World Premier International Research Center Initiative (WPI)
FY2012 WPI Project Progress Report (Post-Interim Evaluation)

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

Common instructions:
* Unless otherwise specified, prepare this report from the timeline of 31 March 2013.
* So as to base this fiscal year's follow-up review on the document "Post-interim evaluation revised center project," please prepare this report from the perspective of the revised project.
* Use yen (¥) when writing monetary amounts in the report. If an exchange rate is used to calculate the yen amount, give the rate.

Summary of State of WPI Center Project Progress (write within two pages)

Conducting research of the highest world level

We at MANA take great pride in having conducted the world's highest level materials research these past six years. Most of the accomplishments described below represent the outcome of studies bridging two or three different research fields.

Our finding on unusually massive, instantaneous and reversible swelling of layered crystals will provide important insights into delamination reaction and contribute to controlled production of high-quality nanosheets. We have found more important properties/functions of the atomic switch, such as interesting characteristics similar to the synapse in the neuron network of the human brain. We have developed several oxide photo-catalysts with sufficient negative conduction band potential to successfully convert CO_2 into CH_4 fuel under light irradiation.

Theoretical studies and the development of novel measurement methods are regarded as very important for nanoarchitectonics research in MANA. Recently, various important results triggering great interest have been obtained such as half metallic antiferromagnet as a prospective material for spintronics by first principles calculations. We have also developed revolutionary in situ measurements of the tensile strength on very thin Si nanowires inside a transmission electron microscope.

Advancing fusion of various research fields

To promote research fusion, we have established a variety of programs. The Grand Challenge Research Program was launched in FY2011, and in the spring of 2013, after two years, a debrief meeting of the seven selected projects was held in an open style and it was clearly observed that all the projects had already obtained noteworthy preliminary results. In FY2012, we launched the Theory-Experiment Fusion Research Program and the Nano-Life Fusion Research Program. Five applications for the former and two applications for the latter were accepted through hearing. According to a follow-up review after one year, all of the projects made a good start.

MANA held "camp"-type Grand Challenge Meetings twice in FY 2012. We have observed that these meetings are remarkably useful in triggering fusion research among MANA's scientists in different research specialties. The new WPI-MANA Building has emphasized transparency and increased interaction between researchers from different disciplines.

Globalization of the institution

About 300 researchers from around the globe, including renowned scientists, young faculty and students,

have visited MANA. The number of requests from Japanese and foreign government agencies, universities and research institutes to hold research meetings with MANA increased. MANA has become one of Japan's premier international research hubs where numerous researchers from around the world gather, and is accomplishing one of its missions—to construct a network of nanotechnology centers throughout the world.

We continue to engage in a wide range of initiatives to spread the word about our original concept of nanoarchitectonics and to raise MANA's recognition. We announced an open forum entitled "Nanoarchitectonics and the Interface" in the American Chemical Society's *Langmuir*. The special issue was published in June 2013, and 33 of the 48 papers were contributed by non-MANA researchers from around the world. A similar special issue entitled "Nanoarchitectonics and Porous Materials" was published in the *Journal of Nanoscience and Nanotechnology* in April 2013.

The Thomson Reuters citation rankings are an important indicator of research performance. While the global rankings of Japanese universities and research institutes have fallen across the board, NIMS's ranking in the field of materials science has soared from 13th to 4th in the world and from 4th to 1st in Japan in five years thanks to substantial contributions of MANA.

Implementing organizational reforms

The various systemic reforms implemented by MANA to date are gradually permeating our host institution, NIMS, thereby facilitating its own systemic reforms.

NIMS established the International Center for Young Scientists (ICYS) to select and train young outstanding post-doc researchers from around the world, and it uses this as a career path system for handpicking the best candidates for permanent researcher positions at NIMS. MANA plays a central role as an organization for accepting and training ICYS Researchers. In light of this, an ICYS system was established to cultivate young researchers working in new fields in two NIMS' newly established centers.

Also MANA's international research institute administration systems are now spreading to other universities and research institutes.

Efforts to secure the center's future development over the mid- to long term

NIMS's third five-year plan, which commenced in April 2011, already includes a strategy aimed at making MANA a permanent organization. MANA is positioned within NIMS as the Nano-scale Materials Division, one of NIMS's three research divisions. Along with efforts to ensure the organizational permanence of MANA, NIMS is deliberately increasing the number of the Center's permanent researchers and administrative staff.

Regardless of whether the WPI program grant is extended or not, NIMS promises to provide the following research resources for MANA:

i) Approximately 100 core members will be assigned to MANA as permanent employees of NIMS;
ii) Expenses required to sustain basic and fundamental research at MANA are borne from NIMS operations subsidies totaling more than 1 billion yen.

However, MANA strongly requests a five-year extension of the program. We will designate the five-year extension as a period to establish MANA's "world premier status" and become independent, and we will enact the following initiatives.

i) We will work to cover the salaries of permanent and fixed-term staff members with operations subsidies and external funding, respectively.
ii) MANA's original programs will be transferred, as much as possible, to NIMS, and we will operate those programs that need to be implemented on their own on a self-sustaining basis.
iii) We will encourage our researchers to engage in challenging and interdisciplinary research, thereby cultivating numerous highly creative research projects and leading to more external funding.

・Please concisely describe the progress being made by the WPI center project from the viewpoints described below.
・In addressing the below-listed 1-6 criteria, please place emphasis on the following:
(1) Whether research is being carried out at a top world-level (including whether research advances are being made by fusing fields).
(2) Whether a proactive effort continues to be made to establish itself as a "truly" world premier international research center.
(3) Whether a steadfast effort is being made to secure the center's future development over the mid- to long term.
・Please prepare this report within 10-20 pages (excluding the attached forms).

1. Conducting research of the highest world level

* Regarding the criteria used when evaluating the world level of center, please note any updated results using your previous evaluation criteria and methods or any improvements you have made to those criteria and methods.

MANA entered the second five-year period of the WPI program from FY2012 garnering high evaluations of the activities of the first five-year period. We at MANA take great pride in having conducted the world's highest level materials research these past six years. This research spans a wide range of programs from basic studies to advanced applications. In this research, we regard theoretical studies and the development of novel measurement methods as very important. All research in MANA is conducted on the basis of "materials nanoarchitectonics", which we regard as a key concept for new materials development. The high quality of MANA research is mirrored in the various parameters presented later in the supplementary materials of the appendices.

The following is a brief description of MANA accomplishments in FY2012. MANA conducts research in the four fields of Nano-Materials, Nano-System, Nano-Power and Nano-Life; it should be pointed out that the Nano-Green and Nano-Bio fields, having existed in the first five-year period, were remodeled into the Nano-Power and Nano-Life fields, respectively, in October 2012, five years after MANA's establishment. Most of the accomplishments described below represent the outcome of studies bridging two or three different research fields.

A) Further remarkable progress in "nanosheet technology"

We are creating a wide variety of novel materials based on our original "nanosheet technology", which features soft-chemical delamination and restacking "nanosheet" processes. In addition to the remarkable results obtained in the first 5-year period, the following unexpected discoveries have been made recently.

a. Unusually massive, instantaneous and reversible swelling of layered crystals

We have found that layered titanate crystals show enormous ~100 fold swelling in an amino alcohol solution in a few seconds then shrink back to their original size also in seconds (see Fig. 1). This unprecedented behavior is dramatically different from that with quaternary ammonium as a well-known delaminating agent. This finding will provide important insights into delamination reaction and contribute to controlled production of high-quality nanosheets.

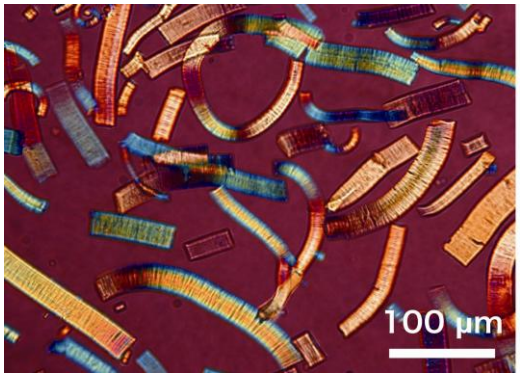


Fig. 1 Huge swelling of titanate crystals.
T. Sasaki et al., Nature Commun. 4 (2013) 1632.

b. Hydroxide nanocones as the first example except for carbon-like material

We have found that homogeneous precipitation of Co or Ni salts in a presence of surfactant produces a

unique hydroxide-based nanocone. This is the first nanocone structure derived from non-carbon materials. The nanocone was found to be delaminated, providing a new route to hydroxide nanosheets.

B) Further remarkable progress in the "atomic switch"

We developed the "atomic switch" in the first 5-year period of MANA. This is a novel electronic device in which migration of atoms at the nanoscale perform ON/OFF switching depending on the polarity of applied voltage. This is in contrast to the conventional transistor switch in which a change of the electronic state due to voltage change is responsible for ON/OFF switching. Teamed with the NEC Corp., we have already reached a technological level of mounting the atomic switch in practical integrated circuits for significantly improved performance. Recently, we have found more important properties/functions of the atomic switch as described below.

a. Synaptic characteristics of the atomic switch discovered

We have found that a certain type of atomic switch exhibits interesting characteristics similar to the synapse in the neuron network of the human brain. Namely, even if the atomic switch is switched ON by a voltage pulse, it gradually becomes an OFF state under zero voltage. However, if a strong voltage pulse is applied, the ON state is maintained forever under zero voltage. Interestingly, even if the voltage pulse is not significantly strong, by applying such voltage pulses repeatedly at a high frequency, an ON state is obtained suddenly and the state is stable forever under zero voltage.

b. Networks of hundreds of millions of atomic switches exhibit unexpected characteristics

The results described above encouraged us to construct a random network of hundreds of millions of atomic switches (see Fig. 2). We constructed the network by combining the lithography of Pt electrodes and wet chemistry to form Ag and Ag_2S dendritic nanowires. At each crossing points of Ag and Ag_2S nanowires, an atomic switch was formed. This network comprising hundreds of millions of atomic switches exhibited unexpected characteristics that are attracting great interest. For example, when we apply a DC voltage between two of the Pt electrodes, the conductance between them does not increase monotonically with time but repeats increase and decrease at all time scales of 100 ms, 1 and 100 s, indicating that recurrent currents flow in the network. This promises the possibility of novel computational circuits.

