1039/B9NR00415G
17	Science and Technology of Advanced Materials *Front Cover of Promotional Copy*	2010	11	5	10.1088/1468-6996/11/5/054506
18	Angewandte Chemie – International Edition *Journal Frontispiece*	2011	50	6	10.1002/anie.201005271
19	Angewandte Chemie – International Edition *Journal Frontispiece*	2011	50	17	10.1002/anie.201007370
20	Chemical Communications *Journal Inside Front Cover*	2011	47	45	10.1039/C1CC15169J
21	Energy & Environmental Science *Journal Inside Back Cover*	2011	4	11	10.1039/C1EE01400E
22	Journal of Materials Chemistry *Journal Front Cover*	2011	21	18	10.1039/C0JM04557H
23	Journal of Materials Chemistry *Journal Inside Front Cover*	2011	21	44	10.1039/C1JM13180J

	Journal name *Type of cover sheet*	Year	Volume	Issue	doi number (of related paper)
24	Journal of Nanoscience and Nanotechnology *Journal Front Cover*	2011	11	9	10.1166/jnn.2011.4718
25	Journal of the American Chemical Society *Journal Front Cover*	2011	133	20	10.1021/ja110691t
26	Physical Chemistry Chemical Physics *Journal Back Cover*	2011	13	11	10.1039/C0CP02025G
27	Physical Review Letters *Journal Front Cover*	2011	106	3	10.1103/ PhysRevLett.106.037002
28	Small *Journal Frontispiece*	2011	7	4	10.1002/smll.201001849
29	Small *Journal Frontispiece*	2011	7	10	10.1002/smll.201002350
30	Advanced Functional Materials *Journal Front Cover*	2012	22	13	10.1002/adfm.201103110
31	Advanced Functional Materials *Journal Frontispiece*	2012	22	17	10.1002/adfm.201290101
32	Advanced Materials *Journal Front Cover*	2012	24	2	10.1002/adma.201290004
33	Advanced Materials *Journal Frontispiece*	2012	24	2	10.1002/adma.201102617
34	Advanced Materials *Journal Frontispiece*	2012	24	2	10.1002/adma.201103241
35	Advanced Materials *Journal Frontispiece*	2012	24	2	10.1002/adma.201102958
36	Advanced Materials *Journal Inside Front Cover*	2012	24	2	10.1002/adma.201103053
37	Bulletin of the Chemical Society of Japan *Journal Front Cover*	2012	85	1	10.1246/bcsj.20110162
38	Chemical Communications *Journal Inside Back Cover*	2012	48	33	10.1039/C2CC31118F
39	Chemical Communications *Journal Inside Front Cover*	2012	48	40	10.1039/C2CC30643C
40	Chemistry - A European Journal *Journal Frontispiece*	2012	18	6	10.1002/chem.201102013
41	Inorganic Chemistry *Journal Front Cover*	2012	51	19	10.1021/ic300557u
42	Journal of Materials Chemistry *Journal Inside Back Cover*	2012	22	14	10.1039/C2JM00044J
43	Journal of Materials Chemistry *Journal Back Cover*	2012	22	21	10.1039/C2JM16629A
44	Nanoscale *Journal Front Cover*	2012	4	8	10.1039/C2NR11835A
45	Nanoscale *Journal Front Cover*	2012	4	10	10.1039/C2NR00010E
46	Oyo Buturi (in Japanese) *Journal Front Cover*	2012	81	12	(not available)
47	Physica Status Solidi: RRL *Journal Front Cover*	2012	6	5	10.1002/pssr.201206082
48	Physical Chemistry Chemical Physics *Journal Back Cover*	2012	14	17	10.1039/C2CP24010F

	Journal name *Type of cover sheet*	Year	Volume	Issue	doi number (of related paper)
49	Polymer Journal *Journal Front Cover*	2012	44	6	10.1038/pj.2012.30
50	Advanced Materials *Journal Inside Front Cover*	2013	25	8	10.1002/adma.201204434
51	Angewandte Chemie – International Edition *Journal Back Cover*	2013	52	31	10.1002/anie.201303035
52	Chemical Communications *Journal Inside Front Cover*	2013	49	35	10.1039/c3cc40398j
53	Chemical Communications *Journal Inside Front Cover*	2013	49	36	10.1039/C3CC39273B
54	Chemical Society Reviews *Journal Inside Front Cover*	2013	42	15	10.1039/C2CS35475F
55	Chemistry – An Asian Journal *Journal Frontispiece*	2013	8	8	10.1002/asia.201300247
56	Chemistry – An Asian Journal *Journal Inside Front Cover*	2013	8	12	10.1002/asia.201300940
57	CrystEngComm *Journal Inside Front Cover*	2013	15	45	10.1039/C3CE41150H
58	Journal of Materials Chemistry A *Journal Front Cover*	2013	1	13	10.1039/c2ta00450j
59	Journal of Materials Chemistry B *Journal Inside Front Cover*	2013	1	26	10.1039/C3TB20461H
60	Journal of Materials Chemistry C *Journal Front Cover*	2013	1	11	10.1039/C3TC00930K
61	Journal of Materials Chemistry C *Journal Front Cover*	2013	1	14	10.1039/C3TC00952A
62	Langmuir *Journal Front Cover*	2013	29	24	10.1021/la401652f
63	Langmuir *Journal Front Cover*	2013	29	27	10.1021/la4006423
64	Physical Chemistry Chemical Physics *Journal Back Cover*	2013	15	26	10.1039/c3cp50620g
65	Advanced Materials *Journal Front Cover*	2014	26	26	10.1002/adma.201306055
66	Advanced Materials *Journal Frontispiece*	2014	26	19	10.1002/adma.201305457
67	Angewandte Chemie - International Edition *Journal Inside Front Cover*	2014	53	43	10.1002/anie.201404953
68	Biomaterials Science *Journal Front Cover*	2014	2	5	10.1039/C3BM60263J
69	Biomaterials Science *Journal Front Cover*	2014	2	6	10.1039/c3bm60212e
70	ChemCatChem *Journal Front Cover*	2014	6	12	10.1002/cctc.201402449
71	ChemElectroChem *Journal Back Cover*	2014	1	4	10.1002/celc.201300240
72	Chemical Communications *Journal Back Cover*	2014	50	49	10.1039/C4CC01336K
73	Chemical Society Reviews *Journal Inside Front Cover*	2014	43	5	10.1039/C3CS60348B

	Journal name *Type of cover sheet*	Year	Volume	Issue	doi number (of related paper)
74	Chemistry - A European Journal *Journal Back Cover*	2014	20	36	10.1002/chem.201403308
75	Chemistry Letters *Journal Front Cover*	2014	43	1	10.1246/cl.130987
76	Journal of Materials Chemistry A *Journal Showcase*	2014	2	12	10.1039/C3TA13769D
77	Journal of Materials Chemistry C *Journal Inside Front Cover*	2014	2	3	10.1039/C3TC31787K
78	Journal of Porphyrins and Phthalocyanines *Journal Front Cover*	2014	18	3	10.1142/S1088424613501071
79	Journal of Physical Chemistry C *Journal Front Cover*	2014	118	37	10.1021/jp5036426
80	Journal of the American Chemical Society *Journal Front Cover*	2014	136	29	10.1021/ja502008t
81	Nanotechnology *Journal Front Cover*	2014	25	46	10.1088/0957-4484/25/46/465305
82	New Journal of Chemistry *Journal Front Cover*	2014	38	8	10.1039/C4NJ00016A
83	New Journal of Chemistry *Journal Front Cover*	2014	38	11	10.1039/c4nj00864b
84	Particle & Particle Systems Characterization *Journal Inside Front Cover*	2014	31	7	10.1002/ppsc.201300365
85	Physica Status Solidi C *Journal Front Cover*	2014	11	2	10.1002/pssc.20130010
86	Physical Chemistry Chemical Physics *Journal Back Cover*	2014	16	21	10.1039/C3CP55431G
87	Advanced Functional Materials *Journal Front Cover*	2015	25	37	10.1002/adfm.201502499
88	Advanced Materials *Journal Inside Back Cover*	2015	27	48	10.1002/adma.201570333
89	Advanced Science *Journal Back Cover*	2015	2	8	10.1002/advs.201570032
90	Angewandte Chemie - International Edition *Journal Back Cover*	2015	54	14	10.1002/anie.201410942
91	Angewandte Chemie - International Edition *Journal Back Cover*	2015	54	38	10.1002/anie.201505232
92	ChemCatChem *Journal Inside Back Cover*	2015	7	5	10.1002/cctc.201402916
93	ChemElectroChem *Journal Inside Front Cover*	2015	2	4	10.1002/celc.201402365
94	Chemical Communications *Journal Back Cover*	2015	51	13	10.1039/C4CC09366F
95	Chemical Communications *Journal Inside Front Cover*	2015	51	96	10.1039/c5cc05408g
96	Chemistry - A European Journal *Journal Front Cover*	2015	21	9	10.1002/chem.201404895
97	Chemistry – An Asian Journal *Journal Inside Back Cover*	2015	10	6	10.1002/asia.201500098
98	ChemSusChem *Journal Inside Front Cover*	2015	8	5	10.1002/cssc.201402996

	Journal name *Type of cover sheet*	Year	Volume	Issue	doi number (of related paper)
99	Energy & Environmental Science *Journal Inside Front Cover*	2015	8	6	10.1039/C4EE03746D
100	Inorganic Chemistry *Journal Front Cover*	2015	54	24	1021/acs.inorgchem.5b01183
101	Journal of Materials Chemistry A *Journal Back Cover*	2015	3	6	10.1039/c4ta06027j
102	Journal of Materials Chemistry C *Journal Back Cover*	2015	3	11	10.1039/c4tc02778g
103	Materials Horizons *Journal Back Cover*	2015	2	4	10.1039/C5MH00012B
104	Nanoscale *Journal Front Cover*	2015	7	48	10.1039/c5nr05645d
105	Nanoscale *Journal Inside Back Cover*	2015	7	1	10.1039/c4nr03019b
106	Nanotechnology *Journal Front Cover*	2015	26	34	10.1088/0957-4484/26/34/344004
107	Physica Status Solidi C *Journal Front Cover*	2015	12	8	10.1002/pssc.201400299
108	Physical Review Letters *Journal Front Cover*	2015	115	17	10.1103/PhysRevLett.115.177001
109	Solid State Physics (in Japanese) *Journal Front Cover*	2015	50	2	(not available)

Appendix 7.8: MANA Patents

All MANA patent applications and MANA patent registrations listed in this Appendix are or were partly or fully owned by NIMS.

1. List of Japanese Patent Applications (January 2013 - December 2015):

Between October 2007 and December 2012, MANA has made 378 Japanese Patent Applications.

No.	Date of Application *Name of Invention*	Application Number
379	2013 Jan 11 *Self-heating nanofibers with drug release function, fabrication method of the sane, and fabrication method of the nonwoven material*	**2013-003341**
380	2013 Jan 18 *Fabrication method of adhesion for tissues*	**2013-006961**
381	2013 Jan 24 *Fluorescence probe and detection method for materials containing Cs*	**2013-011300**
382	2013 Jan 25 *Electric field-tunable topological insulator utilizing perovskite structure*	**2013-011584**
383	2013 Jan 28 *Multi-functional device for electric conductivity*	**2013-012848**
384	2013 Feb 1 *Green light emissive germanium nanoparticles and fabrication method of the same*	**2013-018245**
385	2013 Feb 6 *Perovskite nano-sheets based on homologous layered provskite-oxide, and their applications*	**2013-021150**
386	2013 Feb 13 *Conductive polymer-metal composites and materials adhered by them, and fabrication method of the same*	**2013-025154**
387	2013 Feb 27 *Thermoelectric semiconductors of rare-earth alumino-borides, and fabrication method of the same and thermoelectric devices using the same*	**2013-036757**
388	2013 Mar 1 *Nano carbon and graphene or carbon composite materials with graphene, and fabrication method of the same*	**2013-040445**
389	2013 Mar 13 *Adhesive bone filling agents and kits of the same*	**2013-050139**
390	2013 Mar 18 *Resettable optical sensors and resetting methods of optical sensors*	**2013-054733**

