MANA Progress Report

Facts and Achievements 2014

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 original five centers under the World Premier International Research Center Initiative (WPI Program) of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT). Our vision is to "create a better future for humanity by supporting the development of new materials through opening up a new paradigm of nanotechnology." We believe that conceptual innovation must be brought into the nanotechnology developed to date. We express the concept of this innovated nanotechnology by the term nanoarchitectonics.

MANA achieved remarkable research results in the past 7 years. MANA's excellence is apparent from several indicators. For example, A) the number of papers in the world's top 1% by the number of citations has reached 106, B) MANA has achieved a very high field-weighted citation impact (FWCI) — a new indicator devised by Elsevier to fairly compare the quality of papers published by interdisciplinary research institutions — of 2.44 (both statistics are based on papers published between 2008 and 2014), and C) the average impact factor (IF) of journals in which MANA researchers have published papers is very high 5.36. These figures far exceed those of many other world-class research institutes.

The MANA Progress Report consists of two booklets named "Research Digest 2014" and "Facts and Achievements 2014". This booklet "Facts and Achievements 2014" serves as a summary to highlight the progress of the MANA project. The other booklet "Research Digest 2014" presents MANA research activities.

wpi

Nano Revolution
for the Future

NIMS

MANA Progress Report
Facts and Achievements 2014

1. WPI Project Progress Report

In July 2014, MANA submitted a WPI Project Progress Report and Plan for Fiscal Years 2007-2013 to the WPI Program Committee. The full report is published on the website of Japan Society for the Promotion of Science (JSPS) (see www.jsps.go.jp/english/e-toplevel/). The first six pages of the report entitled *World Premier International Research Center Initiative (WPI) Executive Summary (For Extension application screening)* are reproduced below. This executive summary covers the first 6.5 years of the MANA project (from October 2007 to March 2014) and consists of two parts *Progress Report* (A) and *Progress Plan* (B).

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

World Premier International Research Center Initiative (WPI) Executive Summary (For Extension application screening):

A. Progress Report of the WPI Center

I. Summary

MANA has grown into a world-class research hub for the fields it handles after the 6.5 years since its launch. MANA has accomplished remarkable research achievements from the basics to application.

MANA's excellence is apparent from several indicators. For example, A) the number of papers in the world's top 1% by the number of citations has reached 80, B) MANA has achieved a very high field-weighted citation impact (FWCI) — a new indicator devised by Elsevier to fairly compare the quality of papers published by interdisciplinary research institutes — of 2.5, and C) the average impact factor (IF) of journals in which MANA researchers have published papers is very high 5.24. These figures exceed those of many other world-class research institutions.

MANA has a unique characteristic as compared with many other materials science research institutions around the world. Namely, MANA is operated on the basis of our new concept of "nano- architectonics", which is a new paradigm of nanotechnology. We believe that this unique concept has been an important key in accomplishing the remarkable research achievements of MANA.

In 6.5 years, MANA has made various outstanding research. Typical examples are a) "nanosheet technology" and its application, b) "atomic switch" and related devices, c) various single-molecule level devices, d) highly-efficient photocatalysts, e) nanoarchitectonic diagnosis and treatment, f) transmission electron microscopy combined with mechanical, electrical and optical measurements, g) multiple-probe scanning probe microscopes for nanoscale electrical conductance measurement, etc.

MANA has established one of the most internationalized research centers in Japan with a foreign researcher ratio of more than 50%. MANA has succeeded in developing a near perfect research environment by providing swift administrative and technical support to all researchers regardless of nationality. We have provided our knowledge of running an international research center to the rest of NIMS and outside institutions in Japan. We have made dramatic improvements in NIMS's ability to provide support in English to foreign researchers.

The cultivation of young researchers is another key pillar of MANA in addition to the four pillars of the WPI Program. The Independent Scientist (about 20% of permanent researchers) and ICYS Researcher (about 20% of postdocs) systems, in which researchers conduct independent research without belonging to a specific group, have posted good results.

The research undertaking at MANA is recognized as one of NIMS's priority R&D fields, and MANA is positioned as the Nanoscale Materials Division, one of NIMS's three research divisions. In other words, MANA has become a permanent unit of NIMS's research organization. Thus NIMS has supported MANA extensively by providing approximately 90 tenure positions, allocating about ¥1.5 billion annually.

II. Items

1. Overall Image of Your Center

<Vision and Background>

When MANA was established 6.5 years ago, nanotechnology (and its foundation, nanoscience) was progressing rapidly and fast becoming indispensable in the field of materials science. Amid this backdrop, we designed MANA with the intention of creating a world-leading research center that could boldly promote the development of new materials through the effective use of nanotechnology. We were keenly aware that the true power of nanotechnology could not be harnessed without acknowledging that nanotechnology was essentially different from conventional microtechnology and that the usual view of nanotechnology as an extension of microtechnology was incorrect, so that we put our vision in:

> "Pioneering a new paradigm of nanotechnology for new materials development".

At the same time, to express the new paradigm of nanotechnology succinctly and clearly, we proposed the concept of "nanoarchitectonics", which is discussed in Progress Report in detail. This concept has made MANA's research distinctive among the world's nanotechnology research institutions. We are happy that the concept of nanoarchitectonics is starting to gain acceptance around the globe.

<Present Status>

MANA has four research fields, Nano-Materials, Nano-Systems, Nano-Power and Nano-Life fields. At present, 22 PIs, 2 Associate PIs, 75 permanent researchers, 72 postdoctoral researchers and 36 students are working in the four research fields and they are supported by 29 administrative and technical staff. The present status of MANA can be summarized in the following five points:

- MANA has realized world's top-level research activities;
- With a foreign researcher ratio of 51%, MANA has become a truly international research center;
- MANA is actively engaged in research that combines nanotechnology with other fields;
- MANA has fulfilled its responsibility to promote reforms in the host institution NIMS very well;
- MANA has produced outstanding young researchers who are now active around the world.

<Future Perspective>

Based on our experience and confidence in the successful 6.5 years, MANA will further promote the development of nanoarchitectonics and its fusion with various research fields. Our final goal is of course to develop earth-shaking new materials for realizing various revolutionary technologies.

2. Research Activities

<Outstanding Research Results>

Research in MANA has been conducted in the four research fields (Nano-Materials, Nano-Systems, Nano-Power and Nano-Life fields) as mentioned already. Selected outstanding research results from the four research fields are:

A) Opening a "nanosheet"-based new horizon for novel materials creation. We are proud of having developed an original method to create various new materials with novel useful properties. The realization of metamaterials and novel superconductors with this method is our next challenge.

B) Development of the "atomic switch" and related prospective devices and systems. We are also proud of having invented the atomic switch, which is a promising beyond CMOS device (in collaboration with NEC Corp.). More importantly, the atomic switch in a certain condition is similar to the synapse of our brain in functionality. The realization of neuromorphic network circuits consisting of such atomic switches is our next challenge.

C) World's top level efficiency of photocatalysts: We have also succeeded in artificial photo- synthesis of methane, for example. Our next challenge is to increase the efficiency of artificial photosynthesis dramatically using various nanoarchitectonic systems.

D) Development of an original ultra-sensitive/ultra-parallel molecular censing method (membrane- type stress sensor: MSS): The sensitivity of this method is over 100 times higher than conventional cantilever sensors. We have succeeded to distinguish between cancer patients and healthy persons by breath analysis (in collaboration with Basel University, Switzerland).

E) Development of innovative nanoscale characterization methods: We have developed a trans- mission electron microscope (TEM) in which the mechanical, electrical and optical properties of a nanoscale sample can be measured under high-resolution image observation. Also, multiple-probe (2, 3 or 4 probes) scanning tunneling microscopes (STM), atomic force microscopes (AFM) and Kelvin force microscopes have been developed; this has enabled electrical conductance measurements at the nanometer scale.

<MANA's Three Grand Challenges>

MANA has declared the following three grand challenges:

★ Nanoarchitectonic artificial brain
★ Room-temperature superconductivity
★ Practical artificial photosynthesis

We consider these as long-term research objectives, but some intriguing preliminary outcomes have already been obtained. Such results concerning the first and third grand challenges were in part touched in B) and C) of the previous section. Regarding the second grand challenge, we have attempted to transform insulators or semiconductors into superconductors by injecting electrons or holes by field effect. So far, we have succeeded to make pure diamond metallic. Apart from this, we have found theoretically 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 temperatures above room temperature up to 600 K. An experiment has been launched in an attempt to prove this theory.

<Application of Research Results>

Many fundamental researches at MANA have led to applied researches in collaboration with various companies such as NEC, HONDA, Murata, Tokyo Chemical Industry, etc. In 2007-2013, MANA researchers applied for 640 patents (435 in Japan and 205 overseas) and had 416 patents registered (318 in Japan and 98 overseas).

3. Interdisciplinary Research Activities

<Strategies>

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

A) Fusion Research Fund,
B) Theory-Experiment Fusion Research Fund,
C) Nano-Life Fusion Research Fund,
D) Grand Challenge Research Program.

Based on the belief that promoting joint research across different fields can lead to the creation of new research fields, we opened these funds to applications from MANA's young researchers. The selection of proposals was done by organizing a special committee.

<Typical Examples>

Selected examples of the interdisciplinary research activities are as follows:

- A wide range of research on nanosheet technology; from the basics to applications
(Fusion of soft chemistry, materials physics and electronic device technology)
- A wide range of research on the atomic switch; from the basics to applications
(Fusion of electrochemistry, electronic device technology and neuroscience)
- Development and application of ultra-sensitive/ultra-parallel molecular sensors
(Fusion of animal olfactory organs, nanoarchitectonics and medical diagnosis)
- Development of efficient *artificial photosynthetic systems*
(Fusion of photocatalytic chemistry, plant photosynthesis and nanoarchitectonics)
- Cancer and Alzheimer's disease treatments *using nanoarchitectonics*
(Fusion of *medical care and nanoarchitectonics*)
- Exploration of decoherence-free quantum bits, room-temperature "superconducting" devices
(Fusion of theory and experiment)

4. International Research Environment

<International Circulation of Best Brains>

MANA has established satellites in the research institutes to which its external Principal Investigators are affiliated. At present, there are satellites at four overseas institutions: UCLA, Georgia Tech, CNRS-CEMES, Univ. Montreal. These satellites play important roles in each of MANA's research fields and serve as training grounds for MANA's young researchers. In addition, the number of famous scientists, young faculty members, students and other researchers who visit MANA from around the world increases every year.

ICYS Researchers, established as tenure-track positions for permanent researchers at NIMS, are hired twice a year by way of international open recruiting. Over the past 6.5 years, 40 researchers have been hired at MANA from a total of 942 applicants.

Eight postdocs from MANA have been appointed as NIMS permanent researchers, and 171 have leveled up to universities and research institutions in Japan and around the world.

One of MANA's missions is to become a hub and build a network connecting the world's nanotechnology centers. At present, MANA has memoranda of understanding (MOU) with 34 research institutes in 15 countries and promotes research and personnel exchange with these partners.

<System for Supporting the Research Activities of Overseas Researchers>

All of the staff in MANA's Administrative Office are fluent in English, and they provide all researchers, regardless of age or nationality, with the same highly attentive, Japanese-style services: bilingual documentation and communication, livelihood support, technical support, Japanese language and culture courses, etc.

<Others>

The Independent Scientist and ICYS Researcher systems, in which researchers conduct independent research without belonging to a specific group, have posted good results in terms of the recruitment and training of young researchers.

To cultivate internationally-minded, interdisciplinary Japanese researchers, we encourage young Japanese permanent researchers to go overseas and conduct research at major foreign research institutions for long periods of time. We also established the YAMATO-MANA Program to attract outstanding young Japanese researchers to MANA and cultivate Japan's future research leaders.

5. Organizational Reforms

<Decision-Making System in the Center>

The Director-General has successfully recruited outstanding researchers from around the globe and created an atmosphere in which they can freely engage in research and hone their skills through friendly rivalry.

He has exhibited the strong leadership in all aspects of Center administration, including setting research policy, streamlining systems, adopting new measures and distributing research resources. In addition, he has helped to firmly establish the concept of nanoarchitectonics worldwide by holding numerous research forums, publishing special features on nanoarchitectonics in well-known journals and distributing an online newsletter.

<Arrangement of Administrative Support Staff and Effectiveness of Support System>

MANA has succeeded in developing a near perfect research environment in which MANA can provide swift administrative and technical support to all researchers regardless of nationality.

<System Reforms Advanced by WPI Program and Their Ripple Effects>

System reforms at MANA

(1) Promotion of interdisciplinary research by adopting new programs.
(2) Thorough internationalization of MANA by promoting bilingual administration and providing research and livelihood support to foreign researchers.
(3) Cultivating and recruiting young researchers by adopting new systems: ICYS and 3D system.

Ripple effect on the host institution

(1) Building a system in which the structural reforms undertaken at MANA can be easily transferred to NIMS: imposing the MANA's role in NIMS's five-year plan.
(2) Dramatic improvements in NIMS's ability to provide support in English by implementing programs to improve the English proficiency of NIMS administrative staff and producing major documents and internal announcements in both Japanese and English.
(3) Provision of young excellent researchers to NIMS as permanent researchers.
(4) Provision of our knowledge of running an international research center to other centers of NIMS and outside institutions in Japan.

<Support by Host Institution>

NIMS supports MANA extensively by providing staff, research funds and research space and delegating operational authority to the Director-General. Since MANA's founding, NIMS has allocated approximately ¥1 billion annually for research project expenses and more than ¥400 million annually for project promotion expenses from its operations subsidies.

<Position of the Center within the Host Institution's Mid-Term Plan>

In NIMS's third five-year plan, launched in April 2011, MANA's development of innovative new materials based on nanoarchitectonics was recognized as one of NIMS's priority R&D fields, and MANA was positioned as the Nanoscale Materials Division, one of NIMS's three research divisions. NIMS is also increasing the number of MANA's permanent researchers and administrative staff. Sixteen new permanent staff were added between April 2011 and March 2014, bringing the total number of permanent staff at MANA to 89 (as of March 31, 2014).

B. Progress Plan

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

<Outline>

In preparation of MANA's extension application, we conducted a detailed analysis of our research achievements to date. The analysis clearly highlighted the importance of cross-linking theoretical and experimental research and fusing nanotechnology (nanoarchitectonics) with the life sciences. In the extension period, MANA will vigorously promote these two types of fusion.

Also, when we analyzed the progress made on the three grand challenges that MANA has declared, we found that several promising preliminary outcomes had been obtained. Therefore, we decided to continue pursuing these in the extension period. In addition, we add another grand challenge related to the fusion of nanotechnology (nanoarchitectonics) with life science mentioned above.

<Theory-Experiment "Cross-linkage" (Fusion)>

In the extension period, MANA will organize a fifth field, Nano-Theory field, in addition to the existing four research fields (Nano-Materials, Nano-Systems, Nano-Power and Nano-Life fields). The new Nano-Theory field will be a large group of about 50 theoreticians. This means that about one- fourth of MANA researchers will be theoreticians.

Despite the fact that many interesting nanoscale phenomena are accompanied by excited states, dynamic processes and many-body effects, contemporary first principles calculations are not conducive to handling these. To overcome this obstacle, we will introduce bold yet appropriate approximation methods to spur a new trend in theoretical research. This will encourage the fusion of theoretical research with experimentation. Not only will the Nano-Theory field fuse theory and experimentation, it will act to promote interdisciplinary research among MANA's four other experimentation-oriented research fields.

< **MANA's Unique Nano-Life Research** >

MANA established the Nano-Life field with the aim of creating a new field that fuses MANA's world-leading nanotechnology with the life sciences. One important feature of MANA is this environment in which high caliber nanotechnology (nanoarchitectonics) and life science researchers work side-by-side and gain a thorough understanding of each other's disciplines. This has recently started producing remarkable results. In the extension period, we will take advantage of this environment to renew the Nano-Life field. We aim to create new, never-before-seen things and systems by studying the functions of cells (which are the building blocks of life), sensory organs and the brain, the most complex biological structure, and incorporating the knowledge gained into our best nanoarchitectonics technologies. Conversely, we will also promote the active utilization of nano- architectonics technologies in Nano-Life research.

<MANA's Grand Challenges>

MANA has declared three grand challenges and will continues pursuing the three grand challenges in the extension period. In addition, we add another grand challenge related to the fusion of nanotechnology (nanoarchitectonics) with life science:

★ Nanoarchitectonic supreme bio-sensing.

To tackle this challenge, we will make full use of MANA's original nanoarchitectonic techniques and nanoscale measurement methods such as multiple-probe scanning probe microscopes and ultra- sensitive/ultra-parallel molecular sensors.

2. Management System of the Research Organization

<Research Organizational Management System>

In April 2016, one year before the end of the 10-year project period, NIMS will launch its next Seven-Year Plan and MANA will implement the following key structural reforms: appointing a new Deputy Director, shuffle of PI lineup, constructive dissolution of MANA satellites, establishing Nano-Theory field, strengthening Nano-Life field, investment in MANA Grand Challenges, encouraging innovative and challenging research.

<Initiatives and Plans that will Impel System Reforms>

Reforming NIMS: The administrative experience cultivated at MANA and thorough clerical and technical support systems will be transplanted into NIMS.

Internationalizing NIMS and Other Japanese Research Institutions and Universities: We will strive to export MANA's research environment to other research institutions and universities aside from NIMS.

Promoting Global Research Exchange: MANA has grown into a world-class research center that attracts researchers from around the globe, and our name recognition has increased. We will expand our network beyond the leading countries of the West to include every country and region in the world.

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

<Position of the Center within the Organization of the Host Institution>

NIMS's next seven-year plan will begin in April 2016, one year before the conclusion of the originally scheduled WPI Project period (10 years). As such, this plan will make the necessary revisions to MANA's organization and research fields before then in preparation for the extended operation of the Center beginning in April 2017. In subsequent seven-year plans, MANA will continue to handle one of NIMS's Priority R&D Fields and will remain a core part of the Institution's research.

<Host Institution's Implementation Plan for Sustaining and Advancing the Center>

Regardless of whether the WPI program grant is extended or not, NIMS promises to provide MANA with the following research resources so that it can continue its basic activities.

i) Provision of approximately 90 tenure positions to MANA, including Principle Investigators, other scientists and administrative staff.

ii) Annual allocation of research project expenses and center activity expenses from NIMS's operations subsidies totaling about ¥1 billion/year to MANA.

After the WPI program concludes, in addition to i) and ii) above, we intend to take the following measures.

iii) We will replace the post-docs and other fixed- term employees hired using the WPI grant with those hired using external funding.

iv) MANA's original programs such as young researcher development programs, symposia and outreach activities will be transferred to NIMS.

v) In order to continue the administrative and technical research support that is especially advanced at MANA, we will create a replacement framework and boost research support functions by reforming NIMS's systems.

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 March 2015 (see www.jsps.go.jp/english/e-toplevel/).

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.

Fig. 2-1: WPI logo.

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.

● Outline of WPI Program

Competition for securing the world's finest brains has intensified over recent years. So that Japan may take a world lead by virtue of its strength in science and technology amidst this demanding environment, it needs to place itself within the global flow of outstanding human resources while creating open research platforms that attract such people from around the globe.

Given this perception, the World Premier International Research Center Initiative (WPI) provides concentrated support for projects implemented by Japanese universities and research institutes aimed at building top world-level research centers staffed by the highest caliber of core researchers. By achieving a very high research standard and providing an excellent research environment, these centers should possess a level of *global visibility* that attracts top researchers from around the world. They are given a high degree of autonomy, allowing them to virtually revolutionize conventional modes of research operation and administration in Japan.

The program is underscored by four main concepts:

- advancing leading edge research
- establishing international research environments,
- reforming research organizations, and
- creating interdisciplinary domains.

To realize them, the WPI centers advance research activities and create new disciplines under the strong leadership of their center director. The content of WPI program is summarized in Table 2-1.

Table 2-1: Content of WPI program.

Targeted fields:	Fields of basic research
Funding period:	10-15 years
Project Funding:	Around ¥1.4 billion per year per center (¥ 700 million)
WPI center staffing:	● 10-20 world-class principal investigators (~10 PI) ● About 200 researchers and staffs (~100 persons) ● At least 30% of the researchers from overseas
International-standard working and living environments:	● Strong leadership by center director ● Merit-based salary system ● Strong support functions for researchers ● English as the primary working language ● Housing and support for child education and daily living
Follow-up Procedure:	● WPI Program Committee conducts follow-up activities on progress being made by the WPI centers with an eye to developing them into *highly visible research centers*

Note: (): Centers selected in 2012

Table 2-2: The 9 WPI research centers (as of January 2015).

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

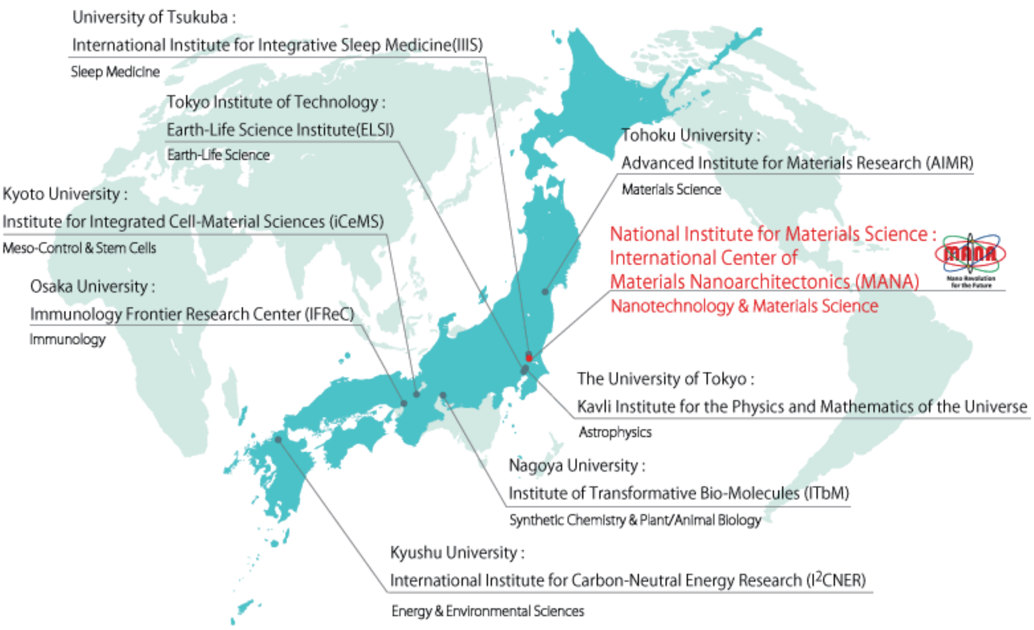


Fig. 2-2: Location of the 9 WPI research centers.

● **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 2-2 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.

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

MANA's Vision

Toward a better global future:

Pioneering a new paradigm

in materials development

using nanoarchitectonics concept

MANA's Mission

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

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

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

Construct a world wide network
of nanotechnology centers

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

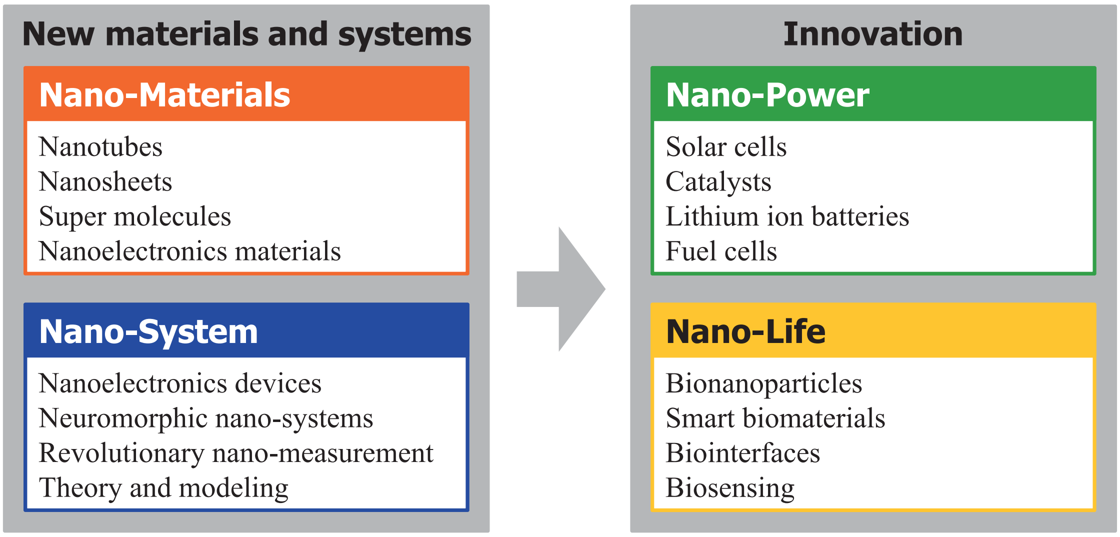


Fig. 2-4: The four research fields of MANA (as of January 2015).