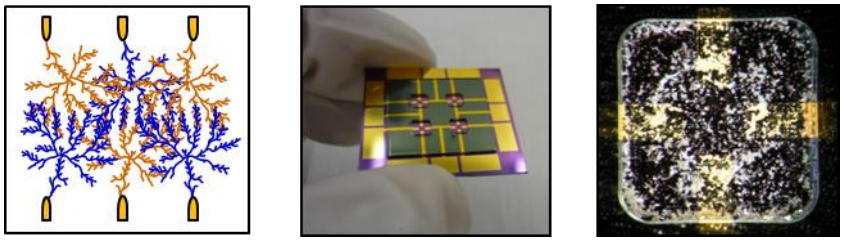


Fig. 2 Random network of hundreds of millions of atomic switches, which exhibits unexpected characteristics.
A. Stieg et al., *Adv. Mater. 24* (2012) 286.

C) Towards realization of artificial photosynthesis

We have made considerable headway in realizing one of the three MANA grand challenges, i.e. practical artificial photosynthesis. Two examples are shown below.

a. Efficient conversion of CO_2 to CH_4 fuel by oxide nanowires

We have developed several oxide photo-catalysts with sufficient negative conduction band potential to successfully convert CO_2 into CH_4 fuel under light irradiation. In particular, we have revealed that controlling surface oxygen deficiency is critical in carbon dioxide reduction reactions. An extensive study from both experimental and theoretical approaches demonstrated that the enhanced catalytic activity resulted from oxygen deficiency-related synergistic effects on the visible light absorption and the carbon dioxide adsorption properties of the catalyst surface. The result provides an important guideline for developing

highly efficient catalysts (see Fig. 3).

b. A new strategy for enhancing solar-fuel production via modulating reaction- environment

We found that surface alkalinization induced by a high alkalinity of the solution environment can significantly shift the surface energy band of $SrTiO_3$ photocatalyst to a more negative level, supplying a strong potential for H_2O reduction and consequently promoting the photocatalytic efficiency of H_2 evolution to a quantum efficiency as high as 25.6% under visible light irradiation.

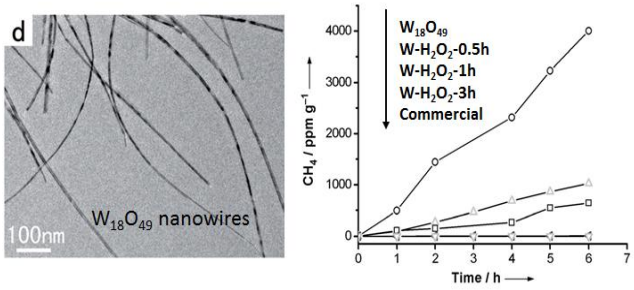


Fig. 3 Efficient conversion of CO_2 to CH_4 fuel by oxide nanowires.
G. Xi et al., Angew. Chem. Int. Ed., 51 (2012) 2395.

D) Theoretical nanoarchitectonics

Theoretical studies are regarded as very important for nanoarchitectonics research in MANA. Recently, various important results triggering great interest have been obtained. Two examples are shown below.

a. Half metallic antiferromagnet as a prospective material for spintronics

Spintronics, expected to be next-generation technology, is based on the spin degree of freedom of electrons, a new notch additional to charge. Half metals (HM), a class of materials which are metallic in one spin channel and insulating in the opposite spin channel, are ideal for spintronics since they can yield infinite magnetoresistance. We noticed that the iron pnictides can be used to generate an even novel state called half metallic antiferromagnet (HMAFM), which is further characterized by zero total magnetization. We focus on $BaFe_2As_2$, a poor metal of AFM order with zero net magnetization. Nominally, an Fe atom has six 3d electrons and shows an effective spin moment of $4\mu_B$ due to Hund's coupling. We propose to replace half the Fe atoms with the Cr atoms, noticing that Cr possesses four 3d electrons and thus will not change the AFM order of the parent material, while it will modify the band structure due to the different atomic number. This idea has been confirmed successfully with first principles calculations, which indicate clearly $BaCrFeAs_2$ is a HMAFM (see Fig. 4).

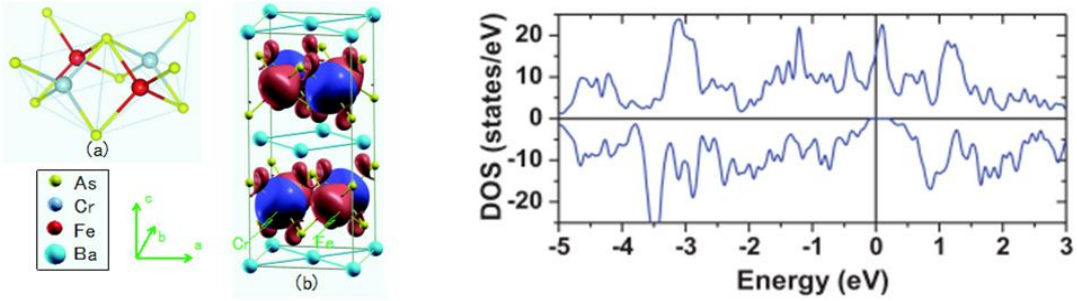


Fig. 4 Lattice structure, distribution of spin magnetization and the density of states of $BaCrFeAs_2$.
X. Hu, Adv. Mater. 24 (2012) 294.

b. Novel topological material

By using staggered electric potential, antiferromagnetic exchange field and spin-orbit coupling, we can control the spin, valley and sublattice degrees of freedom of electrons on a honeycomb lattice, and achieve a novel topological insulator with simultaneous finite charge and spin Chern numbers. With first principles calculations we demonstrated that the scheme can be realized by material modification in perovskite G-type AFM insulators grown along (111) direction, where d electrons hop on a buckled honeycomb lattice and

exhibit Dirac behaviors. In a finite sample of this material, there appears a quantized edge current with full spin polarization, while the total magnetization is compensated to zero. In this topological HMAFM, the spin polarization of the dissipationless edge current can be inverted by electric field, which has a great advantage in spintronics.

E) Valence tunable Resistivity Random Access Memory

As a future nonvolatile memory, Resistivity Random Access Memory (ReRAM) has been a focus. In this memory, the most urgent issue is the reliability at the memory function. The ReRAM function is dominated by vacancy formation and the reliability depends on the controlled number of vacancies. However, under the bias, applied voltage causes many vacancies, resulting in device breakdown. The self-limiting control of vacancy is expected. Nd_2O_5 is a candidate to balance the valence due to mixed valence, and Ta_2O_5 is noticed as a stable host oxide for ReRAM. By combinatorial screening, the best composition of Nd_2O_5-Ta_2O_5 was found and stable and reliable ReRAM operation was demonstrated.

F) Development of revolutionary in situ TEM techniques for nanomaterial property analysis

a. First tensile strength measurements on ultrathin silicon nanowires

We designed a unique nanomechanical stage for the first direct measurements of the tensile strength on very thin Si nanowires inside a transmission electron microscope under a spatial resolution of 0.17 nm and for the first time obtained the diameter dependence of Si wire strength at such tiny dimensions. This value was found to linearly increase with a decrease in wire diameter and reached more than 11 GPa for the thinnest nanowires of 8 nm in diameter (see Fig. 5). This data has a crucial value for the future development of Si-based nanoelectronics and accurate estimates of sustainability.

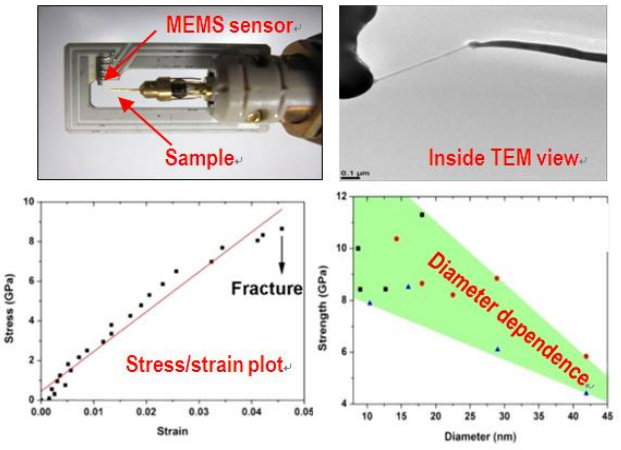


Fig. 5 Nanomechanical measurements inside a transmission electron microscope on ultrathin silicon nano- wires.
D.M. Tang et al., *Nano Lett*. 12 (2012) 1898.

b. Ultrastrong and superlight Al-BN nanotube composites

Using an analogous setup we performed direct *in situ* bending and tensile testing on individual boron nitride nanotube (BNNT)/Al nanocomposites prepared by magnetron sputtering of Al on a BN nanotube powder. In parallel, high-resolution TEM images and video recordings were taken for the analysis of deformation kinetics and fracture mechanisms. The nanohybrids having an individual BN nanotube core with a decently thick aluminum coating (40-200 nm) withstood nearly 10-20 times higher stresses compared to a pure not armed Al metal, reaching huge values exceeding 1.0 GPa (comparable to the best high-strength steels), while exhibiting a density of less than 2.5 g/cm^3. This pioneering work opens up a prospective pathway for making ultralight and super strong "dream" structural materials.

G) Nano-life related materials research

For development of novel biomaterials or devices to repair the human body, it is necessary to prepare composite materials by joining different kinds of material surfaces or by employing novel methods for surface modification with bio-active molecules.

We have discovered novel peptides that can specifically bind metallic or ceramic surfaces, by the phage

display method. As metallic materials, nickel-free high nitrogen stainless steel (HNS), Co-Cr alloy and SUS316L were selected because HNS is used for drug-eluting stents in our research. The developed peptide is adsorbed effectively to the Co-Cr alloy surface. In addition, we analyzed the binding capacity for HNS of the peptide binding. We observed no desorption in any serum. This means that the peptide was adsorbed on the surface strongly. In drug eluting stents, drug-sustained release is required for long-time suppression of stenosis. The developed peptide is expected to contribute to fabrication of a stably-bound matrix for drug release. We also prepared the antibody-peptide complex to investigate the enhancement of cell-materials interaction. The antibody binds the endothelial cells. Larger amounts of the cells adhered on only the complex-adsorbed metallic surface. It was found that the developed peptide is very effective as a linker-molecule.