No.	Date of Application *Name of Invention*	Application Number
391	2013 Mar 21 *Adhesive agents for cells and clusters of aggregate cells*	**2013-057544**
392	2013 Mar 21 *Sensor devices for measurement of very small amount of samples*	**2013-057649**
393	2013 Mar 22 *Nanoparticles with high sensitivity for light emission and light amplifiers using laser media*	**2013-060077**
394	2013 Mar 28 *Organic EL devices*	**2013-067782**
395	2013 Mar 28 *Organic EL devices and fabrication method of the same*	**2013-067801**
396	2013 Mar 28 *Organic EL devices and fabrication method of the same*	**2013-068164**
397	2013 Apr 11 *Production and controlling method of surface areas where crystal orientation, crystal structure or composition varies with position and optimization of abrasive coefficient*	**2013-083027**
398	2013 Apr 12 *Freestanding organometallics nanomembrane and fabrication method of the same*	**2013-083992**
399	2013 Apr 26 *Equipment for molecular measurement and fabrication method of the same*	**2013-094200**
400	2013 Apr 26 *Mesoporous materials of inorganic oxides and fabrication method of the same*	**2013-094728**
401	2013 May 2 *Holders for sensor tips*	**2013-096690**
402	2013 May 9 *Thin film transistors and fabrication method of the same*	**2013-099284**
403	2013 May 13 *Conductive polymer-metal composites and materials adhering them, and fabrication method of the same*	**2013-100815**
404	2013 May 13 *Fabrication method of substrates for cell culture, substrates for cell culture and method of cell culture*	**2013-101259**
405	2013 May 27 *Self assembling peptides*	**2013-110898**
406	2013 Jun 4 *Transistor of dual gate polymer thin film*	**2013-117654**
407	2013 Jun 5 *Model surface stress sensors fixing antibodies or antigens and fabrication methods of the same, and immunity measurement method using the same*	**2013-119299**
408	2013 Jun 7 *Contact probe and fabrication method of the same, non-destructive forming method for contacts, the measurement method in fabrication process of multi-layers*	**2013-120634**
409	2013 Jun 13 *Nanoparticles of platinum alloy, and fabrication method of the same, electrodes using nanoparticles of platinum alloy and fuel cells*	**2013-124873**
410	2013 Jun 13 *Thin film transistors, fabrication method of the same and semiconductor equipment*	**2014-521410**
411	2013 Jun 27 *Devices for variable electric conductivity using all solid electric double layers and electric equipment using the same*	**2013-134534**
412	2013 Jun 27 *Substrates for surface enhancement Raman spectroscopy (SERS), fabrication method of the same, and biosensors and devices of micro flow channel using the same*	**2013-135565**
413	2013 Jul 1 *Chiral shift agents for NMR, and method for determination of photo purity and absolute arrangement using the same*	**2013-137744**
414	2013 Jul 3 *Thin film transistor and fabrication method of the same*	**2013-139425**
415	2013 Jul 11 *Apparatus for electron back scattering*	**2013-145573**
416	2013 Jul 26 *High proton conductive polymer films and fabrication method of the same, and humidity sensors*	**2014-528113**
417	2013 Jul 30 *Inactive bio membranes, liquids for coating and fabrication method of the same, and substrates for bio inactive treatment*	**2013-157967**
418	2013 Aug 8 *Fabrication method for recombined proteins using non protein/non lipid conditioned cell strain*	**2013-164837**
419	2013 Aug 23 *Equipment for measurement of micro heat conductivity, and measurement method*	**2013-172783**
420	2013 Aug 26 *Blood purification membranes, fabrication method of the same and dialyzers*	**2013-174636**
421	2013 Aug 27 *Adhesion membranes of cancer cells, devices for adhesion of cancer cells and fabrication method of the same, and equipment for removing cancer cells*	**2013-175387**
422	2013 Sep 26 *Layered resist films of high sensitive metal layers and method for improving photo sensitivity of resist layers*	**2013-199700**
423	2013 Sep 27 *Metal electrodes and semi-conductive device using the same*	**2013-201187**
424	2013 Sep 30 *Aromatic amine adsorbents, quartz resonator using the same, and fabrication method of the same*	**2013-203943**
425	2013 Oct 1 *Adhesive bone filling agents and kit of the same*	**2013-206357**
426	2013 Oct 3 *Materials of three dimensional graphene foam and fabrication method of the same*	**2013-208464**
427	2013 Nov 6 *Mesoporous metallic nanoparticles, fabrication method of the same, and catalysts containing the same*	**2013-230655**
428	2013 Nov 11 *Electric conductive devices using oxidized graphene, graphene and/or ion conductive materials, electric equipment of electric conductive devices using electric conductive devices, and handling method of electric conductive devices*	**2013-233226**
429	2013 Nov 15 *Signal inducing functional polymers for information transfer molecules among cells and fabrication method of the same*	**2013-236845**
430	2013 Nov 22 *Cell adhesive porous membranes, fabrication method of the same and tissue adhesive porous membrane tapes*	**2013-241764**

No.	Date of Application / *Name of Invention*	Application Number
431	2013 Nov 26 *Thin film transistors and fabrication method of the same*	2013-243413
432	2013 Nov 26 *Photo catalytic materials and fabrication method of the same*	2013-243826
433	2013 Nov 28 *Nanoparticles of platinum alloy, fabrication method of the same and electrodes and fuel cells containing the same*	2013-245982
434	2013 Dec 2 *Memory media and memory equipment using the same, method for recording and erasing of information*	2013-249601
435	2013 Dec 11 *Single crystal silicon wafers of rectangular shape*	2013-255895
436	2013 Dec 20 *Method of fractionating nanomaterial comprising elongated elements of different lengths*	2013-264489
437	2014 Jan 17 *Fluorescent probe, and a method for detecting nicotine adenine dinucleotide derivative*	2014-006978
438	2014 Jan 31 *Thin film transistor and a method of manufacturing the same*	2014-016266
439	2014 Jan 31 *Thin film transistor and a method of manufacturing the same*	2014-016273
440	2014 Jan 31 *Oxide thin film transistor and a method of manufacturing the same*	2014-016630
441	2014 Jan 31 *Oxide semiconductor and a method of manufacturing the same*	2014-016631
442	2014 Jan 31 *Structure of the thin film transistor, thin film transistor manufacturing method and semiconductor device*	2014-016632
443	2014 Jan 31 *A gate insulating film induce a fixed charge therein*	2014-016633
444	2014 Jan 31 *Thin film transistor and a method of manufacturing the same*	2014-016634
445	2014 Jan 31 *Thin-film transistor, thin film transistor manufacturing method and semiconductor device*	2014-016635
446	2014 Feb 3 *Neuron operating elements*	2014-018374
447	2014 Feb 6 *Semiconductor photodetector*	2014-020952
448	2014 Feb 12 *Applications fullerene structure and using the same*	2014-023960
449	2014 Feb 12 *Boron nitride particles and a method of manufacturing the same*	2014-024008
450	2014 Feb 12 *Spherical boron nitride particles and a method of manufacturing the same*	2014-024009
451	2014 Feb 28 *Epitaxial film with a substrate having a method and defect-free region forming an epitaxial film having a defect-free area on the substrate*	2014-039113
452	2014 Mar 6 *An optical amplifier with high efficiency luminescent nanoparticles and the laser medium*	2014-043414
453	2014 Mar 31 *Rust nano coating material, manufacturing method thereof, rust nano coating film and the film-forming method*	2014-072029
454	2014 Apr 3 *Luminescent silicon nano-particles and the field-driven light-emitting element*	2014-076813
455	2014 Apr 4 *Superlattice structure, the electrode material using the method and the same its production*	2014-077997
456	2014 Apr 7 *Electrode catalyst for hydrogen evolution reaction*	2014-078297
457	2014 May 1 *Cross-linked polymer gel - method of manufacturing processing body, cross-linkable polymer encapsulated - coordination binding polymer gel, cross-linked polymer encapsulated - coordination binding polymer gel*	2014-094421
458	2014 May 8 *The hollow carbon particle, a method for producing a metal or hollow carbon particles and a manufacturing method thereof that are modified with nanoparticles of an oxide*	2014-097002
459	2014 May 16 *Silver diffusion barrier material, silver diffusion barrier, silver diffusion barrier coating*	2014-102210
460	2014 May 30 *Sensitivity method of improving high sensitivity metal layer laminated resist film and the resist film*	2014-111883
461	2014 Jun 5 *Contact probe and a method of manufacturing the same, non-destructive contact formation method, the measuring method in the manufacturing process of the multilayer film and prober*	2014-116359
462	2014 Jun 9 *Photocatalyst composite material and a method of manufacturing the same*	2014-118601
463	2014 Jun 18 *Rust nano coating material, manufacturing method thereof, rust nano coating film and the film-forming method*	2014-125143
464	2014 Jun 25 *Nano-particles and a method of manufacturing the same*	2014-130172
465	2014 Jun 26 *Magnetic refrigeration equipment*	2014-131905
466	2014 Jul 16 *Crosslinked gelatin sponge and a method of manufacturing the same*	2014-145757
467	2014 Jul 23 *Corrosive environment sensor*	2014-149505
468	2014 Jul 24 *Medical bio-absorbable member and a method of manufacturing the same*	2014-151229
469	2014 Jul 28 *Band lineup apparatus and measurement method*	2014-153347
470	2014 Aug 25 *Particle formation method and particle*	2014-170457
471	2014 Aug 26 *Dielectric thin film*	2014-171406

No.	Date of Application / *Name of Invention*	Application Number
472	2014 Aug 27 *Silicon (Si) based nano-structural materials and a method of manufacturing the same*	2014-173124
473	2014 Aug 27 *Lithium using silicon (Si) based nano-structured material in the negative electrode material (Li) ion secondary battery*	2014-173156
474	2014 Aug 29 *Electromagnetic wave absorption and radiation material and a method of manufacturing the same*	2014-176247
475	2014 Sep 1 *Transparent fibroin nanofiber nonwoven fabric, cell culture base material, manufacturing method of the cell sheet and transparent fibroin nanofiber nonwoven fabric*	2014-177280
476	2014 Sep 5 *How to monolayer peeling the layered transition metal hydroxides nanocone, a method of manufacturing a transition metal oxide nanocone, and transition metal hydroxides nano*	2014-181325
477	2014 Sep 9 *Ferroelectric capacitors and electronic devices*	2014-183094
478	2014 Sep 9 *Ferroelectric capacitors and electronic devices*	2014-183184
479	2014 Sep 10 *Electronic semi-transparent device*	2014-184038
480	2014 Sep 18 *Organic semiconductor transistor and a method of manufacturing the same*	2014-189603
481	2014 Sep 22 *Skutterudite thermoelectric variable semiconductor doped with silicon and tellurium, its manufacturing method and a thermoelectric power generating device using the same*	2014-192823
482	2014 Sep 24 *Electron scanning microscope*	2014-193213
483	2014 Sep 26 *Zinc - gallium binary oxide complex-type thermoelectric conversion material and a method of manufacturing the same*	2014-196464
484	2014 Sep 29 *Silicon surface passivation method and surface passivation treated silicon*	2014-198340
485	2014 Oct 2 *NMR for chiral shift agent and a method of determining optical purity using the same*	2014-203915
486	2014 Oct 8 *Resistance change element*	2014-207339
487	2014 Oct 23 *Proton conductor and fuel cell*	2014-215905
488	2014 Nov 6 *Surface stress sensor*	2014-226301
489	2014 Nov 10 *Method for the synthesis of producing signal-induced polymer, producing signal induces monomer precursor and produce signal-induced polymer precursor*	2014-227661
490	2014 Nov 18 *Porous particles, and its method of manufacture and the guest molecule inclusion porous particles*	2014-233671
491	2014 Nov 28 *Energy discriminating electron detector and scanning electron microscope using it*	2014-241309
492	2014 Dec 11 *Luminescent silicon nanoparticles and current injection type light-emitting element*	2014-250651
493	2014 Dec 18 *Colloidal solution of silica nanosheet mesh structure coated substrate manufacturing method of gene transfection base material and a colloidal solution*	2014-256239
494	2014 Dec 26 *Sunlight absorption fluid and distillation process*	2014-264545
495	2015 Jan 15 *Resistance-varying element and process for production thereof*	2015-005464
496	2015 Jan 20 *Surgical sealant and method for producing same*	2015-008556
497	2015 Jan 27 *Sensor using receptor layer composed of granular materials*	2015-013271
498	2015 Jan 30 *Sugar responsive gel and medicine administering device*	2015-016395
499	2015 Feb 2 *Bismuth telluride thin film manufacturing method and bismuth telluride thin film*	2015-018256
500	2015 Feb 9 *Immunosuppressive agents that suppress the formation of amyloid fibrils, decomposition agent that dissolves amyloid fibers, prevention of neurodegenerative disease and medicine for treatment and growth of the decease as well as immunosuppressive agent and manufacturing method of decomposition agent*	2015-023490
501	2015 Feb 25 *Topological Photonic crystals*	2015-034902
502	2015 Feb 27 *Sensor covered with receptor layer of base material mixed with granular material*	2015-038190
503	2015 Mar 6 *Capacitor and electrode for dielectric materials involving Bismuth*	2015-044135
504	2015 Mar 6 *Determination of molecular weight and molecular weight measuring equipment*	2015-045316
505	2015 Mar 12 *Tunnel field effect transistor and using method*	2015-050089
506	2015 Mar 16 *Light catalyst composition, improved light catalyst activator and improved method of optical catalyst activity*	2015-052136
507	2015 Mar 17 *Mesoporous metal film and method for producing same*	2015-053162
508	2015 Mar 17 *Mesoporous metal film based molecular sensor, redox catalyst and lithium-ion battery electrodes*	2015-053191
509	2015 Mar 20 *Mesoporous metal film*	2015-057066
510	2015 Mar 23 *Water soluble near-infrared luminescence nano-particles and fluorescent labeling material*	2015-059049
511	2015 Mar 24 *Titanium nitride thin film thermoelectric semiconductor, method for producing same and thermoelectric generator*	2015-060270
512	2015 Mar 31 *Solar cell and production of solar cell*	2015-071854