Nanoarchitectonics has the following four essential characteristics:

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

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

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

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

Based on this paradigm of nanoarchitectonics, MANA is engaged in a full range of research, from basic to applied, in four research fields: Nano-Materials, Nano-System, Nano-Power and Nano-Life (Fig. 2-4).

● 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. 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 2014 are listed in Table 2-3.

The Evaluation of MANA by the WPI Program Committee consists of an annual 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 WPI Program Committee and MEXT and JSPS Officials was held in the auditorium of the new WPI-MANA Building on September 25-26, 2014 (Fig. 2-5). This site visit was part of MANA’s application for a possible 5-year extension after the initial 10-year supporting period until March 2017.

Table 2-3: Program Director (PD), Program Officer (PO) and Working Group members for MANA in Fiscal Year 2014.

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, 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 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**

Fig. 2-5: The seventh MANA Site Visit in September 2014. WPI Program Director, Prof. Toshio Kuroki (left) and MANA Center Director, Prof. Masakazu Aono (right).

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.

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.

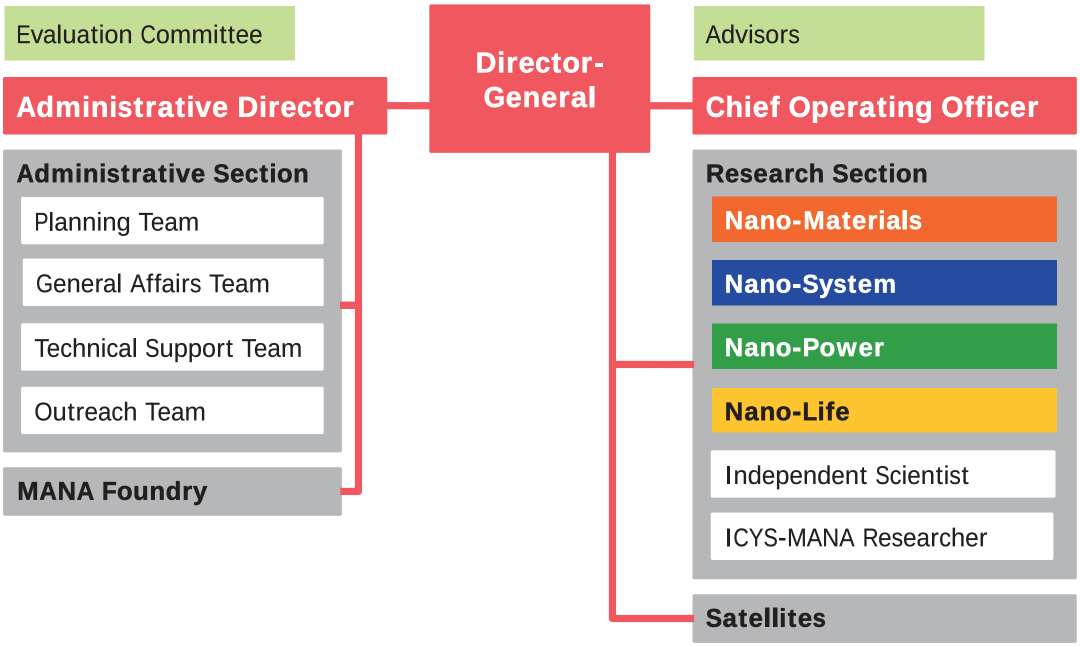


Fig. 3-1: Organization of MANA (as of January 2015).

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, 2015, consisting of 209 researchers and 28 technical and administrative staff. The proportion of foreign researchers is 51.7% from 25 different countries (Table 3-3), showing MANA is now really international. The proportion of female researchers is 18.7%, and MANA would like to further increase this number.

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

Table 3-2: MANA workforce (as of January 1, 2015).

Position	**Number**	**Non-Japanese**	**Female**
Principal Investigators	22	8	2
Associate Principal Investigators	2	1	0
Group Leaders	11	0	1
MANA Scientists	51	7	9
Independent Scientists	15	3	2
ICYS-MANA Researchers *	10	8	0
MANA Research Associates *	60	47	14
JSPS Fellows *	5	4	1
Junior Researchers #	33	30	10
Technical Staff	11	0	3
Administrative Staff	17	1	14
Total	**237**	**109**	**56**

*: Postdocs #: Graduate Students

Proportion of Foreign Researchers: 51.7% (108/209)
Proportion of Female Researchers: 18.7% (39/209)

Table 3-3: MANA workforce with foreign nationality (as of January 1, 2015).

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	3	19	1	23		52
	India				1	15				16
	Korea		1			1		4		6
	Nepal		1				1			2
	Indonesia					1				1
	Myanmar					1				1
	Pakistan							1		1
	Singapore					1				1
	Taiwan					1				1
	Thailand		1							1
	Vietnam					1				1
Oceania	Fiji							1		1
Europe	France	1			1	3				5
	UK	2	1		1					4
	Russia	1		1						2
	Belgium				1					1
	Czech					1				1
	Finland						1			1
	Germany					1				1
	Greece					1				1
	Switzerland								1	1
Near East	Iran					1	1			2
Africa	Algeria				1					1
	Egypt							1		1
America	USA	2		1						3
	Canada	1								1
Total		**9**	**7**	**3**	**8**	**47**	**4**	**30**	**1**	**109**

● **MANA Advisors**

As of January 2015, 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 2015, the MANA Evaluation Committee is composed of eight external eminent scientists (Appendix 7.4) and is chaired by Prof. Cheetham from the University of Cambridge. To date, the committee has met four times, once each in 2008, 2010, 2012 and 2015 (Fig. 3-2), 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

Fig. 3-2: The 4^{th} MANA Evaluation Committee meeting was held in Tsukuba on March 13, 2015.

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**

Unique Triple Double (3D) System

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

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

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 (Fig. 3-3).

• *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.

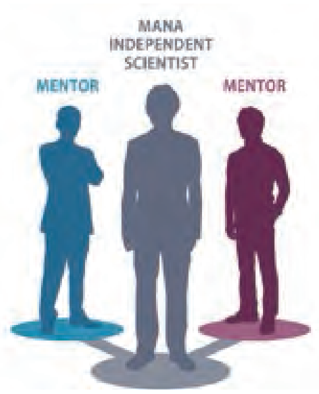


Fig. 3-3: Training of MANA Independent Scientists.

• *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-MANA has been organized in MANA to continue and develop the concept of ICYS. Talented young multinational researchers will gather to conduct independent research in a melting pot environment mixing different research fields and cultures. At NIMS, ICYS researchers are hired twice a year by way of international open recruiting. Over the 7.5 years between October 2007 and March 2015, 97 scientists have worked as ICYS researchers at NIMS and of these, 47 were ICYS-MANA researchers.

● **Cutting-edge Research Facilities**

Researchers at MANA have the opportunity to use some of the world’s most advanced, highest performance research equipment at MANA’s host institution, the National Institute for Materials Science (NIMS), such as high field magnets, a dedicated beamline at Japan’s Spring-8 synchrotron facility, high-voltage und ultrahigh vacuum electron microscopes, a belt-type high-pressure apparatus, high energy X-ray photoemission spectroscopy and high precision X-ray diffractometers.

In April 2009, MANA has set up an independent *MANA Foundry* equipped with over 30 facilities for nano-fabrication and characterization to support research of nanoarchitectonics (Fig. 3-4). The purpose of *MANA Foundry* is to provide delicate support by its skilled engineers and facilities where various types of materials can be handled for researchers with diverse backgrounds from all over the world. The clean room facility consists of eight areas in its 235 m^2 floor space: Drawing and Photo Lithography, Wet Process, Etching, Film Deposition, Nano Measurement, Nano Analysis, Heat Treatment and Dicing & Wiring. *MANA Foundry* is able to provide consistent processes from test piece preparation to structural observation and functional verification including nano-gap electrode patterning by electron beam lithography on complicated structures such as nano dots, nano wires and nano sheets made of various materials like organic, inorganic, metal, insulator, magnetic, superconductor and composite.

In addition, MANA researchers have access to more than 50 “user facilities” (Fig. 3-4) and can use these with the support of experienced English speaking staff from MANA Technical Support Team (TST).

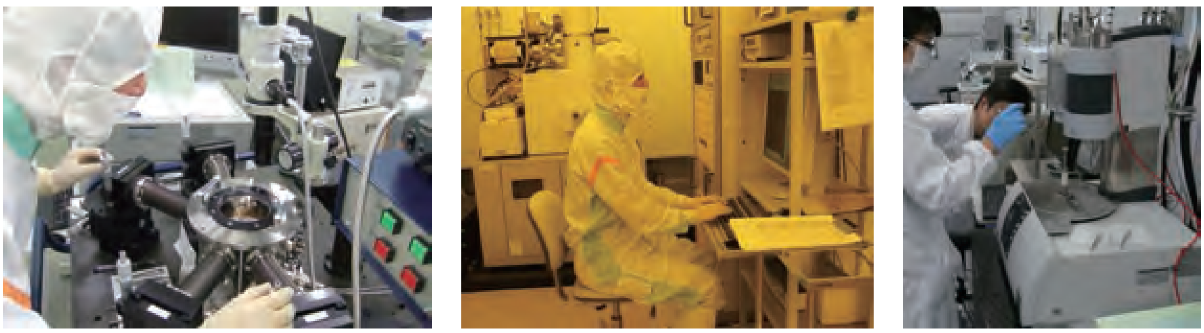


Fig. 3-4: Left and middle: Clean room facility in MANA Foundry. Right: High temperature Differential Thermal Analysis (DTA) at MANA user facility.

- **Full Support for Researchers**

Fusion of different fields and cultures creates the possibility of innovation. MANA is pursuing a *melting pot environment* (Fig. 3-5) 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 2014, MANA seminars were conducted with 18 speakers from NIMS and 63 invited renowned researchers from around Japan and the world (total 81 speakers).

Fig. 3-5: Melting pot environment has characteristics of In^4: International, Interdisciplinary, Independent, Innovative.

Appendix 7.5: MANA Seminars

MANA has created an environment where researchers can devote their full attention to their research, regardless of nationality, by adopting English as a common language and assigning experienced staff to act as secretaries providing administrative and technical support to researchers. To eliminate the barriers of language and nationality, MANA has the following system:

- Use of English for information on Web and intranet in MANA
- Use of English in documents related to administrative procedures, etc.
- Information in English about external funds
- English-language orientation for non-Japanese researchers
- English-language support by administrative staff and research support staff
- Japanese culture classes
- Research/daily life guidebook in English

The system provides information necessary for daily life, for example, about public agencies, searching for a house or apartment and emergency support. Japanese language and culture classes are held for overseas researchers at MANA in order to help deepen their understanding of Japan. 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 2014, 84 participants attended the Japanese language classes. The Japanese culture class is held monthly. Specialist instructors are invited to give lectures on traditional Japanese culture as shown in Fig. 3-6 and listed in Table 3-4. In 2014, 133 participants joined the Japanese culture classes.

Fig. 3-6: Japanese culture class events at NIMS in 2014. Top from left to right: Origami, Japanese Drum (Wadaiko), Sushi, and Kimono. Bottom from left to right: Indigo-dyeing & Japanese-weaving, Seal Carving (Tenkoku), Japanese Cuisine (Kaiseki), and Calligraphy.

Table 3-4: Schedule of Japanese culture classes in 2014.

1	2014 Jan 31 **Kimono** (14 participants)	5	2014 May 24 **Sightseeing in Japan** (10 participants)	9	2014 Sep 26 **Japanese Flower Arrangement** (8 participants)
2	2014 Feb 25 **Seal Carving (Tenkoku)** (11 participants)	6	2014 Jun 27 **Origami** (6 participants)	10	2014 Oct 31 **Seal Carving (Tenkoku)** (17 participants)
3	2014 Mar 30 **Japanese Cuisine (Kaiseki)** (8 participants)	7	2014 Jul 25 & Aug 1 **Japanese Drum (Wadaiko)** (12 participants)	11	2014 Dec 5 **Kimono** (14 participants)
4	2014 Apr 25 **Calligraphy** (8 participants)	8	2014 Aug 30 **Indigo-dyeing & Japanese-weaving** (9 participants)	12	2014 Dec 17 **Sushi** (16 participants)

● **New Research Building**

Next to the MANA Building (13,000 m^2, 5-story) at NIMS Namiki site, construction work of a new multidisciplinary research complex was completed in March 2012 (Fig. 3-7). The complex consists of two units - the NanoGREEN Building and the WPI-MANA Building (6,000 m^2, 5-story) – with the area between the two buildings serving as a free space where researchers can meet and discuss their work. The complex 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 building received the rank of S, the highest possible rating, from CASBEE, a tool for assessing and rating the environmental performance of buildings.

Fig. 3-7: The new WPI-MANA Building at NIMS Namiki site.

The WPI-MANA Building employs cutting-edge technologies, including a photocatalyst-coated glass watering system, solar panels, and sunlight-controlling louvers made of recycled wood. These technologies automatically control temperature, humidity, light and other environmental aspects to achieve both energy-savings and comfort. 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 2014**

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.

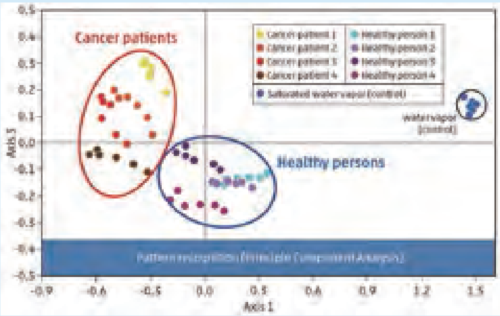
● **MANA Research Highlights**

Since September 2011, MANA has been disseminating MANA's outstanding research outcomes around the world in an online newsletter *MANA Research Highlights*. This newsletter is distributed to 2,000~3,000 media outlets and

Volume 14 (April 23, 2014):

Nanomechanical sensors detect cancer from breath

An array of functionalized membrane-type surface stress sensors (MSS) distinguishes cancer patients from healthy people through a signature response to breath samples.



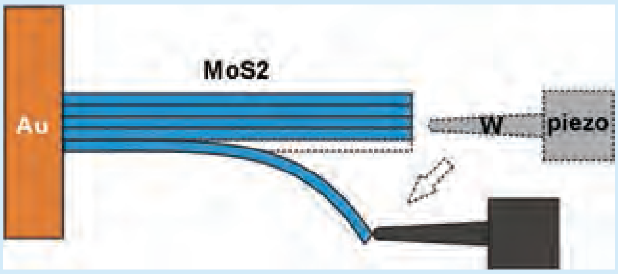
Principal Component Analysis case scores for breath samples of 4 healthy persons and 4 cancer patients.

Publication:
F. Loizeau, H.P. Lang, T. Akiyama, S. Gautsch, P. Vettiger, A. Tonin, G. Yoshikawa, C. Gerber, N de Rooij,
Piezoresistive membrane-type surface stress sensor arranged in arrays for cancer diagnosis through breath analysis,
Micro Electro Mechanical Systems (MEMS) 621 (2013).
doi: 10.1109/MEMSYS.2013.6474318

Volume 15 (June 27, 2014):

Revealing the "Scotch-tape" technique mechanism

First In-Tandem Experimental and Theoretical Modeling of a Famous "Scotch-Tape" Technique for Making Two-Dimensional Graphene-like Nanosheets.



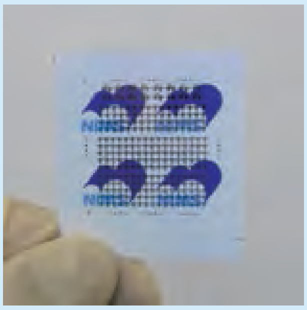
Nanomechanical cleavage of molybdenum disulphide atomic layers.

Publication:
D.M. Tang, D.G. Kvashnin, S. Najmaei, Y. Bando, K. Kimoto, P. Koskinen, P.M. Ajayan, B.I. Yakobson, P. B. Sorokin, J. Lou, D. Golberg,
Nanomechanical cleavage of molybdenum disulphide atomic layers,
Nature Communications **5**, 4631 (2014).
doi: 10.1038/ncomms4631

Volume 16 (July 10, 2014):

A cool approach to flexible electronics

A nanoparticle ink that can be used for printing electronics without high-temperature annealing presents a possible profitable approach for manufacturing flexible electronics.



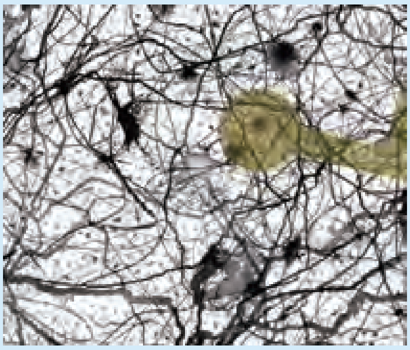
Fully printed organic thin film transistors (OTFTs) on a paper substrate.

Publication:
T. Minari, Y. Kanehara, C. Liu, K. Sakamoto, T. Yasuda, A. Yaguchi, S. Tsukada, K. Kashizaki, M. Kanehara,
Room-Temperature Printing of Organic Thin-Film Transistors with pi-Junction Gold Nanoparticles,
Advanced Functional Materials **24**(31), 4886 (2014).
doi: 10.1002/adfm.201400169

Volume 17 (August 1, 2014):

Atomic Switch Networks for Cognitive Technology

A self-organized network of inorganic synapses provides a unique approach toward the development of brain-like computers.



A look inside the ASN device reveals its highly interconnected architecture which comprises synaptic circuit elements at each point of contact between nanowires.

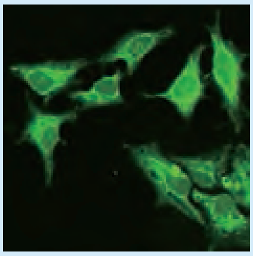
Publication:
A.V. Avizienis, H.O. Sillin, C. Martin-Olmos, H.H. Shieh, M. Aono, A.Z. Stieg, J.K. Gimzewski,
Neuromorphic Atomic Switch Networks,
Plos One **7**(8), e42772 (2012).
doi: 10.1371/journal.pone.0042772

Fig. 4-2: Volumes 14-17 of the newsletter MANA Research Highlights published in FY2014.

Volume 18 (August 29, 2014):

Intracellular imaging gets interactive

A so-called bioparallel chemistry approach is successfully used to image and activate an essential metabolism compound inside a cell.



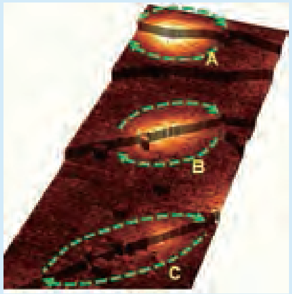
The researchers incubated ubiquinone-rhodol with HeLa cells. When the metabolic process that generates NADH was triggered in the cells the fluorescence was found to decrease.

Publication:
H. Komatsu, Y. Shindo, K. Oka, J.P. Hill, K. Ariga,
Ubiquinone- Rhodol (UQ-Rh) for Fluorescence Imaging of NAD(P) H through Intracellular Activation,
Angewandte Chemie - International Edition **53**(15), 3993 (2014).
doi: 10.1002/anie.201311192

Volume 19 (February 27, 2015):

Visualizing superconductive coupling over atomic steps

Scanning tunnelling microscopy imaging under differing magnetic fields gives fundamental insights into the behavior of supercurrents and vortices on the surface of indium-doped silicon films.



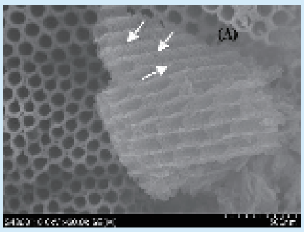
Scientists at the International Center for Materials Nanoarchitectonics have uncovered how supercurrents flow over atomic steps and terraces on indium-covered silicon surface.

Publication:
S. Yoshizawa, H. Kim, T. Kawakami, Y. Nagai, T. Nakayama, X. Hu, Y. Hasegawa, T. Uchihashi,
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

Volume 20 (March 10, 2015):

Hydrocarbon photocatalysts get in shape and go for gold

A combination of semiconductor catalysts, optimum catalyst shape, gold-copper co-catalyst alloy nanoparticles and hydrous hydrazine reducing agent enables an increase of hydrocarbon generation from CO_2 by a factor of ten.



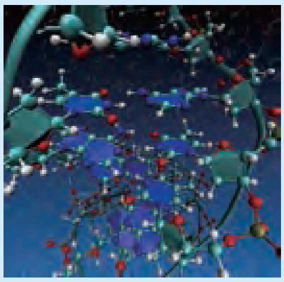
A combination approach increases the generation of hyrdrocarbons from CO_2 by a factor of ten.

Publication:
Q. Kang, T. Wang, P. Li, L.Q. Liu, K. Chang, M. Li, J.H. Ye,
Photocatalytic Reduction of Carbon Dioxide by Hydrous Hydrazine over Au-Cu Alloy Nanoparticles Supported on $SrTiO_3/TiO_2$ Coaxial Nanotube Arrays,
Angewandte Chemie - International Edition **54**(3), 841 (2015).
doi: 10.1002/anie.201409183

Volume 21 (March 27, 2015):

Supercomputing in materials science: First-principles simulations of large molecules

Large-scale calculation capable of handling material systems containing 100 to 1,000 times more atoms than conventional methods.



Snapshot structure from first-principles simulation of DNA in water medium using the calculation method developed by the research.

Publication:
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

Fig. 4-3: Volumes 18-21 of the newsletter MANA Research Highlights published in FY2014.

science journalists and to about 2,000 MANA mailing list members. Particularly outstanding research results are sent to approximately 4,000 researchers around the globe via *Science* e-mail alerts. These efforts have been an effective means of sharing MANA's outcomes with the global science community, and some of the highlighted papers have been the most downloaded articles. 21 volumes of *MANA Research Highlights* have been published between FY2011 and FY2014 (Table 4-1). The information is available on the MANA website at www.nims.go.jp/mana/research/index.html . The volumes published in FY2014 are illustrated in Figs. 4-2 and 4-3.

Table 4-1: Volumes of *MANA Research Highlights* published between FY2011 and FY2014.

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

- **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)**
  Encouragement of interdisciplinary research
- **Grand Challenge Program (7 projects, FY2011 – FY2012)**
  To promote challenging but risky research projects
- **Nano-Bio (Nano-Life) Fusion Research Program (2 projects, FY2012 – FY2014)**
  Interdisciplinary research in Nano-Bio / Nano-Life field
- **Theory-Experiment Fusion Research Program (10 projects, FY2012 – FY2014 and FY2013 – FY2015)**
  True fusion of experimental and computational science

- **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 (Fig. 4-4). 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."

Fig. 4-4: Participants of the fourth Grand Challenge Meeting in Nasu on February 25-26, 2015.

- **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 2015, 170 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 2015, 68 researchers have visited MANA within this program.

4.2 Research Output

● Research Papers of MANA

MANA's excellent research achievements are apparent from several indicators showing research activities of individual institutions in the world. Various indicators analyzed by Thomson Reuters and Elsevier show that the paper publication activity of MANA is at the world's highest level.