H) Novel nanoscale characterization/analysis methods

a. New paradigm of nanomechanical sensors

We have been developing advanced nanomechanical sensors based on a membrane-type surface stress sensor (MSS). Recently, we have succeeded in overcoming one of the long-standing major issues of nanomechanical sensors, that is, the coating problem. We investigated the nanomechanical properties of MSS and found that a double-side coating is applicable to MSS instead of a single-side coating which is a standard method with various difficulties. The double-side coating allows almost any kind of coating method to be implemented including dip coating methods, making nanomechanical sensors open to virtually all coating materials. Double-side-coated MSS represents a new paradigm of one-chip-one-channel (channels on a chip are all coated with the same receptor layers) shifting from the conventional one-chip-multiple-channel (channels on a chip are coated with different receptor layers) paradigm.

b. Novel real-time molecule identifier based on dynamic chemical desorption

We have developed nanomechanical gas sensors with minimal experimental requirements such as "one polymer" in "ambient air". Dynamic desorption behavior modulated by changing the thickness of a polymer receptor layer can yield multiple signals from an identical polymer material (see Fig. 6).

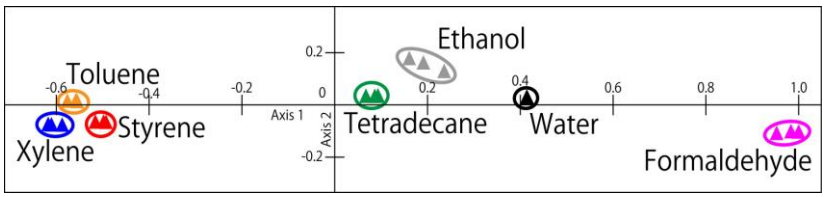


Fig. 6 Novel gas identification with minimal requirements.
G. Yoshikawa et al., (to be published)

Taking advantage of the high sensitivity of the MSS platform, sick house syndrome chemicals were clearly identified even with one polymer in ambient air. With this new strategy, we can prepare a large variety of receptor layers from a few types of polymers.

2. Advancing fusion of various research fields

Since the establishment of MANA six years ago, we have regarded the fusion of different research fields as a gateway to accomplishing advanced research. Our research organization, comprising four research fields, was designed so as to promote the fusion of different research fields. Briefly, basic research in the Nano-Materials and Nano-System fields is fused to application research in the Nano-Power and Nano-Life fields (the latter two were called "Nano-Green" and "Nano-Bio" fields in the first five-year period). We have seen this scheme work considerably well. It should be pointed out that MANA's seven research satellites placed in the USA, UK, France, Canada and Japan have also contributed significantly to research fusion.

To promote research fusion, we have established a variety of programs: The MANA Grand Challenge

Research Program was launched in FY2011 in the first five-year period to encourage researchers to undertake innovative, "outside-the-box" interdisciplinary research not limited to materials science. This initiative sought applications for risky yet challenging topics that matched the concept of nanoarchitectonics. Seven applications were accepted through hearings. In the spring of 2013, after two years, a debrief meeting of the selected projects was held in an open style and it was clearly observed that all the projects had already obtained noteworthy preliminary results.

Annually and sometimes biannually, MANA holds a "camp"-type approach called "Grand Challenge Meetings." 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. Two meetings were held in the spring and fall of 2012. We have observed that these meetings are remarkably useful in triggering fusion research among MANA's scientists in different research specialties.

In FY2012, we launched the Theory-Experiment Fusion Research Program and the Nano-Life Fusion Research Program. Five applications for the former and two applications for the latter were accepted through hearing. According to a follow-up review after one year, all of the projects made a good start.

MANA Seminars have been held regularly since our inception. At these seminars, researchers from both within and outside MANA present timely research topics and engage in discussions with MANA researchers of different fields. Each seminar comes into its own as a true "melting pot." As such, the seminars play a key role in promoting field integration.

MANA's fusion research studies are varied. The following section introduces two examples of ongoing fusion research that is attracting attention.

1) Fusion research between nanobiology and nanotechnology

Two remarkable fusion research activities should be pointed out in this category:

Dr. Genki Yoshikawa in the Nano-System field has developed a novel molecular sensor that can detect/identify various kinds of molecules in gas or liquid at the same time at an ultra-high sensitivity (about 100 times in comparison with conventional similar methods). He has started a close collaboration with Dr. Mitsuhiro Ebara of the Nano-Life field and an expert of biomarker science. This team is off to a good start toward development of a new low-cost, portable biomarker sensor for medical diagnosis.

Another prime example of fusion research is conducted by Prof. Francoise Winnik, a PI in the Nano-Life field and also a professor at the University of Montreal. She is an authority of near-infrared (IR) in-vivo bioimaging. Recognizing the value of cooperative research, she has teamed with Dr. Naoto Shirahata (Nano-Materials expert and developer of novel nanoparticles active in near-IR region) and Dr. Tadaaki Nagao (Nano-System expert engaged in advanced studies in plasmonic nano-antennas in the near-IR region) to explore new methods of highly-sensitive near-IR in-vivo bioimaging. The preliminary results of their fusion-research effort are already seen as promising.

2) Fusion research linking theoretical nanoscience and nanotechnology

Dr. Xiao Hu, a PI in the Nano-System field, recently made the following theoretical prediction which is attracting wide interest. If a heterostructure consisting of a superconductor, semiconductor with large spin-orbit coupling and ferromagnetic insulator is constructed, a Majorana particle appears at the edge of the heterostructure in a certain condition. If three such heterostructures are connected through a gated pathway, it is possible to control the exchange of Majorana particles between the heterostructures, achieving non-Abelian quantum bit operation for quantum computation without decoherence. Independently, Dr. Takashi Uchihashi, Nano-System expert, has observed macroscopic superconducting current through a surface of a semiconductor, i.e. the Si (111) surface modified with a small amount of Indium. If these two studies are fused, the quantum bit without decoherence mentioned above will be materialized relatively easily. This exciting fusion research is now underway.

3. Globalization of the institution

* Describe what's been accomplished or recognized in the efforts to raise the center's international recognition as a genuine top world-level research institute, along with innovative efforts proactively being taken in accordance with the development stage of the center, including the following points, for example:

- Efforts being developed based on the analysis of number and state of world-leading, frontline researchers; number and state of visiting researchers; exchange with overseas entities

As of March 31, 2013, the Center employed 199 researchers, of which 107, or 54%, are foreign nationals. In addition, about 300 researchers from around the globe, including renowned scientists, young faculty and students, have visited MANA by way of invitational programs, cooperative graduate schools and internships. In this way, MANA is one of Japan's premier international research hubs where numerous researchers from around the world gather.

A handful of foreign researchers resigned from MANA in the wake of the nuclear power plant incident after the Great East Japan Earthquake, and there was a time when researchers from overseas stopped visiting, but it seems that this so-called "Japan allergy" has disappeared almost entirely after two years have passed.

In FY2012, the number of requests from Japanese and foreign government agencies, universities and research institutes to hold research meetings increased. We held bilateral workshops with Canada and Australia as well as symposia with several Japanese and foreign universities (i.e., Osaka, Waseda, Northwestern, Montreal, Bristol, Rennes and National Taiwan). In addition, the Japan portion of the Asia PCCP Symposia, a series of academic conferences held by *Physical Chemistry Chemical Physics* (PCCP; the journal of the Royal Society of Chemistry in Great Britain) in Japan, China and Korea, was held at MANA. These efforts have helped us to broadcast MANA's activities widely and to find joint research partners.

As this shows, MANA is gradually accomplishing one of its missions—to construct a network of nanotechnology centers throughout the world.

- Proactive efforts to raise the level of the Center's international recognition

We continue to engage in a wide range of initiatives to spread the word about our original concept of nanoarchitectonics and to raise MANA's recognition.

In FY2011, two journals of original refereed contributions, *Advanced Materials* and *Science and Technology of Advanced Materials*, published special features on MANA which served as compilations of the research outcomes of MANA researchers. In FY2012, we took this one step further and announced an open forum entitled "Nanoarchitectonics and the Interface" in the American Chemical Society's *Langmuir*; we received submissions from many non-MANA researchers. This was published in June 2013, and 33 of the 48 papers were contributed by researchers from around the world. We issued a similar call for papers in the *Journal of Nanoscience and Nanotechnology* (American Scientific Publishers), and published a special issue entitled "Nanoarchitectonics and Porous Materials" in April 2013.

Langmuir's special issue on Interfacial Nanoarchitechtonics

In addition, we began disseminating information worldwide in FY2011 with an English e-mail newsletter called MANA Research Highlight, and in FY2012 we began running banner ads for highlighted articles on a

trial basis. For one month from February 15, we ran a banner ad on the top page of the *Science* website for an article on the naked-eye detection of cesium. The site where we had made the article available received a large number of viewers who had clicked on the banner. Going forward, we will use an effective balance of push and pull strategies to transmit information as part of our plan to broadcast MANA's research output worldwide.

The establishment of MANA has raised the overall level of research at NIMS and heightened the presence of NIMS in the world. The Thomson Reuters citation rankings are an important indicator of research performance. While the global rankings of Japanese universities and research institutes have fallen across the board, NIMS's ranking in the field of material science has soared from 13th to 4th in the world and from 4th to 1st in Japan in five years. Even though MANA researchers only account for about 20% of NIMS researchers, approximately 50% of NIMS's citations are for papers authored by MANA-affiliated researchers, which shows that MANA's contribution to NIMS's advancement is extremely significant.