No.	Date of Application *Name of Invention*	Application Number
513	2015 Apr 3 *Sericin-phosphate-copper hybrid structure and method for production thereof and heavy metal ion adsorbent*	2015-076769
514	2015 Apr 27 *Template substrate fabrication method and fabrication equipment*	2015-089930
515	2015 Apr 30 *Electrode wire using metal foil and manufacturing method of organic transistors using same*	2015-092555
516	2015 May 8 *Complex photocatalyst and its manufacturing method*	2015-095761
517	2015 May 11 *Coating agent, material with this coating and method for producing same*	2015-096768
518	2015 May 15 *Surface stress sensor having receptor layer coated with porous material and method for producing same*	2015-100405
519	2015 May 18 *Kekule superlattice structure with huge effective spin-orbit interaction and topological state of honeycomb lattice-type material*	2015-101321
520	2015 May 21 *Hybrid solar cells using nanocrystalline silicon quantum dots fully terminated by molecules*	2015-103575
521	2015 May 26 *Low friction coating and micro machine consisting of boron-doped zinc oxide thin film*	2015-105970
522	2015 Jun 9 *NMR for chiral shift agent, and a method of determining optical purity using the same*	2015-116459
523	2015 Jun 17 *Oxidation-induced self-healing ceramic composition containing a cure activator, method for producing same and the use of high-performance method of oxidation-induced self-healing ceramic composition*	2015-122293
524	2015 Jun24 *Thin-film transistor of the multi-layer structure, method for producing same and active matrix driving display*	2015-126796
525	2015 Jul 3 *Tissue adhesive, including gelatin derivatives*	2015-134188
526	2015 Jul 8 *Probes for scanning probe microscope and method for producing same*	2015-136715
527	2015 Jul 9 *Immunostimulatory oligonucleotide complex*	2015-138004
528	2015 Jul 24 *Single-electron transistor, a method for manufacturing same and integrated circuit*	2015-146869
529	2015 Aug 26 *Petri dish-type cell culture vessels*	2015-167060
530	2015 Aug 27 *Cationic glycidyl polymer*	2015-167548
531	2015 Sep 3 *Increased primary particle boundary of titanium oxide and method for producing same*	2015-173456
532	2015 Sep 8 *Sensor module*	2015-176709
533	2015 Sep 10 *Solid electrochemical reaction by magnetic control structure and method and variable magnetic resistance-type electrical device*	2015-178256
534	2015 Sep 18 *Zinc-gallium binary oxide composite-type thermoelectric material and method for producing same*	2015-184586
535	2015 Sep 18 *Skutterudite thermoelectric strange semiconductor doped with silicon and tellurium, method for producing same and thermoelectric power*	2015-184746
536	2015 Oct 6 *Ethylene - vinyl alcohol copolymer and polyvinyl alcohol function method of ethylene - vinyl alcohol copolymer and polyvinyl alcohol*	2015-198316
537	2015 Oct 21 *Coating agent, material with this coating and method for producing same*	2015-206937
538	2015 Oct 21 *Proton conductor and fuel cell*	2015-207235
539	2015 Nov 17 *Adhesion of Bone filler*	2015-224957
540	2015 Dec 8 *Specific gas identification sensor using receptor layer with functional particles*	2015-239115
541	2015 Dec 18 *Laser oscillators composed of colloidal crystal gels, Laser oscillation device and method for producing same*	2015-247549

2. List of Japanese Patent Registrations (January 2013 – December 2015):

Between October 2007 and December 2012, MANA has made 232 Japanese Patent Registrations.

No.	Date of Registration *Name of Invention*	Registration Number
233	2013 Jan 11 *Cell attaching/culturing base material capable of imparting cell attaching property by irradiation of light*	5167738
234	2013 Jan 11 *Manufacturing method of silicon carbide nanowire*	5170609
235	2013 Jan 11 *Method for forming cone emitter*	5170653
236	2013 Jan 11 *Electron source, and manufacturing method of electron source*	5173516
237	2013 Feb 1 *Method for peeling layered double hydroxide, double hydroxide nanosheet, composite thin film material thereof, method for producing the same, and method for producing layered double hydroxide thin film material*	5187797
238	2013 Feb 1 *Supramolecular structure and its production method*	5187812
239	2013 Feb 15 *Crystalline nano structure consisting of strontium aluminate and its producing method*	5196361

No.	Date of Registration / *Name of Invention*	Registration Number
240	2013 Feb 15 *Ribbon-like beta Ga_2O_3 tube with cylindrical internal passage filled up with thin nanowire*	**5196363**
241	2013 Feb 22 *Thermosetting resin composite composition, resin molded body, and method for producing the composition*	**5201367**
242	2013 Feb 22 *Surface cleaning method for biocompatible material and cleaning apparatus used for the same*	**5201507**
243	2013 Feb 22 *Cathodic photo-protection coating structure, and its production method*	**5201707**
244	2013 Mar 1 *Method of injecting molecule by beam, method of processing material by beam, and devices therefor*	**5205669**
245	2013 Mar 1 *Solid-state device structure, and electric/electronic device and electric/electronic appliance using it*	**5205670**
246	2013 Mar 1 *Collagen sponge and method of manufacturing the same*	**5205673**
247	2013 Mar 1 *Photocatalyst nanosheet, photocatalyst material, and their manufacturing methods*	**5205675**
248	2013 Mar 1 *Blended polymer fibers and nonwoven fabric thereof and their production method*	**5207265**
249	2013 Mar 15 *Magnetic semiconductor and its production method*	**5218953**
250	2013 Mar 15 *Porous scaffold material for regeneration and its production method*	**5218955**
251	2013 Mar 15 *Artificial opal film production device*	**5218961**
252	2013 Mar 15 *BN thin film having sp3-bonded BN high density phase, and method for producing the same*	**5218969**
253	2013 Mar 29 *Electronic spectroscopic measuring apparatus under voltage impression*	**5229848**
254	2013 Mar 29 *Heteronanowire structure having trunk part and branch-shaped part, and its producing method*	**5229851**
255	2013 Mar 29 *Method for producing MgB_2 superconductor*	**5229868**
256	2013 Apr 12 *Method for producing fiber-reinforced composite*	**5240754**
257	2013 Apr 12 *Optical electric field amplifying element and probe using the same*	**5241730**
258	2013 Apr 12 *Heat-resistant resin composition with excellent mechanical properties and method for producing the same*	**5242888**
259	2013 Apr 19 *Iodide-based single crystal materials, method of producing the same, and scintillator based on the same*	**5245176**
260	2013 Apr 19 *Current-perpendicular-to-plane giant magnetoresistance (CPP-GMR) element*	**5245179**
261	2013 Apr 26 *Manufacturing method for SiC nanoparticle by nitrogen plasma*	**5252460**
262	2013 Apr 26 *Dope for forming*	**5255284**
263	2013 May 2 *Metal nanoparticles, method for producing the same, and electrolyte using the same*	**5258117**
264	2013 May 24 *N-type thermoelectric conversion element utilizing carbon-and nitrogen-doped rare-earth polyboride-based high-temperature acid-resistant n-type thermoelectric material*	**5273685**
265	2013 Jun 14 *Solar cell*	**5288368**
266	2013 Jun 21 *Dielectric element and method for producing the dielectric element*	**5294201**
267	2013 Jun 21 *Nitrogen-doped mesoporous carbon (N-KIT-6) and its production method*	**5294234**
268	2013 Jun 21 *Electronic element*	**5294238**
269	2013 Jun 21 *Oxide layered illuminant and oxide nanosheet illuminant*	**5294246**
270	2013 Jun 21 *Display element*	**5294301**
271	2013 Jul 5 *Probe for scanning type probe microscope, and scanning type probe microscope*	**5306015**
272	2013 Jul 12 *Lithium ion conductive solid electrolyte, its manufacturing method, solid electrolyte for lithium secondary battery using the solid electrolyte, and whole solid lithium battery using the solid electrolyte for secondary battery*	**5311169**
273	2013 Jul 12 *Resin composition and method for producing same*	**5311298**
274	2013 Jul 19 *Regular mesoporous fullerene having large specific surface area and method for producing the same*	**5316988**
275	2013 Jul 19 *Lead-free magneto-optical element and method for manufacturing the same*	**5317065**
276	2013 Jul 19 *Method for producing anion-exchanging layered double hydroxide*	**5317293**
277	2013 Jul 26 *Scaffold material for living body*	**5322146**
278	2013 Jul 26 *Co based Heusler alloy*	**5322209**
279	2013 Aug 9 *Method of preparing decellularized soft tissue, graft and culture material*	**5331960**
280	2013 Aug 9 *Magnesium-based biodegradable metal material*	**5333886**
281	2013 Aug 9 *Porous body and production method of the same*	**5334081**
282	2013 Aug 16 *Porous article and method for producing the same*	**5339323**

No.	Date of Registration / *Name of Invention*	Registration Number
283	2013 Aug 16 *Method for producing layered rare earth hydroxide*	**5339330**
284	2013 Aug 16 *Layered hydroxides and mono-layered nano sheets, and fabrication methods of the same*	**5339331**
285	2013 Aug 16 *Medical biological absorbent member and method of manufacturing the same*	**5339347**
286	2013 Sep 6 *Superconducting wire rod*	**5356132**
287	2013 Sep 13 *Electronic device and manufacturing method therefor*	**5360739**
288	2013 Sep 27 *Layered rare earth hydroxide, thin film thereof and method of manufacturing them*	**5370740**
289	2013 Sep 27 *Surface increasing Raman scattering reactive nanoscale pH sensor*	**5370995**
290	2013 Sep 27 *Switching element and application of the same*	**5371010**
291	2013 Oct 11 *Cerium oxide nanotube and method for producing the same*	**5382673**
292	2013 Oct 11 *Nanoscale pH sensor*	**5382690**
293	2013 Oct 11 *Nanorod formulation for liquid crystal display for polarization control-type electro-optical apparatus*	**5382691**
294	2013 Oct 11 *Thermoelectric semiconductor, and thermoelectric power generation element using the same*	**5382707**
295	2013 Oct 18 *Layered rare earth hydroxide and anion-exchange material and fluorescent material using it*	**5386687**
296	2013 Oct 18 *Mesoporous carbon (MC-MCM-48) and method for producing the same*	**5388051**
297	2013 Oct 18 *Reduced hydrogen water-forming agent*	**5388215**
298	2013 Oct 25 *All-solid lithium ion secondary battery*	**5395258**
299	2013 Nov 1 *Detection device and biosenser*	**5398017**
300	2013 Nov 1 *Vapor-deposition apparatus and vapor-deposition method*	**5401130**
301	2013 Nov 8 *Substrate for crystal growth and crystal growing method using the same*	**5403497**
302	2013 Nov 8 *Cage-type mesoporous silica (SNC-2), method for producing the same and adsorbent using the same*	**5403502**
303	2013 Nov 8 *Electrospun fiber mat composite and glucose sensor*	**5403520**
304	2013 Nov 8 *Device for forming polarization inversion region*	**5403521**
305	2013 Nov 8 *Magnesium alloys with high strength and high ductility*	**5404391**
306	2013 Nov 15 *Amorphous base material*	**5408564**
307	2013 Nov 15 *Surface enhanced infrared absorption sensor and process for producing it*	**5408565**
308	2013 Nov 15 *Rare earth multi-boride thermoelectric element, and thermoelectric element using the same*	**5408567**
309	2013 Nov 22 *Dye-sensitized solar cell*	**5413770**
310	2013 Nov 22 *Microscale ultraviolet sensor and method of manufacturing the same*	**5414050**
311	2013 Nov 22 *Metal electrode and semiconductor element using the same*	**5414053**
312	2013 Nov 29 *Magnesium alloy*	**5419061**
313	2013 Nov 29 *Magnesium alloy*	**5419062**
314	2013 Dec 13 *Organic field effect transistor*	**5429848**
315	2013 Dec 13 *Thermoelectric element*	**5429863**
316	2013 Dec 13 *Method for producing biologically reactive carbon nanotube functionalized by bonding redox protein through non-conjugated bond*	**5429893**
317	2013 Dec 20 *Ultrathin boron nitride nanosheet, method for production thereof, and optical material containing the nanosheet*	**5435559**
318	2013 Dec 20 *Production method of group IV semiconductor nano thin wire*	**5435600**
319	2013 Dec 20 *Polymer brush-solid composite material, and method for producing the same*	**5437256**
320	2014 Jan 10 *Injection method for organic molecule and its apparatus*	**5445990**
321	2014 Jan 10 *Nano flake-like metal composite material, and manufacturing method of the same and surface enhanced Raman scattering active substrate*	**5445991**
322	2014 Jan 10 *Organic-inorganic hybrid polymer, method for production thereof, and method for control of molecular weight*	**5446007**
323	2014 Jan 10 *Method for manufacturing boron nitride nanotube*	**5448067**
324	2014 Jan 31 *Rare earth oxide fluorescent materials, thin film using the same, and methods for producing them*	**5464404**
325	2014 Jan 31 *Method for growing single crystal silicon having square cross section and silicon wafer having square section*	**5464429**
326	2014 Feb 7 *Biosensor, method for detecting biological material with biosensor, and kit therefor*	**5467312**
327	2014 Feb 21 *New diblock copolymer and high mobility/ photodconductivity anisotropic nanowire formed by self-assembling of the diblock copolymer*	**5476561**