As shown in Fig. 4-5, MANA published 2,850 MANA affiliated research papers in English between October 2007 and December 2014, and the average impact factor (IF) of the journals in which the 2,850 papers were published is larger than 5.0 in recent years. The number of MANA papers published per year increased until 2011 and then remained at a high value of slightly above 470 papers per year. The average journal impact factor of the MANA papers increased from 4.0 in 2008 to 5.11 in 2011, and remained at an extremely high value above 5. The year 2014 (January – December) turned out to be an excellent year for MANA with the *largest number of MANA papers* (488) so far and the *highest average journal impact factor* (5.36) so far. The 488 MANA papers published in 2014 are listed in Appendix 7-6 including the *digital object identifier* (doi), the *Accession number* (WOS), and *electric identifier* (eid).

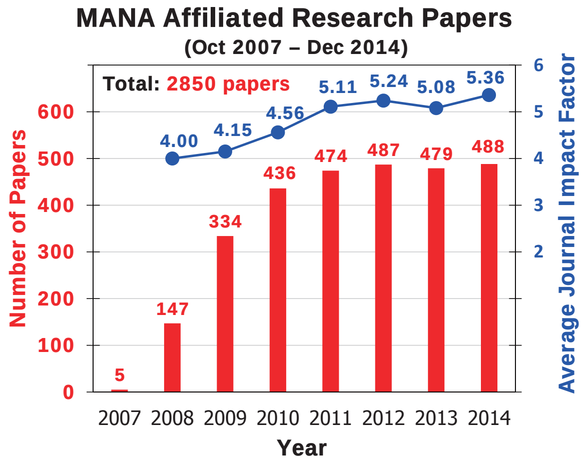


Fig. 4-5: MANA affiliated research papers in English published between October 2007 and December 2014 and average journal impact factor (Source: Web of Science database, as of June 2015).

- 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 2014

Table 4-2: Number of MANA affiliated papers published 2014 in top journals with an impact factor 2014 above 7.5.

Name of journal	Journal impact factor 2014 *	Number of MANA papers 2014
Chemical Reviews	46.568	1
Chemical Society Reviews	33.383	2
Energy & Environmental Science	20.523	2
Advanced Materials	17.493	5
Advanced Energy Materials	16.146	1
Nano Today	15.000	2
Nano Letters	13.592	3
ACS Nano	12.881	17
Journal of the American Chemical Society	12.113	10
Advanced Functional Materials	11.805	6
Nature Communications	11.470	2
Angewandte Chemie - International Edition	11.261	2
Nano Energy	10.325	5
Chemical Science	9.211	1
Biomaterials	8.557	1
Small	8.368	3
Chemistry of Materials	8.354	5
Journal of Controlled Release	7.705	1
ChemSusChem	7.657	1
Physical Review Letters	7.512	1

*: Source: Web of Science database, as of June 2015.

The high quality of MANA's research is witnessed by a large number of papers that our researchers have published in high impact journals. Of the 488 papers that MANA researchers published in 2014, 71 papers (or 14.6%) appeared in top journals with an impact factor 2014 above 7.5 (Table 4-2).

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 2,850 MANA papers, 106 papers (3.7%) have achieved very high acclaim, entering the top 1% in the world by number of citations (source: Web of Science database, as of April 2015). The breakdown of the 106 MANA top 1% papers into Research Fields and Year published is illustrated in Fig. 4-6. MANA top 1% papers appeared in 42 different journals. The journals publishing a large number of MANA top 1% papers are listed in Table 4-3.

Web of Science: 106 highly cited (top 1%) MANA papers

Breakdown into Research Fields:*

Research Field	Percentage
Materials Science	45.3%
Chemistry	34.9%
Physics	12.3%
Environment/Ecology	3.7%
Engineering	1.9%
Pharmacology & Toxicology	1.9%
Total	**100.0%**

* Classified by Web of Science

Breakdown into Year published:

Year Published	Number of papers
2014	11
2013	20
2012	24
2011	17
2010	18
2009	10
2008	6
Total	**106**

Fig. 4-6: Breakdown of the 106 highly cited (top 1%) MANA papers into Research Fields (left) and Year Published (right).

Table 4-3: Journals publishing a large number of highly cited (top 1%) MANA papers.

Name of journal	Journal impact factor 2014 *	Number of MANA top 1% papers
Advanced Materials	17.493	15
Journal of the American Chemical Society	12.113	12
Advanced Functional Materials	11.805	8
Journal of Materials Chemistry A **	7.443	8
Chemical Society Reviews	33.383	5
Chemical Communications	6.834	5
Energy & Environmental Science	20.543	4

*: Source: Web of Science database, as of June 2015

**: including Journal of Materials Chemistry

MANA researchers proactively conduct joint research with researchers from around Japan and throughout the world. As shown in Fig. 4-7, from the total of 2,850 MANA papers, 1,259 papers (44.2%) have been international joint work. Since 2013, the number of internationally co-authored MANA papers account for about half of all papers published. This high number is comparable to Germany, one of the world leaders in internationally co-authored papers.

Elsevier recently called devised a new indicator called *Field-Weighted Citation Impact* (FWCI) to fairly compare the quality of papers published from interdisciplinary research institutions. Fig. 4-8 compares the values of FWCI for MANA and various other institutes and universities in the world. The calculated FWCI value of 2.44 for MANA means that MANA output is 144% more cited than expected for the world average (FWCI =1). It is found that FWCI for MANA is at the world top level.

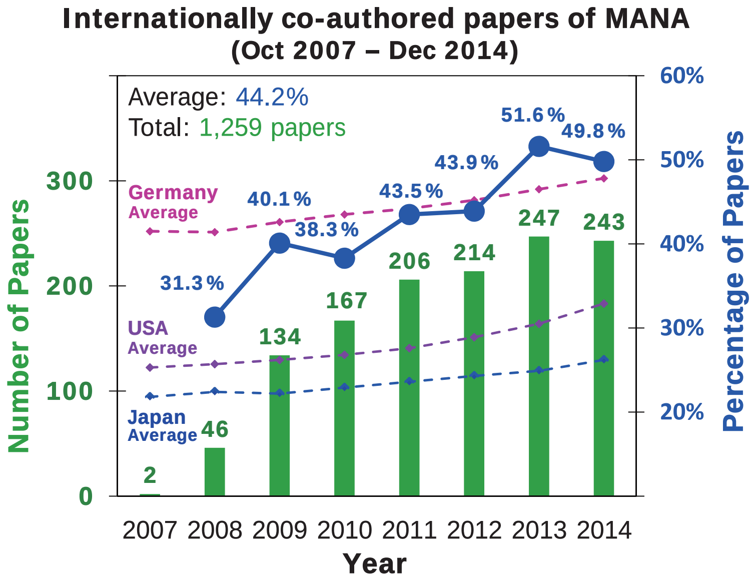


Fig. 4-7: Internationally co-authored papers of MANA published between October 2007 and December 2014. Information based on SCOPUS database. Source of national average: SciVal database, Elsevier B.V., downloaded in April 2015.

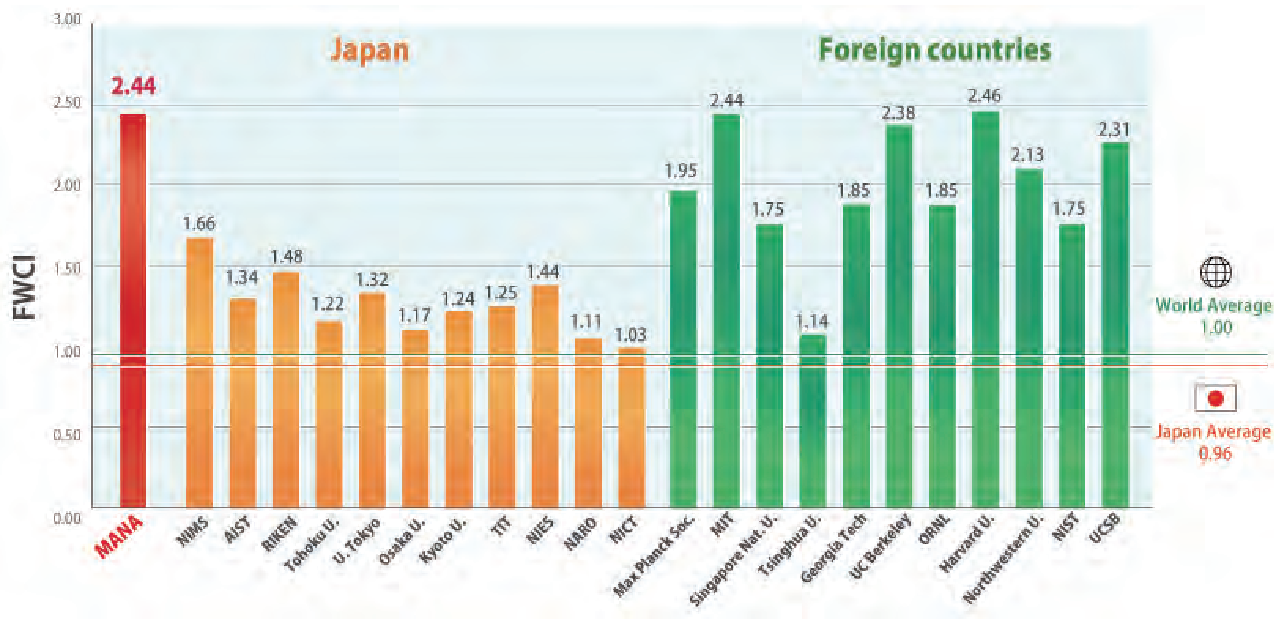


Fig. 4-8: Field Weighted Citation Impact (FWCI) of MANA and other institutions in the world. Source: SciVal database, Elsevier B.V., downloaded in February 2015. FWCIs were calculated for papers published during six years from 2008 to 2013.

- **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 2014 are listed in Appendix 7.7. Some examples from 2014 are shown in Fig. 4-9.

Appendix 7.7: MANA Journal Cover Sheets

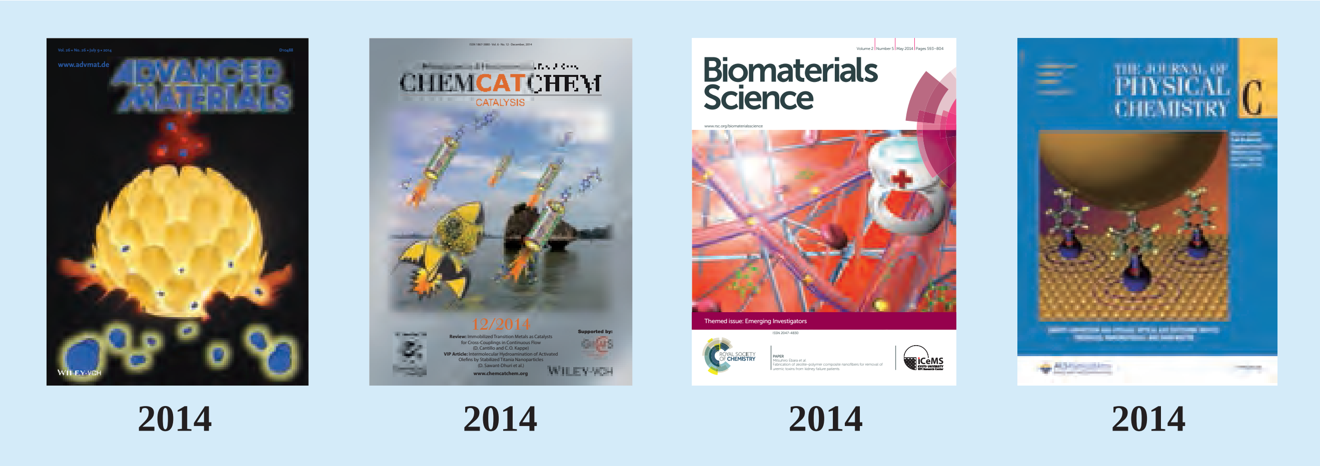


Fig. 4-9: Examples of recent journal front covers related to MANA affiliated papers.

- **MANA Patents**

In addition to writing research papers, many MANA scientists actively apply for patents. The number of MANA patent applications and MANA patent registrations between the launch of MANA in October 2007 and December 2014 is illustrated in Fig. 4-10 and summarized in Table 4-4. MANA reached a total number of 1218 MANA patents, consisting of 713

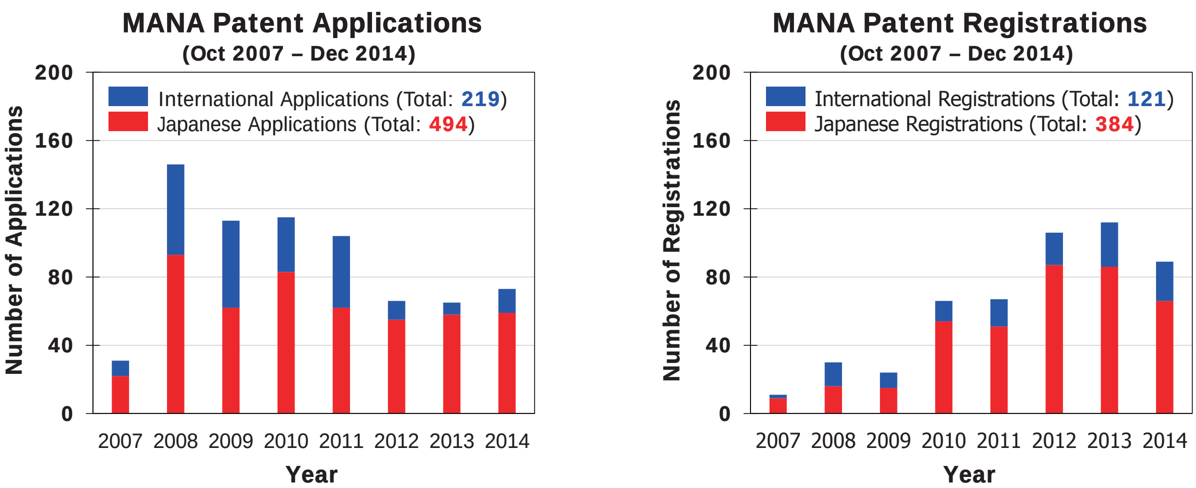


Fig. 4-10: Number of MANA patent applications and registrations between October 2007 and December 2014.

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

	Total Number (2007 Oct – 2014 Dec)	Average Number (per year)
Japanese Patent Applications	494	68.1
Japanese Patent Registrations	384	53.0
International Patent Applications	219	30.2
International Patent Registrations	121	16.7

applications and 505 registrations. A complete list of patent applications and registrations can be found in Appendix 7.8 of this report (for Jan 2012 to Dec 2014) and in Appendix 8.9 of the report *Facts and Achievements 2012* (for Oct 2007 to Dec 2012). All listed patent applications and patent registrations are or were partly or fully owned by NIMS.

Appendix 7.8: MANA Patents

- **Commendations**

In 2014, MANA's renowned researchers again won several prestigious prizes and awards.

Project Prize at nano tech 2014

An exhibition of research results obtained by MANA Scientist Mitsuhiro Ebara, entitled *Development of Anti-Cancer Nanofiber Mesh*, was awarded the Project Prize at the 13th nano tech International Nanotechnology Exhibition & Conference (nano tech 2014) on January 29-31, 2014.

PSJ Young Scientist Award 2014

MANA Independent Scientist Takako Konoike was awarded the 8th (2014) Young Scientist Award of the Physical Society of Japan (Area 7). This award was established in 2007 to encourage research by outstanding young scientists who will be responsible for physics in the future. The award to Dr. Konoike recognized her contributions to research on *the thermal properties of Dirac electron systems*. The award ceremony and memorial lecture were held at the 69th Annual Meeting of the Japan Physical Society on March 27, 2014.

Distinguished Lectureship Award of the CSJ Asian International Symposium 2014

MANA Scientist Lok Kumar Shrestha was awarded the Distinguished Lectureship Award of the Chemical Society of Japan (CSJ) Asian International Symposium. The award to Dr. Shrestha recognized his contributions to work on *self-assembled nanostructures*. The award ceremony was held during the International Chemists' Evening of the symposium on March 29, 2014 (Fig. 4-11).

JSM Seto Award 2014

MANA Principal Investigator Dmitri Golberg was awarded the 59th JSM Seto Prize of the Japanese Society of Microscopy. This prize was established in 1956 for individuals who contribute to the Society through outstanding achievements which expand microscopy in basic and applied research. The award to Dr. Golberg recognized his contributions to the Society through his outstanding long-term research entitled *Fabrication of boron nitride nanotubes and their property studies in a high-resolution transmission electron microscope*. The award ceremony and a memorial lecture by Dr. Golberg were held at the 70th Annual Meeting of the Japanese Society of Microscopy on May 12, 2014.

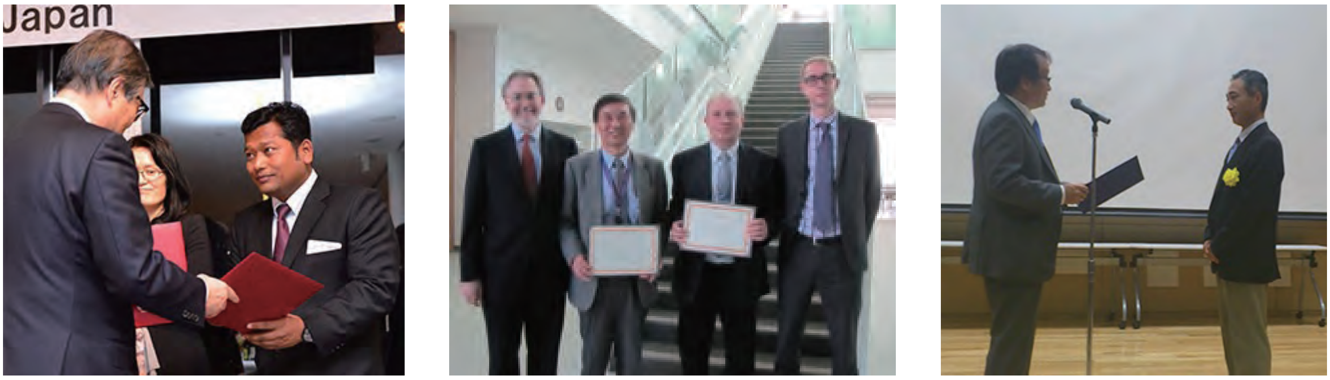


Fig. 4-11: Award Ceremonies with researchers from MANA. Left: CSJ President Kohei Tamao hands an award certificate to MANA Scientist Lok Kumar Shrestha on March 29. Middle: MANA PI Yoshio Bando and MANA PI Dmitri Golberg received an award certificate for ISI Highly cited researchers 2014 in Materials Science from Thomson Reuters on November 4. Right: The Japan Society for Applied Physics (JSAP)'s Paper Award 2014 for MANA PI Kazuhito Tsukagoshi.

Surface Science Society of Japan Prize 2014

MANA Principal Investigator Kohei Uosaki was awarded the 18th Surface Science Society of Japan Prize. This prize was established for individual members of the Society who made an outstanding contribution to surface science. The award to Prof. Uosaki recognized his research entitled *Construction of functional material phases based on the understanding and control of structures at solid/liquid interfaces*. The award ceremony was held at the Annual Meeting of the Surface Science Society of Japan on May 26, 2014.

ISI Highly cited researchers 2014 (Thomson Reuters)

ISI Highly cited researchers 2014 are authors of papers published between 2002 and 2012 whose number of citations is in the top 1% of a certain research field in the Thomson Reuters Essential Science Indicators database. On June 18, 2014, Thomson Reuters announced the members of this elite group that contains 5 Principal Investigators from MANA (Figs. 4-11, 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.

JSAP Paper Award 2014

MANA Principal Investigator Kazuhito Tsukagoshi and MANA Postdoctoral Researcher Katsuyoshi Komatsu were awarded the 36th Japan Society of Applied Physics (JSAP) Paper Award. The JSAP Paper Award is given for excellent original papers contributing to the progress and improvement of applied physics. The award ceremony was held at the JSAP Autumn Meeting 2014 in Sapporo on September 17, 2014 (Fig. 4-11).

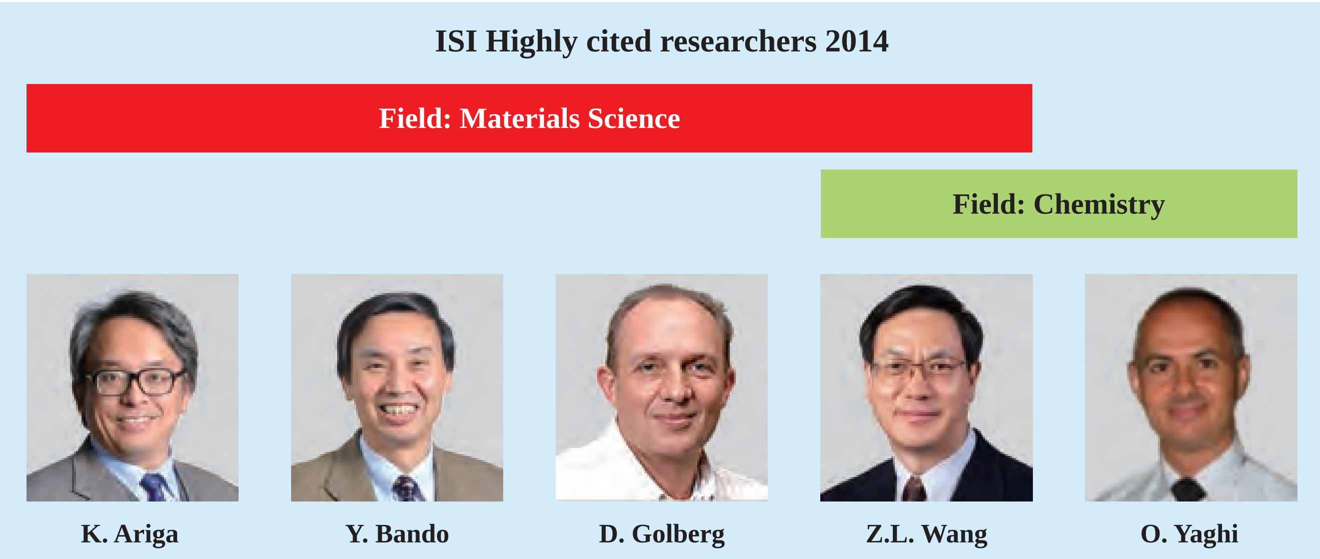


Fig. 4-12: 5 MANA Principal Investigators were selected as *ISI Highly cited researchers 2014* in the fields of Materials Science and Chemistry.

4.3 Research Achievements

In June 2015, MANA submitted a WPI Project Progress Report for Fiscal Year 2014 to the WPI Program Committee. Parts A) and B) of this section have been reproduced from the above mentioned report.

A) Conducting research of the highest world level

All the research at MANA has been performed on the basis of MANA's unique concept of "nanoarchitectonics." This concept has already penetrated into researchers working at MANA. In 2014, MANA performed various researches at the highest world level. In the following, two examples of them are selected and described a bit in detail.

- *Visualizing superconductive coupling over atomic steps in surface superconductivity - Scanning tunneling microscopy imaging under differing magnetic fields gives fundamental insights into the behavior of supercurrents and vortices on the indium-mediated silicon surface -*

Superconductors have effectively zero resistance and act as perpetual carriers of electric current with no need for a connected power source. As such they have many applications in electronics. One of the thinnest two-dimensional materials ever created, called Si(111)-(√7 x √3)-In, recently surprised scientists with its superconducting abilities. The race is now on to find out how and why this silicon surface is capable of superconductivity, as well as what uses it may have. Takashi Uchihashi and co-workers at MANA, together with scientists across Japan, have now uncovered the underlying structures and the behavior of currents on the surface of Si(111)-(√7 x √3)-In which provide clues to its superconductivity. The silicon surface comprises individual terraces separated by steps measuring the height of a single atom ('atomic steps'). These steps could potentially interrupt, or decouple, neighboring terraces and break the current flowing over large surfaces. Uchihashi and his team used a scanning tunnelling microscope in order to verify how superconductivity occurs in the presence of atomic steps and terraces. The team applied different magnetic fields, which influenced the strength of the current and the presence of associated vortices. By taking a series of images of the silicon surface, the team uncovered a pattern of supercurrent vortices present on the silicon surface. Two vortex types were present. Pearl vortices were present on the terrace surfaces, and appeared as bright round features in the images. However, at the atomic steps the vortices appeared to become trapped and altered in character. These elongated 'Josephson vortices' give evidence that the atomic steps work as so-called Josephson junctions, allowing coupling to occur across stepped terraces and enabling supercurrents to flow. The idea was firmly established with the help of microscopic theoretical calculations by Xiao Hu's group at MANA. In this way, MANA has uncovered how supercurrents flow over atomic steps and terraces on indium-covered silicon surface (Fig. 4-13). Vortices trapped at the atomic steps change their characters from Pearl to Josephson vortices (from A to C in the left panel of Fig. 4-13). These reflect change in strength of Josephson coupling between the neighboring terraces.