1997 - 2007		
Domestic Ranking	World Ranking	Institution
1	3	Tohoku Univ
2	4	AIST
3	7	Osaka Univ
4	13	NIMS
5	14	Univ Tokyo
6	15	Kyoto Univ
7	18	Tokyo Tech
8	33	Kyusyu Univ
9	40	JST
10	56	Nagoya Univ

2002 - 2012		
Domestic Ranking	World Ranking	Institution
1	4	NIMS
2	6	Tohoku Univ
3	9	AIST
4	19	Osaka Univ
5	21	Univ Tokyo
6	25	JST
7	28	Kyoto Univ
8	32	Tokyo Tech
9	65	Kyusyu Univ
10	100	Hokkaido Univ

Source: Thomson Reuters Professional KK

Top 10 institutional citation ranking in materials science in Japan

- Efforts to make the Center into one that attracts excellent young researchers from around the world (such as efforts fostering young researchers and contributing to advancing their career paths)

In addition to the four pillars of the WPI Program—world-class research, interdisciplinary research promotion, internationalization and systemic reform—the cultivation of young researchers is another key pillar of MANA.

106 of the Center's 199 researchers are postdoc researchers and graduate students, of which 90, or 85%, are foreign nationals. In this manner, MANA has achieved an environment in which a large number of young researchers from around the world can hone their skills through friendly rivalry.

The 8th Japan-UK-USA Nanotechnology Students' Summer School was held at MANA in late August as part of our efforts to cultivate young researchers. The objective of the program was to boost student creativity and communication skills by having them work in groups to "tackle the impossible". Nine students from NIMS joined instructors invited from the US and Europe and 12 students from the US, England and Australia to hold discussions in English and issue unique proposals on the far-reaching topic of ways to ensure the continued existence of all humankind.

Meanwhile, despite the fact that MANA has developed into an outstanding international research hub

within Japan, the Program Committee remarked that the number of Japanese postdocs is low and should be increased. For this reason, we established the YAMATO-MANA Program (**Y**oung, **A**spiring **M**otherland **A**cademics **TO MANA**) to bring talented young Japanese researchers to MANA in an effort to cultivate Japan's future leaders; this is a Center-wide effort to locate human resources. (Note: "Yamato" is an ancient name of Japan.)

In addition, we believe that sending MANA's young researchers to conduct research at major foreign research institutions for long periods of time is an effective way to produce international and interdisciplinary young researchers. In FY2012, we sent three young researchers to the University of Cambridge (UK), RWTH Aachen University (Germany) and MINATEC (France), respectively, to conduct research for periods of one to two years. Several other young researchers spent short stints with renowned Western scientists (mentors) receiving valuable research advice.

4. Implementing organizational reforms

* If innovated system reforms generated by the center have had a ripple effect on other departments of the host institutions or on other research institutions, clearly describe in what ways.

The various systemic reforms and staff awareness-raising initiatives implemented by MANA to date are gradually permeating our host institution, NIMS, thereby facilitating its own systemic reforms.

Learning from MANA, NIMS is working to improve the English proficiency of its administrative staff in an effort to establish an Institute-wide bilingual administration system. In addition to focusing on hiring staff with advanced English proficiency, NIMS has been using operations subsidies since FY2010 to provide English conversation lessons, correspondence education and overseas language training for its young permanent staff. Over the last four years, the average TOEIC score has jumped from 381 to 507, which is proof that our efforts are starting to show results.

NIMS established the International Center for Young Scientists (ICYS) to select and train young outstanding postdoc researchers from around the world, and it uses this as a career path system for handpicking the best candidates for permanent researcher positions at NIMS. MANA plays a central role as an organization for accepting and training ICYS Researchers. These young researchers flourish in MANA's international melting pot environment, and many of them are later appointed as permanent researchers at NIMS. In light of this, an ICYS system was established to cultivate young researchers working in new fields in NIMS' newly established Elements Strategy Initiative Center for Magnetic Materials (ESICMM) and Global Research Center for Environment and Energy Based on Nanomaterials Science (GREEN).

The aforementioned roles of MANA have been officially defined in NIMS's third five-year plan as follows: "We will use the experience of building an international research environment and young researcher recruitment and training system at MANA in our efforts to internationalize the entire Institute."

At MANA, foreigners account for more than half of the researchers and English is the official language. These international research institute administration systems are now spreading to other universities and research institutes. In April, we led a tour of our facilities for institutions scheduled to apply for the WPI Focus Program and explained our administrative systems. We also share information on our systems with the existing WPI Centers, AIMR, I^2CNER and IIIS. In addition, we have welcomed officials from JAXA, JST and the World Class Institute Program—the Korean version of WPI—for hearings on our administrative systems. Furthermore, our international research institute administration systems were showcased at the University Research Administrators (URA) Forum at the University of Tsukuba.

5. Efforts to secure the center's future development over the mid- to long term

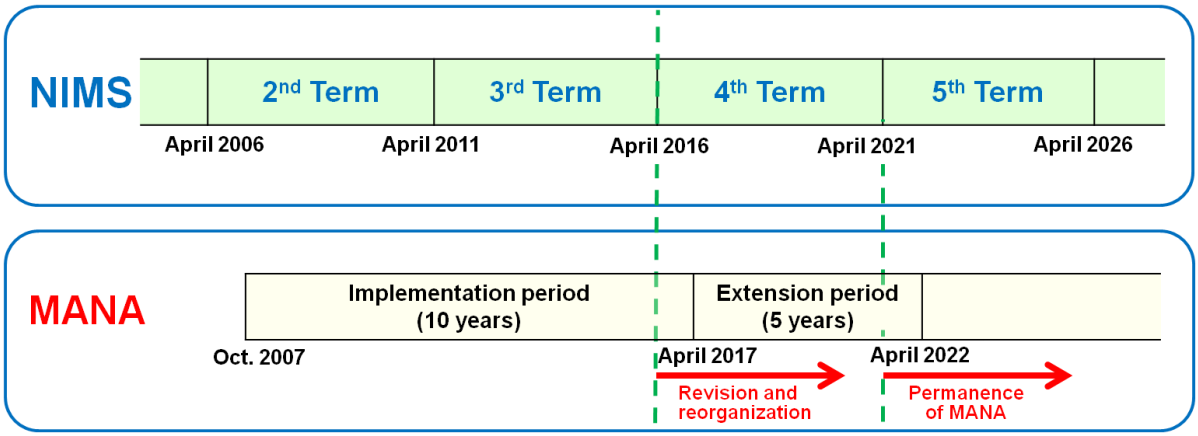
* Please address the following items, which are essential to mid- to long-term center development:

- Future Prospects with regard to the research plan, research organization and PI composition; prospects for the fostering and securing of next-generation researchers

NIMS's third five-year plan, which commenced in April 2011, already includes a strategy aimed at making MANA a permanent organization. MANA's development of innovative new materials based on nanoarchitectonics is recognized as one of NIMS's three Priority R&D Fields, and MANA is positioned within NIMS as the Nano-scale Materials Division, one of NIMS's three research divisions.

Along with efforts to ensure the organizational permanence of MANA, NIMS is deliberately increasing the number of the Center's permanent researchers and administrative staff. Between April 2011 and April 2013, 13 new permanent staff joined MANA. Of these, 11 were newly appointed from outside the organization; the other two were internal transfers. As a result of this, MANA has 88 permanent staff as of April 1, 2013. Going forward, NIMS plans to expand the Center and will continue hiring several new researchers every year.

NIMS's next five-year plan will begin in April 2016, one year before the conclusion of the originally scheduled WPI Project period (10 years) in March 2017. 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 five-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. Furthermore, we plan to undertake bold reforms by reviewing MANA's research fields and strengthening theoretical research in light of the advice received from the Program Committee and other advisors.



MANA's position in NIMS's five-year plan

- Prospects for securing resources such as permanent positions and revenues; plan and/or implementation for defining the Center's role and/or positioning within the host institution's institutional structure

Regardless of whether the WPI program grant is extended or not, NIMS promises to provide the following research resources for MANA:

i) Approximately 100 core members, including Principle Investigators, Group Leaders, Associate Principle Investigators, MANA Scientists, Independent Scientists, and administrative staff will be assigned to MANA as permanent employees of NIMS;

ii) Research project expenses, MANA Foundry operation expenses, fees for inviting and dispatching researchers, utilities and other R&D expenses required to sustain basic and fundamental research at MANA are borne from NIMS operations subsidies totaling more than 1 billion yen.

Once the WPI program concludes, it will become difficult for us to allocated salaries for roughly 100 fixed-term staff members (i.e., postdoc researchers, graduate students and some administrative staff). In addition to salaries, raising funds to cover those expenses that give MANA its unique features, including

expenses for young researcher development programs, Satellite operation expenses, and fees for symposia and other outreach events, remains an issue.

Since we do not anticipate increased operations subsidies from NIMS, we must rely on the external funding that MANA researchers obtain in order to continue hiring fixed-term staff members and sustaining our activities as a "premier international research center". The roughly 1 billion yen in external funding that MANA researchers have currently obtained is not sufficient, so we will need to increase this amount dramatically. Securing funds for programs that include elements of human resources development is particularly effective. There are several groundbreaking research topics that have started to come out of the Grand Challenge Research Program and other interdisciplinary research efforts initiated during the WPI Program, and growing these into large-scale, externally-funded projects will become an overriding priority.

- Measures to sustain the Center as a premier international research center after program funding ends (including support by the host institution)

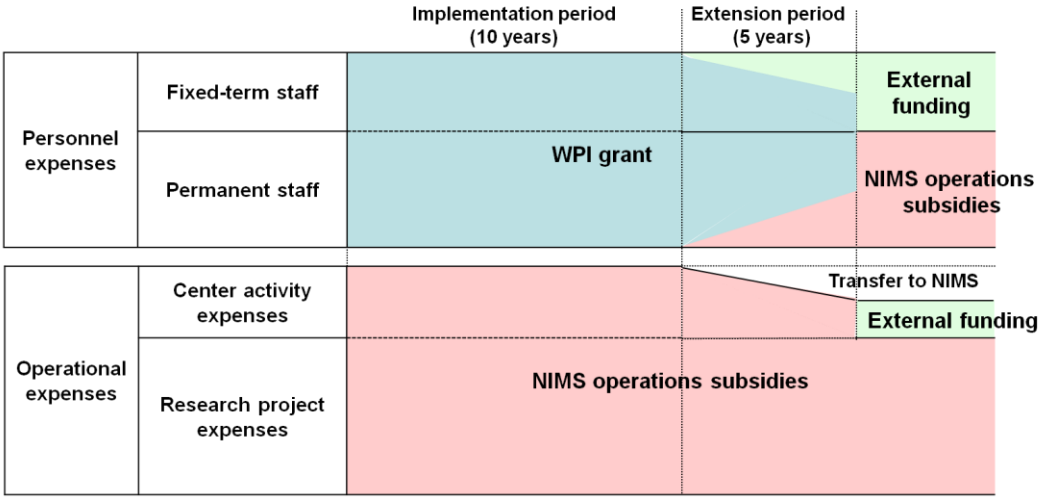
If the program grant is stopped at the end of the 10-year project period, we will not have enough funding to retain postdoc researchers, graduate students, and staff and to maintain the various programs that give MANA its unique character. In this way, the Center would face severe restrictions in its activities.