No.	Date of Registration	*Name of Invention*	Registration Number
328	2014 Feb 21	*Method for manufacturing surface enhanced infrared absorption sensor*	**5476574**
329	2014 Feb 21	*Method of producing silicon carbide*	**5477445**
330	2014 Feb 21	*Boron nitride nanotube derivative, its dispersion, and method for producing the boron nitride nanotube derivative*	**5477702**
331	2014 Feb 21	*Highly-transparent alumina ceramic and method for producing the same*	**5477715**
332	2014 Mar 7	*Solar cell*	**5487449**
333	2014 Mar 14	*Electrically conductive polyrotaxane*	**5493204**
334	2014 Mar 14	*Recording medium, and recording device and information recording/erasure method using the same*	**5493210**
335	2014 Mar 14	*Fiber fragment manufacturing method*	**5493215**
336	2014 Mar 14	*Fullerene structure, method for manufacturing the same, and application using the same*	**5493232**
337	2014 Mar 14	*Fluorescence emitting silicon nanoparticle and method for producing the same*	**5495038**
338	2014 Mar 20	*Zinc sulfide nanobelt, UV light detection sensor and method for producing the same*	**5500543**
339	2014 Apr 11	*Electrode catalyst for fuel cell and manufacturing method thereof*	**5515115**
340	2014 Apr 11	*Mg-based structured member*	**5517024**
341	2014 Apr 11	*Electron element substrate*	**5517034**
342	2014 Apr 11	*Method for synthesizing brookite*	**5517048**
343	2014 Apr 11	*Switching element and switch array*	**5517065**
344	2014 Apr 18	*Mesoporous carbon nitride material and process for producing the same*	**5521191**
345	2014 Apr 25	*Photoresponsive drug transporter and photoresponsive drug transporter with drug*	**5526324**
346	2014 Apr 25	*Fullerene derivative composition and field-effect transistor element using the same*	**5529439**
347	2014 Apr 25	*Dielectric thin film, dielectric thin film element, and thin film capacitor*	**5531163**
348	2014 May 16	*Porous base, method of producing the same and method of using the porous base*	**5540301**
349	2014 May 16	*Nanocrystal particle coated with organic molecular film and manufacturing method of nanocrystal particle coated with organic molecular film*	**5540307**
350	2014 May 16	*Low-temperature sintering method of silicon carbide powder*	**5540318**
351	2014 May 16	*Light emitting nano sheet, fluorescent illumination body, solar cell, color display using the same*	**5540407**
352	2014 May 16	*Nano sheet coating*	**5540408**
353	2014 May 16	*Powdery medicine inhalation device*	**5543850**
354	2014 May 23	*Electrochemical transistor*	**5544621**
355	2014 May 30	*TiO_2 nanoparticles*	**5548991**
356	2014 May 30	*Molecular electronic device, and method of manufacturing the same*	**5549971**
357	2014 Jun 6	*Electrode catalyst for fuel cell and manufacturing method thereof*	**5553344**
358	2014 Jun 13	*Tissue regeneration method*	**5557084**
359	2014 Jun 13	*Photodegradable hetero-bivalent crosslinking agent*	**5557229**
360	2014 Jun 27	*Boron nitride nanotube derivative, its dispersion, and method for producing the boron nitride nanotube derivative*	**5565694**
361	2014 Jun 27	*Porous ceramic material and method of producing the same*	**5565721**
362	2014 Jul 4	*Method for producing graphene film*	**5569769**
363	2014 Jul 4	*Polymer fiber, production method for same, and production device*	**5569826**
364	2014 Aug 1	*Nanoribbon and manufacturing method thereof, fet using nanoribbon and manufacturing method thereof, and base sequence determination method using nanoribbon and apparatus for the same*	**5586001**
365	2014 Aug 1	*Ferromagnetic tunnel junction structure, and magnetoresistive effect element and spintronics device each comprising same*	**5586028**
366	2014 Aug 15	*Two-component tissue adhesive and method for producing same*	**5594633**
367	2014 Aug 22	*Organic polymer nanowire and manufacturing method thereof*	**5598805**
368	2014 Aug 22	*Bis(terpyridine) compound metal assembled body, hybrid polymer, method for producing the same and use of the same*	**5598807**
369	2014 Aug 22	*Light-emitting element*	**5598809**
370	2014 Aug 22	*Resin coated member and method of resin coating*	**5598901**
371	2014 Aug 22	*Gate electrode and method of manufacturing the same*	**5598916**

No.	Date of Registration / Name of Invention	Registration Number
372	2014 Aug 22 *Method of producing dense material of electrolyte for solid oxide fuel cell*	5598920
373	2014 Sep 12 *Dielectric film, dielectric element, and process for producing the dielectric element*	5610348
374	2014 Sep 12 *Film which is formed of hemispherical particles, method for producing same, and use of same*	5610358
375	2014 Sep 19 *Method for producing cobalt (II) hydroxide-iron (III) hexagonal plate-like lamellar crystal*	5614689
376	2014 Sep 26 *Perpendicular magnetic recording medium and method for manufacturing the same*	5617112
377	2014 Oct 3 *Phenylboronic acid-based monomer and phenylboronic acid-based polymer*	5622188
378	2014 Oct 10 *Electromagnetic wave absorbent material*	5626649
379	2014 Oct 10 *Alloy particle and wire rod which are used in air plasma spraying and wire arc spraying*	5626947
380	2014 Oct 10 *Graphene-coated member and method for producing the same*	5626948
381	2014 Oct 10 *Contact structure of organic semiconductor device, organic semiconductor device, and method of fabricating the same*	5626959
382	2014 Nov 7 *Metal nanoparticle having dendritic portion and method for producing the same*	5641385
383	2014 Nov 7 *Bio-hybrid material, production method therefor, and stent*	5641454
384	2014 Nov 21 *Surface stress sensor*	5649138
385	2014 Nov 21 *Electrochromic complex compound and electrochromic element using the same*	5650449
386	2014 Nov 28 *Electrolyte material for solid fuel cell and manufacturing method thereof*	5652602
387	2014 Nov 28 *Method for producing mesoporous silica*	5652792
388	2014 Dec 12 *Organic solvent dispersion containing flaky titanium oxide, method for production of the dispersion, titanium oxide film using the dispersion, and method for production of the titanium oxide film*	5659371
389	2014 Dec 12 *Compound oxide semiconductor, yellow pigment using the same, and photocatalyst*	5660419
390	2014 Dec 12 *Epitaxial growing method of graphene film*	5660425
391	2014 Dec 12 *Hydrogen generating material, method for producing same, method for producing hydrogen, and apparatus for producing hydrogen*	5660430
392	2014 Dec 12 *Composite material comprising high-molecular-weight matrix and low-molecular-weight organic compound and process for producing same*	5660452
393	2014 Dec 12 *Liquid organic material at ambient temperature and use thereof*	5660470
394	2014 Dec 12 *Recording device and recording/deletion method for information*	5660478
395	2014 Dec 19 *Binary aluminum-based sintered material, and method for producing the same*	5665037
396	2014 Dec 19 *Chiral shift reagent for NMR and method for determining optical purity and absolute configuration using the same*	5665043
397	2014 Dec 19 *Layered rare-earth hydroxide, method for producing the same and application thereof*	5665051
398	2014 Dec 26 *Porous scaffold material*	5669248
399	2014 Dec 26 *Porous copper sulfide, method for manufacturing the same, and use of the same*	5669265
400	2015 Jan 9 *Organic solvent dispersion in which flaky perovskite oxide particle is blended and method for producing the same, and perovskite oxide thin film using the organic solvent dispersion and method for producing the same*	5672726
401	2015 Jan 23 *Nano crystal grain dispersion solution, electronic device, and its production process*	5682880
402	2015 Feb 6 *Ferroelectric thin film having superlattice structure, manufacturing method thereof, ferroelectric element, and manufacturing method thereof*	5688816
403	2015 Feb 20 *Sugar responsive gel and medicine administering device*	5696961
404	2015 Feb 20 *Synapse operation element*	5696988
405	2015 Feb 20 *Negative-electrode material and lithium secondary battery using same*	5696993
406	2015 Mar 6 *Elastic body material having periodic structure which varies structural color with modulus*	5704007
407	2015 Mar 13 *Axis alignment method and device of energy analyzer*	5711552
408	2015 Mar 20 *Rare earth boron carbide based thermolectric semiconductor doped with transition metal, method of producing the same and thermoelectric power generation element*	5713283
409	2015 Mar 20 *High hardness B4C oriented by ferromagnetic field technique and method for manufacturing the same*	5713284
410	2015 Mar 20 *Metal complex, dye-sensitized oxide semiconductor electrode, and dye-sensitized solar battery*	5713285

No.	Date of Registration / *Name of Invention*	Registration Number
411	2015 Mar 27 *Composite cathode material for solid oxide fuel cell operating at medium-low temperature, composite cathode for solid oxide fuel cell, and method for manufacturing electrolyte-composite cathode structure for solid oxide fuel cell*	5717067
412	2015 Apr 3 *Plate single crystal composed of metal oxide, thin film of the metal oxide, production methods for the single crystal and the film and variable-resistance element using the single crystal of the film*	5721100
413	2015 Apr 17 *Analyzer and manufacturing method of analyzer*	5728778
414	2015 Apr 24 *Silicon nanoparticle-silicon nanowire composite material, solar cell, light-emitting device, and manufacturing method*	5733655
415	2015 May 15 *Double-sided coated surface stress sensor*	5743026
416	2015 May 15 *Method of manufacturing anisotropic sliding material and anisotropic sliding material*	5745771
417	2015 May 22 *Field-effect transistor and method of manufacturing the same*	5747245
418	2015 May 22 *Organic/fluorescent metal hybrid polymer and ligand thereof*	5747247
419	2015 May 22 *Tissue adhesive film and method for producing same*	5747264
420	2015 May 29 *Porous carbon film, method of manufacturing the same, and application using the same*	5751582
421	2015 Jun 12 *Organic/metal hybrid polymer which contains metal whose coordination number is 4 and bisphenanthroline derivative, ligand thereof, and method for producing the same*	5757615
422	2015 Jun 12 *Interface layer reduction method, method for forming high dielectric constant gate insulating film, high dielectric constant gate insulating film, high dielectric constant gate oxide film, and transistor having high dielectric constant gate oxide film*	5757628
423	2015 Jun 26 *Highly proton-conductive polymer film, method for producing same, and humidity sensor*	5765692
424	2015 Jun 26 *Amine functionalized mesopore carbon nanocage and method for manufacturing the same*	5765709
425	2015 Jul 3 *Composite porous scaffold*	5769159
426	2015 Jul 3 *Magnetic optical material, magnetic optical element, and manufacturing method of magnetic optical material*	5769238
427	2015 Jul 3 *Process for production of contact structure for organic semiconductor device, and contact structure for organic semiconductor device*	5769254
428	2015 Jul 17 *Adhesive substrate and method for manufacturing the same*	5777052
429	2015 Jul 24 *Zirconium diboride powder and method for synthesizing the same*	5780540
430	2015 Jul 31 *Layered double hydroxide having I3-, and method for producing the same*	5783560
431	2015 Aug 14 *Ultraviolet light detection device and method of manufacturing the same*	5791026
432	2015 Sep 11 *Porous carbon nitride film, method of manufacturing the same, and application using the same*	5804251
433	2015 Sep 18 *Dielectric composition and method for manufacturing the same*	5807861
434	2015 Oct 9 *Chiral shift reagent for NMR and method for determing optical purity using the same*	5817901
435	2015 Oct 9 *Metal catalyst structure and method for producing the same*	5818244
436	2015 Oct 9 *Isopropyl acrylamide derivative having azido group or alkyne group and polymer thereof*	5818245
437	2015 Oct 16 *Patterned porous material and method for manufacturing the same*	5822266
438	2015 Dec 4 *Short fiber scaffold material, method for making short fiber-cell composite agglomerated mass, and short fiber-cell composite agglomerated mass*	5846550
439	2015 Dec 4 *Method for rolling and drawing processing of material made of nickel-free high nitrogen stainless steel, seamless capillary made of nickel-free high nitrogen stainless steel, and method for producing the same*	5846555
440	2015 Dec 4 *Thin-film transistor, method for producing a thin-film transistor, and semiconductor device*	5846563
441	2015 Dec 11 *Mesoporous metal film, and method for producing mesoporous metal film from low-concentration aqueous surfactant solution*	5849369

3. List of International Patent Applications (January 2013 – December 2015):

Between October 2007 and December 2012, MANA has made 198 International Patent Applications.