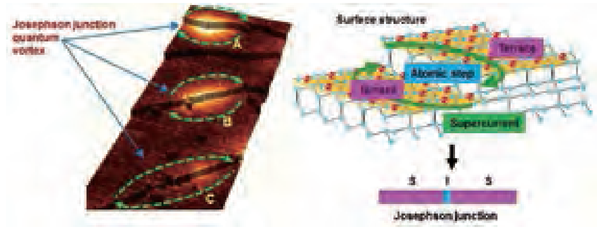


Fig. 4-13: (Right) Structure of the Si(111)-(√7 x √3)-In surface having atomic steps each of which acts as a Josephson junction. (Left) Josephson junction quantum vortexes observed by the scanning tunneling microscope (STM).

Reference: 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). (Editor's Suggestion.) doi: 10.1103/PhysRevLett.113.247004

- *Supercomputing in materials science: First-principles simulations of large molecules - Large-scale calculation capable of handling material systems containing 100 to 1,000 times more atoms than conventional methods -*

Matter is composed of atoms, and its physical properties are determined by the complex interactions between atoms and electrons. Theoreticians use quantum mechanics to calculate the forces between atoms, and the behavior of electrons in materials. Specifically, first-principles simulations are based on quantum mechanics, and are a powerful technique widely used to elucidate diverse properties of matter and materials at the atomic scale. However, the size of the systems modelled with conventional first-principles methods is limited to only a few hundred atoms (in most cases) because the complexity and time required for simulations increases as the cube of the number of atoms being modelled. Now, a research team at MANA including David Bowler and Tsuyoshi Miyazaki has successfully developed a highly efficient, large-scale first-principles simulation method for simulating the dynamics of very large systems, containing 100-1,000 times more atoms

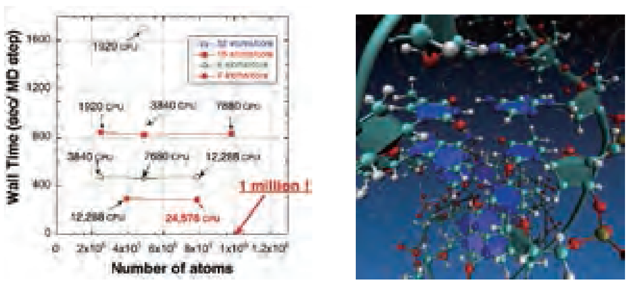


Fig. 4-14: (Left) Calculation time of O(N) first-principles calculation program run by the "K computer" (1 CPU = 8 cores). The calculations were performed on silicon systems. The horizontal axis shows the number of atoms, indicating that first-principles calculation of million atom systems is possible. The O(N) method combined with ideal parallel performance of the program (twice the number of CPUs achieving twice the amount of calculation) can calculate systems containing twice the number of atoms in the same time by doubling the number of CPUs. (Right) Snapshot structure from first-principles simulation of DNA in water medium using the calculation method developed by the research. The forces between atoms are calculated by first-principles calculation (joint research with RIKEN).

than conventional methods (up to millions of atoms) as shown in Fig. 4-14. This method provides the means of performing atomic and electronic structure simulations of biological molecules and complex matter, including nanostructured materials, for which conventional methods cannot be used. The research team has been pursuing the development of a calculation method capable of performing highly efficient large-scale simulations of dynamics. Here, by introducing a new technique where the time required increases linearly with the number of atoms and utilizing supercomputers, namely the “K computer” and FX10 installed at RIKEN and the University of Tokyo, respectively, the team successfully performed first-principles dynamical simulations of systems comprising more than 30,000 atoms, which is 100 times larger than is usual with conventional methods. Their success will pave the way for simulation of very large systems including up to millions of atoms.

Reference: 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

B) Advancing fusion of various research fields

MANA has promoted interdisciplinary research fusion strongly by operating *Fusion Research Fund*, *Grand Challenge Research Fund*, *Theory-Experiment Fusion Research Fund* and *Nano-life Fusion Research Fund*. As a result, various fusion researches have been actively performed at MANA. In the following, two examples performed in 2014 are described by picking up *life-science-inspired nanoarchitectonics* and *nanoarchitectonics-inspired life science*.

- *Nanomechanical sensors for detecting cancer from breath - An array of functionalized membrane-type surface stress sensors (MSS) distinguishes cancer patients from healthy people through a signature response to breath samples -*

Cancer is the cause of 1 in 8 deaths worldwide, and early diagnosis can significantly improve survival rates. A collaboration of the research team led by Genki Yoshikawa at MANA and Swiss scientists has developed portable cancer detection units for non-invasive diagnosis. “We created an artificial nose that is sensitive enough to diagnose head and neck cancer through analysis of the breath,” the researchers concluded in a recent report on their work. The sensor design originates from conventional piezoresistive cantilever devices. Chemical layers coated on cantilevers absorb specific compounds and cause deflection of the cantilevers. These deflections can be measured through the change in electrical resistance at piezoresistors. However, these piezoresistive cantilever-type sensors have suffered from limited sensitivity. Recently, comprehensive structural optimization has led to a membrane-type surface stress sensor (MSS), achieving a significant improvement in sensitivity and stability. The MSS is composed of a thin silicon membrane (typically 2.5 μm thick and 500 μm in diameter) suspended by four piezoresistive beams attached to the circumference. The research group fabricated an array of MSS and coated them with different polymers to absorb various chemical compounds in breath samples. Reporting at the 26th IEEE International Conference on Micro Electro Mechanical Systems (IEEE MEMS 2013), the research group presented that MSS could distinguish, in a double blind trial, the breath of four cancer patients from four healthy people (Fig. 4-15).

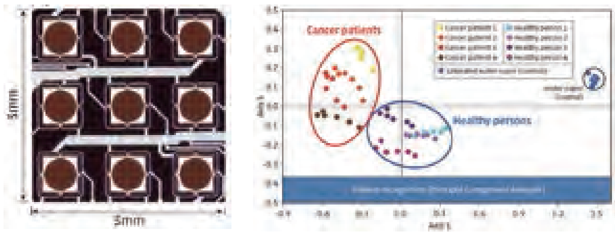


Fig. 4-15: Principal Component Analysis case scores for breath samples of 4 healthy persons and 4 cancer patients. Each sample has been measured 6 times (colored dots). A breath sample bag containing saturated water vapor has been measured as a control (blue dots). Healthy persons can be clearly distinguished from cancer patients (the ellipses are a guide to the eye).

Reference: F. Loizeau, H.P. Lang, T. Akiyama, S. Gautsch, P. Vettiger, A. Tonin, G. Yoshikawa, C. Gerber, N de Rooij, *Piezoresistive membrane-type surface stress sensor arranged in arrays for cancer diagnosis through breath analysis,* Micro Electro Mechanical Systems (MEMS) 621 (2013). doi: 10.1109/MEMSYS.2013.6474318

- *A simple way to treat kidney failure - A new technique for purifying blood using a nanofiber mesh could prove useful as a cheap, wearable alternative to kidney dialysis -*

Kidney failure results in a build up of toxins and excess waste in the body. Dialysis is the most common treatment, performed daily either at home or in hospital. However, dialysis machines require electricity and careful maintenance, and are therefore more readily available in developed countries than poorer nations. Around one million people die each year worldwide from potentially preventable end-stage renal disease. In addition to this, in the aftermath of disasters such as the Japan Earthquake and Tsunami of 2011, dialysis patients are frequently left without treatment until normal hospital services are resumed. With this in mind, Mitsuhiro Ebara and co-workers at MANA, have developed a way of removing toxins and waste from blood using a cheap, easy-to-produce nanofiber mesh. The mesh could be incorporated into a blood purification product small enough to be worn on a patient's arm, reducing the need for expensive, time-consuming dialysis. The team made their nanofiber mesh using two components: a blood-compatible primary matrix polymer made from polyethylene-co-vinyl alchohol, or EVOH, and several different forms of zeolites - naturally occurring aluminosilicates. Zeolites have microporous structures capable of adsorbing toxins such as creatinine from blood. The team made their nanofiber mesh using two components: a blood-compatible primary matrix polymer made from polyethylene-co-vinyl alchohol, or EVOH, and several different forms of zeolites - naturally occurring aluminosilicates. Zeolites have microporous structures capable of adsorbing toxins such as creatinine from blood. Although the new design is still in its early stages and not yet ready for production, Ebara and his team are confident that a product based on their nanofiber mesh will soon be a feasible, compact and cheap alternative to dialysis for kidney failure patients across the world (Fig. 4-16).

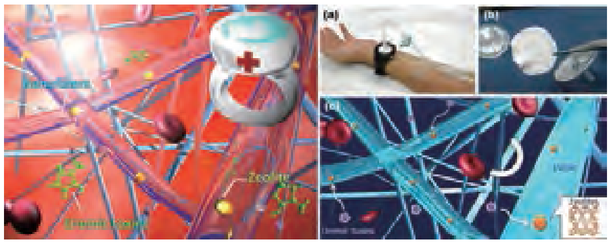


Fig. 4-16: The newly-fabricated nanofiber mesh for the removal of toxins from the blood, made by WPI-MANA researchers, may be incorporated into wearable blood purification systems for kidney failure patients.

Reference: K. Namekawa, M.T. Schreiber, T. Aoyagi, M. Ebara, *Fabrication of zeolite–polymer composite nanofibers for removal of uremic toxins from kidney failure patients*, Biomaterials Science **2**(5), 674 (2014). doi: 10.1039/C3BM60263J

C) Selected 20 Research Results of MANA (FY2007 - FY2013)

In September 2014, MANA published the booklet *Research at MANA* (Fig. 4-17) about 20 selected research results of MANA between October 2007 and March 2014. The pdf file of the booklet *Research at MANA* can be downloaded from the MANA website at
www.nims.go.jp/mana/pror/periodical/index.html
Here we give a brief explanation of the 20 selected MANA research achievements, which can be grouped into three major categories

- Creation of New Fields of Research
- Fusion of Interdisciplinary Research Fields
- Other Remarkable Research Results

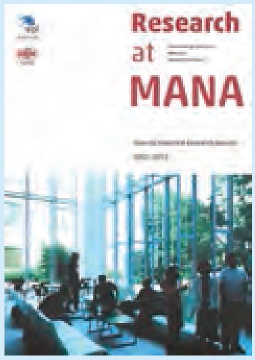


Fig. 4-17: Booklet *Research at MANA* published in September 2014.

The category ***Creation of New Fields of Research*** refers to original research conducted at MANA that possesses generality and is gradually spreading worldwide. This includes various new materials fabricated with nanosheet technology, atomic switches and the wide array of devices derived therefrom and nanoarchitectonic chemistry research, which aims to realize monomolecular devices.

The category ***Fusion of Interdisciplinary Research Fields*** refers to nano-life research that borrow from MANA's advanced nanoarchitectonics, and conversely, nanoarchitectonics research that borrows from nano-life research, as well as research aimed at fusing theory and experimentation.

The category ***Other Remarkable Research Results*** includes a wide variety of outstanding research that does not fit in the other two categories.

Creation of New Fields of Research

★ Nanosheet-based Breakthroughs for Creating Novel Materials

[1] Production of high-quality functional nanosheets via massive swelling/exfoliation of layered crystals

Representative researcher: T. Sasaki

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

[2] High-*k* oxide nanosheets: New 2D materials and devices beyond graphene

Representative researchers: M. Osada, T. Sasaki

We have developed high-k oxide nanosheets, an important material platform for ultra-scale electronic devices and post-graphene technology. The new nanosheets (Ti_2NbO_7, $(Ca,Sr)_2Nb_3O_{10}$) realized the highest permittivity ($\varepsilon_r = 210–320$) of all known dielectrics in the ultrathin region (< 10 nm). Layer-by-layer engineering of these nanosheets enabled us to design 2D dielectric devices that cannot be achieved in graphene and other materials. Graphene is only the tip of the iceberg, and we are now starting to discover new possibilities afforded by 2D oxide nanosheets.

★ Atomic Switch and Related Prospective Devices and Systems

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

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

We have developed a novel switching device having better characteristics than conventional semiconductor transistors in that it is a non-volatile switch having smaller dimensions and lower energy consumption. The unique operating mechanisms of the atomic switch--movement of metal atoms/ions associated with their redox processes due to an applied potential--have enabled the development of various novel functions, such as non-volatile three-terminal operations and synaptic operations.

[4] Atomic Switch Networks: A new approach to neuromorphic computation

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

Atomic Switch Networks (ASN) are a unique class of biologically inspired computing architectures designed to produce a complex, dynamical system through the collective interactions of functional nanoscale materials. These self-organized devices retain the properties of their atomic switch elements, generate a class of emergent behaviors known to underlie biological cognition, and have demonstrated a capacity to perform computational tasks without a need for pre-programming.

★ Molecular-scale Site-designated Chemical Nanoarchitectonics

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

Representative researchers: Y. Okawa, 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.

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

Representative researchers: T. Nakayama, M. Aono

Ultrahigh-density data storage has been considered to be one of the important outcomes by utilizing single-molecule manipulation with a scanning tunneling microscope (STM). However, there has been a crucial problem for many years;

how to achieve reversible and repeatable control of a molecular bit to represent 0 and 1. We solved this long-standing problem by reversibly controlling bound and unbound states of C_{60} molecules at room temperature, and demonstrated actual bit operations at a bit density of 190 Tbits/in^2.

Fusion of Interdisciplinary Research Fields

★ Nanoarchitectonics-inspired Nano-life Science

[7] Nanoarchitectonic smart nanofibers for cancer therapy

Representative researchers: M. Ebara, T. Aoyagi

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

[8] Novel Nanoarchitectonic therapeutics – Complete recovery of Alzheimer's disease

Representative researcher: Y. Nagasaki

Surprisingly, reactive oxygen species (ROS) have been known to affect more than 90% of diseases. Conventional drugs are problematic because of limited efficiencies along with severe adverse side effects. Guided by a nanoarchitectonic strategy, we have developed novel anti-oxidative polymer therapeutics which achieved complete recovery of cognition in Alzheimer model mice.

★ Nano-life Science-inspired Nanoarchitectonics

[9] Ultrasensitive and ultraparallel molecular sensing for artificial nose and other various applications

Representative researchers: G. Yoshikawa, M. Aono

We have developed a novel molecular sensor, which researchers worldwide have been trying to realize these last 20 years. We named the new sensor "Membrane-type Surface stress Sensor (MSS)." Significant improvements in sensitivity as well as in all the practical aspects pave the way for implementing nanoarchitectonic technologies in real-life applications.

[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 potential solution for global warming and energy shortage issues. A new material Ag_3PO_4 with the world's highest quantum efficiency (approaching that of natural photosynthesis) in photocatalytic water oxidation has been developed by a unique material-designing guideline. Sophisticated control of surface/interface structure has enabled efficient light harvesting, charge separation, and gas diffusion/conversion, making a big step towards realization of a high-efficiency artificial photosynthesis.

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

[11] Topological matter nanoarchitectonics for novel quantum devices

Representative researchers: X. Hu, T. Uchihashi

Because the uncertainty of quantum mechanics becomes prominent, functionalities of nano devices are hard to be realized upon design similar to those in macroscopic and microscopic scales. In order to develop new design principles for advanced quantum devices, we exploit topology of electron systems, which bridges bulk to surface and nano to macro as a quantum holography principle. A brand-new approach coined topological matter nanoarchitectonics is emerging.

[12] Ultra-large-scale computation: Development and application of an advanced code

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

CONQUEST, a world-leading linear scaling density functional theory (DFT) code, has been developed to bridge the gap between experimental and theoretical investigations of organic and inorganic nanosystems . It is capable of modeling millions of atoms with DFT both accurately and robustly. We want to drive innovative experiments by the application of CONQUEST.

Other Remarkable Research Results

★ Innovative Nanoscale Devices and Systems

[13] Mesoscopic superconductivity quantum phenomena in superconductor and normal-metal junctions

Representative researcher: H. Takayanagi

We have been working on mesoscopic superconductivity. In particular, we have treated superconductor (S) / normal-conductor (N) junctions, which has revealed various new quantum phenomena. As to N, we use normal metal, semiconductor two dimensional electron gas, graphene, and quantum dot. In an S/N junction, electron Cooper pairs in S can penetrate into N (proximity effect). This effect results in many interesting quantum phenomena that can be applied in quantum information technology.

[14] Silicon-doped metal oxide thin film transistor for flat panel application

Representative researchers: K. Tsukagoshi, T. Nabatame

For the next-generation amorphous metal-oxide thin film transistor (a-OxTFT), we found that the stability of the transistor properties strongly depends on the bond dissociation energy of dopant element. Because the doped silicon in amorphous In_2O_3-based thin films is found to suppress the formation of unstable oxygen vacancies, silicon doped metal oxide TFTs (SiM-OxTFTs) behave as the stable high-performance a-OxTFT.

[15] Nanogenerators and self-powered nanosystems

Representative researcher: Z.L. Wang

A theoretical model for contact-mode triboelectric nanogenerators (TENGs) was constructed. Its real-time output characteristics and the relationship between the optimum resistance and TENG parameters were derived. The theory presented here is the first in-depth interpretation of the contact-mode TENG, which can serve as important guidance for rational design of the TENG structure in specific application.

★ Innovative Nanoscale Characterization Methodologies

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

Representative researchers: T. Nakayama, M. Aono

The novel properties of individual nanostructures and nanosystems—the outgrowth of materials nanoarchitectonics--must be characterized using innovative instruments and methodologies. For this purpose, we developed multiple-probe scanning probe microscopes (MP-SPMs) and realized a new class of nanoscale measurements which enable us to perform unique and indispensable nano measurements.

[17] Pioneering development of *in situ* TEM techniques for nanomaterial property analysis

Representative researchers: D. Golberg, Y. Bando

Fascinating nanomaterial properties are the subject of a continuous excitement. And the exact knowledge of those, in particular on the individual structure level (that gives the clearest picture free of artifacts), is of key importance as far as the nanomaterial integrations into modern technologies are concerned. Such properties should precisely be studied in order to clarify that the substitution of conventional bulk materials, e.g. Si in electronics, is essential, realistic and profitable. However, in most cases, the nanoproperties are measured using instruments with no direct access to nanoscale range of dimensions. This has significantly limited the relevance of acquired data since any particular structural features of a nano-object prior/during/after testing have been hidden. Thus, the results could not be directly linked to a particular nanomorphology, crystallography, spatially-resolved chemistry and existing defects. This explains a common scatter of nano-property data reported by various scientific groups which has greatly confused the practical engineers.

★ **Nanoarchitectonics Related to Sustainable Energy and Environment**

[18] Novel porous materials for next-generation high-performance batteries

Representative researcher: Y. Yamauchi

Platinum (Pt) have long been regarded as highly useful catalysts in fuel cells. However, the high cost of Pt catalysts, together with the limited reserves of Pt in nature, has been shown to be the major bottleneck for commercial applications. We have developed novel porous electrodes with highly electrocatalytic activity through chemical design.

[19] Nanoarchitectonic sensing/imaging of Cs in life environment

Representative researcher: K. Ariga

Various sensing molecules for detection of toxic or useful substances in our life environments have been explored. Especially, micrometer-level naked-eye detection of caesium (Cs) ions, a major source of contamination upon nuclear plant explosion, has been demonstrated. As a result of the accident at the Fukushima No. 1 Nuclear Power Plant following the Great East Japan Earthquake of March 2011, a large amount of radioactive substances leaked and contaminated a wide area. Among those substances, caesium 137, will continue to be a source of radiation in the future. The Japanese government has planned and implemented decontamination measures for the region which was contaminated by radioactive substances. However, if the distribution of caesium can be visualized, this decontamination work can be carried out more efficiently, and a reduction in the amount of contaminated waste generated by the decontamination work can also be expected.

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

Representative researcher: T. Nagao

Plasmonics and metamaterials are the new emerging paradigms for materials science which enable us to control the light in nanospace. Through this strategy, we aim at tailoring the remarkable functionality such as extraordinary signal enhancement of molecules, enhanced photocatalytic reaction, and smart solar power harvesting. Also a new platform for photonic quantum computing in nanometer scale is expected.

5. Global Nanotechnology Network

5.1 MANA Satellite Network

Seven out of the 24 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 2015, there are seven MANA satellite laboratories, two in Europe, two in Japan and three in USA/Canada (Figs. 5-1, 5-2). At the end of FY2014, 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 299 MANA affiliated papers (Fig. 5-3) or 10.5% of the total of 2,850 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.

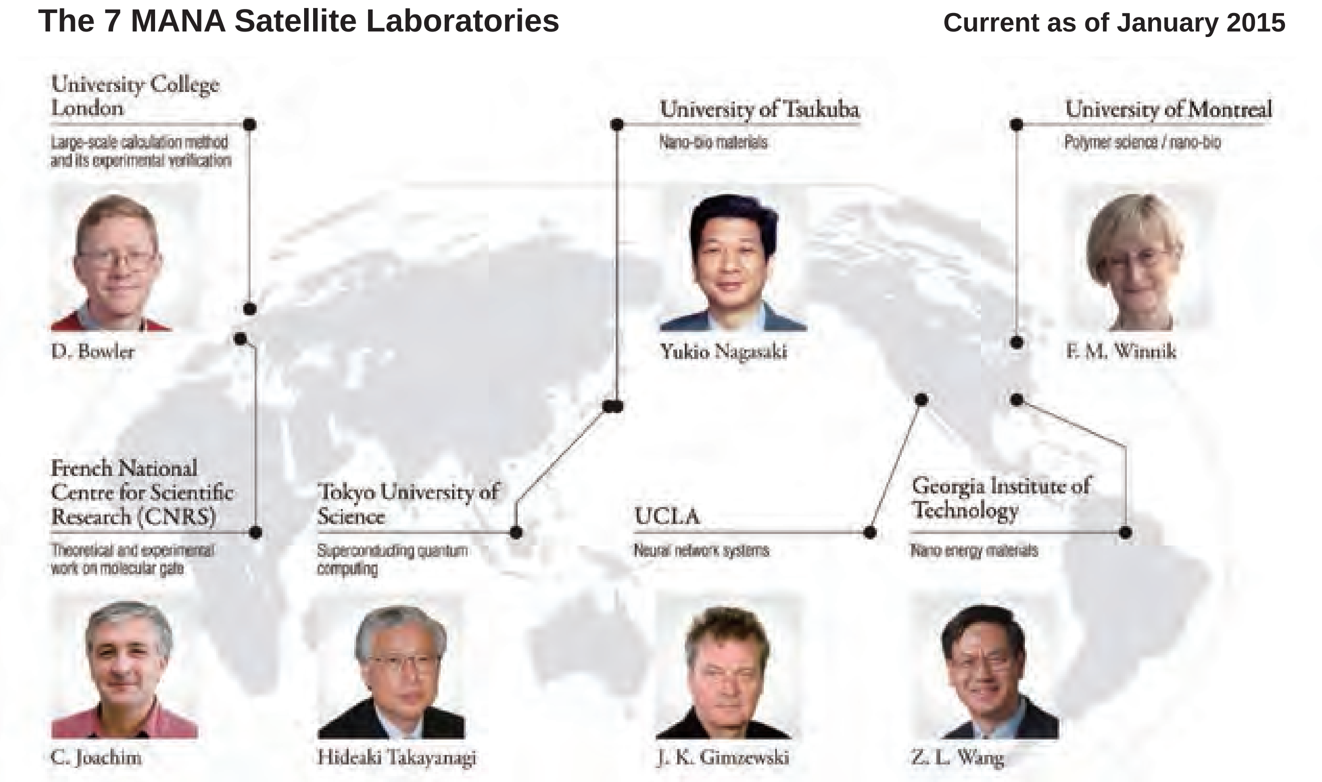


Fig. 5-1: The seven MANA satellite laboratories.