As such, MANA strongly requests a five-year extension of the program. We will designate the five-year extension as a period to establish MANA's "world premier status" and become independent, and we will enact the following initiatives.

i) We will work to replace the program grant used to cover the salaries of permanent and fixed-term staff members with operations subsidies and external funding, respectively.
ii) MANA's original programs, including young researcher development programs, Satellites, symposia and other outreach events, will be transferred, as much as possible, to NIMS, and we will operate those programs that need to be implemented on their own on a self-sustaining basis.
iii) We will encourage our researchers to engage in challenging and interdisciplinary research, thereby cultivating numerous highly creative research projects and leading to more external funding.

Regardless of whether the program is extended or not, MANA researchers will need to work hard to secure the large-scale external funding required to hire postdoc researchers and graduate students, but if an extension is granted, there is no doubt it will makes this process easier.

NIMS's fifth five-year plan, which will commence one year before the five-year extension concludes, will promise to make MANA a permanent organization while maintaining its "world premier status" by engaging in a review of organizations and frameworks focusing on carrying on the research projects and administrative systems developed at MANA.



Financing structure: present and future

6. Others

* In addition to the above 1-5 evaluation items, only if there is anything else that deserves mention regarding the center project's progress, please note it.

(1) Highly Visible New Research Building

The WPI-MANA Building, opened in FY2012, was designed to increase interaction between researchers from different disciplines, and has been a game-changer in terms of transforming the research style of MANA's researchers.

The offices on each floor employ an open floor plan with no partitions, and researchers from different disciplines are assigned to the same space. As a result, interdisciplinary research is starting to occur due to "forced" interactions. An example of this is Prof. Winnik and Dr. Golberg's research on biopolymer-coated BN nanotubes.

The labs also emphasize transparency with glass walls and doors facing the hallways. The aim is to make the experiments inside the labs visible to the researchers coming and going in the hallways. This has had the positive secondary effects of making the entire building brighter, facilitating the early detection of and early response to accidents and encouraging researchers to keep their work spaces organized.

The glass walled atrium that connects the WPI-MANA Building with the neighboring NanoGREEN Building has contributed to the new building's lively atmosphere. There are interaction spaces on each floor of the atrium where, at any given time of the day, one can see researchers engaged in discussions with each other or immersed in reading and writing. Researchers also interact with each other in the first floor cafeteria during lunchtime and when there are parties.

The auditorium on the first floor was designed to encourage friendly rivalry among the researchers, and it acts as the heart of MANA. There is a large screen and terraced seating that enable attendances to see presentations well no matter where they are sitting. Additionally, every seat is equipped with a table microphone to encourage active discussion.

(2) Balancing an Open Atmosphere with Security

NIMS has a key card entry system to prevent information leaks and keep unauthorized personnel out of the buildings, and the new building had also used this system. At first, researchers had to swipe their cards on the sensors when passing through every door, but one of the WPI Working Group members pointed out that excessive security was "inappropriate for an open international research center." In light of this, we switched to a system that divides security levels by areas on the floors occupied by MANA. Now researchers and visitors can freely access the hallways, the interaction spaces on each floor and other common spaces without swiping their key cards. That being said, we still limit access to the offices and labs to authorized researchers.

It is also our policy to use this system to determine the whereabouts and confirm the safety of employees during disasters. For this reason, all employees must swipe their key cards when they pass through the first floor entrance so that we can keep a record of who enters and exits the building. At the disaster prevention drill held in the fall, we demonstrated that the safety of the employees can be confirmed swiftly.

7. Center's response to the results of the FY2012 follow-up (including the results of the site visit)

* Note how the center has responded to the results of FY2012 follow-up. However, if you have already provided this information, please indicate where in the report.

Actions Required and Recommendations (follow-up report)

1) Reinforcement of Nano-Life is needed if MANA considers it as a major target of research. Vivid interactions between materials scientists and biologists are strongly recommended. In addition, advisory committee consisting of biologists or medical doctors seems necessary to find good collaborators.

MANA places extreme importance on the Nano-Life field because we believe new fields of highly innovative and interesting sciences and technologies can be created through the fusion of nanotechnology and bio-related research fields. Based on this belief, we will overhaul the Nano-Life field. We will strengthen fundamental research into unlocking the mysteries of biological phenomena and finding applications, including by adding more researchers. We will also invite a scholar from a bio-related field to join the MANA Evaluation Committee.

2) The PI's are not paying sufficient attention to framing their projects in terms of the most fundamental science questions underlying the results they get. Once these questions are properly framed, one can see what needs to be done or to understand, and what new experiments or theory might lead into new areas of science.

Most of MANA's researchers are conducting research that will create new global trends in their fields, and this has garnered high acclaim worldwide in both tangible and intangible ways. We believe this is proof that our researchers take their research seriously and pay sufficient attention to the fundamental questions of science. Therefore, we take the comment above as encouragement to work harder.

3) Internationalization of staff is achieved to a high level and extended to NIMS; but why such a small number of Japanese postdocs?

To attract outstanding Japanese researchers to MANA and cultivate Japan's future research leaders, we established the YAMATO-MANA Program (**Y**oung, **A**spiring **M**otherland **A**cademics **TO MANA**) and are seeking out talent in a Center-wide effort.

4) MANA should take steps to ensure that its researchers are not limited by confidentiality agreements that may hold over from other work (for companies or in other NIMS projects). MANA needs a clear policy regarding restricted research, which means any research with restrictions on publication.

The bulk of MANA's work is basic research, but since our host is NIMS, an independent administrative institution, our mission also includes applied research. Researchers who engage in applied joint research with private companies are subject to confidentiality obligations, but MANA leaves this decision to the individual researchers and does not set any special restrictions on their research freedom. That being said, NIMS has regulations on collaborative research and requires researchers to submit collaborative research plans in advance in order to limit the scope of work and prevent the mixing of original NIMS/MANA research and collaborative research with companies.

5) Strategy for 5 year extension after 10 year period, and mid-term and long term strategy to sustain the center's development should be drafted until the next site visit. Discussion at the task force team might be desired.

We established the MANA Mid-to-Long-Term Vision Task Force with Vice President Muromachi as the chair. The Task Force compiled a mid-to-long-term strategy outlining a five-year extension application at the end of the 10-year program period as well as the administrative framework after the conclusion of the program, and this was arranged into a written response to the WPI Program Working Group. The details of this strategy are contained in "5. Efforts to secure the center's future development over the mid- to long term" in this report.

Actions Required and Recommendations (site visit report)

Ultimate goal of Nanoarchitectonics and Mid-long term strategy

- What is the ultimate goal of nanoarchitectonics as a whole and how it should be differentiated from the ordinary "materials science"? The final goal and the strategy to establish the common concept should be confirmed by every research individuals.

The core of MANA's Mission is contained in the phrase "Oriented towards a better global future: Pioneering a new paradigm for nanotechnology in materials development". In other words, MANA does not just engage in ordinary materials science, it researches the technological innovations and applications required to develop new materials for the future of humankind. The most fundamental concept for this research is represented by the word "nanoarchitectonics". Nanoarchitectonics can be thought of as an amalgamation of conventional materials science, nanotechnology and complex systems science. In other words, nanoarchitectonics is a combination of the following three ideas: 1) Interactions between atoms and molecules have served as the basis of materials science thus far, but going forward we will need to create a methodology for the development of new materials based on the mutual interaction of nanoscale structural units; 2) In conventional microtechnology, it was possible to microfabricate structures according to their design, but in the realm of nanotechnology, which is much smaller in scale, fabricating nanostructures as they were designed is not always expected due to thermal and statistical fluctuations; 3) Organizing massive numbers of nanostructural units can lead to the creation of revolutionary emergent functions.

Every researcher at MANA understands the concept of nanoarchitectonics very well and effectively incorporates it into his or her research. It has also begun to spread rapidly throughout the world.

Strategy for extension

- Strategy for 5 year extension after 10 year period, and mid-term and long term strategy to sustain the center's development should be drafted until the next site visit. Discussion at the task force team might be desired.

Please refer to Section 5) of Actions Required and Recommendations (follow-up report).

- In the second step of the WPI program to construct the genuine globally-visible center, the projects should proceed to the advanced phases in visible way: for example, the atomic switch should be raised to realistic artificial neural network/circuit, and the nano-sheets and meso-porous materials should be connected to realistic application fields.

We are making good progress on all of the primary research topics that we have been exploring since MANA's inception, that is, atomic switches, nano-sheets, mesoporous materials and battery materials, and we are actively engaged in partnerships with companies and other organizations. For example, we are

making steady progress on the use of atomic switches in neuromorphic circuit networks, despite the fact that it is an extremely challenging topic. We expect this research to bear fruit in about one or two more years.

Reinforcement of Nano-Life

- Reinforcement of Nano-Life is needed if MANA considers it as a major target of research.

Please refer to Section 1) of Actions Required and Recommendations (follow-up report).

Human resources & Career-path

- The success of a basic research laboratory depends mainly on the quality of the graduate students and postdoc researchers. A careful selection of these scientists is very important and some transparent rules should be developed for accepting scientists at MANA.

We openly recruit postdocs and graduate students from around the world with announcements on our homepage. NIMS graduate school faculty members conduct stringent document screenings and interviews to select graduate students. Postdocs are employed after document screenings and interviews by a three-person screening panel. To attract even better young researchers, we will focus on finding human resources through the international networks MANA has developed to date, in addition to using existing open applications.