Note: PCT: Patent Cooperation Treaty EPC: European Patent Convention

No.	Date of Application / Country *Name of Invention*	Application Number
199	2013 Apr 17 **PCT** *Double-sided coated surface stress sensor*	**PCT/JP2013/061404**
200	2013 Apr 19 **PCT** *Biomaterial coated with HAp/Col composite*	**PCT/JP2013/061666**
201	2013 Jun 13 **Korea** *Thin-film transistor, method for producing a thin-film transistor, and semiconductor device*	**2014-7012459**
202	2013 Jun 13 **PCT** *Thin-film transistor, method for producing a thin-film transistor, and semiconductor device*	**PCT/JP2013/066384**
203	2013 Jul 26 **PCT** *Highly proton-conductive polymer film, method for producing same, and humidity sensor*	**PCT/JP2013/070299**
204	2013 Oct 21 **PCT** *Adhesive body between conductive polymer-metal complex and substrate and method for forming adhesive body, conductive polymer-metal complex dispersion liquid, method for manufacturing and applying same, and method for filling hole using conductive material*	**PCT/JP2013/078486**
205	2013 Nov 22 **PCT** *Tissue adhesive film and method for producing same*	**PCT/JP2013/081559**
206	2014 Jan 10 **PCT** *Nanofiber having self-heating properties and biologically active substance release properties, production method for same, and nonwoven fabric having self-heating properties and biologically active substance release capabilities*	**PCT/JP2014/050306**
207	2014 Jan 21 **China** *Nanoporous Alkali-Metal/Alkaline-Earth-Metal Titanate Photocatalysts and Their Synthesis Methods*	**201410025118.2**
208	2014 Jan 21 **Korea** *Manufacturing methods of recombinant proteins using the protein-free, lipid-free medium conditioned cell lines*	**2014-0007407**
209	2014 Feb 21 **USA** *Manufacturing methods of recombinant proteins using the protein-free, lipid-free medium conditioned cell lines*	**14/186881**
210	2014 Mar 11 **PCT** *Adhesive bone filler and adhesive bone filler kit*	**PCT/JP2014/056368**
211	2014 Mar 28 **PCT** *Organic EL element and Method for manufacturing same*	**PCT/JP2014/059190**
212	2014 Apr 25 **PCT** *Molecular weight measurement device and molecular weight measurement method*	**PCT/JP2014/061803**
213	2014 May 2 **PCT** *Thin-film transistor and method for manufacturing same*	**PCT/JP2014/062188**
214	2014 Jun 5 **PCT** *Membrane-type surface stress sensor having antibody or antigen immobilized thereon, method for producing same, and immunoassay method using same*	**PCT/JP2014/064997**
215	2014 Aug 25 **PCT** *Blood purification membrane, method for manufacturing blood purification membrane, and dialysis device*	**PCT/JP2014/072131**
216	2014 Sep 25 **PCT** *Highly sensitive multilayer resist film and method for improving photosensitivity of resist film*	**PCT/JP2014/075422**
217	2014 Oct 31 **PCT** *Electrical conduction element, electronic device, and method for operating electrical conduction element*	**PCT/JP2014/079047**
218	2014 Nov 18 **PCT** *Tissue adhesive porous film, its production method and tissue adhesive porous film tape*	**PCT/JP2014/080477**
219	2014 Nov 21 **PCT** *Oxygen reduction electrode catalyst and the oxygen electrode*	**PCT/JP2014/080923**
220	2015 Jan 23 **PCT** *Thin-film transistor, oxide semiconductor, and method for producing same*	**PCT/JP2015/051845**
221	2015 Feb 9 **PCT** *Boron nitride particles and production method therefor*	**PCT/JP2015/053488**
222	2015 Feb 9 **PCT** *Spherical boron nitride particles and production method thereof*	**PCT/JP2015/053489**
223	2015 Feb 11 **Taiwan** *Spherical boron nitride particles and production method thereof*	**104104538**
224	2015 Feb 11 **Taiwan** *Boron nitride particles and production method therefor*	**104104539**
225	2015 Feb 26 **PCT** *Semiconductor device comprising a hydrogen diffusion barrier and method of fabricating same*	**PCT/JP2015/001013**
226	2015 Mar 30 **PCT** *Nano-coating material, method for manufacturing same, coating agent, functional material, and method for manufacturing same*	**PCT/JP2015/060000**
227	2015 May 14 **PCT** *Silver diffusion barrier material, silver diffusion barrier and a semiconductor device using the same*	**PCT/JP2015/063860**
228	2015 Jul 21 **PCT** *Sensor having a high-speed and high sensitivity wet and dry response*	**PCT/JP2015/070692**
229	2015 Jul 22 **PCT** *Bioabsorbable member for medical use and method for producing same*	**PCT/JP2015/070888**
230	2015 Aug 10 **PCT** *Electromagnetic wave absorber and emitter material and method for producing the same*	**PCT/JP2015/072687**
231	2015 Aug 31 **PCT** *Sensor having a porous material or granular material as the receptor layer*	**PCT/JP2015/074659**
232	2015 Sep 17 **PCT** *Energy filtered electron detector and scanning electron microscope using the same*	**PCT/JP2015/076404**
233	2015 Nov 16 **PCT** *Method for producing porous particles*	**PCT/JP2015/082087**

4. List of International Patent Registrations (January 2013 – December 2015):

Between October 2007 and December 2012, MANA has made 72 International Patent registrations.

Note: PCT: Patent Cooperation Treaty EPC: European Patent Convention

No.	Date of Registration	Registration Number	Country	Name of Invention
73	2013 Jan 29	8361203	US	*Carbon porous body and adsorbent using the same*
74	2013 Feb 6	1825868	EPC, France, Germany, UK	*Process for producing porous object comprising apatite/collagen composite fiber*
75	2013 Feb 27	2184793	EPC, Germany, UK	*Switching element and application of the same*
76	2013 Apr 9	8414855	US	*Spherical boron nitride nanoparticles and synthetic method thereof*
77	2013 May 1	I395360	Taiwan	*All-solid battery*
78	2013 May 7	8435910	US	*Preparation method for anion-exchangeable, layered double hydroxides*
79	2013 May 28	2585577	Canada	*Process for producing porous object comprising apatite/collagen composite fiber*
80	2013 Jun 20	2485635	Russia	*All-solid battery*
81	2013 Jul 1	I400288	Taiwan	*Resin composition*
82	2013 Jul 3	ZL200580010769.0	China	*Process for producing porous object comprising apatite/collagen composite fiber*
83	2013 Jul 5	HK1141821	Hong Kong	*Resin composition*
84	2013 Jul 10	2423242	EPC, France, Germany	*Electrically conductive polyrotaxane*
85	2013 Aug 27	8518584	US	*Production method for electrode for battery, electrode produced by production method, and battery including electrode*
86	2013 Sep 18	ZL201080005817.8	China	*Mg-based structured member*
87	2013 Sep 25	ZL200980118276.7	China	*Dielectric film, dielectric element, and process for producing the dielectric element*
88	2013 Sep 25	1314031	Korea	*All-solid battery*
89	2013 Oct 22	8563975	US	*Hetero pn junction semiconductor and process for producing the same*
90	2013 Nov 5	8575038	US	*Method for reducing thickness of interfacial layer, method for forming high dielectric constant gate insulating film, high dielectric constant gate insulating film, high dielectric constant gate oxide film, and transistor having high dielectric constant gate oxide film*
91	2013 Nov 5	8575674	US	*Ferromagnetic tunnel junction structure, and magneto-resistive element and spintronics device each using same*
92	2013 Nov 6	140391	France, Germany, UK	*Thin film device with a MnS intermediate layer and its fabrication method*
93	2013 Nov 28	2009323792	Australia	*All-solid battery*
94	2013 Dec 3	8601610	US	*Optical electric field enhancement element and probe using the same*
95	2013 Dec 17	1345390	Korea	*Interface layer reduction method, method for forming high dielectric constant gate insulating film, high dielectric constant gate insulating film, high dielectric constant gate oxide film, and transistor having high dielectric constant gate oxide film*
96	2013 Dec 17	8609235	US	*Porous ceramic material and method of producing the same*
97	2013 Dec 24	8613611	US	*Electrically conductive polyrotaxane*
98	2013 Dec 24	8613811	US	*Graphene-coated member and process for producing same*
99	2014 Jan 15	1354334	Korea	*Lithium ion conductive sulfide-based crystallized glass, a solid electrolyte and said solid lithium secondary battery employing the manufacturing method and the crystallized glass*
100	2014 Jan 28	8637121	US	*Resin coated member and method of resin coating*
101	2014 Feb 1	I425039	Taiwan	*Thermosetting resin composite composition, resin molding and manufacturing method thereof*
102	2014 Mar 5	1500405	EPC, France, Germany, UK	*Method for preparing porous composite material*
103	2014 Mar 18	8673640	US	*Porous scaffold, method of producing the same and method of using the porous scaffold*
104	2014 Mar 19	2237320	EPC, Belgium, France	*Metal electrode and semiconductor element using the same*
105	2014 Mar 26	1693703	France, Germany, UK	*Method of fixing organic molecule and micro/nano-article*
106	2014 Apr 15	8698077	US	*Method for determining number of layers of two-dimensional thin film atomic structure and device for determining number of layers of two-dimensional thin film atomic structure*
107	2014 Apr 29	8710730	US	*Luminescent nanosheets, and fluorescent illuminators, solar cells and color displays utilizing the same as well as nanosheet paints*
108	2014 Jun 2	1405078	Korea	*Dielectric element and a method of manufacturing the same*

No.	Date of Registration / Registration Number / Country / Name of Invention
109	2014 Jun 24 **8759925** **US** *Method for reducing thickness of interfacial layer, method for forming high dielectric constant gate insulating film, high dielectric constant gate insulating film, high dielectric constant gate oxide film, and transistor having high dielectric constant gate oxide film*
110	2014 Jul 2 **ZL2000980134329.4** **China** *Composites and a manufacturing method thereof comprising a polymer matrix and low-molecular organic compound*
111	2014 Jul 8 **8771872** **US** *Negative-electrode material and lithium secondary battery using same*
112	2014 Jul 16 **1422315** **Korea** *Resin composition*
113	2014 Aug 12 **8802192** **US** *Warm spray coating method and particles used therefor*
114	2014 Aug 20 **1630218** **EPC, France, Germany** *Zinc oxide phosphor and process for producing the same*
115	2014 Sep 9 **8828488** **US** *Methods for producing a thin film consisting of nanosheet monolayer film(s) by spin coat methods, and hyperhydrophilized materials, substrates for an oxide thin film and dielectric materials obtained therefrom*
116	2014 Sep 10 **ZL201180020787.2** **China** *Orientation MAX phase ceramic and a method of manufacturing the same*
117	2014 Sep 24 **2172278** **EPC, France, Germany** *Method of resin coating*
118	2014 Oct 10 **1451697** **Korea** *Surface stress sensor*
119	2014 Nov 10 **1462125** **Korea** *All-solid-state lithium battery*
120	2014 Nov 25 **8896033** **US** *Electrochemical transistor*
121	2014 Dec 24 **ZL201310087447.2** **China** *Production method of silicon carbide*
122	2015 Apr 8 **2421063** **EPC, France, Germany** *Ferromagnetic tunnel junction structure, and magnetoresistive effect element and spintronics device each comprising same*
123	2015 Apr 9 **112005000293** **Germany** *Gene detection field-effect device and method of analyzing gene polymorphism therewith*
124	2015 Apr 21 **9011811** **US** *Method of producing silicon carbide*
125	2015 Apr 21 **9012354** **US** *Photocatalytic film, method for forming photocatalytic film and photocatalytic film coated product*
126	2015 Apr 28 **1517532** **Korea** *Dielectric thin film, dielectric thin film element, and thin film capacitor*
127	2015 May 13 **1997522** **EPC, France, Germany, UK** *Method of controlling degradation time of a biodegradable device*
128	2015 Jun 16 **9057022** **US** *Luminescent nanosheets*
129	2015 Jun 17 **2259100** **EPC, Germany** *Device for forming artificial opal membrane and method for forming artificial opal membrane*
130	2015 Jun 24 **ZL201080053634.3** **China** *Fabrication method and structure of electrode for organic device*
131	2015 Jul 7 **9074938** **US** *Substrate for surface enhanced Raman spectroscopy analysis and manufacturing method of the same, biosensor using the same, and microfluidic device using the same*
132	2015 Jul 14 **9082551** **US** *High dielectric nanosheet laminate, high dielectric element and method for producing the same*
133	2015 Jul 15 **1647843** **EPC, France, Germany** *Colloidal crystal and method and device for manufacturing colloidal crystal gel*
134	2015 Oct 12 **1561147** **Korea** *Mg-based alloy*
135	2015 Oct 13 **9155816** **US** *Magnesium-based medical device and manufacturing method thereof*
136	2015 Oct 21 **ZL201180023013.5** **China** *Polymer fiber, production method for same, and production device*
137	2015 Nov 16 **1570878** **Korea** *Method of producing silicon carbide*
138	2015 Nov 18 **2157201** **EPC, Germany, UK** *Mg-based alloy*
139	2015 Nov 25 **ZL201180017128.3** **China** *All-solid-state lithium battery*
140	2015 Dec 12 **1743661** **EPC, France, Germany, UK** *Method of controlling average pore diameter of porous material containing apatite/collagen composite fiber*

Appendix 7.9: International Cooperation

List of MOU agreements of MANA with overseas institutions signed between October 2007 and March 2016:

No.	Organization, **Country** Signed (Expired, Replaced)
1	Kent State University, Department of Chemistry, **USA** Signed: 2008 Jan 10 (Expired: 2013 Jan 10)
2	Rensselaer Polytechnic Institute, Chemistry and Biological Engineering, **USA** Signed: 2008 Feb 28 (Expired: 2013 Feb 28)
3	University of California, Los Angeles (UCLA), **USA** Signed: 2008 Mar 24 (Expired: 2013 Mar 24)
4	Georgia Institute of Technology (GIT), Center for Nanostructure Characterization, **USA** Signed: 2008 May 6 (Expired: 2013 May 6)
5	CNRS, Centre d'élaboration de matériaux et d'études structurales (CEMES), **France** Signed: 2008 May 30 (Expired: 2013 May 30)
6	University of Cambridge, Nanoscience Centre, **UK** Signed: 2008 Jun 20 (Expired: 2013 Jun 20)
7	Indian Institute of Chemical Technology (IICT), **India** Signed: 2008 Jul 3 (Expired: 2013 Jul 3)
8	University of Basel, Institute of Physics, National Center of Competence for Nanoscale Science, **Switzerland** Signed: 2008 Jul 20 (Expired: 2013 Jul 20)
9	Yonsei University, Seoul, **Korea** Signed: 2008 Sep 1 (Expired: 2013 Sep 1)
10	Indian Institute of Science, Education and Research, **India** Signed: 2008 Dec 19 (Expired: 2013 Dec 19)
11	University of Karlsruhe, Institute for Inorganic Chemistry, Supramolecular Chemistry Group, **Germany** Signed: 2009 Jan 29 (Expired: 2014 Jan 29)
12	Fudan University, Department of Chemistry, New Energy and Materials Laboratory (NEML), **China** Signed: 2009 Mar 16 (Expired: 2014 Mar 16)
13	Indian Institute of Technology Madras, National Centre for Catalysis Research (NCCR), **India** Signed: 2009 Apr 5 (Expired: 2014 Apr 5)
14	University of Cologne, Institute of Inorganic Chemistry, Inorganic and Materials Chemistry, **Germany** Signed: 2009 May 28 (Expired: 2014 May 28)
15	École Polytechnique Fédérale de Lausanne (EPFL), Institute of Microengineering, **Switzerland** Signed: 2009 Jul 20 (Expired: 2014 Jul 20)
16	University of Rome Tor Vergata, Center for Nanoscience & Nanotechnology & Innovative Instrumentation (NAST), **Italy** Signed: 2009 Jul 30 (Expired: 2014 Jul 30)
17	University of Heidelberg, Kirchhoff Institute of Physics, **Germany** Signed: 2009 Aug 31 (Expired: 2014 Aug 31)
18	Loughborough University, **UK** Signed: 2009 Oct 28 (Expired: 2014 Oct 28)
19	Lawrence Berkeley National Laboratory (LBNL), **USA** Signed: 2010 Feb 9 (Expired: 2015 Feb 9)
20	University of Valenciennes, **France** Signed: 2010 May 20 (Expired: 2015 May 20)
21	Friedrich-Alexander University, Erlangen-Nürnberg, **Germany** Signed: 2010 Jun 21 (Expired: 2015 Jun 21)
22	Fudan University, Department of Materials Science, **China** Signed: 2010 Jul 23 (Expired: 2015 Jul 23)
23	EWHA Womans University Seoul, Department of Chemistry and Nanoscience, **Korea** Signed: 2010 Aug 27 (Expired: 2015 Aug 27)
24	Karlsruhe Institute of Technology, **Germany** Signed: 2010 Sep 16 (Expired: 2015 Sep 16)
25	Univesité de la Méditerranée, Marseille, **France** Signed: 2010 Sep 20 (Expired: 2015 Sep 20)
26	Anhui Key Laboratory of Nanomaterials and Nanostructures, **China** Signed: 2010 Oct 6 (Expired: 2015 Oct 6)
27	Multidisciplinary Center for Development of Ceramic Materials, **Brazil** Signed: 2010 Oct 26 (Expired: 2015 Oct 26)
28	Vietnam National University Ho Chi Minh City, **Vietnam** Signed: 2011 Jan 24 (Expired: 2016 Jan 24)
29	King Saud University, **Saudi Arabia** Signed: 2011 Jan 25 (Expired: 2016 Jan 25)
30	LMPG, Grenoble, **France** Signed: 2011 Feb 1 (Expired: 2016 Feb 1)
31	Université de Montréal (UdeM), **Canada** Signed: 2011 Jul 4
32	Flinders University, **Australia** Signed: 2011 Jul 19
33	University of Melbourne, **Australia** Signed: 2011 Sep 21
34	Shanghai Institute of Ceramics, **China** Signed: 2011 Dec 1
35	Tsinghua University, **China** Signed: 2012 Jan 28
36	Hanoi University of Science and Technology (HUST), **Vietnam** Signed: 2012 Feb 7
37	University of Sao Paolo, **Brazil** Signed: 2012 Apr 25
38	University College London (UCL), **UK** Signed: 2012 Oct 8
39	Kyungpook National University, **Korea** Signed: 2013 Jan 18 (Replaced on 2014 Sep 27)
40	Centre Interdisciplinaire de Nanoscience de Marseille (CINaM-CNRS), **France** Signed: 2013 May 2
41	National Center for Nanoscience and Technology (NCNST), Beijing, **China** Signed: 2013 Jun 24
42	Huazhong University of Science and Technology (HUST), **China** Signed: 2013 Jul 29

No.	Organization, **Country** Signed (Expired, Replaced)
43	Georgia Institute of Technology (GIT), Center for Nanostructure Characterization, **USA** (Renewal) Signed: 2013 Nov 25
44	CNRS, Centre d'élaboration de matériaux et d'études structurales (CEMES), **France** (Renewal) Signed: 2013 Dec 10
45	St. Petersburg State Electrotechnical University (LETI), **Russia** Signed: 2014 Feb 28
46	University of Bristol, Bristol Centre for Nanoscience and Quantum Information (NSQI), **UK** Signed: 2014 Mar 7
47	University of California Los Angeles (UCLA), The California NanoSystems Institute (CNSI), **USA** (Renewal) Signed: 2014 Sep 8
48	Donostia International Physics Center (DIPC), San Sebastian, **Spain** Signed: 2014 Sep 9
49	Kyungpook National University, **Korea** (Replacement of MOU signed on 2013 Jan 18) Signed: 2014 Sep 27
50	University of Eastern Finland, **Finland** Signed: 2014 Dec 31

No.	Organization, **Country** Signed (Expired, Replaced)
51	Indian Institute of Science (IISc), Bangalore, **India** Signed: 2015 Jan 13
52	University of Toronto, **Canada** Signed: 2015 Jan 21
53	Chongqing University of Science & Technology (CQUST), **China** Signed: 2015 May 15
54	Paul Drude Institute for Solid State Electronics (PDI), **Germany** Signed: 2015 May 29
55	National Cheng Kung University (CKU), **Taiwan** Signed: 2015 May 30
56	University of Washington (UW), **USA** Signed: 2015 Sep 15
57	University of Science and Technology of Hanoi (USTH), **Vietnam** Signed: 2015 Sep 24
58	University of Wollongong (UOW), **Australia** Signed: 2015 Sep 29
59	University of Chemistry and Technology (UCT), **Czech Republic** Signed: 2016 Jan 18
60	University of Sydney, **Australia** Signed: 2016 Feb 16

Appendix 7.10: MANA History

MANA History between October 2007 and March 2016:

Fiscal Year 2007

Date	Event
2007 Sep 12	NIMS with the project called "International Center for Materials Nanoarchitectonics (MANA)" has been selected to participate as one of five institutions in the World Premier International (WPI) Research Center Initiative, a program sponsored by the Ministry of Education, Culture, Sports, Science and Technology (MEXT)
2007 Oct 1	Official Inauguration of MANA
2007 Oct 18	The Launching Ceremony of MANA was held at Okura Frontier Hotel, Tsukuba
2008 Jan 10	MANA signed a Memorandum of Understanding (MOU) with Kent State University, USA
2008 Feb 1	Launch of the new MANA Website in English
2008 Feb 7	The 1st MANA Seminar entitled "Nanotechnology, a Key to Sustainability" was given by Dr. Heinrich Rohrer (Nobel Laureate in Physics 1986 and MANA Advisor)
2008 Feb 28	MANA signed a Memorandum of Understanding (MOU) with Rensselaer Polytechnic Institute, USA
2008 Mar 10-13	The 1st MANA International Symposium was held in Tsukuba
2008 Mar 12	1st MANA Evaluation Committee Meeting
2008 Mar 24	MANA signed a Memorandum of Understanding (MOU) with University of California, Los Angeles (UCLA), USA

Fiscal Year 2008

Date	Event	Date	Event
2008 Apr 1	Start of ICYS-MANA Program	2008 Sep 1	MANA signed a Memorandum of Understanding (MOU) with Yonsei University, Seoul, Korea
2008 Apr 16	1st MANA Site Visit by the WPI Program Committee	2008 Sep 11	MANA Principal Investigator Kohei Uosaki was named "International Society of Electrochemistry Fellow"
2008 May 6	MANA signed a Memorandum of Understanding (MOU) with Georgia Institute of Technology (GIT), USA	2008 Sep 25	MANA Independent Scientist Masayoshi Higuchi received the "SPSJ Hitachi Chemical Award" given by the Society of Polymer Science, Japan (SPSJ)
2008 May 7	MANA Independent Scientist Ajayan Vinu received the Asian Excellent Young researcher Lectureship Award 2008 by the Chemical Society of Japan	2008 Oct 1	Celebration of 1st Anniversary of MANA. Organizational Reform of MANA
2008 May 20	1st Follow-up Meeting by the WPI Follow-Up Committee	2008 Oct 6	MANA Chief Operating Officer Yoshio Bando was named "American Ceramic Society Fellow"
2008 May 30	MANA signed a Memorandum of Understanding (MOU) with CNRS, France	2008 Nov 27-28	2nd MANA Site Visit by the WPI Program Committee
2008 Jun 2	NIMS Overseas Operation Office opened at the University of Washington, USA	2008 Dec 11	MANA activities were introduced in the NHK Program "Ohayou Nippon (Good Morning Japan)"
2008 Jun 20	MANA signed a Memorandum of Understanding (MOU) with University of Cambridge, UK	2008 Dec 13	MANA Independent Scientist Alexei Belik and ICYS-MANA Researcher Pavuluri Srinivasu received the "Encouragement of Research in Materials Science Award" given by the Materials Research Society of Japan
2008 Jul 3	MANA signed a Memorandum of Understanding (MOU) with Indian Institute of Technology (IICT), Hyderabad, India	2008 Dec 19	MANA signed a Memorandum of Understanding (MOU) with Indian Institute of Science, Education and Research, India
2008 Jul 9	MANA Principal Investigator Kenji Kitamura received the "Inoue Harushige Prize" given by the Japan Science and Technology Agency	2009 Jan 29	MANA signed a Memorandum of Understanding (MOU) with University of Karlsruhe, Germany
2008 Jul 16	MANA Principal Investigator Takayoshi Sasaki and MANA Scientist Minoru Osada received the "2008 Tsukuba Prize"	2009 Feb 25-27	The 2nd MANA International Symposium was held in Tsukuba
2008 Jul 19	Prof. Sir Harry W. Kroto visited MANA	2009 Mar 16	MANA signed a Memorandum of Understanding (MOU) with Fudan University, China
2008 Jul 20	MANA signed a Memorandum of Understanding (MOU) with University of Basel, Switzerland	2009 Mar 17	2nd Follow-up Meeting by the WPI Follow-Up Committee
2008 Jul 28 – Aug 1	The 5th NIMS-IRC-UCLA Nanotechnology Summer School was held at NIMS	2009 Mar 28	MANA Independent Scientist Ajayan Vinu received the "CSJ Award for Young Chemists" given by the Chemical Society of Japan

Fiscal Year 2009

Date	Event	Date	Event
2009 Apr 5	MANA signed a Memorandum of Understanding (MOU) with Indian Institute of Technology, Madras, India	2009 Jul 3	The 1st MANA-NSC Joint Workshop on Fusion of Nanotechnology and Bioscience was held at the MANA Satellite at University of Cambridge, UK
2009 Apr 14	MANA Scientist Minoru Osada received the "Young Scientists' Prize" given by the Minister of Education, Culture, Sports, Science and Technology (MEXT)	2009 Jul 14	A delegation from U.S. Department of Energy (DOE) and U.S. Department of Defense (DOD) visited MANA
2009 May 8	MANA Principal Investigator Kazuhiro Hono received the "2009 Honda Frontier Award" given by the Honda Memorial Foundation	2009 Jul 20	MANA signed a Memorandum of Understanding (MOU) with EPFL, Switzerland
2009 May 19	MANA Satellite Principal Investigator James K. Gimzewski was elected as "Fellow of the Royal Society"	2009 Jul 30	MANA signed a Memorandum of Understanding (MOU) with University of Rome Tor Vergata, Italy
2009 May 28	MANA signed a Memorandum of Understanding (MOU) with University of Cologne, Germany	2009 Jul 27-31	The 6th MANA-NSC-CNSI Nanotechnology Students' Summer School was held at the UCLA MANA Satellite, Los Angeles, USA
2009 Jun 15-17	The 8th Japan-France Workshop on Nanomaterials held at NIMS	2009 Aug 31	MANA signed a Memorandum of Understanding (MOU) with University of Heidelberg, Germany
		2009 Sep 20-22	XJTU-NIMS/MANA Workshop on Materials Science 2009 was held at Xi'an Jiaotong University, China

Date	Event	Date	Event
2009 Sep 25	MANA Independent Scientist Jun Nakanishi received the "Japan Society for Analytical Chemistry Award for Younger Researchers"	2010 Jan 7-8	3rd MANA Site Visit by the WPI Program Committee
2009 Sep 29	MANA Scientist Kohsaku Kawakami received the "JSCTA Award for Young Scientists" given by the Japan Society of Calorimetry and Thermal Analysis	2010 Jan 14	The 1st NIMS/MANA-Waseda University Joint Symposium on "Advanced Materials Designed at Nano- and Meso-scales toward Practical Chemical Wisdom" was held at Waseda University
2009 Oct 2	Prof. Svante Lindqvist, Nobel Museum Director and Chair at the Royal Institute of Technology, Stockholm, visited MANA	2010 Jan 31	MANA Satellite Principal Investigator James Gimzewski was featured in the NHK's satellite TV program "The proposal for the future (mirai-e-no teigen)"
2009 Oct 5	MANA Principal Investigator Kohei Uosaki received the "ECS Fellow Award" given by the Electrochemical Society	2010 Feb 4	MANA Satellite Principal Investigator James Gimzewski was featured in the NHK's satellite TV program "The proposal for the future (mirai-e-no teigen)"
2009 Oct 9	Prof. Sir Harry W. Kroto visited MANA for one-on-one meetings with young scientists	2010 Feb 4	MANA Independent Scientist Yusuke Yamauchi received "Inoue Research Aid for Young Scientists"
2009 Oct 10-12	Tsukuba-Shinchu Bilateral Symposium on "Advanced Materials Science and Technology" was held at National Tsing Hua University, Taiwan	2010 Feb 9	MANA signed a Memorandum of Understanding (MOU) with Lawrence Berkeley National Laboratory (LBNL), USA
2009 Oct 13	MANA-URTV Joint Workshop on Nanostructured Materials for Sustainable Development was held at University Rome Tor Vergata, Italy	2010 Feb 16	MANA Principal Investigator Takayoshi Sasaki ranked as the 18th most-prolific author in the high quality journal "Chemistry of Materials" (Impact Factor 5.046)
2009 Oct 13-14	The 1st MANA-CEMES Joint Workshop on Fusion of Theory and Experiment was held at the MANA Satellite in CNRS Toulouse, France	2010 Mar 3	MANA Independent Scientist Masayoshi Higuchi received the "Marubun Academy Award"
2009 Oct 26	MANA Principal Investigator Naoki Ohashi received the "Richard M. Fulrath Award" given by the American Ceramics Society	2010 Mar 3-5	The 3rd MANA International Symposium was held in Tsukuba
2009 Oct 28	MANA signed a Memorandum of Understanding (MOU) with Loughborough University, UK	2010 Mar 5	2nd MANA Evaluation Committee Meeting
2009 Nov 10	Nanjing University-Anhui Normal University-Hokkaido University-MANA Joint Symposium was held at Nanjing University, China	2010 Mar 21	MANA Scientist Masanori Kohno received the "Young Scientist Award" given by the Physical Society of Japan (PSJ)
2009 Dec 2	MANA Independent Scientist Ajayan Vinu received the "ICSB Award of Excellence" given by the Indian Scociety of Chemists and Biologists	2010 Mar 24-26	The Workshop on "Materials Nanoarchitectonics for Sustainable Development" as a part of the "Invitation Program for Advanced Research Institutions in Japan" sponsored by the Japan Society for the Promotion of Science (JSPS), was held in Gora, Hakone, Japan
2009 Dec 10	The Osaka University-MANA/NIMS Joint Symposium on "Advanced Structural and Functional Materials Design" was held at Osaka University		
2009 Dec 18	Visit of the MANA Satellite at UCLA by WPI Program Director, Prof. Toshio Kuroki	2010 Mar 27	MANA Principal Investigator Kohei Uosaki received the "Chemical Society of Japan Award"