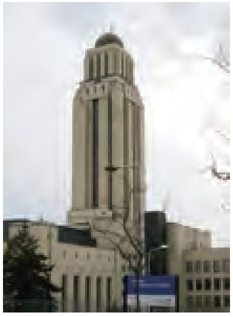
UCLA
USA

Tokyo University of Science
Japan

Georgia Tech
USA

UCL
UK

CNRS
France



UdeM
Canada

University of Tsukuba
Japan

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

● **Prof. James K. Gimzewski** from UCLA is a world-renowned nanotechnology researcher and recipient of the 1997 Feynman Prize. At MANA, he is conducting research on neuromorphic circuit networks in the Nano-System Field. Until March 2015, Prof. Gimzewski visited MANA 27 times for a total of 283 days to conduct research on projects such as new neurocomputer circuits that use the learning abilities of atomic switches. Between 2008 and 2014, he has published 54 MANA papers. His research was covered by NHK in the January 2010 program entitled *Proposal for the Future* and the February 2012 special report called *Nano Revolution: How Atoms Will Change Our Lives*. Prof. Gimzewski has also work tirelessly to train young researchers, graduate students and administrative staff by hosting postdocs from MANA, holding the Japan-UK-USA Nanotechnology Summer School, and accepting MANA staff for internship at UCLA.

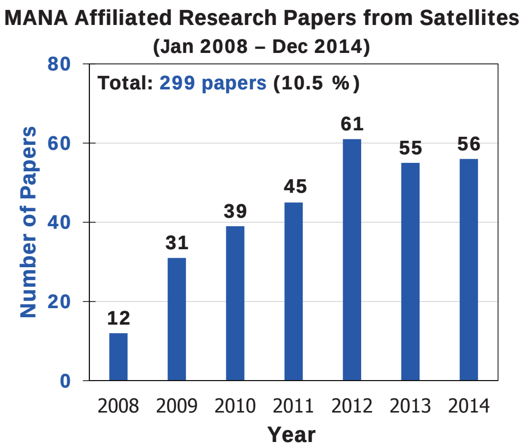


Fig. 5-3: MANA affiliated research papers from satellites.

Key to successful international collaboration *

Dr. Adam Stieg (Vice Director, MANA satellite at UCLA)

If there exists a recipe for effective international collaboration it most certainly involves two main ingredients: substantive commitments and immersive cultural exchange. Commonly galvanized by mutual interest and formally sanctioned through bilateral agreements, successful Institutional collaborations are best achieved by parties whose operational models and shared interests both enable and motivate the commitment of tangible resources. Ambitious ventures like the WPI Initiative and California Institutes for Science and Innovation (ISI) program provide such a framework. The artful execution of any good recipe lies in the attention to detail. Since 2007, the MANA Satellite at UCLA played an active role in realizing the vision of nanoarchitectonics through collaborative research and scholarship. A blend of vigorous engagement and perseverance has been crucial, especially when faced with inevitable yet unforeseen challenges. One must always be mindful of culture, not only through the lens of scientific discourse but also from the personal and societal perspectives. Indeed, the value of opportunities for cultural exchange extending beyond meetings and symposia cannot be over-stated. Participants at all levels of research and administration must do more than just visit - they must host and be hosted, they must live and learn together, they must not simply share ideas but generate them as partners. When paired with openness to unconventional ideas, such a recipe can only produce an exciting potential for innovation.

*: Note: This article has been published in the MANA Newsletter Convergence No. 19 (February 2015).

● **Prof. Zhong Lin Wang** from the Georgia Institute of Technology is a highly active researcher whose publications, which have been cited more than 67,000 times, boast and H-index of 126. At MANA, he works in the Nano-Materials Field where he conducts research on bio-inspired photonic structures and nanogenerators that harvest mechanical energy. Prof. Wang is also the mentor to group leader Dr. Fukuta, who has visited the Georgia Institute of Technology 14 times for a total of 27 weeks. Together they conduct joint research on nano devices and have published their results in *ACS Nano*. Prof. Wang and Dr. Fukuda also promote personnel exchange, with one of Prof. Wang's postdocs working for Dr. Fukuta.

● **Prof. Françoise M. Winnik** from the University of Montreal is a world-renowned scientist in the fields of polymer chemistry, surface chemistry, and nanoscience, and serves as Editor-in-Chief of the publication Langmuir of the American Chemical Society. At MANA, her research in the Nano-Life Field focuses primarily on applications of new biocompatible polymers in nanomedicine, but she also conducts wide-ranging, interdisciplinary research using the nanotubes and nanoparticles developed by MANA researchers in other fields. Prof. Winnik has laboratories at both MANA and the University of Montreal, and has spent a total of 631 days at MANA in the past 4 years (FY2011~FY2014) and published 20 MANA papers in the past 3 years (2012 – 2014).

● **Dr. 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 where he studies the design, fabrication and atomic manipulation of nanocircuits as well as theories of surface electron interconnection. He actively engages in joint research with MANA researchers and has published 37 papers on the research conducted at MANA (including several papers published in top-tier journals such as *Nature Nanotechnology*). In addition, he has organized two workshops at CEMES: an October 2009 event aimed at promoting cooperation between computational scientists and experimental scientists and the November 2010 Japan-France Workshop on Nanomaterials.

MANA-NIMS molecule vehicle for the nano-car race at the CNRS MANA satellite

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

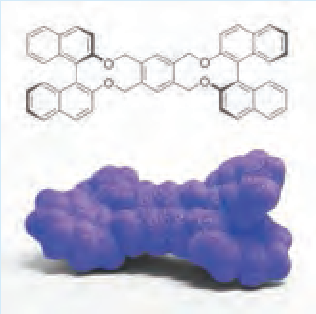


Fig. 5-4: 3D print of the MANA- NIMS molecule vehicle for the nano-car race.

The design, synthesis, and running of a molecular nano-vehicle on a surface assisted by proper nano-communication channels for feeding and guiding the vehicle now constitute an active field of research and are no longer a nano-joke [1]. Dr. Joachim announced to organize a molecule concept nano-car race using a new low-temperature UHV 4 probe-STM/AFM machine which was recently introduced in his group at CNRS MANA. Researchers from MANA and NIMS, including MANA Scientist Waka Nakanishi, NIMS researcher Yasuhiro Shirai, MANA Scientist Yuji Okawa and MANA PI Katsuhiko Ariga, are accepting the challenge to participate in the nano-car race and have designed the molecule vehicle shown in Fig. 5-4.

[1] C. Joachim, G. Rapenne, *Molecule Concept Nanocars: Chassis, Wheels, and Motors?* ACS Nano **7**(1), 11 (2013). doi: 10.1021/nn3058246

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 2015, MANA has concluded 48 MOUs, renewed 3 MOUs and replaced 1 MOU with institutions from 17 countries (Appendix 7.9). As of March 31, 2015, 32 MOUs are valid, 19 have expired and 1 has been replaced. The network of the 32 valid MANA MOUs is listed in Table 5-1. In January 2015, MANA signed a MOU with Indian Institute of Science (Fig. 5-5).

Appendix 7.9: International Cooperation

Fig. 5-5: On January 13, 2015, MANA signed a MOU with Indian Institute of Science (IISc). The photo shows Prof. Masakazu Aono from MANA (left) and Prof. Karuna Kar Nanda from IISc (right).

Table 5-1: Network of the 32 valid MANA MOUs (as of March 31, 2015).

Region	Number of valid MOUs
Europa	12
Asia	11
North America	4
Australia	2
South America	2
Middle East	1
Total	**32**

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 2014, MANA continued to hold joint workshops and symposia with the aim of promoting research exchange and boosting MANA's name recognition in order to scout for talent.

● **List of Workshops and Joint Symposia held in 2014**

Jan 29-31, 2014

Trends in Nanotechnology (TNT) Japan 2014

On January 29-31, 2014, the first edition of the TNT Japan (Trends in Nanotechnology) conference was held at Tokyo Big Sight, Japan, in parallel with nano tech 2014, the largest International exhibition on Nanotechnology. This "TNT Japan

2014" was co-organized by MANA/NIMS and the Phantom Foundation, Spain, and contained a "MANA Day" on January 30. The series of high-level scientific TNT meetings aims to present a broad range of current research in Nanoscience and Nanotechnology as well as related policies or other kind of International initiatives.

Mar 11-12, 2014

Japan-Taiwan Joint Workshop on Nanospace Materials

On March 11-12, 2014, the Japan-Taiwan Joint Workshop on Nanospace Materials was held at the Fukuoka Institute of Technology, Japan. Focusing on the research field of Nanospace Materials, this workshop aimed at further development of the scientific and technological exchange between Japan and Taiwan. 35 top-level scientists from both countries were invited to present the latest research topics for two days. This work shop was co-sponsored by the Department of Innovation Research, Japan Science and Technology Agency, National Taiwan University and Fukuoka Institute of Technology.

Fig. 5-6: Participants of the 5th NIMS/MANA-Waseda University International Symposium 2014 (left) and the International Symposium on Smart Biomaterials 2014 (right).

Mar 24, 2014

The 5th NIMS/MANA-Waseda University International Symposium

On March 24, 2014, the 5th NIMS/MANA-Waseda University International Symposium was held at NIMS with 79 participants (Fig. 5-6). Featured were oral presentations by graduate program professors and 24 associate researchers.

Mar 24-25, 2014

International Symposium on Smart Biomaterials

On March 24-25, 2014, the International Symposium on Smart Biomaterials or "2nd Hoffman Family Symposium" was held at MANA, NIMS, with 135 participants (Fig. 5-6). The 2-day event featured 21 invited lectures and 48 poster presentations. Prof. Allan S. Hoffman (University of Washington, USA) gave a plenary lecture on *History of Smart Hydrogels*.

Apr 1-2, 2014

International Workshop: Topology in the New Frontiers of Materials Science

On April 1-2, 2014, the International Workshop *Topology in the New Frontiers of Materials Science* was held at MANA, NIMS, with 27 invited lectures and 174 participants (Fig. 5-7). With a full panel of top-notch scientists from the world, the purpose of this workshop was to highlight the recent progresses in the field of topological states and phenomena, and discuss possible new frontiers of materials science with topology as the central concept.

Fig. 5-7: Participants of the International Workshop: Topology in the New Frontiers of Materials Science (left) and the 2nd International Symposium on the Functionality of Organized Nanostructures, FON'14 (right).

Jun 22-26, 2014

12th International Workshop on Beam Injection Assessment of Microstructures in Semiconductors (BIAMS 12)

On June 22-26, 2014, the 12th International Workshop on Beam Injection Assessment of Microstructures of Semiconductors (BIAMS12) was held at MANA, NIMS. The workshop with 8 invited lectures, and 36 oral and 18 poster presentations focused on advances in the field of the assessment of microstructures in semiconductors by beam injection and related methods. Over 80 participants from 13 countries shared ideas and information about semiconductor characterization methods and their application to study photovoltaic materials and devices, nanostructures, optical and electronic properties of defects.

Jul 18, 2014

International Symposium on Material Architectonics for Sustainable Action (MASA 2014)

On July 18, 2014, the International Symposium on Material Architectonics for Sustainable Action (MASA 2014) has been jointly held by MANA and JST-PRESTO "Nanosystems and Emergent Functions" at MANA, NIMS, with 109 participants. The Symposium with 18 oral and 22 poster presentations from PRESTO and NIMS focused on the topics of *Materials Nanoarchitectonics* and *Emergent Functions* in a broad range of research fields, including Applied Physics, Chemistry, Biochemistry, Pharmacy and Robotics.

Nov 26-28, 2014

The 2nd International Symposium on the Functionality of Organized Nanostructures

On November 26-28, 2014, 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. The symposium also commemorated another important milestone in the 25th Anniversary of the start of the "Aono Atomcraft Project," which was carried as an ERATO Project of the Research Development Corporation of Japan, and was held to mourn the loss of Dr. Heinrich Rohrer, who was a recipient of the Nobel Prize in Physics in 1986 and passed away in 2013. The event featured 24 invited lectures and 78 poster presentations, as well as a special session held to remember Dr. Rohrer's passion for science. A total of 217 persons attended during the 3-day period (Fig. 5-7).

● 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 2014, 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 FY2014, there are 41 junior researchers working at MANA, of which 36 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 FY2014.

School	No. of Faculties	No. of Students
University of Tsukuba	10	21
Hokkaido University	5	9
Waseda University	6	9
Kyushu University	2	2

International Joint Graduate Schools

The International Joint Graduate School is a program in which PhD students from renowned universities around the globe spend several months to one year researching under the supervision of NIMS researchers. By March 2015, MANA brought in 49 students within this program from 10 different universities (Fig. 5-8): Flinders University (Australia), Xian Jiatong University (China), Charles University and the University of Pardubice (Czech Republic), Anna University and Jawaharlal Nehru Centre for Advanced Scientific Research (India), Yonsei University (Korea), Warsaw University of Technology (Poland), Moscow State University (Russia), National Taiwan University (Taiwan).

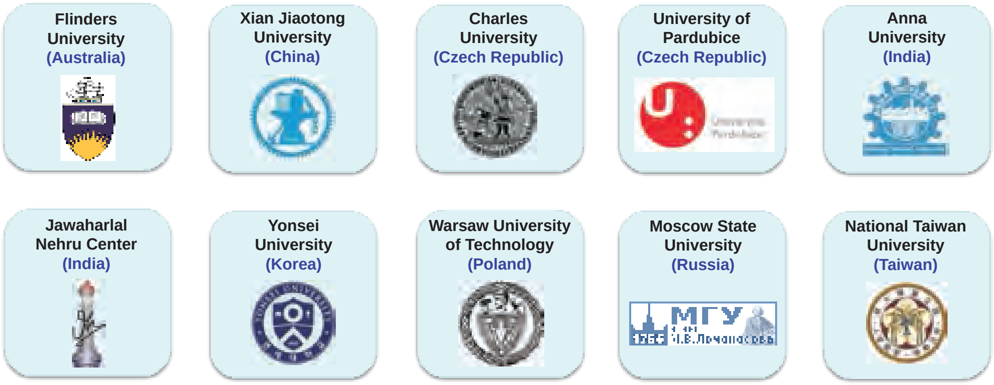


Fig. 5-8: The 10 International Joint Graduate Schools with MANA participation.

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 2015, MANA has accepted 318 interns, of which 255 have been foreigners. MANA has welcomed 27 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. It is MANA's policy to not only attract young researchers from around the world and cultivate them into outstanding scientists, but to enhance their understanding of Japan and help them take the next step in their careers in many countries in the world. Form 238 MANA postdoc alumni over the 7.5 years between October 2007 and March 2015, 11 postdocs from MANA have been appointed as NIMS permanent researchers, and 227 have leveled up to universities and research institutions in Japan and around the world. Looking at these former MANA postdocs, 39% have secured positions in Japan, and 61% have found jobs overseas, primarily in Asia but also in the United States, Europe and elsewhere in the world (Fig. 5-9). In this way, MANA has become the hub for an ever-expanding network of nanotechnology researchers.

Fig. 5-9: Destinations of the 238 MANA postdoc alumni between October 2007 and March 2015.

Examples of career advancement of MANA Alumni:

- Professor, University of Queensland, Australia
- Professor, Fudan University, China
- Professor, Nanyang Technological University, Singapore
- Research Group Leader, Max Planck Institute for Intelligent Systems, Germany
- Associate Professor, Uppsala University, Sweden

Between 2008 and 2011, Dr. Xaosheng Fang and Dr. Ujjal. K. Gautam worked for 3 years as ICYS-MANA researchers. Their research at MANA was so successful that in 2014 these two ICYS-MANA alumni were selected as *ISI Highly cited researchers* in field of Materials Science. *ISI Highly cited researchers 2014* are authors of papers published in the 11 years between 2002 and 2012 whose number of citations is in the top 1% of a certain research field in the Thomson Reuters Essential Science Indicators database.

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 8th MANA International Symposium 2015 was held at Epochal Tsukuba in Tsukuba City, Japan over a 3-day period from March 11 (Wednesday) to March 13 (Friday), 2015 (Figs. 6-1, 6-2, 6-3, 6-4). The symposium featured a Special Lecture entitled *Background of the discovery of carbon nanotubes* by Prof. Sumio Iijima, as well as Invited Talks by 14 distinguished scientists from Japan and other countries. Research results at MANA were also announced in a total of 14 oral presentations and 133 poster presentations, and 6 young scientists who made excellent poster presentations won the MANA International Symposium 2015 Poster Award. The Symposium attracted 410 participants from 26 countries over the 3-day period, with lively question-and-answer sessions and exchanges of ideas.

Fig. 6-1: The 8th MANA International Symposium in March 2015.

Prof. Iijima

Prof. Aono

Poster Award Ceremony

Fig. 6-2: Left: Special lecture by Prof. Sumio Iijima (Meijo University, Japan) entitled *The background of the discovery of carbon nanotubes.* Middle: *Outline of MANA* by Prof. Masakazu Aono (Director-General MANA). Right: Poster Award Ceremony.


Prof. Oshiyama


Prof. Sakai


Prof. Fujioka

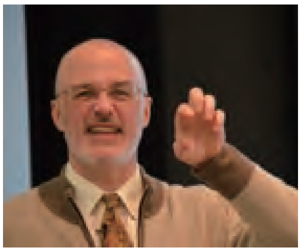

Prof. Nakamura


Prof. Domen


Prof. Sun


Prof. Lippert


Prof. Hahn


Prof. Rotello


Prof. Sugiyama


Prof. Kataoka


Prof. Leong


Prof. Noda

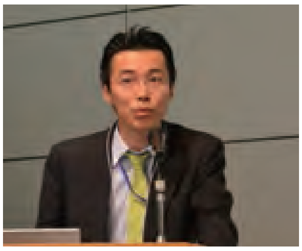

Prof. Teizer

Fig. 6-3: Invited lectures at the 8th MANA International Symposium by renowned scientists from outside MANA. Top row from left to right: Prof. Atsushi Oshiyama (University of Tokyo, Japan), Prof. Ken Sakai (Principal Investigator, I^{2}CNER Kyushu University, Japan), Prof. Hiroshi Fujioka (University of Tokyo, Japan) and Prof. Eiichi Nakamura (University of Tokyo, Japan). Second row from left to right: Prof. Kazunari Domen (University of Tokyo, Japan), Prof. Licheng Sun (KTH Royal Institute of Technology, Sweden), Prof. Thomas Lippert (Head Materials Group, Paul Scherrer Institute, Switzerland) and Prof. Horst Hahn (Karlsruhe Institute of Technology, Germany). Third row from left to right: Prof. Vincent Rotello (University of Massachusetts, USA), Prof. Hiroshi Sugiyama (WPI-iCeMS Kyoto University, Japan), Prof. Kazunori Kataoka (University of Tokyo, Japan) and Prof. Kam W. Leong (Colombia University, USA). Bottom Row: Prof. Susumu Noda (Kyoto University, Japan) and Prof. Winfried Teizer (AIMR, Tohoku University, Japan and Texas A&M University, USA).

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.

Dr. Ushioda



Mr. Iwabuchi

Prof. Kuroki

Prof. Saito

Fig. 6-4: From left to right: Opening address by Dr. Sukekatsu Ushioda (NIMS President) and subsequent greeting addresses by Mr. Hideki Iwabuchi (Director, Office for Basic Research Projects, Research Promotion Bureau, MEXT), Prof. Toshio Kuroki (Director of WPI Program) and Prof. Gunzi Saito (WPI Program Officer of MANA).

6.3 MANA Newsletter

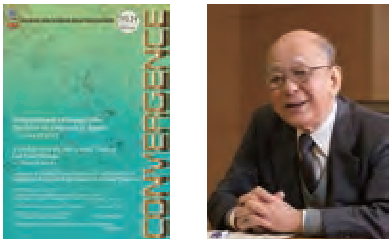
Since MANA's inception, a bilingual newsletter named CONVERGENCE has been published three times a year and reached 18 issues until end of 2014. Each issue includes a status report of the MANA project and interviews with Nobel Prize-class researchers (Fig. 6-5). Currently, 1,650 copies of CONVERGENCE are distributed to researchers in Japan and 1,800 copies to researchers overseas in about 70 countries.

MANA Newsletter CONVERGENCE

No. 13
February 2013

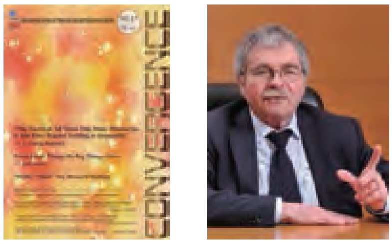
Prof. Teruo OKANO

No. 14
June 2013



Prof. Akira SUZUKI

No. 15
October 2013



Prof. J. Georg BEDNORZ

No. 16
February 2014

Prof. Yoshinori TOKURA

No. 17
June 2014

Prof. Makoto KOBAYASHI

No. 18
October 2014

Prof. Teruo KISHI

Fig. 6-5: Issues of the MANA newsletter CONVERGENCE published in 2013 and 2014.

6.4 Outreach Activities

MANA has actively pursued outreach activities geared to the general public. To generate an interest in science among young people, MANA held events such as *MANA Science Café*, joint symposia, summer camps and summer school events for elementary and junior high school students featuring Nobel Prize winners Prof. H. Rohrer and Prof. H. Kroto. MANA also published easy to understand videos of MANA research results on the internet. In 2014, MANA has participated in domestic and international outreach events, some of which are organized by the Japan Science and Technology Agency (JST) or sponsored by Tsukuba city.

Fig. 6-6: WPI booth at the E-MRS 2014 Spring Meeting in Lille, France (left). Summer Camp 2014 at MANA: High school students in a group photo (middle) and using a scanning electron microscope (right).

● E-MRS 2014 Spring Meeting

Four WPI Research Centers, MANA, AIMR (Advanced Institute for Materials Research, Tohoku University), iCeMS (Institute for Integrated Cell-Materials Science, Kyoto University), and I^2CNER (International Institute for Carbon-Neutral Energy Research, Kyushu University), exhibited jointly at the European materials Research Society (E-MRS) 2014 Spring Meeting, which was held in Lille, France May 26-30, 2014 (Fig. 6-6). With the aims of increasing the global visibility of Japan's WPI program, attracting outstanding human resources, etc., the Japanese group held a workshop entitled "Japan in Motion – Recent WPI Advances in Materials," and also presented invited talks, oral presentations, poster presentations, and a booth exhibit. Throughout the preparation and management of the event, MANA contributed as the coordinator of the exhibition on behalf of the four research centers.

● Summer Science Camp 2014

On July 29-31, 2014, MANA held the "Summer Science Camp 2014," which is a camp-type program in which high school students live and study together for 3 days. A total of 16 young people, including 8 male and 8 female students, was selected from all parts of Japan, and enjoyed "hands-on" practice in observation with the electron microscope, development and processing in the clean room and other topics under the title *Hear, See, and Create: Experiencing Nanoscience* (Fig. 6-6). The camp also featured a social gathering with young MANA researchers from other countries, giving the participating high school students a full taste of the state-of-art international research environment at MANA.

● Publication of book "Materials Revolution: Nanoarchitectonics"

In 2014, MANA Principal Investigator Katsuhiko Ariga published an introductory book in Japanese, "Materials Revolution: Nanoarchitectonics" (Iwanami Science Library, ISBN978-4-00-029627-4 C0343), which presents the new paradigm of materials development called "nanoarchitectonics" to general readers (Fig. 6-7). Dr. Ariga's book introduces cutting-edge materials science research being developed at MANA, including atomic switches that will open the way to brain-type computers, photocatalysts aimed at realizing artificial photosynthesis, biomaterials that contribute to medicine, and many more topics in a way that is easy to understand for non-scientific readers. The new book has been very warmly received, and publication of an English edition is being studied.