- In near future MANA should consider MANA becomes the center of human resources to have responsibility to develop other university and research organization. So, good PIs and postdocs should be considered to be exported to other university and research organization to encourage the materials science field in Japan and other countries.

We do not want to lose excellent PIs and young researchers, but we believe it is the mission of a WPI Center to promote the field of materials science and to train and produce good human resources, so we will embrace this idea with a positive mindset. In FY2012, two young MANA scientists left MANA for Osaka University and the City University of Hong Kong, and one Independent Scientist left for the Paul Scherrer Institute in Switzerland. In addition, 24 postdocs found jobs at other universities and research institutes around the globe. We will continue striving to cultivate young researchers, and we will help them take the next step in their careers to research institutes throughout Japan and around the world.

International symposium

- Current MANA International Symposium held in every March is a useful event to make public MANA's R&D achievements. Coming to the second stage, in order to enhance the international profile as WPI, the organization of an international symposium or workshop on the MANA's prominent subjects, to provide a platform for discussion on state-of-the-art issues among the leading researchers, will be useful.

The past MANA International Symposia focused primarily on annual reports of research findings, but going forward, we will turn the International Symposium into a venue that attracts the world's top researchers and make it a more open and higher caliber event. In light of this change in policy, we invited 22 top researchers, including two Nobel Prize laureates, to the 6th MANA International Symposium held in March 201~~2~~3, and presentations of the latest research findings were given on MANA's main theme. As a result, we attracted an all-time high 414 participants and received high marks for organizing a high caliber international conference.

Going forward, we will set a main theme every year and continue communicating research findings and the concept of nanoarchitectonics to the world.

Frame of science

- The PI's are not paying sufficient attention to framing their projects in terms of the most fundamental science questions underlying the results they get. Once these questions are properly framed one can see what needs to be done to understand what new experiments or theory might lead into new areas of science.

Please refer to Section 2) of Actions Required and Recommendations (follow-up report).

Security

- The security control (many locked doors within the building) is not appropriate for a fruitful atmosphere at an internationally open basic research center.

Please refer to "6. Others (2) Balancing an Open Atmosphere with Security" in this report.

List of Center's Research Results and Main Awards

A. Refereed Papers

List only the Center's papers published in 2012. (Note: The list should be for the calendar year, not the fiscal year.)

(1) Divide the papers into two categories, A and B.

A. WPI papers
List papers whose author(s) can be identified as affiliated with the WPI program (e.g., that state the name of his/her WPI center). (*Not including* papers whose acknowledgements contain the names of persons affiliated with the WPI program.)

B. WPI-related papers
Among papers published in 2012, list those related to the WPI program but whose authors are not noted in the institutional affiliations as WPI affiliated. (*Including* papers whose acknowledgements contain the names of researchers affiliated with the WPI program.)

Note: On 14 December 2011, the Basic Research Promotion Division in MEXT's Research Promotion Bureau circulated an instruction requiring paper authors to include the name or abbreviation of their WPI center among their institutional affiliations. As some WPI-affiliated authors of papers published up to 2013 may not be aware of this requirement, their papers are treated as "WPI-related papers." From 2014, however, the authors' affiliations must be clearly noted and only category A papers will be listed.

Newly selected centers are to list papers under category C below (in addition to categories A and B above).

C. Previously published important WPI-related papers
List previously published papers that provided the basis for the center's research project plan. (Around 30 papers as a yardstick.)

(2) Method of listing paper

- List only referred papers. Divide them into categories (e.g., original articles, reviews, proceedings).
- For each, write the author name(s); year of publication; journal name, volume, page(s), and article title. Any listing order may be used as long as format is the same. (The names of the center researchers do not need to be underlined.)
- If a paper has many authors (say, more than 20), all of their names do not need to be listed.
- If the papers are written in languages other than English, divide them into language categories when listing them.
- Assign a serial number to each paper to be used to identify it throughout the system.

(3) Submission of electronic data

- In addition to the above, for each paper provide a .csv file output from the Web of Science (e.g.) or other database giving the paper's raw data including Document ID. (Note: the Document ID is assigned by paper database.)
- These files do not need to be divided into paper categories.

(4) Use in assessments

- The lists of papers will be used in assessing the state of WPI project's progress in FY 2012.
- They will be used as reference in analyzing the trends and states of research in all the WPI centers, not to evaluate individual researcher performance.
- The special characteristics of each research domain will be considered when conducting assessments.

(5) Additional documents

After all documents, including these paper listings, showing the state of research progress have been submitted, additional documents may be requested.

Order of Listing

A. WPI papers
1. Original articles
2. Review articles
3. Proceedings
4. Other English articles

5. Articles written in other than English

B. WPI-related papers
1. Original articles
2. Review articles
3. Proceedings
4. Other English articles
5. Articles written in other than English

C. Previously published WPI-related papers

A. WPI Papers

1. Original papers

No.	Author names and details
1	Z. Ahmed, S. Belitto, M.L. Di Vona, M. Trombetta, E. Traversa, S. Licoccia, *Sulphonated poly ether ether ketone/amino-diphenylsilandiol composite electrolyte for PEM fuel cells,* Journal of Applied Polymer Science **124**(3), 2610 (2012). doi: 10.1002/app.34906
2	K. Akatsuka, G. Takanashi, Y. Ebina, M. Haga, T. Sasaki, *Electronic Band Structure of Exfoliated Titanium- and/or Niobium-Based Oxide Nanosheets Probed by Electrochemical and Photoelectrochemical Measurements*, Journal of Physical Chemistry C **116**(23), 12426 (2012). doi: 10.1021/jp302417a
3	A.M. Ako, M.S. Alam, M. Rahman, J.P. Hill, N.M. Snachez-Ballester, K. Ariga, G. Buth, C.E. Anson, A.K. Powell, *Self-Assembly of a Mononuclear [Fe^{III}(L)$(EtOH)_2$] Complex Bearing an n-Dodecyl Chain on Solid Highly Oriented Pyrolytic Graphite Surfaces*, Chemistry - A European Journal **18**(51), 16419 (2012). doi: 10.1002/chem.201202858
4	A. Aparecido-Ferreira, H. Miyazaki, S.L. Li, K. Komatsu, S. Nakaharai, K. Tsukagoshi, *Enhanced current-rectification in bilayer graphene with an electrically tuned sloped bandgap*, Nanoscale **4**(24), 7842 (2012). doi: 10.1039/C2NR32526H
5	R. Arafune, H.J. Shin, J. Jung, E. Minamitani, N. Takagi, Y. Kim, M. Kawai, *Combined Scanning Tunneling Microscopy and High-Resolution Electron Energy Loss Spectroscopy Study on the Adsorption State of CO on Ag(001)*, Langmuir **28**(37), 13249 (2012). doi: 10.1021/la3024088
6	K. Ariga, S. Ishihara, H. Abe, M. Li, J.P. Hill, *Materials nanoarchitectonics for environmental remediation and sensing*, Journal of Materials Chemistry **22**(6), 2369 (2012). doi: 10.1039/C1JM14101E
7	K. Ariga, T. Mori, J.P. Hill, *Mechanical Control of Nanomaterials and Nanosystems*, Advanced Materials **24**(2), 158 (2012). doi: 10.1002/adma.201102617
8	K. Ariga, T. Mori, J.P. Hill, *Evolution of molecular machines: from solution to soft matter interface*, Soft Matter **8**(1), 15 (2012). doi: 10.1039/C1SM06832F
9	K. Ariga, A. Vinu, Y. Yamauchi, Qingmin Ji, J.P. Hill, *Nanoarchitectonics for Mesoporous Materials,* Bulletin of the Chemical Society of Japan **85**(1), 1 (2012). doi: 10.1246/bcsj.20110162
10	H. Ataee-Esfahani, Y. Nemoto, M. Imura, Y. Yamauchi, *Facile Synthesis of Nanoporous Pt–Ru Alloy Spheres with Various Compositions toward Highly Active Electrocatalysts*, Chemistry – An Asian Journal **7**(5), 876 (2012). doi: 10.1002/asia.201200053
11	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
12	U. Balakrishnan, N. Ananthi, S. Velmathi, M.R. Benzigar, S.N. Talapaneni, S.S. Aldeyab, K. Ariga, A. Vinu, *Immobilization of chiral amide derived from (1R,2S)-(−)-norephedrine over 3D nanoporous silica for the enantioselective addition of diethylzinc to aldehydes*, Microporous and Mesoporous Materials **155**, 40 (2012). doi: 10.1016/j.micromeso.2012.01.005
13	B.P. Bastakoti, L.C. Chen, K.C.W. Wu, Y. Yamauchi, *Block copolymer assisted synthesis of porous α-$Ni(OH)_2$ microflowers with high surface areas as electrochemical pseudocapacitor materials,* Chemical Communications **48**(73), 9150 (2012). doi: 10.1039/c2cc32945j
14	B.P. Bastakoti, M. Imura, Y. Nemoto, Y. Yamauchi, *Synthesis of MoO_3 nanotubes by thermal mesostructural transition of spherical triblock copolymer micelle templates*, Chemical Communications **48**(99), 12091 (2012). doi: 10.1039/C2CC36287B
15	B.P. Bastakoti, M. Inoue, S. Yusa, S.H. Liao, K.C.W. Wu, K. Nakashima, Y. Yamauchi, *A block copolymer micelle template for synthesis of hollow calcium phosphate nanospheres with excellent biocompatibility*, Chemical Communications **48**(52), 6532 (2012). doi: 10.1039/C2CC32279J