Fiscal Year 2010

Date	Event	Date	Event
2010 Apr 1	MANA Principal Investigator Tsuyoshi Hasegawa and MANA Scientist Kazuya Terabe received the "NIMS President's Research Achievement Award"	2010 Jun 14-15	The joint IBM and NIMS/MANA symposium on "Characterization and manipulation at the atomic scale" was held in Tsukuba
2010 Apr 1	MANA Independent Scientist Yusuke Yamauchi received the "Ceramic Society of Japan Award"	2010 Jun 21	MANA signed a Memorandum of Understanding (MOU) with Friedrich-Alexander University Erlangen-Nürnberg, Germany
2010 Apr 13	MANA Independent Scientist Katsunori Wakabayashi received the "Young Scientists' Prize" given by the Ministry of Education, Culture, Sports, Science and Technology (MEXT)	2010 Jul 14	3rd Follow-up Meeting by the WPI Follow-Up Committee
		2010 Jul 23	MANA signed a Memorandum of Understanding (MOU) with Fudan University, China
2010 May 20	MANA signed a Memorandum of Understanding (MOU) with University of Valenciennes, France	2010 Aug 9	Research results of MANA Independent Scientist Ajayan Vinu on "a new fabrication of gold nanoparticles by self-assembly of nanoporous materials" were reported in Nikkei Online
2010 May 25	ICYS-MANA Researcher Yoshihiro Tsujimoto received the "Research Progress Award" given by the Japan Society of Powder and Powder Metallurgy (JSPM)		

Date	Event
2010 Aug 18	MANA received a high appraisal from the WPI program committee for the activity in Fiscal Year 2009
2010 Aug 25	Three research subjects proposed by MANA researchers were selected for funding from Core Research of Evolutional Science & Technology (CREST) and Precursory Research for Embryonic Science and Technology (PRESTO) by the Japan Science and Technology Agency
2010 Aug 27	MANA signed a Memorandum of Understanding (MOU) with EWHA Womans University Seoul, Korea
2010 Aug 27	The 1st NIMS-EWHA workshop on " Advanced Functional Materials" (NEWAM-10) was held in Tsukuba
2010 Sep 9	MANA Principal Investigator Kohei Uosaki received the "Japanese Photochemistry Association Lectureship Award 2010"
2010 Sep 16	MANA signed a Memorandum of Understanding (MOU) with Karlsruhe Institute of Technology, Germany
2010 Sep 20	MANA signed a Memorandum of Understanding (MOU) with Université de la Méditerranée, Marseille, France
2010 Oct 6	MANA signed a Memorandum of Understanding (MOU) with Anhui Key Laboratory of Nanomaterials and Nanostructures, China
2010 Oct 11	Research results of the Traversa Group (MANA) on "Micro-Solid Oxide Fuel Cells" was introduced on Sankei News and Nikkei Online
2010 Oct 22	Research results on the "Development of an Exhaust Gas Catalyst" by MANA Principal Investigator Katsuhiko Ariga and Hideki Abe (NIMS Advanced Electronic Materials Center) were introduced in Nikkei Online
2010 Oct 26	MANA signed a Memorandum of Understanding (MOU) with Multidisciplinary Center for Development of Ceramic Materials, Brazil
2010 Oct 28	The 1st MANA Science Café "Melting Pot Club" on "What is nanotechnology?" was held at Frontier Hotel Okura, Tsukuba
2010 Nov 11	Outreach activities of MANA were featured in the NHK program "Ohayou Nippon (Good Morning Japan)
2010 Nov 11	MANA Independent Scientist Ajayan Vinu has been selected as the recipient of the prestigious "Friedrich Wilhelm Bessel Research Award 2010" given by the Alexander von Humboldt Foundation, and as recipient of the "Catalysis Society of India Award 2010"
2010 Nov 24-26	The 9th Japan-French International Workshop was held in Toulouse, France
2010 Dec 1	The 2nd NIMS/MANA-Waseda University Joint Symposium was held at NIMS
2010 Dec 9	Ms. Kumiko Hayashi, Parliamentary Secretary for Education, Culture, Sports, Science and Technology (MEXT) visited MANA
2010 Dec 15	Mr. Lim Chuan Poh, Chairman, Agency for Science, Technology and Research (A*STAR), Singapore, visited MANA
2010 Dec 21	MANA Director-General Masakazu Aono was selected as a winner of the "2010 Feynman Prize in Nanotechnology" given by Foresight Institute, USA
2011 Jan 1	The researchers MANA Principal Investigator Jinhua Ye and MANA Independent Scientist Yusuke Yamauchi were featured in the NHK Special program "Can Japan Survive?"
2011 Jan 17	MANA Principal Investigator Katsuhiko Ariga received the "2010 Nice-Step Scientist (NISTEP) Award" by the National Institute of Science and Technology Policy
2011 Jan 19	The satellite workshop "Dirac Electron Systems 2011" of the workshop "Graphene Workshop in Tsukuba 2011" was held at NIMS Namiki-site
2011 Jan 24	MANA signed a Memorandum of Understanding (MOU) with Vietnam National University Ho Chi Minh City, Vietnam
2011 Jan 25	MANA signed a Memorandum of Understanding (MOU) with King Saud University, Saudi Arabia
2011 Jan 27-28	The 1st MANA Grand Challenge Meeting was held in Miura Peninsula, Kanagawa prefecture
2011 Jan 29	Mr. Yoichiro Genba, Minister of State for Science and Technology Policy, visited MANA
2011 Feb 1	Launch of the new MANA Website in Japanese
2011 Feb 1	MANA signed a Memorandum of Understanding (MOU) with LMPG, Grenoble, Fance
2011 Feb 4	Research of MANA Principal Investigator Jinhua Ye was introduced in the NHK Eco Channel
2011 Feb 6	MANA Principal Investigator Katsuhiko Ariga received the "ISCB Award for Excellence 2011" in the area of Chemical Sciences given by the Indian Society of Chemists and Biologists (ISCB)
2011 Feb 18	Dr. H.E. Virachai Virameteekul, Minister of Science and Technology, Thailand, visited MANA
2011 Feb 18	MANA Independent Scientist Masayoshi Higuchi received the "Gottfried Wagener Prize 2010" given by German Innovation Award
2011 Feb 28	The workshop on "Advanced Functional Nanomaterials" was held in Chennai, India
2011 Feb 28	Research of MANA Principal Investigator Tsuyoshi Hasegawa was introduced in the NHK English radio program "Japan and World Update"
2011 Mar 2-4	The 4th MANA International Symposium was held in Tsukuba
2011 Mar 5	MANA hosted "Prof. Rohrer's Science Class" for junior high-school students
2011 Mar 5	Prof. Heinrich Rohrer's Science Class 2011 was held at NIMS
2011 Mar 11	MANA was hit by the Great Tohoku-Kanto earthquake

Fiscal Year 2011

Date	Event
2011 Apr 1	Four MANA researchers, MANA Principal Investigator Katsuhiko Ariga, MANA Scientist Emiliana Fabbri, MANA Scientist Daniele Pergolesi and MANA Scientist Tetsushi Taguchi received NIMS President's Research Awards
2011 Jun 28-29	4th MANA Site Visit by the WPI Program Committee
2011 Jul 4	MANA signed a Memorandum of Understanding (MOU) with Université de Montréal (UdeM), Canada
2011 Jul 19	MANA signed a Memorandum of Understanding (MOU) with Flinders University, Australia
2011 Sep 5-8	The 7th Japan-UK-USA Nanotechnology Students' Summer School was held at the MANA Satellite at University of Cambridge, UK
2011 Sep 17	MANA hosted "Prof. Kroto's Science Class 2011" for preliminary school students and their parents
2011 Sep 21	MANA signed a Memorandum of Understanding (MOU) with University of Melbourne, Australia
2011 Oct 7	The Osaka University-MANA/NIMS Joint Symposium on "Advanced Structural and Functional Materials Design" was held at Osaka University
2011 Oct 19	4th Follow-up Meeting by the WPI Follow-Up Committee
2011 Oct 31	The NIMS/MANA-Flinders University Joint Symposium on "Nanoscience and Nanotechnology" was held at NIMS
2011 Nov 1	The 3rd NIMS/MANA-Waseda University Joint Symposium was held at Waseda University
2011 Nov 19	MANA Visit of Minister Masaharu Nakagwa (MEXT)
2011 Dec 1	MANA signed a Memorandum of Understanding (MOU) with Shanghai Institute of Ceramics, China
2011 Dec 14	MANA was given the grade "A" in the WPI Program Interim Evaluation
2011 Dec 17-18	MANA exhibited a booth at "Science Festa in Kyoto 2011"
2012 Jan 10	MANA was featured in a special issue of the journal Advanced Materials (IF 10.88) published by John Wiley & Sons, Inc.
2012 Jan 23	MANA Satellite Principal Investigator Françoise Winnik won the 2012 Macromolecular Science and Engineering Award of the Chemical Institute of Canada (CIC)
2012 Jan 28	MANA signed a Memorandum of Understanding (MOU) with Tsinghua University, China
2012 Feb 7	MANA signed a Memorandum of Understanding (MOU) with Hanoi University of Science and Technology, Vietnam
2012 Feb 8	MANA Principal Investigator Takayoshi Sasaki received the "29th CSJ Academic Prize" given by the Chemical Society of Japan (CSJ)
2012 Feb 14	MANA Chief Operating Officer Yoshio Bando and MANA Principal Investigator Dmitri Golberg received the "3rd Thomson Reuters Research Front Award"
2012 Feb 16-20	MANA participated in the WPI Joint Exhibition at the 2012 AAAS Annual Meeting in Vancouver, Canada
2012 Feb 29 – Mar 2	The 5th MANA International Symposium was held in Tsukuba
2012 Mar 2	3rd MANA Evaluation Committee Meeting

Fiscal Year 2012

Date	Event
2012 Apr 2	MANA Associate Principal Investigator Minoru Osada received the "7th NIMS President's Research Encouragement Awarad"
2012 Apr 14	MANA Independent Scientist Satoshi Tominaka received the "Funai Research Incentive Award" given by the Funai Foundation for Information Technology
2012 Apr 25	MANA signed a Memorandum of Understanding (MOU) with University of Sao Paolo, Brazil
2012 Apr 26-27	The 2nd MANA Grand Challenge Meeting was held in Nasu, Tochigi prefecture
2012 May 7	The MANA Second-term Kickoff Meeting was held at NIMS
2012 May 10	The Australia/MANA joint workshop on "Nanoarchitectonics for Innovative Materials & Systems" was held at NIMS
2012 Jul 5	Commemorative Ceremony for the Completion of the new NanoGREEN/WPI-MANA Building
2012 Jul 19	The 1st UdeM-MANA Workshop on "Nano-Life" was held in Montreal, Canada
2012 Jul 25	MANA Independent Scientist Yusuke Yamauchi received the "Tsukuba Encouragement Prize"
2012 Aug 21-22	5th MANA Site Visit by the WPI Program Committee
2012 Aug 27-31	The 8th MANA-Cambridge/UCL-UCLA Nanotechnology Summer School was held at MANA
2012 Sep 5	Prof. Chung-Yuan Mou, Deputy Minister of the National Science Council, Taiwan, visited MANA
2012 Sep 28	MANA Principal Investigator Omar M. Yaghi was featured in Science, volume 337, in the column "Satellite Labs Extend Science".
2012 Oct 1	The PCCP-MANA Symposium on "Nanotechnology, Materials and Physical Chemistry" was held at NIMS
2012 Oct 3	The MANA 5th Anniversary Memorial Symposium was held at NIMS
2012 Oct 8	MANA signed a Memorandum of Understanding (MOU) with University College London (UCL), UK