● Tsukuba Science Festival 2014

On November 10, 2014, MANA participated in the Tsukuba Science Festival 2014 with an exhibit titled *Smart Polymer Rangers* (Fig. 6-7). The Tsukuba Science Festival 2014 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. This year, 59 bodies in Tsukuba City, such as schools and research institutes, participated in the event.

MANA exhibited "smart polymers" as a future material for disease diagnosis and treatment, and our researchers, some of whom appeared as children-friendly *Smart Polymer Rangers*, demonstrated science experiments. We also introduced examples of future applications of biomaterials, such as *nanofiber mesh for cancer therapy* and *a portable dialysis system for emergency treatment of chronic kidney failure*. The MANA exhibit was extremely popular with visitors, attracting a large number of parent-and-child family groups and students.

This exhibit was also part of the *Tsukuba Action Project (T-ACT): Science Communication Trainin*g, which is based on collaboration between the University of Tsukuba and MANA. University students who participated in T-ACT training planned and managed the event in cooperation with MANA researchers, and were able to enhance their science communication skills by meeting and talking with visitors at the event.

Fig. 6-7: Cover of the new book “Materials Revolution: Nanoarchitectonics” (left). Researchers dressed as *Smart Polymer Rangers* at Tsukuba Science Festival 2014 (middle, right).

6.5 Media Coverage

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

Between October 2007 and March 2015, in the first 7 1/2 years of the MANA project, 422 press releases about MANA appeared in Japanese newspapers (Fig. 6-8). This corresponds to an average number of press releases of 56.3 per year or 4.7 per month. To encourage foreign researchers to issue press releases, MANA has setup a support system.

On October 24, 2014, a talk by MANA Principal Investigator Katsuhiko Ariga where he explained about *Nanoarchitectonics* has been broadcasted in Radio Tsukuba.

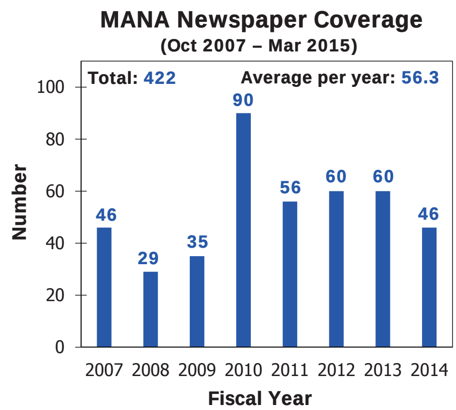


Fig. 6-8: Number of press releases from MANA published in Japanese newspapers.

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))

Table 6-1: Number of short-time visitors to MANA.

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

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 6-1, we observe a strong increase of visitors to MANA since FY2012. The 757 visitors in FY2014 came from all over the world: Europe (147), America (49), Asia (523, including 388 from Japan), and other regions (38). In 2014, MANA visitors included higher-ranked scientists (Fig. 6-9) and students (Fig. 6-10) from foreign and Japanese universities.

Fig. 6-9: MANA visit of scientists in 2014. Left: Dr. Terence McMaster and Dr. Charl F.J. Faul from University of Bristol, UK. Middle: Prof. Masahiko Hara from Tokyo Institute of Technology, Japan on July 25. Right: Prof. Idriss Blakey, University of Queensland, Australia on November 11.

Fig. 6-10: MANA visit of students in 2014. Left: Radboud University, Nijmegen, Netherlands on April 14. Middle: Chulalongkorn University, Thailand on August 5. Right: EPFL, Lausanne, Switzerland on September 5.

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, MANA has received over 100 scientific art pictures, which are being used to decorate empty walls in the MANA Building and the new WPI-MANA Building (Figs. 6-11, 6-12). In addition, MANA scientific art pictures have been used in MANA promotion videos, MANA original goods, NIMS brochures and NIMS greeting cards.

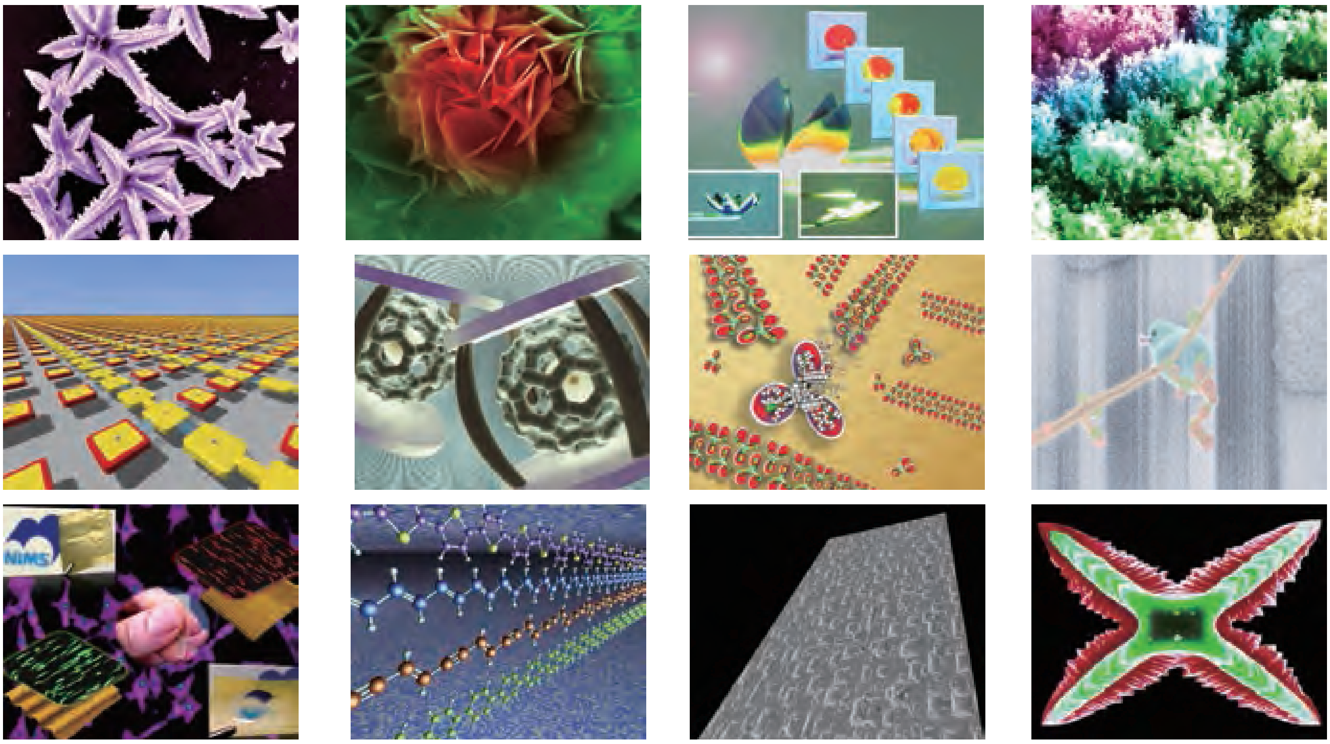


Fig. 6-11: Examples of MANA scientific art pictures.

A MANA art picture entitled “Rainbow Cube” by two MANA Scientists Lok Kumar Shrestha and Jonathan Hill of the Supermolecules Group at MANA received the Award for Excellence at the 8th “Beauty in Science and Technology Panel Exhibition” held as part of Science and Technology Week (Fig. 6-12). The Award Ceremony was held in April 2014 at the Tokyo Headquarters Annex (K’s Gobancho) of the Japan Science and Technology Agency (JST), and a commemorative plaque was presented to the two scientists by Dr. Akito Arima, Chairman of the Organization on Science and Technology.

Fig. 6-12: MANA scientific art pictures decorating the wall of the new WPI-MANA Building (left). In April 2014, a MANA scientific art picture received the Award for Excellence at the “Beauty in Science and Technology Panel Exhibition” (middle and right).

6.8 MANA History

The MANA history between September 2007 and March 2015 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 2015

Masakazu AONO
Director-General

Yoshio BANDO
Chief Operating Officer

Takahiro FUJITA
Administrative Director

Appendix 7.2: MANA Research Staff

MANA Principal Investigators (22):

Current as of January 1, 2015

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 (8)

Coordinator

Masakazu AONO
NIMS

James K. GIMZEWSKI
UCLA (Satellite)

Tsuyoshi HASEGAWA
NIMS

Xiao HU
NIMS

Christian JOACHIM
CNRS (Satellite)

Tomonobu NAKAYAMA
NIMS

Hideaki TAKAYANAGI
Tokyo Univ. Sci. (Satellite)

Kazuhito TSUKAGOSHI
NIMS

Nano-Life Field (4)

Coordinator

Takao AOYAGI
NIMS

Guoping CHEN
NIMS

Yukio NAGASAKI
Univ. Tsukuba (Satellite)

Françoise M. WINNIK
Univ. Montreal (Satellite)

Associate PIs (2), Group Leaders (11), MANA Scientists (51): Current as of January 1, 2015

Nano-Materials Field (27)


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


Qingmin JI


Jin KAWAKITA


Naoyuki KAWAMOTO


Renzhi MA


Masanori MITOME


Takahiro NAGATA


Takayuki NAKANE


Waka NAKANISHI


Isao OHKUBO


Tadashi OZAWA


Nobuyuki SAKAI


Lok Kumar SHRESTHA


Ryutaro SOUDA


Yutaka WAKAYAMA


Shinjiro YAGYU


Yoshiyuki YAMASHITA


Michiko YOSHITAKE

Nano-Power Field (7)

David
BOWLER
(Associate PI)

Yoshitaka
TATEYAMA
(Group Leader)

Ikutaro
HAMADA

Hiori
KINO

Hidenori
NOGUCHI

Tsuyoshi
OHNISHI

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

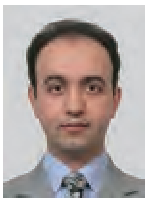
JSPS Fellows (5):

Current as of January 1, 2015

Nano-Materials Field (4)


Bishnu Prasad BASTAKOTI
Nepal


Cuiling LI
China


Amir PAKDEL
Iran


Tommi Paavo TYNELL
Finland

Nano-Power Field (1)


Satoru SATO
Japan

MANA Independent Scientists (15):

Current as of January 1, 2015

MANA Independent Scientists


Ryuichi ARAFUNE


Alexei A. BELIK


Ryoma HAYAKAWA

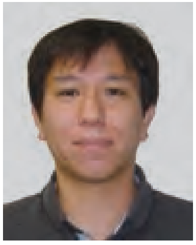

Joel HENZIE


Takako KONOIKE


Takeo MINARI


Satoshi MORIYAMA


Jun NAKANISHI


Takashi NAKANISHI


Liwen SANG


Naoto SHIRAHATA


Satoshi TOMINAKA


Katsunori WAKABAYASHI


Yusuke YAMAUCHI


Genki YOSHIKAWA

ICYS-MANA Researchers (10):

Current as of January 1, 2015

ICYS-MANA Researchers


Sudipta DUTTA

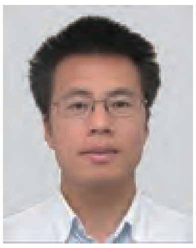

Hicham HAMOUDI


Yohei KOTSUCHIBASHI


Huynh Thien NGO

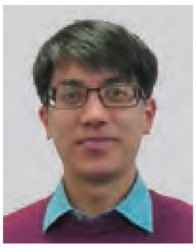

Gaulthier RYDZEK


Kota SHIBA


Daiming TANG


Xi WANG


Xuebin WANG


Hamish Hei-Man YEUNG

MANA Research Associates (60):

Current as of January 1, 2015

Nano-Materials Field (19)


Partha BAIRI India


Pengcheng DAI China


Asami FUNATSU Japan


Dominic GERLACH Germany


Batu GHOSH India

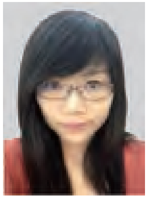

Xiangfen JIANG China


Shangbin JIN China


Hirokazu KOMATSU Japan


Xia LI China


Jianbo LIN China


Jia LIU China


Satofumi MARUYAMA Japan


Kosuke MINAMI Japan


Waqas Alam MIR India


Chinnamuthu PAULSAMY India

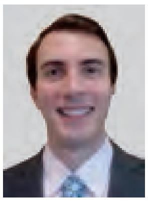

Rahul Raghunath SALUNKHE India


Junzheng WANG China


Jinghua WU China


Tomoe YAYAMA Japan

Nano-Power Field (14)


Nicephore BONNET France


Kun CHANG China


Hung Cuong DINH Vietnam


Sudipta DUTTA India


Maryam JAHAN Iran


Huimin LIU China


Yuki MORITA Japan


Koichi OKADA Japan


Saurabh SRIVASTAVA India


Pradip Kumar SUKUL India


Lucie SZABOVA Czech


Kazuhisa WADA Japan


Tao WANG China

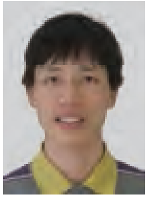

Huabin ZHANG China

Nano-System Field (18)


ARRAMEL
Indonesia


Chanchal
CHAKRABORTY
India


Kai
CHEN
China


Haiyao
DENG
China


Rintaro
HIGUCHI
Japan


Gaku
IMAMURA
Japan

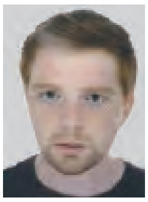

Hironori
ITO
Japan

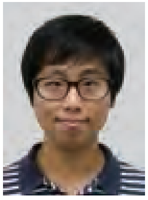

Pradyot
KOLEY
India


Karthik
KRISHNAN
India


Hai
LI
China


Xu-Ying
LIU
China


Cedric Romuald
MANNEQUIN
France


Seungjun
OH
Korea


Takashi
TSUCHIYA
Japan

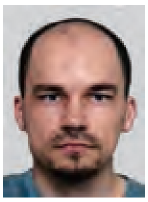

Elisseos
VERVENIOTIS
Greece


Saranyan
VIYAHARAGHAVAN
India


Mahito
YAMAMOTO
Japan


Rui
YU
China

Nano-Life Field (9)


Gregory
BEAUNE
France


Sourov
CHANDRA
India


Lingfeng
GUO
China


Jasmine
LI
Singapore


Wei-Chih
LIN
Taiwan


Sharmy Saimon
MANO
India


Saw
MARLAR
Myanmar


Usharani
NAGARAJAN
India


Baiyao
XU
China

Appendix 7.3: MANA Advisors and International Cooperation Advisors

MANA Advisors (3):

Current as of January 2015

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 2015

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 (8):

Current as of January 2015

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

Kazuhito Hashimoto
Professor,
University of Tokyo,
Japan

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 2014):

1	2014 Jan 15 *Soft Electroactive Nanostructured Materials* **Dr. Charl F.J. Faul** University of Bristol, **UK**	12	2014 Mar 14 *Complex molecules at liquid interfaces V insights from molecular simulation* **Dr. David Cheung** Department of Pure and Applied Chemistry, University of Strathclyde, **UK**
2	2014 Jan 15 *Recent developments in Atomic Force Microscopy applied to plant systems* **Dr. Terry McMaster** University of Bristol, **UK**	13	2014 Mar 24 *How to move forward to the future large project for research and development* **Prof. Tetsuya Osaka** Waseda University, **Japan**
3	2014 Jan 16 *Carrier response in band gap and multiband transport in bilayer graphene under the ultra-high displacement* **Dr. Kosuke Nagashio** University of Tokyo, **Japan**	14	2014 Mar 24 *Preparation of organic-inorganic hybrid materials using nanostructures* **Prof. Yoshiyuki Sugahara** Waseda University, **Japan**
4	2014 Jan 28 *Matrix principle in synthesis technology for nanolayers compositions of inorganic and organic nature* **Prof. Victor Luchinin** St Petersburg Electrotechnical University, **Russia**	15	2014 Mar 24 *Molecular dynamics simulation of gate dielectric thin films* **Prof. Takanobu Watanabe** Waseda University, **Japan**
5	2014 Feb 4 *IOP Publishing: Maximizing the impact of your work* **Dr. Anna Demming** Publishing Editor, Institute of Physics Publishing, **UK**	16	2014 Apr 4 *High-k/hydrogenated-diamond metal-insulator-semiconductor field effect transistors fabrication* **Dr. Jiangwei Liu** ICYS-Namiki Researcher, NIMS, **Japan**
6	2014 Feb 6 *Three-dimensional Ag Nanostructures for Surface-Enhanced Raman Spectroscopy and Anti-counterfeiting Applications* **Prof. Xing Yi Ling** Nanyang Technological University, **Singapore**	17	2014 Apr 4 *Best suited protocol for applying magnetic field in magnetic refrigeration* **Dr. Ryo Tamura** ICYS-Sengen Researcher, NIMS, **Japan**
7	2014 Feb 7 *Magnetically Oriented Single-Crystal-Like Polymer Networks* **Dr. Yasuhiro Ishida** RIKEN Center for Emergent Matter Science, **Japan**	18	2014 Apr 11 *Soft X-ray nano-spectroscopy for nano wire ReRAM, graphene FET and organic FET* **Prof. Masaharu Oshima** University of Tokyo, **Japan**
8	2014 Feb 7 *Light-driven functional nanocarbon complexes for nanobiotechnological applications* **Dr. Eijirou Miyako** Health Research Institute, National Institute of Advanced Industrial Science and Technology, **Japan**	19	2014 Apr 18 *HTS Magnet Protection: Quench Detection and Protection Techniques Designed for HTS Magnets* **Dr. Yasuyuki Miyoshi** ICYS-Sengen Researcher, NIMS, **Japan**
9	2014 Feb 7 *Flexible-Rigid Hybrid π Systems that Show Environment-Dependent Multi-Luminescence for Materials Imaging Technique* **Dr. Shohei Saito** Research Center for Materials Science, Nagoya University, **Japan**	20	2014 Apr 18 *Coordination Polymers for Next Generation Energy Storage* **Dr. Hamish Hei-Man Yeung** ICYS-MANA Researcher, NIMS, **Japan**
10	2014 Feb 12 *Carbon-dots to ferry drugs and controlled release* **Dr. Madhuri Sharon** N.S.N .Research Centre for Nanotechnology & Bionanotechnology, **India**	21	2014 Apr 21 *Materials Engineering at the University of Toronto* **Prof. Jun Nogami** Department of Materials Science & Engineering, University of Toronto, **Canada**
11	2014 Feb 27 *Inorganic Colloid Liquid Crystals: Crossroads of Soft and Hard Matter* **Dr. Teruyuki Nakato** Department of Applied Chemistry, Kyushu Institute of Technology, **Japan**	22	2014 May 15 *Highly Ordered Porous Materials for Sensing and Energy Storage Application* **Prof. Ajayan Vinu** University of Queensland, **Australia**
		23	2014 May 16 *3D Graphene and BN Nanosheets: Chemical-Bubbling Synthesis and the Applications* **Dr. Xuebin Wang** ICYS-MANA Researcher, NIMS, **Japan**

24	2014 May 16 *Characterization of III-V compounds-based optoelectronic devices using cross-sectional scanning probe microscopy* **Dr. Nobuyuki Ishida** ICYS-Sengen Researcher, NIMS, **Japan**
25	2014 May 20 *Efficient $Cu_2ZnSn(S_{1-x},Se_x)_4$ solar cells spray coated from a hydro-alcoholic colloid synthesized by instantaneous reaction* **Dr. Gilles Dennler** Head of Energy and Environment Department, IMRA, **France**
26	2014 May 22 *Low cell stiffness as a malignant indicator of cancer progression* **Prof. Masami Suganuma** Saitama University, **Japan**
27	2014 May 26 *Functional Materials for Energy Conversion* **Prof. Suresh Valiyaveettil** Department of Chemistry, National University of Singapore, **Singapore**
28	2014 Jun 4 *Ab Initio Insights into Molecular Electronics and Spintronics* **Dr. Nicolae Atodiresei** Peter Grünberg Institute and Institute for Advanced Simulation, **Germany**
29	2014 Jun 6 *Challenges for the Use of Non-siliceous Mesoporous Thin Films to Improve Device Performances* **Dr. Norihiro Suzuki** ICYS-Sengen Researcher, NIMS, **Japan**
30	2014 Jun 6 *Advanced Single Particle Measurement for Next-generation Battery Materials* **Dr. Kei Nishikawa** ICYS-GREEN Researcher, NIMS, **Japan**
31	2014 Jun 11 *Growth and Processing of Graphene and Related 2D Nanomaterials for Future Electronics* **Prof. Hiroki Ago** Institute for Materials Chemistry and Engineering, Kyushu University, **Japan**
32	2014 Jun 12 *Combining Theory and Experiment to Understand Gold Clusters on Titania* **Prof. Greg Metha** Department of Chemistry, University of Adelaide, **Australia**
33	2014 Jun 13 *Detection, separation and quantification of nanoparticles in aqueous matrices* **Dr. Patrick Bäuerlein** KWR Watercycle Research Institute, **The Netherlands**
34	2014 Jun 16 *Precise construction of elaborate self-assembled structures and their functions* **Prof. Takashi Nakamura** University of Tsukuba, **Japan**
35	2014 Jun 17 *Electronic states at donor-acceptor/metal interfaces probed with electron spectroscopies* **Prof. Enrique Ortega** University of the Basque Country, San Sebastian, **Spain**
36	2014 Jun 17 *Bioinspired and Layered Oxide Materials for Renewable Energy and Therapeutics: Insight from Molecular Models and Simulations at the 1-100 Nanometer Scale* **Prof. Hendrik Heinz** Department of Polymer Engineering, University of Akron, **USA**
37	2014 Jun 20 *Intramolecular structure of individual organic molecules by Atomic Force Microscopy* **Dr. Ceser Moreno Sierra** ICYS-Sengen Researcher, NIMS, **Japan**
38	2014 Jun 20 *Diagnosis/Therapy Using 'Smart' Nanoparticles-Kit Consisting of Self-Assemble Copolymers and Block Copolymers* **Dr. Yohei Kotsuchibashi** ICYS-MANA Researcher, NIMS, **Japan**
39	2014 Jun 27 *Rediscovery of Nafion Membrane Using Infrared Spectroscopy* **Prof. Takeshi Hasegawa** Institute for Chemical Research, Kyoto University, **Japan**
40	2014 Jun 27 *Self-assembly of Metallic Nanoparticles on Ferroelectrics for Raman Enhancement* **Prof. Xiaoyan Liu** Chongqing University of Science and Technology, **China**
41	2014 Jul 4 *Water-dispersible CNTs to fabricate advanced hydrogel, metal and ceramic-matrix composite materials* **Dr. Mehdi Estili** ICYS-MANA Researcher, NIMS, **Japan**
42	2014 Jul 4 *Can we use molecules at the heart of the computer chips?* **Dr. Hicham Hamoudi** ICYS-Sengen Researcher, NIMS, **Japan**
43	2014 Jul 7 *Ultrafast Spectroscopy Applied to Biophysics and Material Science* **Prof. Stefan Haacke** IPCMS, University of Strasbourg, **France**
44	2014 Jul 8 *Schwinger's Pair Creation in Reduced Graphene Oxides* **Prof. Wen-Bin Jian** National Chiao Tung University, **Taiwan**
45	2014 Jul 10 *Business opportunities in chiral separation: New chiral bonded/immobilized silica and polymer monolithic capillary columns for enantioselective nano-LC separations* **Prof. Asharaf Ghanem** University of Canberra, **Australia**
46	2014 Jul 11 *Theoretical Studies on Membrane and Protein Complex Systems* **Prof. Hidemi Nagao** Kanazawa University, **Japan**
47	2014 Jul 18 *Smart Materials Design of Wide Bandgap ZnO: Functional Core* **Prof. Tetsuya Yamamoto** Kochi University of Technology, **Japan**