16	L. Bei, E. Fabbri, E. Traversa, *Effect of anode functional layer on the performance of proton-conducting solid oxide fuel cells (SOFCs)*, Electrochemistry Communications **16**(1), 37 (2012). doi: 10.1016/j.elecom.2011.12.023
17	L. Bei, E. Fabbri, E. Traversa, *Novel $Ba_{0.5}Sr_{0.5}(Co_{0.8}Fe_{0.2})_{1-x}Ti_xO_{3-\delta}$ (x = 0, 0.05, and 0.1) cathode materials for proton-conducting solid oxide fuel cells*, Solid State Ionics **214**, 1 (2012). doi: 10.1016/j.ssi.2012.02.049
18	A.A. Belik, Y. Matsushita, M. Tanaka, E. Takayama-Muromachi, *Crystal Structures and Properties of Perovskites $ScCrO_3$ and $InCrO_3$ with Small Ions at the A Site*, Chemistry of Materials **24**(11), 2197 (2012). doi: 10.1021/cm3009144
19	A.A. Belik, D.A. Rusakov, T. Furubayashi, E. Takayama-Muromachi, *$BiGaO_3$-Based Perovskites: A Large Family of Polar Materials*, Chemistry of Materials **24**(15), 3056 (2012). doi: 10.1021/cm301603v
20	Y. Bi, H. Hu, Z. Jiao. H. Yu, G. Lu, Y. Je, *Two-dimensional dendritic Ag_3PO_4 nanostructures and their photocatalytic properties*, Physical Chemistry Chemical Physics **14**(42), 14486 (2012). doi: 10.1039/C2CP42822A
21	Y. Bi, H. Hu, S. Ouyang, Z. Jiao, G. Lu, J. Ye, *Sective Growth of Metallic Ag Nanocrystals on Ag_3PO_4 Submicro-Cubes for Photocatalytic Applications,* Chemistry - A European Journal **18**(45), 14272 (2012). doi: 10.1002/chem.201201435
22	Y. Bi, H. Hu, S. Ouyang, Z. Jiao, G. Lu, J. Ye, *Selective growth of Ag_3PO_4 submicro-cubes on Ag nanowires to fabricate necklace-like heterostructures for photocatalytic applications*, Journal of Materials Chemistry **22**(30), 14847 (2012). doi: 10.1039/C2JM32800C
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2. Review articles

No.	Author names and details
609	D.R. Bowler, T. Miyazaki, *O(N) methods in electronic structure calculations*, Reports on Progress in Physics **75**(3), 036503 (2012). doi: 10.1088/0034-4885/75/3/036503
610	N. Hanagata, *Structure-dependent immunostimulatory effect of CpG oligodeoxynucleotides and their delivery system*, International Journal of Nanomedicine **7**, 2181 (2012). doi: 10.2147/IJN.S30197
611	K. Kataoka, A. Harada, Y. Nagasaki, *Block copolymer micelles for drug delivery: Design, characterization and biological significance*, Advanced Drug Delivery Reviews **64**, Supplement, 37 (2012). doi: 10.1016/j.addr.2012.09.013
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613	J. Shi, J. Ye, L. Ma, S. Ouyang, D. Jing, L. Guo, *Site-Selected Doping of Upconversion Luminescent Er^{3+} into $SrTiO_3$ for Visible-Light-Driven Photocatalytic H_2 or O_2 Evolution*, Chemistry – A European Journal **18**(24), 7543 (2012). doi: 10.1002/chem.201102807
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615	M. Tagaya, T. Ikoma, N. Hanagata, J. Tanaka, *Analytical Investigation of Protein Mediation Between Biomaterials and Cells*, Materials Express **2**(1), 1 (2012). doi: 10.1166/mex.2012.1053
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3. Proceedings

No.	Author names and details
617	G. Kichin, T. Weiss, H. Gao, J. Henzie, T.W. Odom, S.G. Tikhodeev, H. Giessen, *Metal–dielectric photonic crystal superlattice: 1D and 2D models and empty lattice approximation*, Physica B: Condensed Matter **407**(20), 4037 (2012). doi: 10.1016/j.physb.2012.01.128
618	K. Takada, N. Ohta, L. Zhang, X. Xu, B.T. Hang, T. Ohnishi, M. Osada, T. Sasaki, *Interfacial phenomena in solid-state lithium battery with sulfide solid electrolyte*, Solid State Ionics **225**, 594 (2012). doi: 10.1016/j.ssi.2012.01.009

B. Invited Lectures, Plenary Addresses (etc.) at International Conferences and International Research Meetings

- List up to 10 main presentations during FY2012 in order from most recent.
- For each, write the lecturer/presenter's name, presentation title, conference name and date(s)

No.	Lecturer/presenter names and details
1	Tomonobu NAKAYAMA *Multiple-Probe Scanning Probe Microscopes for Nanosystems Research* 2012 Second International Confernce on Small Science (ICSS), Florida, USA 16-19 December 2012
2	Kazuhito TSUKAGOSHI *Band engineering in graphene for future electronics* The International Symposium on Graphene Devices (ISGD), Paris, France 5-9 November 2012
3	Jinhua YE *Design of Novel Nano-Photocatalytic Materials for Solar Fuel Conversion and Environmental Remediation* 12th International Conference on Clean Energy (ICCE 2012), Xi'an, China 26-30 October 2012
4	Takao AOYAGI *Design of smart materials in response to indirect stimuli* Royal Society of Chemistry, The 8th annual symposium, CA, USA 21-23 October 2012
5	Kazunori TAKADA *6Interface structures in solid-state lithium batteries with sulfide electrolytes* APRiME 2012, Honolulu, USA 7-12 October 2012
6	Masakazu AONO *Synaptic characteristics of the atomic switch* Trends in Nanotechnology International Conference (TNT2012), Madrid, Spain 10-14 September 2012
7	Kohei UOSAKI *627 - Formation and structural determination of confined molecular catalysts on and within molecular layers formed on Si(111) surface with direct Si-C bond for photoelectrochemical hydrogen generation and CO2 reduction* American Chemistry Society National Meeting &Exposition, Philadelphia, USA 19-23 August 2012
8	Katsuhiko ARIGA *Interfacial Assemblies for Bridging Macro & Nano: Hand-Operating Nanotechnology* 7th International Symposium on Advanced Materials and Nanostures, Sorocaba, Brazil 20-23 May 2012
9	Tsuyoshi HASEGAWA *Novel functions achieved by atom movement controlled devices* E-MRS 2012 Spring Meeting, Strasbourg, France 14-18 May 2012
10	Dmitri GOLBERG *Diverse nanoinorganics for various energy applications* 2012 Spring Meeting of the Materials Research Society, San Francisco, USA 9-13 April 2012

C. Major Awards
- List up to 10 main awards received during FY2012 in order from the most recent.
- For each, write the recipient's name, name of award, and year issued.
- In case of multiple recipients, underline those affiliated with the center.

No.	Recipient names and details
1	Yusuke YAMAUCHI **The 7th PCCP Prize** (by The Chemical Society of Japan) 2013
2	Francoise M. WINNIK **SPSJ International Award** (The Society of Polymer Science, Japan) 2013
3	Kazuhito TSUKAGOSHI **JSPS Prize** (by JSPS) 2012
4	Yusuke YAMAUCHI **The 22nd Tsukuba Encouragement Prize for Young Researchers** (by The Science and Technology Promotion Foundation of Ibaraki) 2012
5	Zhong Lin WANG **Edward Orton Memorial Lecture Award** (by the American Ceramic Society) 2012
6	Tsuyoshi HASEGAWA, Yaomi ITO, Takami HINO, Tohru TSURUOKA, Kazuya TERABE, Hisao MIYAZAKI, Kazuhito TSUKAGOSHI, Takuji OGAWA, Shu Yamaguchi, Masakazu AONO **34th Award for the Best Original Paper** (by the Japan Society of Applied Physics) 2012
7	Jin KAWAKITA, Toyohiro CHIKYOW **2012 Academic Plaza Award** (by Japan Institute of Electronics Packaging) 2012
8	Mitsuhiro EBARA **Young Scientist Award** (by 9th World Biomaterials Congress) 2012
9	Minoru OSADA **JWS Interfacial Joining Award for Research Promotion** (by Japan Welding Society) 2012
10	Satoshi TOMINAKA **Funai Research Incentive Award** (by the FUNAI Foundation for Information Technology) 2012

FY 2012 List of Principal Investigators

<Results at the end of FY2012>
Principal Investigators Total: 24

Name (Age)	Affiliation (Position title, department, organization)	Academic degree, specialty	Working hours (Total working hours: 100%)				Starting date of project participation	Status of project participation (Describe in concrete terms)	Contributions by PIs from overseas research institutions
			Work on center project		Others				
			Research activities	Other activities	Research activities	Other activities			
Director-General AONO, Masakazu* (68)	Director-General, International Center for Materials Nanoarchitectonics (MANA)	Ph.D. Tokyo Univ (1972) NanoSciene and Nanotechnology	60%	15%	15%	10%	10/1/2007	a) usually stays at the center	–
BANDO, Yoshio*(65)	Chief Operating Officer, International Center for Materials Nanoarchitectonics (MANA)	Ph.D. Osaka University, 1975 Nanomaterials and Transmission electron microscope	70%	30%	0%	0%	10/1/2007	a) usually stays at the center	–
ARIGA, Katsuhiko*(50)	International Center for Materials Nanoarchitectonics (MANA)	Dr. Eng. Tokyo Institute of Technology, 1990 Supramolecular Chemistry and Surface Science	100%	0%	0%	0%	10/1/2007	a) usually stays at the center	–
HU, Xiao (51)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D. (Physics), University of Tokyo, 1990 condensed-matter-physics	100%	0%	0%	0%	10/1/2007	a) usually stays at the center	–

YE, Jinhua* (50)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D. The University of Tokyo, 1990 Photocatalyst, Eco-Materials	30%	0%	50%	20%	10/1/2007	a) usually stays at the center	–
HASEGAWA, Tsuyoshi (50)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D. (science) The Tokyo Inst. Tech., 1996 Nano-devices	100%	0%	0%	0%	10/1/2007	a) usually stays at the center	–
SASAKI, Takayoshi*(57)	International Center for Materials Nanoarchitectonics (MANA)	Dr, (Science) The University of Tokyo, 1986 nanosheet and softchemistry	100%	0%	0%	0%	10/1/2007	a) usually stays at the center	–
GOLBERG, Dmitri* (52)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D. Moscow Institute for Ferrous Metallurgy, 1990 nanotubes and nanowires	100%	0%	0%	0%	10/1/2007	a) usually stays at the center	–
TAKAYANAGI, Hideaki*(61)	Professor, Tokyo University of Science, Research Institute for Science and Technology	Ph.D. (science) The University of Tokyo, 1987 mesoscopic superconductivity and quantum information physics	50%	10%	20%	20%	10/1/2007	b) stays at the center twice a week, at Tokyo University of Science satellite usually	–