Date	Event
2012 Oct 9	MANA Satellite Principal Investigator Zhong Lin Wang was awarded the ACerS Edward Orton, Jr. Memorial Lecture by the American Ceramic Society
2012 Oct 24	5th Follow-up Meeting by the WPI Follow-Up Committee
2012 Nov 7	The NSQI-MANA Joint Symposium was held at NIMS
2012 Nov 12-13	The 3rd MANA Grand Challenge Meeting (for young researchers) was held at Miura Peninsula, Kanagawa prefecture
2012 Nov 24	The 2nd WPI Joint Symposium: Inspiring Insights into Pioneering Scientific Research was held in Tsukuba
2012 Dec 17	MANA Principal Investigator Kazuhito Tsukagoshi received the 9th JSPS Prize from the Japan Society for the Promotion of Science

Date	Event
2013 Jan 18	MANA signed a Memorandum of Understanding (MOU) with Kyungpook National University, Korea
2013 Jan 29-30	The 2nd Canada-Japan Nanotechnology Workshop was held at Tokyo Big Sight.
2013 Feb 14-18	MANA participated in the WPI Joint Exhibition at the 2013 AAAS Annual Meeting in Boston, USA
2013 Feb 27 – Mar 1	The 6th MANA International Symposium was held in Tsukuba
2013 Mar 11	The 4th NIMS/MANA-Waseda University International Joint Symposium was held at NIMS
2013 Mar 18	The Osaka University-NIMS/MANA Joint Symposium on "Advanced Structural and Functional Materials Design" was held at MANA
2013 Mar 19	The International Symposium MASA 2013 on "Material Architectonics for Sustainable Action" was held at MANA

Fiscal Year 2013

Date	Event
2013 Apr 2	MANA Independent Scientist Yusuke Yamauchi received the 7th PCCP Prize 2013
2013 Apr 5	MANA Principal Investigator Katsuhiko Ariga has been admitted as a Fellow of the Royal Society of Chemistry
2013 Apr 16	MEXT Commendations for Science and Technology for FY2013 have been awarded to 3 MANA researchers: Principal Investigator Takayoshi Sasaki (Science and Technology Prize for Research), Independent Scientist Alexei A. Belik (Young Scientist's Prize) and Independent Scientist Yusuke Yamauchi (Young Scientist's Prize)
2013 May 2	MANA signed a Memorandum of Understanding (MOU) with Centre Interdisciplinaire de Nanoscience de Marseille (CINaM-CNRS), France
2013 May 16	MANA Advisor, Dr. Heinrich Rohrer (Nobel Laureate in Physics 1986) passed away
2013 May 29	MANA Satellite Principal Investigator Francoise M. Winnik received the Society of Polymer Science Japan (SPSJ)'s International Award 2013
2013 Jun 24	MANA signed a Memorandum of Understanding (MOU) with National Center for Nanoscience and Technology (NCNST), Beijing, China
2013 Jun 28	Research of MANA Scientist Mitsuhiro Ebara has been featured in Japanese television (Yajiuma TV, TV Asahi)
2013 Jun 28-29	The International Workshop on "Thermoelectric Research & Thermal Management Technology" was held at MANA
2013 Jul 16	Research of MANA Scientist Mitsuhiro Ebara has been featured in the program "Ohayo-Nippon" of Japanese NHK General TV
2013 Jul 29	MANA signed a Memorandum of Understanding (MOU) with Huazhong University of Science and Technology (HUST), China
2013 Aug 6-8	MANA participated in the "Summer Science Camp" for high school students

Date	Event
2013 Aug 19-20	6th MANA Site Visit by the WPI Program Committee
2013 Sep 3	Independent Scientist Genki Yoshikawa from MANA received a Tsukuba Encouragement Prize 2013
2013 Oct 9-11	The Swiss-Japanese Nanoscience Workshop on "Materials Phenomena at Small Scale" was held at MANA
2013 Oct 29	6th Follow-up Meeting by the WPI Follow-Up Committee
2013 Nov 7	MANA Director-General Masakazu Aono won the Nanoscience Prize 2013
2013 Nov 9-10	MANA represented by MANA's Smart Biomaterials Group participated in the event "Science Agora 2013" held at Odaiba, Tokyo
2013 Nov 25	MANA Principal Investigator Katsuhiko Ariga presented a lecture at Takezono Higashi Junior High School in Tsukuba within the "Science Q lectures" sponsored by the Tsukuba-Science City Network
2013 Dec 20	MANA Independent Scientist Yusuke Yamauchi received a Chemical Society of Japan (CSJ) Award for Young Chemists FY2013
2014 Jan 29-31	The first edition of the TNT Japan (Trends in Nanotechnology) conference was held at Tokyo Big Sight with a "MANA Day" on January 30
2014 Jan 29-31	An exhibition of research results obtained by MANA Scientist Mitsuhiro Ebara, was awarded the Project Prize at the 13th nano tech International Nanotechnology Exhibition & Conference (nano tech 2014)
2014 Feb 28	MANA signed a Memorandum of Understanding (MOU) with St. Petersburg State Electrotechnical University (LETI), Russia
2014 Mar 3-4	The MANA/ICYS Reunion Workshop was held at MANA

Date	Event
2014 Mar 5-7	The 7th MANA International Symposium was held in Tsukuba
2014 Mar 7	MANA signed a Memorandum of Understanding (MOU) with University of Bristol, Bristol Centre for Nanoscience and Quantum Information (NSQI), UK
2014 Mar 11-12	The Japan-Taiwan Joint Workshop on "Nanospace Materials" was held at Fukuoka Institute of Technology
2014 Mar 24	The 5th NIMS/MANA-Waseda University Joint Symposium was held at NIMS

Date	Event
2014 Mar 24-25	The International Symposium on Smart Biomaterials was held at MANA
2014 Mar 27	MANA Independent Scientist Takako Konoike was awarded the 8th (2014) Young Scientist Award of the Physical Society of Japan
2014 March 29	MANA Scientist Lok Kumar Shrestha received the Distinguished Lectureship Award of the Chemical Society of Japan (CSJ) Asian International Symposium

Fiscal Year 2014

Date	Event
2014 Apr 1-2	The International Workshop *Topology in the New Frontiers of Materials Science* was held at MANA
2014 Apr 11	A MANA scientific art picture entitled "Rainbow Cube" by two MANA Scientists, Lok Kumar Shrestha and Jonathan Hill, received the Award for Excellence at the 8th "Beauty in Science Technology Panel exhibition" organized by the Japan Science and Technology Agency (JST)
2014 May 12	MANA Principal Investigator Dmitri Golberg was awarded the 59th JSM Seto Prize of the Japanese Society of Microscopy
2014 May 26	MANA Principal Investigator Kohei Uosaki was awarded the 18th Surface Science Society of Japan Prize
2014 Jun 18	Thomson Reuters announced the "ISI Highly cited researchers 2014," whose number of citations is in the top 1% of a certain research field. This elite group contains 5 Principal Investigators from MANA:: Katsuhiko Ariga, Yoshio Bando, Dmitri Golberg, Zhong-Lin Wang and Prof. Omar Yaghi
2014 Jun 22-26	The 12th International Workshop on Beam Injection Assessment of Microstructures in Semiconductors (BIAMS 12) was held at MANA
2014 Jul 18	The International Symposium on Material Architectonics for Sustainable Action (MASA 2014) was held at MANA
2014 Sep 1-2	7th MANA Site Visit by the WPI Program Committee
2014 Sep 9	MANA signed a Memorandum of Understanding (MOU) with Donostia International Physics Center (DIPC), San Sebastian, Spain
2014 Sep 17	MANA Principal Investigator Kazuhito Tsujagoshi and MANA Research Associate Katsuyoshi Komatsu received the "Paper Award 2014" by the Japan Society for Applied Physics (JSAP)
2014 Oct 24	A talk by MANA Principal Investigator Katsuhiko Ariga where he explained about *Nanoarchitectonics* has been broadcasted in Radio Tsukuba

Date	Event
2014 Nov 19	7th Follow-up Meeting by the WPI Follow-Up Committee
2014 Nov 26-28	The 2nd International Symposium on the Functionality of Organized Nanostructures (FON'14) was held at the National Museum of Emerging Science and Innovation in Odaiba, Tokyo
2014 Dec 31	MANA signed a Memorandum of Understanding (MOU) with University of Eastern Finland, Finland
2015 Jan 13	MANA signed a Memorandum of Understanding (MOU) with Indian Institute of Science (IISc), Bangalore, India
2015 Jan 28-30	An exhibition of research results obtained by MANA Independent Scientist Genki Yoshikawa was awarded the Project Prize at the 14th nano tech International Nanotechnology Exhibition & Conference (nano tech 2015)
2015 Jan 21	MANA signed a Memorandum of Understanding (MOU) with University of Toronto, Canada
2015 Jan 30	MANA Principal Investigator Guoping Chen has been admitted as a Fellow of the Royal Society of Chemistry
2015 Feb 25-26	The 4th MANA Grand Challenge Meeting was held in Nasu, Tochigi prefecture
2015 Mar 9	MANA Scientist Satoshi Ishii received the Konica Minolta Imaging Science Encouragement Award for FY2014
2015 Mar 11-13	The 8th MANA International Symposium was held in Tsukuba
2015 Mar 13	4th MANA Evaluation Committee Meeting
2015 Mar 18	MANA Scientist Jin Kawakita received the Japan Institute of Metals and Materials Meritorious Award
2015 Mar 31	MANA Scientist Mitsuhiro Ebara received the Silver Award of the Tanaka Precious Metals' 2014 "Precious Metals Research Grants"

Fiscal Year 2015

Date	Event
2015 May 15	MANA signed a Memorandum of Understanding (MOU) with Chongqing University of Science & Technology (CQUST), China
2015 May 29	MANA signed a Memorandum of Understanding (MOU) with Paul Drude Institute for Solid State Electronics (PDI), Germany
2015 May 30	MANA signed a Memorandum of Understanding (MOU) with National Cheng Kung University (CKU), Taiwan
2015 Jun 29 – Jul 3	The 9th Nanotechnology Summer School with students from Japan, Canada, US, Australia, and France was held at MANA
2015 June 30	Group Leader Yoshitaka Tateyama received the "German Innovation Award - Gottfried Wagener 2015"
2015 July 4	MANA Scientist Satoshi Ishii received the Ando Incentive Prize for the Study of Electronics 2015
2015 Jul 29	The 6th NIMS/MANA-Waseda University Joint Symposium was held at Waseda University
2015 Jul 29-30	The International Symposium on Nanoarchitectonics for Mechanobiology was held at MANA
2015 Jul 30	MANA Principal Investigator Katsuhiko Ariga received the Japan Society of Coordination Chemistry Contribution Award
2015 Aug 7, 8	Research of MANA Scientist Mitsuhiro Ebara has been featured in Japanese television news (NHK Ibaraki, NHK)
2015 Sep 15	MANA signed a Memorandum of Understanding (MOU) with University of Washington (UW), USA
2015 Sep 24	MANA signed a Memorandum of Understanding (MOU) with University of Science and Technology of Hanoi (USTH), Vietnam
2015 Sep 25-26	8th MANA Site Visit by WPI Program Director, WPI Program Officer, MEXT and JSPS
2015 Sep 29	MANA signed a Memorandum of Understanding (MOU) with University of Wollongong (UOW), Australia
2015 Sep 29	Research of MANA Independent Scientist Genki Yoshikawa has been featured in Japanese television (Nittere CS news)
2015 Oct 15-16	The MANA-RSC Symposium: Materials for Energy Generation and Storage was held at MANA
2015 Oct 16	8th Follow-up Meeting by the WPI Follow-Up Committee
2015 Oct 17	Research of MANA Independent Scientist Genki Yoshikawa has been featured in Japanese television (NHK news)
2015 Oct 20	Research of MANA Independent Scientist Genki Yoshikawa has been featured in Japanese television documentary "*News no kimo*" (Essential news) on Fuji TV
2015 Nov 9	MANA Satellite Principal Investigator Françoise M. Winnik received the Urgel Archambault Prize 2015
2015 Nov 10	MANA Satellite Principal Investigator Yukio Nagasaki received the 15th Japan DDS society NAGAI Award
2015 Nov 11	MANA scientist Mitsuhiro Ebara received the 37th Japanese Society for Biomaterials Scientific Incentive Award
2015 Nov 27-28	The 5th MANA Grand Challenge Meeting (together with the Institute for Solid State Physics (ISSP) of the University of Tokyo) was held in Nasu, Tochigi prefecture
2015 Dec 2	MANA Research Associate Mahito Yamamoto received the Japan Society of Applied Physics (JSAP) Young Scientist Presentation Award
2016 Jan 8, 15	The 6th MANA Grand Challenge Meeting (together with Tokyo University of Science) was held in two parts at Tokyo University of Science (on Jan 8) and at MANA (on Jan 15)
2016 Jan 10, 27	Research of MANA Independent Scientist Genki Yoshikawa has been featured in Japanese television news (NHK, NHK Ibaraki)
2016 Jan 18	MANA signed a Memorandum of Understanding (MOU) with University of Chemistry and Technology (UCT), Czech Republic
2016 Feb 16	MANA signed a Memorandum of Understanding (MOU) with University of Sydney, Australia
2016 Feb 18	Research of MANA Scientist Tetsushi Taguchi has been featured in Japanese television news (NHK Ibaraki)
2016 Mar 9-11	The 9th MANA International Symposium was held in Tsukuba
2016 Mar 13	Research of MANA Scientist Mitsuhiro Ebara has been featured in the Japanese television documentary "*Yume no Tobira*" (A door opened to dreams) on TBS

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International Center for Materials Nanoarchitectonics (MANA)
National Institute for Materials Science (NIMS)

1-1 Namiki, Tsukuba, Ibaraki 305-0047, JAPAN
Phone: +81-29-860-4709, Fax +81-29-860-4706
E-mail: mana@nims.go.jp
URL: http://www.nims.go.jp/mana/

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