48	2014 Jul 18 *Pulsed laser deposition of thin films: from hard coatings to transparent and conductive oxides* **Dr. Valentin Craciun** National Institute for Laser, Plasma and Radiation Physics, **Romania**
49	2014 Jul 22 *Directed assembly of π-system-containing materials for organic electronics* **Prof. Martin Hollamby** Keele University, **UK**
50	2014 Jul 22 *Water-soluble fullerene derivatives for biological application* **Dr. Yoko Yamakoshi** ETH Zurich, **Switzerland**
51	2014 Jul 30 *Terahertz Modulation by Graphene Enhanced by Extraordinary Transmission through Ring Apertures* **Prof. D.M. Mittleman** Rice University, **USA**
52	2014 Aug 22 *Computational studies of catalytic reactions on oxide supported metal clusters* **Prof. Bjørk Hammer** Aarhus University, **Denmark**
53	2014 Aug 22 *Native defects and carrier doping in Ag_3PO_4: An insight from density-functional calculations* **Dr. Pakpoom Reunchan** Kasetsart University, **Thailand**
54	2014 Sep 4 *Structure and Forces in Self-Supported Foam Films* **Prof. Gunther Andersson** Flinders University, **Australia**
55	2014 Sep 8 *In-situ Analysis of the Oxide Growth Thermodynamics and Kinetics during MBE and Electron Transport in the Semiconducting Oxides In_2O_3 and SnO_2* **Dr. Oliver Bierwagen** Paul-Drude-Institut für Festkörperelektronik, **Germany**
56	2014 Sep 12 *Development of Low-cost Passive Sampling Diffusion Tubes for Monitoring Air Pollutants* **Prof. Krishna Manandhar** Tribhuvan University, **Nepal**
57	2014 Sep 12 *Iron Impregnated Nanoporous Carbons Derived from Lapsi (Choerospondias axillaries) for the Removal of Arsenic from Ground Water* **Prof. Raja Ram Pradhananga** Tribhuvan University, **Nepal**
58	2014 Sep 19 *A new strategy to control sensitivity/selectivity of nanomechanical sensors* **Dr. Kota Shiba** ICYS-MANA Researcher, NIMS, **Japan**
59	2014 Sep 19 *Development of pi-Conjugated Actuating Polymers* **Dr. Atsuro Takai** ICYS-Sengen Researcher, NIMS, **Japan**
60	2014 Sep 24 *Polyoxometalate-templated Metal-Organic Frameworks* **Dr. Sneha Bajpe** University of Cambridge, **UK**
61	2014 Sep 24 *Molecular Mechanics of Flexible Metal-Organic Frameworks* **Dr. Sebastian Henke** University of Cambridge, **UK**
62	2014 Sep 26 *Structure and dynamics by NMR spectroscopy - from proteins to silicon nanocrystals and MOFs* **Prof. Jan Lang** Charles University, **Czech Republic**
63	2014 Sep 29 *Orthogonally Modulated Molecular Transport Junctions for Resettable Electronic Logic Gates* **Prof. Xiaodong Chen** Nanyang Technological University, **Singapore**
64	2014 Oct 7 *Templated nanocarbons and carbon-coated materials for energy storage* **Prof. Hirotomo Nishihara** Tohoku University, **Japan**
65	2014 Oct 17 *Mesoporous Titania Photoanode with Sub-Micron Order Thickness: Toward an Efficient Photoanode for the Electricity Generating Window* **Dr. Norihiro Suzuki** ICYS-Sengen Researcher, NIMS, **Japan**
66	2014 Oct 17 *Phase Transition in Carbon Nanotubes* **Dr. Dai-Ming Tang** ICYS-MANA Researcher, NIMS, **Japan**
67	2014 Oct 27 *Suspended Microchannel Resonators (SMR) for metrology of cells, nanoparticles, and fine bubbles* **Dr. Vincent Agache** CEA/LETI, **France**
68	2014 Nov 4 *Dithiol & thiol adsorption on surfaces: questions of alternative adsorption sites and complex interfaces formed on reactive surfaces* **Prof. Vladimir A. Esaulov** Universite Paris Sud, Orsay, **France**
69	2014 Nov 4 *Architecture and decoration at the mesoscale using Mesoporous Hybrid Thin Films* **Prof. Galo Juan de Avila Arturo Soler-Illia** CNEA /Universidad de Buenos Aires, **Argentina**
70	2014 Nov 5 *H-Bonding Driven Supramolecular Assembly of Donor-Acceptor Chromophores and Amphiphilic Macromolecules* **Prof. Suhrit Ghosh** Indian Association for the Cultivation of Science, **India**
71	2014 Nov 7 *Materials in silico: Structure and transport* **Prof. Mark E. Tuckerman** New York University, **USA**
72	2014 Nov 7 *Fabrication, Properties, and Applications of van der Waals Heterostructures* **Prof. James Hone** Columbia University, **USA**
73	2014 Nov 7 *Endotaxy of Silver Nanostructures in Silicon: Growth, Characterization and Applications* **Prof. P.V. Satyam** Institute of Physics, **India**

74	2014 Nov 10 *Atomic and molecular contacts: Spins, Forces, Photons, Noise* **Prof. Richard Berndt** Christian-Albrechts-Universität zu Kiel, **Germany**	78	2014 Nov 25 *Mesoporous silica as Nanocarrier and Diagnostics* **Prof. Chung-Yuan Mou** National Taiwan University, **Taiwan**
75	2014 Nov 11 *Tuning the properties and nanostructure of functional polymers and nanomaterials for applications ranging from nanofabrication to nanomedicine* **Prof. Idriss Blakey** University of Queensland, **Australia**	79	2014 Dec 2 *Aggregation-Induced Emission* **Prof. Ben Zhong Tang** The Hong Kong University of Science and Technology, **China**
76	2014 Nov 21 *N-/P-doped graphene for high-performance rechargeable batteries and the origin* **Dr. Xi Wang** ICYS-MANA Researcher, NIMS, **Japan**	80	2014 Dec 15 *Engineered Bionanocomposites* **Prof. Vladimir V. Tsukruk** Georgia Institute of Technology, Atlanta, **USA**
77	2014 Nov 21 *Development of chirality sensors beyond the current paradigm* **Dr. Jan Labuta** ICYS-Sengen Researcher, NIMS, **Japan**	81	2014 Dec 18 *Basicity and Oxygen Vacancy in Layered Titanates: The conversion of fatty acids into diesel fuel* **Dr. Tosapol Maluangnont** King Mongkut's Institute of Technology Ladkrabang , **Thailand**

Appendix 7.6: MANA Research Papers 2014

List of MANA affiliated research papers in English published 2014 in scientific journals (488 papers):

1	S.A. Abdellatef, A. Ohi, T. Nabatame, A. Taniguchi, *Induction of hepatocyte functional protein expression by submicron/nano-patterning substrates to mimic in vivo structures*, Biomaterials Science **2**(3), 330 (2014). doi: 10.1039/c3bm60191a WOS:000330797800005 2-s2.0-84893340405	5	M. Akamatsu, T. Mori, K. Okamoto, H. Sakai, M. Abe, J.P. Hill, K. Ariga, *Multicolour Fluorescent Memory Based on the Interaction of Hydroxy Terphenyls with Fluoride Anions*, Chemistry - A European Journal **20**(49), 16293 (2014). doi: 10.1002/chem.201404089 WOS:000345515700035 2-s2.0-84915791540
2	S.A. Abdellatef, A. Ohi, T. Nabatame, A. Taniguchi, *The Effect of Physical and Chemical Cues on Hepatocellular Function and Morphology*, International Journal of Molecular Sciences **15**(3), 4299 (2014). doi: 10.3390/ijms15034299 WOS:000334444700057 2-s2.0-84896487510	6	M.M. Alam, H. Yamahana, B.P. Bastakoti, H.N. Luitel, W.W. Zhao, Y. Yamauchi, T. Watari, H. Noguchi, K. Nakashima, *Synthesis of hollow silica nanosphere with high accessible surface area and their hybridization with carbon matrix for drastic enhancement of electrochemical property*, Applied Surface Science **314**, 552 (2014). doi: 10.1016/j.apsusc.2014.07.030 WOS:000341464100076 2-s2.0-84906706591
3	C. Abe, Y. Uto, A. Kawasaki, C. Noguchi, R. Tanaka, T. Yoshitomi, Y. Nagasaki, Y. Endo, H. Hori, *Evaluation of the in vivo antioxidative activity of redox nanoparticles by using a developing chicken egg as an alternative animal model*, Journal of Controlled Release **182**, 67 (2014). doi: 10.1016/j.jconrel.2014.03.015 WOS:000335554000007 2-s2.0-84897382722	7	S. Alam, C. Anand, K.S. Lakhi, J.H. Choy, W.S. Cha, A. Elzhatry, S.S. Al-Deyab, Y. Ohya, A. Vinu, *Highly Magnetic Nanoporous Carbon/Iron-Oxide Hybrid Materials*, ChemPhysChem **15**(16), 3440 (2014). doi: 10.1002/cphc.201402448 WOS:000344370900003 2-s2.0-84919338351
4	M. Akamatsu, H. Komatsu, T. Mori, E. Adams, R. Shin, H. Sakai, M. Abe, J.P. Hill, K. Ariga, *Intracellular Imaging of Cesium Distribution in Arabidopsis Using Cesium Green*, ACS Applied Materials & Interfaces **6**(11), 8208 (2014). doi: 10.1021/am5009453 WOS:000337336900030 2-s2.0-84902440436	8	J.X. An, A. Dedinaite, F.M. Winnik, X.P. Qiu, P.M. Claesson, *Temperature-Dependent Adsorption and Adsorption Hysteresis of a Thermoresponsive Diblock Copolymer*, Langmuir **30**(15), 4333 (2014). doi: 10.1021/la500377w WOS:000334991400017 2-s2.0-84899408073

9	C. Anand, G. Lawrence, A.A. Elzatahry, S.S. Al-Deyab, V.V. Balasubramanian, W.S. Cha, J.S.M. Zaidi, A. Vinu, *Highly Dispersed and Active Iron Oxide Nanoparticles in SBA-15 with Different Pore Sizes for the Synthesis of Diphenylmethane*, Science of Advanced Materials **6**(7), 1618 (2014). doi: 10.1166/sam.2014.1844 WOS:000338125200050 2-s2.0-84902988957	18	F.M. Auxilia, S. Ishihara, S. Mandal, T. Tanabe, G. Saravanan, G.V. Ramesh, N. Umezawa, T. Hara, Y. Xu, S. Hishita, Y. Yamauchi, A. Dakshanamoorthy, J.P. Hill, A. Ariga, H. Abe, *Low-Temperature Remediation of NO Catalyzed by Interleaved CuO Nanoplates*, Advanced Materials **26**(26), 4481 (2014). doi: 10.1002/adma.201306055 WOS:000339565100010 2-s2.0-84904097519
10	C.A. Antonyraj, D.N. Srivastava, G.P. Mane, S. Sankaranarayanan, A. Vinu, K. Srinivasan, *Co_3O_4 microcubes with exceptionally high conductivity using a CoAl layered double hydroxide precursor via soft chemically synthesized cobalt carbonate*, Journal of Materials Chemistry A **2**(18), 6301 (2014). doi: 10.1039/c4ta00561a WOS:000334123100004 2-s2.0-84897996059	19	F.M. Auxilia, T. Tanaba, S. Ishihara, G. Saravanan, G.V. Ramesh, F. Matsumoto, X. Ya, K. Ariga, A. Dakshanamoorthy, H. Abe, *Interleaved Mesoporous Copper for the Anode Catalysis in Direct Ammonium Borane Fuel Cells*, Journal of Nanoscience and Nanotechnology **14**(6), 4443 (2014). doi: 10.1166/jnn.2014.8278 WOS:000332339500067 2-s2.0-84899722123
11	M. Aono, S.J. Kim, M. Hara, T. Munakata, *Amoeba-inspired Tug-of-War algorithms for exploration-exploitation dilemma in extended Bandit Problem*, Biosystems **117**, 1 (2014). doi: 10.1016/j.biosystems.2013.12.007 WOS:000333873000001 2-s2.0-84892849955	20	C. Avci, A. Aydin, Z. Tuna, Z. Yavuz, Y. Yamauchi, N. Suzuki, O. Dag, *Molten Salt Assisted Self Assembly (MASA): Synthesis of Mesoporous Metal Titanate ($CoTiO_3$, $MnTiO_3$, and $Li_4Ti_5O_{12}$) Thin Films and Monoliths*, Chemistry of Materials **26**(20), 6050 (2014). doi: 10.1021/cm503020y WOS:000343950300029 2-s2.0-84908304760
12	K. Ariga, K. Kawakami, M. Ebara, Y. Kotsuchibashi, Q. Ji, J.P. Hill, *Bioinspired nanoarchitectonics as emerging drug delivery systems*, New Journal of Chemistry **38**(11), 5149 (2014). doi: 10.1039/c4nj00864b WOS:000343922800006 2-s2.0-84908149812	21	M. Ayad, N. Salahuddin, A. Fayed, B.P. Bastakoti, N. Suzuki, Y. Yamauchi, *Chemical design of a smart chitosan-polypyrrole-magnetite nanocomposite toward efficient water treatment*, Physical Chemistry Chemical Physics **16**(39), 21812 (2014). doi: 10.1039/c4cp03062a WOS:000343072900088 2-s2.0-84907822047
13	K. Ariga, T. Mori, M. Akamatsu, J.P. Hill, *Two-dimensional nanofabrication and supramolecular functionality controlled by mechanical stimuli*, Thin Solid Films **554**, 32 (2014). doi: 10.1016/j.tsf.2013.05.060 WOS:000331078800007 2-s2.0-84893898791	22	Z. Baji, Z. Labadi, G. Molnar, B. Pecz, K. Vad, Z.E. Horvath, P.J. Szabo, T. Nagata, J. Volk, *Highly conductive epitaxial ZnO layers deposited by atomic layer deposition*, Thin Solid Films **562**, 485 (2014). doi: 10.1016/j.tsf.2014.04.047 WOS:000340658100077 2-s2.0-84901785130
14	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 WOS:000330416900043 2-s2.0-84892583464	23	B.P. Bastakoti, S. Ishihara, S.Y. Leo, K. Ariga, K.C.W. Wu, Y. Yamauchi, *Polymeric Micelle Assembly for Preparation of Large-Sized Mesoporous Metal Oxides with Various Compositions*, Langmuir **30**(2), 651 (2014). doi: 10.1021/la403901x WOS:000330203900026 2-s2.0-84892743197
15	K. Ariga, Y. Yamauchi, Q.M. Ji, Y. Yonamine, J.P. Hill, *Research Update: Mesoporous sensor nanoarchitectonics*, APL Materials **2**(3), 030701 (2014). doi: 10.1063/1.4868177 WOS:000334220300001 2-s2.0-84900028634	24	B.P. Bastakoti, Y.Q. Li, N. Miyamoto, N.M. Sanchez-Ballester, H. Abe, J.H. Ye, P. Srinivasu, Y. Yamauchi, *Polymeric micelle assembly for the direct synthesis of functionalized mesoporous silica with fully accessible Pt nanoparticles toward an improved CO oxidation reaction*, Chemical Communications **50**(65), 9101 (2014). doi: 10.1039/c4cc02556c WOS:000339930400017 2-s2.0-84904566961
16	K. Ariga, Y. Yamauchi, G. Rydzek, Q.M. Ji, Y. Yonamine, K.C.W. Wu, J.P. Hill, *Layer-by-layer Nanoarchitectonics: Invention, Innovation, and Evolution*, Chemistry Letters **43**(1), 36 (2014). doi: 10.1246/cl.130987 WOS:000329475000006 2-s2.0-84891808513	25	B.P. Bastakoti, R.R. Salunkhe, J.H. Ye, Y. Yamauchi, *Direct synthesis of a mesoporous TiO_2-RuO_2 composite through evaporation-induced polymeric micelle assembly*, Physical Chemistry Chemical Physics **16**(22), 10425 (2014). doi: 10.1039/c4cp01118j WOS:000336781500017 2-s2.0-84900798330
17	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 WOS:000346324000022 2-s2.0-84916917816		

26	B.P. Bastakoti, N.L. Torad, Y. Yamauchi, *Polymeric Micelle Assembly for the Direct Synthesis of Platinum-Decorated Mesoporous TiO_2 toward Highly Selective Sensing of Acetaldehyde*, ACS Applied Materials & Interfaces **6**(2), 854 (2014). doi: 10.1021/am4039954 WOS:000330201900018 2-s2.0-84892903583
27	W. Beenken, M. Presselt, T.H. Ngo, W. Dehaen, W. Maes, M. Kruk, *Molecular Structures and Absorption Spectra Assignment of Corrole NH Tautomers*, Journal of Physical Chemistry A **118**(5), 862 (2014). doi: 10.1021/jp411033h WOS:000331153400009 2-s2.0-84893875805
28	P.J. Beldon, S. Tominaka, P. Singh, T.S. Dasgupta, E.G. Bithell, A.K. Cheetham, *Layered structures and nanosheets of pyrimidinethiolate coordination polymers*, Chemical Communications **50**(30), 3955 (2014). doi: 10.1039/c4cc00771a WOS:000333122300015 2-s2.0-84896525299
29	A.A. Belik, *Negative Exchange Bias in Polycrystalline Hexagonal $ScMnO_3$, $InMnO_3$, $YMnO_3$, 4H-$SrMnO_3$, and 6H-$SrMnO_3$ and Perovskite $YMnO_3$: Effects of Impurities*, Journal of the Physical Society of Japan **83**(7), 074703 (2014). doi: 10.7566/JPSJ.83.07470 WOS:000339047900028 2-s2.0-84924944182
30	A.A. Belik, T. Yamauchi, H. Ueda, Y. Ueda, H. Yusa, N. Hirao, M. Azuma, *Absence of Metallic Conductivity in Tetragonal and Cubic $PbVO_3$ at High Pressure*, Journal of the Physical Society of Japan **83**(7), 074711 (2014). doi: 10.7566/JPSJ.83.074711 WOS:000339047900036 2-s2.0-84925003546
31	A.A. Belik, W. Yi, *High-pressure synthesis, crystal chemistry and physics of perovskites with small cations at the A site*, Journal of Physics: Condensed Matter **26**(16), 163201 (2014). doi: 10.1088/0953-8984/26/16/163201 WOS:000333798500001 2-s2.0-84901741995
32	S. Beyhan, *Electrocatalytic Properties of Au(h k l) Electrodes Towards Oxidation of Ethanol in Alkaline Media*, International Journal of Electrochemical Science **9**(6), 3259 (2014). doi:- WOS:000334493300045 2-s2.0-84897842706
33	I. Bhattacharyya, P. Kumar, D. Goswami, *Effect of isotope substitution in binary liquids with Thermal-Lens spectroscopy*, Chemical Physics Letters **598**, 35 (2014). doi: 10.1016/j.cplett.2014.02.056 WOS:000334294900007 2-s2.0-84897892278
34	P.E.R. Blanchard, E. Reynolds, B.J. Kennedy, J.A. Kimpton, M. Avdeev, A.A. Belik, *Anomalous thermal expansion in orthorhombic perovskite $SrIrO_3$: Interplay between spin-orbit coupling and the crystal lattice*, Physical Review B **89**(21), 214106 (2014). doi: 10.1103/PhysRevB.89.214106 WOS:000337729400001 2-s2.0-84902477887
35	N. Bonnet, M. Otani, O. Sugino, *Self-Poisoning Dynamical Effects in the Oxygen Reduction Reaction on Pt(111) from a Top-Down Kinetic Analysis*, Journal of Physical Chemistry C **118**(25), 13638 (2014). doi: 10.1021/jp502807z WOS:000338184300035 2-s2.0-84914697950
36	X.K. Cai, R.Z. Ma, T.C. Ozawa, N. Sakai, A. Funatsu, T. Sasaki, *Superlattice assembly of graphene oxide (GO) and titania nanosheets: fabrication, in situ photocatalytic reduction of GO and highly improved carrier transport*, Nanoscale **6**(23), 14419 (2014). doi: 10.1039/c4nr04830j WOS:000344997600043 2-s2.0-84908892382
37	J.Y. Cao, L.Q. Liu, A. Hashimoto, J.H. Ye, *Hematite photo-electrodes with multiple ultrathin SiOx interlayers towards enhanced photoelectrochemical properties*, Electrochemistry Communications **48**, 17 (2014). doi: 10.1016/j.elecom.2014.07.030 WOS:000345208000005 2-s2.0-84906549849
38	W. Chaikittisilp, K. Muraoka, Q.M. Ji, K. Ariga, Y. Yamauchi, *Mesoporous architectures with highly crystallized frameworks*, Journal of Materials Chemistry A **2**(31), 12096 (2014). doi: 10.1039/c3ta15389d WOS:000339625500001 2-s2.0-84904431202
39	W. Chaikittisilp, N.L. Torad, C.L. Li, M. Imura, N. Suzuki, S. Ishihara, K. Ariga, Y. Yamauchi, *Synthesis of Nanoporous Carbon- Cobalt- Oxide Hybrid Electrocatalysts by Thermal Conversion of Metal- Organic Frameworks*, Chemistry - A European Journal **20**(15), 4217 (2014). doi: 10.1002/chem.201304404 WOS:000333632800003 2-s2.0-84897998206
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Appendix 7.7: MANA Journal Cover Sheets

Journal cover sheets related to MANA affiliated papers (October 2007 – December 2014):

	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

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 2014):

Between October 2007 and December 2012, MANA has made 377 Japanese Patent Applications. They are listed in Appendix 8.9 of the report *Facts and Achievements 2012*.

No.	Date of Application *Name of Invention*	Application Number
378	2013 Jan 11 *Self-heating nanofibers with drug release function, fabrication method of the sane, and fabrication method of the nonwoven material*	2013-003341
379	2013 Jan 18 *Fabrication method of adhesion for tissues*	2013-006961
380	2013 Jan 24 *Fluorescence probe and detection method for materials containing Cs*	2013-011300
381	2013 Jan 25 *Electric field-tunable topological insulator utilizing perovskite structure*	2013-011584
382	2013 Jan 28 *Multi-functional device for electric conductivity*	2013-012848
383	2013 Feb 1 *Green light emissive germanium nanoparticles and fabrication method of the same*	2013-018245
384	2013 Feb 6 *Perovskite nano-sheets based on homologous layered provskite-oxide, and their applications*	2013-021150
385	2013 Feb 13 *Conductive polymer-metal composites and materials adhered by them, and fabrication method of the same*	2013-025154
386	2013 Feb 27 *Thermoelectric semiconductors of rare-earth alumino-borides, and fabrication method of the same and thermoelectric devices using the same*	2013-036757
387	2013 Mar 1 *Nano carbon and graphene or carbon composite materials with graphene, and fabrication method of the same*	2013-040445
388	2013 Mar 13 *Adhesive bone filling agents and kits of the same*	2013-050139
389	2013 Mar 18 *Resettable optical sensors and resetting methods of optical sensors*	2013-054733
390	2013 Mar 21 *Adhesive agents for cells and clusters of aggregate cells*	2013-057544
391	2013 Mar 21 *Sensor devices for measurement of very small amount of samples*	2013-057649
392	2013 Mar 22 *Nanoparticles with high sensitivity for light emission and light amplifiers using laser media*	2013-060077
393	2013 Mar 28 *Organic EL devices*	2013-067782
394	2013 Mar 28 *Organic EL devices and fabrication method of the same*	2013-067801
395	2013 Mar 28 *Organic EL devices and fabrication method of the same*	2013-068164
396	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
397	2013 Apr 12 *Freestanding organometallics nanomembrane and fabrication method of the same*	2013-083992
398	2013 Apr 26 *Equipment for molecular measurement and fabrication method of the same*	2013-094200
399	2013 Apr 26 *Mesoporous materials of inorganic oxides and fabrication method of the same*	2013-094728
400	2013 May 2 *Holders for sensor tips*	2013-096690
401	2013 May 9 *Thin film transistors and fabrication method of the same*	2013-099284
402	2013 May 13 *Conductive polymer-metal composites and materials adhering them, and fabrication method of the same*	2013-100815
403	2013 May 13 *Fabrication method of substrates for cell culture, substrates for cell culture and method of cell culture*	2013-101259
404	2013 May 27 *Self assembling peptides*	2013-110898
405	2013 Jun 4 *Transistor of dual gate polymer thin film*	2013-117654
406	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
407	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
408	2013 Jun 13 *Nanoparticles of platinum alloy, and fabrication method of the same, electrodes using nanoparticles of platinum alloy and fuel cells*	2013-124873
409	2013 Jun 13 *Thin film transistors, fabrication method of the same and semiconductor equipment*	2014-521410
410	2013 Jun 27 *Devices for variable electric conductivity using all solid electric double layers and electric equipment using the same*	2013-134534

No.	Date of Application / Name of Invention	Application Number
411	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
412	2013 Jul 1 *Chiral shift agents for NMR, and method for determination of photo purity and absolute arrangement using the same*	2013-137744
413	2013 Jul 3 *Thin film transistor and fabrication method of the same*	2013-139425
414	2013 Jul 11 *Apparatus for electron back scattering*	2013-145573
415	2013 Jul 26 *High proton conductive polymer films and fabrication method of the same, and humidity sensors*	2014-528113
416	2013 Jul 30 *Inactive bio membranes, liquids for coating and fabrication method of the same, and substrates for bio inactive treatment*	2013-157967
417	2013 Aug 8 *Fabrication method for recombined proteins using non protein/non lipid conditioned cell strain*	2013-164837
418	2013 Aug 23 *Equipment for measurement of micro heat conductivity, and measurement method*	2013-172783
419	2013 Aug 26 *Blood purification membranes, fabrication method of the same and dialyzers*	2013-174636
420	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
421	2013 Sep 26 *Layered resist films of high sensitive metal layers and method for improving photo sensitivity of resist layers*	2013-199700
422	2013 Sep 27 *Metal electrodes and semi-conductive device using the same*	2013-201187
423	2013 Sep 30 *Aromatic amine adsorbents, quartz resonator using the same, and fabrication method of the same*	2013-203943
424	2013 Oct 1 *Adhesive bone filling agents and kit of the same*	2013-206357
425	2013 Oct 3 *Materials of three dimensional graphene foam and fabrication method of the same*	2013-208464
426	2013 Nov 6 *Mesoporous metallic nanoparticles, fabrication method of the same, and catalysts containing the same*	2013-230655
427	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
428	2013 Nov 15 *Signal inducing functional polymers for information transfer molecules among cells and fabrication method of the same*	2013-236845
429	2013 Nov 22 *Cell adhesive porous membranes, fabrication method of the same and tissue adhesive porous membrane tapes*	2013-241764
430	2013 Nov 26 *Thin film transistors and fabrication method of the same*	2013-243413
431	2013 Nov 26 *Photo catalytic materials and fabrication method of the same*	2013-243826
432	2013 Nov 28 *Nanoparticles of platinum alloy, fabrication method of the same and electrodes and fuel cells containing the same*	2013-245982
433	2013 Dec 2 *Memory media and memory equipment using the same, method for recording and erasing of information*	2013-249601
434	2013 Dec 11 *Single crystal silicon wafers of rectangular shape*	2013-255895
435	2013 Dec 20 *Method of fractionating nanomaterial comprising elongated elements of different lengths*	2013-264489
436	2014 Jan 17 *Fluorescent probe, and a method for detecting nicotine adenine dinucleotide derivative*	2014-006978
437	2014 Jan 31 *Thin film transistor and a method of manufacturing the same*	2014-016266
438	2014 Jan 31 *Thin film transistor and a method of manufacturing the same*	2014-016273
439	2014 Jan 31 *Oxide thin film transistor and a method of manufacturing the same*	2014-016630
440	2014 Jan 31 *Oxide semiconductor and a method of manufacturing the same*	2014-016631
441	2014 Jan 31 *Structure of the thin film transistor, thin film transistor manufacturing method and semiconductor device*	2014-016632
442	2014 Jan 31 *A gate insulating film induce a fixed charge therein*	2014-016633
443	2014 Jan 31 *Thin film transistor and a method of manufacturing the same*	2014-016634
444	2014 Jan 31 *Thin-film transistor, thin film transistor manufacturing method and semiconductor device*	2014-016635
445	2014 Feb 3 *Neuron operating elements*	2014-018374
446	2014 Feb 6 *Semiconductor photodetector*	2014-020952
447	2014 Feb 12 *Applications fullerene structure and using the same*	2014-023960
448	2014 Feb 12 *Boron nitride particles and a method of manufacturing the same*	2014-024008
449	2014 Feb 12 *Spherical boron nitride particles and a method of manufacturing the same*	2014-024009
450	2014 Feb 28 *Semiconductor device comprising a hydrogen diffusion barrier and method of fabricating same*	2014-037643

No.	Date of Application / Name of Invention	Application Number
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
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

No.	Date of Application *Name of Invention*	Application Number
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

2. List of Japanese Patent Registrations (January 2013 – December 2014):

Between October 2007 and December 2012, MANA has made 232 Japanese Patent Registrations. They are listed in Appendix 8.9 of the report *Facts and Achievements 2012*.

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
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

No.	Date of Registration *Name of Invention*	**Registration Number**
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**
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**

No.	Date of Registration / Name of Invention	Registration Number
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 20 *Ultrathin boron nitride nanosheet, method for production thereof, and optical material containing the nanosheet*	5435559
317	2013 Dec 20 *Production method of group IV semiconductor nano thin wire*	5435600
318	2013 Dec 20 *Polymer brush-solid composite material, and method for producing the same*	5437256
319	2014 Jan 10 *Injection method for organic molecule and its apparatus*	5445990
320	2014 Jan 10 *Nano flake-like metal composite material, and manufacturing method of the same and surface enhanced Raman scattering active substrate*	5445991
321	2014 Jan 10 *Method for manufacturing boron nitride nanotube*	5448067
322	2014 Jan 31 *Rare earth oxide fluorescent materials, thin film using the same, and methods for producing them*	5464404
323	2014 Jan 31 *Method for growing single crystal silicon having square cross section and silicon wafer having square section*	5464429
324	2014 Feb 7 *Biosensor, method for detecting biological material with biosensor, and kit therefor*	5467312
325	2014 Feb 21 *New diblock copolymer and high mobility/ photodconductivity anisotropic nanowire formed by self-assembling of the diblock copolymer*	5476561
326	2014 Feb 21 *Method for manufacturing surface enhanced infrared absorption sensor*	5476574
327	2014 Feb 21 *Method of producing silicon carbide*	5477445
328	2014 Feb 21 *Boron nitride nanotube derivative, its dispersion, and method for producing the boron nitride nanotube derivative*	5477702
329	2014 Mar 7 *Solar cell*	5487449
330	2014 Mar 14 *Recording medium, and recording device and information recording/erasure method using the same*	5493210
331	2014 Mar 14 *Fiber fragment manufacturing method*	5493215
332	2014 Mar 14 *Fullerene structure, method for manufacturing the same, and application using the same*	5493232
333	2014 Mar 14 *Fluorescence emitting silicon nanoparticle and method for producing the same*	5495038
334	2014 Mar 20 *Zinc sulfide nanobelt, UV light detection sensor and method for producing the same*	5500543
335	2014 Apr 11 *Electrode catalyst for fuel cell and manufacturing method thereof*	5515115
336	2014 Apr 11 *Mg-based structured member*	5517024
337	2014 Apr 11 *Electron element substrate*	5517034
338	2014 Apr 11 *Method for synthesizing brookite*	5517048
339	2014 Apr 11 *Switching element and switch array*	5517065
340	2014 Apr 18 *Mesoporous carbon nitride material and process for producing the same*	5521191
341	2014 Apr 25 *Photoresponsive drug transporter and photoresponsive drug transporter with drug*	5526324
342	2014 Apr 25 *Fullerene derivative composition and field-effect transistor element using the same*	5529439
343	2014 Apr 25 *Dielectric thin film, dielectric thin film element, and thin film capacitor*	5531163
344	2014 May 16 *Porous base, method of producing the same and method of using the porous base*	5540301
345	2014 May 16 *Nanocrystal particle coated with organic molecular film and manufacturing method of nanocrystal particle coated with organic molecular film*	5540307
346	2014 May 16 *Low-temperature sintering method of silicon carbide powder*	5540318
347	2014 May 16 *Light emitting nano sheet, fluorescent illumination body, solar cell, color display using the same*	5540407
348	2014 May 16 *Nano sheet coating*	5540408
349	2014 May 16 *Powdery medicine inhalation device*	5543850
350	2014 May 23 *Electrochemical transistor*	5544621
351	2014 May 30 *Molecular electronic device, and method of manufacturing the same*	5549971
352	2014 Jun 6 *Electrode catalyst for fuel cell and manufacturing method thereof*	5553344
353	2014 Jun 13 *Tissue regeneration method*	5557084
354	2014 Jun 13 *Photodegradable hetero-bivalent crosslinking agent*	5557229
355	2014 Jun 27 *Boron nitride nanotube derivative, its dispersion, and method for producing the boron nitride nanotube derivative*	5565694
356	2014 Jun 27 *Porous ceramic material and method of producing the same*	5565721

No.	Date of Registration / *Name of Invention*	Registration Number	No.	Date of Registration / *Name of Invention*	Registration Number
357	2014 Jul 4 *Polymer fiber, production method for same, and production device*	5569826	371	2014 Nov 7 *Metal nanoparticle having dendritic portion and method for producing the same*	5641385
358	2014 Aug 15 *Two-component tissue adhesive and method for producing same*	5594633	372	2014 Nov 7 *Bio-hybrid material, production method therefor, and stent*	5641454
359	2014 Aug 22 *Organic polymer nanowire and manufacturing method thereof*	5598805	373	2014 Nov 21 *Surface stress sensor*	5649138
360	2014 Aug 22 *Light-emitting element*	5598809	374	2014 Nov 28 *Electrolyte material for solid fuel cell and manufacturing method thereof*	5652602
361	2014 Aug 22 *Resin coated member and method of resin coating*	5598901	375	2014 Nov 28 *Method for producing mesoporous silica*	5652792
362	2014 Aug 22 *Gate electrode and method of manufacturing the same*	5598916	376	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
363	2014 Aug 22 *Method of producing dense material of electrolyte for solid oxide fuel cell*	5598920	377	2014 Dec 12 *Compound oxide semiconductor, yellow pigment using the same, and photocatalyst*	5660419
364	2014 Sep 12 *Dielectric film, dielectric element, and process for producing the dielectric element*	5610348	378	2014 Dec 12 *Composite material comprising high-molecular-weight matrix and low-molecular-weight organic compound and process for producing same*	5660452
365	2014 Sep 12 *Film which is formed of hemispherical particles, method for producing same, and use of same*	5610358	379	2014 Dec 12 *Liquid organic material at ambient temperature and use thereof*	5660470
366	2014 Sep 19 *Method for producing cobalt (II) hydroxide-iron (III) hexagonal plate-like lamellar crystal*	5614689	380	2014 Dec 12 *Recording device and recording/deletion method for information*	5660478
367	2014 Oct 3 *Phenylboronic acid-based monomer and phenylboronic acid-based polymer*	5622188	381	2014 Dec 19 *Chiral shift reagent for NMR and method for determining optical purity and absolute configuration using the same*	5665043
368	2014 Oct 10 *Electromagnetic wave absorbent material*	5626649	382	2014 Dec 19 *Layered rare-earth hydroxide, method for producing the same and application thereof*	5665051
369	2014 Oct 10 *Alloy particle and wire rod which are used in air plasma spraying and wire arc spraying*	5626947	383	2014 Dec 26 *Porous scaffold material*	5669248
370	2014 Oct 10 *Contact structure of organic semiconductor device, organic semiconductor device, and method of fabricating the same*	5626959	384	2014 Dec 26 *Porous copper sulfide, method for manufacturing the same, and use of the same*	5669265

3. List of International Patent Applications (January 2013 – December 2014):

Between October 2007 and December 2012, MANA has made 198 International Patent Applications. They are listed in Appendix 8.9 of the report *Facts and Achievements 2012*.

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

No.	Date of Application / **Country** *Name of Invention*	Application Number	No.	Date of Application / **Country** *Name of Invention*	Application Number
199	2013 Apr 17 **PCT** *Double-sided coated surface stress sensor*	PCT/JP2013/061404	203	2013 Jul 26 **PCT** *Highly proton-conductive polymer film, method for producing same, and humidity sensor*	PCT/JP2013/070299
200	2013 Apr 19 **PCT** *Biomaterial coated with HAp/Col composite*	PCT/JP2013/061666	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
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			

No.	Date of Application Country *Name of Invention*	Application Number
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**

4. List of International Patent Registrations (January 2013 – December 2014):

Between October 2007 and December 2012, MANA has made 72 International Patent registrations. They are listed in Appendix 8.9 of the report *Facts and Achievements 2012*.

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

No.	Date of Registration Country *Name of Invention*	Registration Number
73	2013 Jan 29 **US** *Carbon porous body and adsorbent using the same*	**8361203**
74	2013 Feb 6 **EPC, France, Germany, UK** *Process for producing porous object comprising apatite/collagen composite fiber*	**1825868**
75	2013 Feb 27 **EPC, Germany, UK** *Switching element and application of the same*	**2184793**
76	2013 Apr 9 **US** *Spherical boron nitride nanoparticles and synthetic method thereof*	**8414855**
77	2013 May 1 **Taiwan** *All-solid battery*	**I395360**
78	2013 May 7 **US** *Preparation method for anion-exchangeable, layered double hydroxides*	**8435910**
79	2013 May 28 **Canada** *Process for producing porous object comprising apatite/collagen composite fiber*	**2585577**
80	2013 Jun 20 **Russia** *All-solid battery*	**2485635**
81	2013 Jul 1 **Taiwan** *Resin composition*	**I400288**
82	2013 Jul 3 **China** *Process for producing porous object comprising apatite/collagen composite fiber*	**ZL200580010769.0**
83	2013 Jul 5 **Hong Kong** *Resin composition*	**HK1141821**
84	2013 Jul 10 **EPC, France, Germany** *Electrically conductive polyrotaxane*	**2423242**
85	2013 Aug 27 **US** *Production method for electrode for battery, electrode produced by production method, and battery including electrode*	**8518584**
86	2013 Sep 18 **China** *Mg-based structured member*	**ZL201080005817.8**
87	2013 Sep 25 **China** *Dielectric film, dielectric element, and process for producing the dielectric element*	**ZL200980118276.7**
88	2013 Sep 25 **Korea** *All-solid battery*	**1314031**
89	2013 Oct 22 **US** *Hetero pn junction semiconductor and process for producing the same*	**8563975**

No.	Date of Registration	Registration Number	Country	Name of Invention
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*
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*

Appendix 7.9: International Cooperation

List of MOU agreements of MANA with overseas institutions signed between October 2007 and March 2015:

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
21	Friedrich-Alexander University, Erlangen-Nürnberg, **Germany** Signed: 2010 Jun 21
22	Fudan University, Department of Materials Science, **China** Signed: 2010 Jul 23
23	EWHA Womans University Seoul, Department of Chemistry and Nanoscience, **Korea** Signed: 2010 Aug 27
24	Karlsruhe Institute of Technology, **Germany** Signed: 2010 Sep 16
25	Univesité de la Méditerranée, Marseille, **France** Signed: 2010 Sep 20
26	Anhui Key Laboratory of Nanomaterials and Nanostructures, **China** Signed: 2010 Oct 6
27	Multidisciplinary Center for Development of Ceramic Materials, **Brazil** Signed: 2010 Oct 26
28	Vietnam National University Ho Chi Minh City, **Vietnam** Signed: 2011 Jan 24
29	King Saud University, **Saudi Arabia** Signed: 2011 Jan 25
30	LMPG, Grenoble, **France** Signed: 2011 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
51	Indian Institute of Science (IISc), Bangalore, **India** Signed: 2015 Jan 13
52	University of Toronto, **Canada** Signed: 2015 Jan 21

Appendix 7.10: MANA History

MANA History between October 2007 and March 2015:

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
2008 Apr 1	Start of ICYS-MANA Program
2008 Apr 16	1st MANA Site Visit by the WPI Program Committee
2008 May 6	MANA signed a Memorandum of Understanding (MOU) with Georgia Institute of Technology (GIT), USA
2008 May 7	MANA Independent Scientist Ajayan Vinu received the Asian Excellent Young researcher Lectureship Award 2008 by the Chemical Society of Japan
2008 May 20	1st Follow-up Meeting by the WPI Follow-Up Committee
2008 May 30	MANA signed a Memorandum of Understanding (MOU) with CNRS, France
2008 Jun 2	NIMS Overseas Operation Office opened at the University of Washington, USA
2008 Jun 20	MANA signed a Memorandum of Understanding (MOU) with University of Cambridge, UK
2008 Jul 3	MANA signed a Memorandum of Understanding (MOU) with Indian Institute of Technology (IICT), Hyderabad, India
2008 Jul 9	MANA Principal Investigator Kenji Kitamura received the “Inoue Harushige Prize” given by the Japan Science and Technology Agency

Date	Event
2008 Jul 16	MANA Principal Investigator Takayoshi Sasaki and MANA Scientist Minoru Osada received the “2008 Tsukuba Prize”
2008 Jul 19	Prof. Sir Harry W. Kroto visited MANA
2008 Jul 20	MANA signed a Memorandum of Understanding (MOU) with University of Basel, Switzerland
2008 Jul 28 – Aug 1	The 5th NIMS-IRC-UCLA Nanotechnology Summer School was held at NIMS
2008 Sep 1	MANA signed a Memorandum of Understanding (MOU) with Yonsei University, Seoul, Korea
2008 Sep 11	MANA Principal Investigator Kohei Uosaki was named “International Society of Electrochemistry Fellow”
2008 Sep 25	MANA Independent Scientist Masayoshi Higuchi received the "SPSJ Hitachi Chemical Award" given by the Society of Polymer Science, Japan (SPSJ)
2008 Oct 1	Celebration of 1st Anniversary of MANA. Organizational Reform of MANA
2008 Oct 6	MANA Chief Operating Officer Yoshio Bando was named "American Ceramic Society Fellow"
2008 Nov 27-28	2nd MANA Site Visit by the WPI Program Committee
2008 Dec 11	MANA activities were introduced in the NHK Program “Ohayou Nippon (Good Morning Japan)”
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 Dec 19	MANA signed a Memorandum of Understanding (MOU) with Indian Institute of Science, Education and Research, India
2009 Jan 29	MANA signed a Memorandum of Understanding (MOU) with University of Karlsruhe, Germany
2009 Feb 25-27	The 2nd MANA International Symposium was held in Tsukuba
2009 Mar 16	MANA signed a Memorandum of Understanding (MOU) with Fudan University, China
2009 Mar 17	2nd Follow-up Meeting by the WPI Follow-Up Committee
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
2009 Apr 5	MANA signed a Memorandum of Understanding (MOU) with Indian Institute of Technology, Madras, India
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 May 8	MANA Principal Investigator Kazuhiro Hono received the "2009 Honda Frontier Award" given by the Honda Memorial Foundation
2009 May 19	MANA Satellite Principal Investigator James K. Gimzewski was elected as "Fellow of the Royal Society"
2009 May 28	MANA signed a Memorandum of Understanding (MOU) with University of Cologne, Germany
2009 Jun 15-17	The 8th Japan-France Workshop on Nanomaterials held at NIMS
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 Jul 14	A delegation from U.S. Department of Energy (DOE) and U.S. Department of Defense (DOD) visited MANA
2009 Jul 20	MANA signed a Memorandum of Understanding (MOU) with EPFL, Switzerland
2009 Jul 30	MANA signed a Memorandum of Understanding (MOU) with University of Rome Tor Vergata, Italy
2009 Jul 27-31	The 6th MANA-NSC-CNSI Nanotechnology Students’ Summer School was held at the UCLA MANA Satellite, Los Angeles, USA
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
2009 Sep 25	MANA Independent Scientist Jun Nakanishi received the "Japan Society for Analytical Chemistry Award for Younger Researchers"
2009 Sep 29	MANA Scientist Kohsaku Kawakami received the "JSCTA Award for Young Scientists" given by the Japan Society of Calorimetry and Thermal Analysis
2009 Oct 2	Prof. Svante Lindqvist, Nobel Museum Director and Chair at the Royal Institute of Technology, Stockholm, visited MANA
2009 Oct 5	MANA Principal Investigator Kohei Uosaki received the "ECS Fellow Award” given by the Electrochemical Society
2009 Oct 9	Prof. Sir Harry W. Kroto visited MANA for one-on-one meetings with young scientists
2009 Oct 10-12	Tsukuba-Shinchu Bilateral Symposium on “Advanced Materials Science and Technology” was held at National Tsing Hua University, Taiwan
2009 Oct 13	MANA-URTV Joint Workshop on Nanostructured Materials for Sustainable Development was held at University Rome Tor Vergata, Italy
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
2009 Oct 26	MANA Principal Investigator Naoki Ohashi received the "Richard M. Fulrath Award" given by the American Ceramics Society
2009 Oct 28	MANA signed a Memorandum of Understanding (MOU) with Loughborough University, UK

Date	Event
2009 Nov 10	Nanjing University-Anhui Normal University-Hokkaido University-MANA Joint Symposium was held at Nanjing University, China
2009 Dec 2	MANA Independent Scientist Ajayan Vinu received the "ICSB Award of Excellence" given by the Indian Scociety of Chemists and Biologists
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 Jan 7-8	3rd MANA Site Visit by the WPI Program Committee
2010 Jan 14	The 1st Waseda University-MANA/NIMS Joint Symposium on “Advanced Materials Designed at Nano- and Meso-scales toward Practical Chemical Wisdom” was held at Waseda University
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)”
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)”
2010 Feb 4	MANA Independent Scientist Yusuke Yamauchi received “Inoue Research Aid for Young Scientists”
2010 Feb 9	MANA signed a Memorandum of Understanding (MOU) with Lawrence Berkeley National Laboratory (LBNL), USA
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)
2010 Mar 3	MANA Independent Scientist Masayoshi Higuchi received the “Marubun Academy Award”
2010 Mar 3-5	The 3rd MANA International Symposium was held in Tsukuba
2010 Mar 5	2nd MANA Evaluation Committee Meeting
2010 Mar 21	MANA Scientist Masanori Kohno received the “Young Scientist Award” given by the Physical Society of Japan (PSJ)
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
2010 Mar 27	MANA Principal Investigator Kohei Uosaki received the “Chemical Society of Japan Award”

Fiscal Year 2010

Date	Event
2010 Apr 1	MANA Principal Investigator Tsuyoshi Hasegawa and MANA Scientist Kazuya Terabe received the “NIMS President's Research Achievement Award”
2010 Apr 1	MANA Independent Scientist Yusuke Yamauchi received the “Ceramic Society of Japan Award”
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 May 20	MANA signed a Memorandum of Understanding (MOU) with University of Valenciennes, France
2010 May 25	ICYS-MANA Researcher Yoshihiro Tsujimoto received the “Research Progress Award” given by the Japan Society of Powder and Powder Metallurgy (JSPM)
2010 Jun 14-15	The joint IBM and NIMS/MANA symposium on "Characterization and manipulation at the atomic scale" was held in Tsukuba
2010 Jun 21	MANA signed a Memorandum of Understanding (MOU) with Friedrich-Alexander University Erlangen-Nürnberg, Germany
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 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 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 Méditerrannée, 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

Date	Event
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 Waseda University-MANA/NIMS 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

Date	Event
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

Date	Event
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

Date	Event
2011 Oct 31	The NIMS/MANA-Flinders University Joint Symposium on “Nanoscience and Nanotechnology” was held at NIMS
2011 Nov 1	The 3rd Waseda University-MANA/NIMS 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
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	Young researcher’s MANA Grand Challenge Meeting 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
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 International Symposium was held at NIMS

Date	Event	Date	Event
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
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
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 International Symposium was held at NIMS
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
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 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"

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