KADOWAKI, Kazuo*(60)	Professor, Institute of Materials Science, Graduate School of Pure and Applied Sciences, University of Tsukuba	Ph.D. Osaka University, 1980 Superconductivity and Nanoelectronics	20%	20%	30%	30%	10/1/2007	b) stays at University of Tsukuba satellite usually	–
NAGASAKI, Yukio*(53)	Professor, Department of Materials Science and Master's Master's School of Medical Sciences, University of Tsukuba	Ph.D. Tokyo University of Science (1986) Biomaterials and Polymer Chemistry	20%	0%	70%	10%	10/1/2007	b) stays at University of Tsukuba satellite usually	–
GIMZEWSKI, James K. *(61)	Dinstinguished Professor, Chemistry & Biochem. Dept., UCLA Director, Nano/Pico Characterization Lab, UCLA California NanoSystems Inst.	Ph.D. (Physical Chemistry) Univ. of Strathclyde, 1977 Nanoscience and Nanobio	23%	3%	67%	7%	10/1/2007	b) stays at the center six times a year, at UCLA satellite usually	To have charge of research themes of MANA
WELLAND, Mark E.*(57)	Professor, University of Cambridge	Ph.D. (Physics) University of Bristol 1984 Nanoscience and nanofabrication	15%	6%	65%	14%	10/1/2007	b) stays at the center once a year, at UCAM satellite usually	To have charge of research themes of MANA
WANG, Zhong Lin *(51)	Professor, School of Materials Science and Engineering, Georgia Institute of Technology	Ph.D. Arizona State University, 1987 Nano Chemistry and Nanodevices	15%	5%	60%	20%	10/1/2007	b) stays at the center once a year, at GIT satellite usually	To have charge of research themes of MANA and to accept a young researcher from MANA (1 month)

JOACHIM Christian*(55)	Centre National de la Recherche Scientifique (CNRS) Lab: CEMES (UPR8011) Toulouse (France)	Ph.D. in Applied Mathematic Ph.D. in Quantum Physics Computer science and Nanoscienc e	18%	3%	72%	7%	10/1/2007	b) stays at the center twice a year, at CNRS satellite usually	To have charge of research themes of MANA
YAGHI, Omar* (48)	The James and Neeltje Tretter Professor of Chemistry, UC Berkley	Ph.D.(Unive rsity of Illinoise, 1990) Nanostruct ure of Organic materials	30%	0%	60%	10%	3/10/2008	b) stays at UCB usually	To supervise a research group in MANA
UOSAKI, Kohei* (66)	International Center for Materials Nanoarchitectonics (MANA)	Ph. D. Surface Physical Chemistry	80%	20%	0%	0%	7/1/2008	a) usually stays at the center	–
NAKAYAMA, Tomonobu (51)	International Center for Materials Nanoarchitectonics (MANA)	PhD in physics, Scanning Probe Microscopy	100%	0%	0%	0%	10/1/2008	a) usually stays at the center	–
TSUKAGOSHI, Kazuhito (45)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D., Nano electronics	90%	0%	10%	0%	1/1/2009	a) usually stays at the center	–
TAKADA, Kazunori* (51)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D., Solid-state Chemistry	30%	0%	70%	0%	1/1/2010	a) usually stays at the center	–

AOYAGI, Takao* (53)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D., Biomaterials	70%	0%	20%	10%	9/1/2010	a) usually stays at the center	–
CHEN, Guoping (47)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D., Kyoto University(1997), Biomaterials and Tissue Engineering	100%	0%	0%	0%	4/1/2011	a) usually stays at the center	–
CHIKYOW, Toyohiro (53)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D., Waseda University (1989), Semiconductor and electric materials	70%	10%	10%	10%	4/1/2011	a) usually stays at the center	–
Françoise M. Winnik* (61)	Faculty of Pharmacy and Department of Chemistry, University of Montreal, Canada	Ph.D.(Chemistry), ,University of Toronto(1979), Polymer Chemistry and Photochemistry	40%	10%	40%	10%	4/1/2011	b) stays at the center four times a year, at University of Montreal usually	To have charge of research themes of MANA

Researchers unable to participate in project in FY 2012

Name	Affiliation (Position title, department, organization)	Starting date of project participation	Reasons	Measures taken

Records of FY2012 Center Activities

1. Researchers and center staffs, satellites, partner institutions

1-1. Number of researchers in the "core" established within the host institution

- Enter the total number of people in the columns below. In the "Researchers" column, put the number and percentage of overseas researchers in the < > brackets and the number and percentage of female researchers in the [ ] brackets.
- In the "Administrative staffs" column, put the number and percentage of bilingual staffs in the ( ) brackets.
- In the "Final Goal" column, enter the currently projected goal and the estimated date for achieving it [OO month, OO year].

	Goal set in the "Post-interim evaluation revised center project"	Results at end of FY 2012	Final goal (October, 2014)
Researchers	200 <120, 60%> [50, 25%]	199 <107, 53.8%> [45, 22.6 %]	200 <120, 60%> [50, 25%]
Principal investigators	25 <10, 40%> [3, 12%]	24 <9, 37.5%> [2, 8.3 %]	25 <10, 40%> [3, 12%]
Other researchers	175 <110, 63%> [47, 27%]	175 <98, 56%> [43, 24.6%]	175 <110, 63%> [47, 27%]
Research support staffs	12	9	12
Administrative staffs	18	17 (17, 100%)	18 (18, 100%)
Total	230	225	230

Other matters of special mention

- Enter matters warranting special mention, such as concrete plans for achieving the Center's goals, established schedules for employing main researchers, particularly principal investigators.
- As background to how the Center is working to mobilize/circulate the world's best brains, give good examples, if any, of how career paths are being established for the Center's researchers; that is, from which top-world research institutions do researchers come to the Center and to which research institutions do the Center's researchers go, and how long are their stays at those institutions.

Major scheduled researcher appointments

・We plan to appoint Dr. David Bowler from the University College London (UCL) as an Associate PI and establish a new satellite at UCL.

Personnel transfers

・Dr. Osamu Kubo, MANA Scientist, joined the Osaka University (Period of research at MANA: 2008.10-2012.11)

・Dr. Chunyi Zhi, MANA Scientist, joined the City University of Hong Kong (Period of research at MANA: 2008.10-2012.12)

・Dr. Daniele Pergolesi, Independent Scientist, joined the Paul Scherrer Institute in Switzerland (Period of research at MANA: 2009.1-2013.1)

1-2. Satellites and partner institutions

- List the satellite and partner institutions in the table below.
- Indicate newly added and deleted institutions in the "Notes" column.
- If satellite institutions have been established, describe by satellite the Center's achievements in coauthored papers and researcher exchanges in Appendix 4.

<Satellite institutions>

Institution name	Principal Investigator(s), if any	Notes
University of Tsukuba	Yukio Nagasaki	
	Kazuo Kadowaki	Close this satellite in the end of FY2012
Tokyo University of Science	Hideaki Takayanagi	
University of Cambridge, UK	Mark E. Welland	Close this satellite in the end of FY2012
UCLA, USA	James K. Gimzewski	
Georgia Institute of Technology, USA	Zhong Lin Wang	
CNRS, France	Christian Joachim	
University of Montreal, Canada	Francoise M. Winnik	

< Partner institutions>

Institution name	Principal Investigator(s), if any	Notes
LMPG, Grenoble, France		
Univesité de la Méditerranée,Marseille, France		
Univ. of Valenciennes, France		
Karlsruhe Inst. of Technology, Germany		
Erlangen Catalysis Resource Center, Friedrich-Alexander Univ., Germany		
Kirchhoff Inst. of Physics at Univ. of Heidelberg, Germany		
Inorganic and Materials Chemistry at the Inst. of Inorganic Chemistry,Univ. of Cologne, Germany		
Supramolecular Chemistry Group at the Inst. for Inorganic Chemistry, Univ. of Karlsruhe, Germany		
Center for Nanoscience & Nanotechnology & Innovative Instrumentation (NAST) at The Univ. of Rome Tor Vergata, Itary		
Inst. of Microengineering, Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland		
Univ. of Basel, National Center of Competence for Nanoscale Science, Inst. of Physics, Switzerland		
Dept. of Chemistry, Loughborough Univ., UK		
University College London (UCL), UK		

Advanced Light Source(ALS) Division, Lawrence Berkeley National Laboratory, USA		
Dept. of Chemistry, Kent State Univ., USA		
Chemistry and Biological Engineering, Rensselaer Polytechnic Inst., USA		
Physics Inst. of Sao Carlos, Univ. of Sao Paulo, Brazil		
Multidisciplinary Center for Development of Ceramic Materials, Brazil		
Dept. of Materials Science & Engineering Tsinghua Univ., China		
The Biomaterials and Tissue Engineering Research Center, Shanghai Inst. of Ceramics, China		
Anhui Key Lab. of Nanomaterials and Nanostructures, Inst. of Solid State Physics, Chinese Academy of Science, China		
Dept. of Materials Science, Fudan Univ., China		
New Energy and Materials Lab. (NEML), Dept. of Chemistry, Fudan Univ., China		
National Centre for Catalysis Research (NCCR), Indian Inst. of Technology Madras, India		
Chemical and Biological Engineering, Indian Inst. of Science Education and Research, India		
Indian Inst. of Chemical Technology, India		
Center for Intelligent Nano Bio Materials(CINBM), Dept. of Chemistry and Nanoscience, EWHA Womans Univ., Korea		
Yonsei Univ., Korea		
Kyungpook National University, Korea		
Petrochemical Research Chair, King Saud Univ., Saudi Arabia		
The International Training Inst. for Materials Science(ITIMS), Hanoi Univ. of Science and Technology (HUST), Vietnam		
Laboratory for Nanotechnolog(LNT), Vietnam National Univ. Ho Chi Minh City, Vietnam		
Flinders Univ., Australia		
Univ. of Melbourne, Australia		

2. Securing competitive research funding

- Competitive and other research funding secured in FY2012:

Total: 991 Million yen

- Describe external funding warranting special mention. Include the name and total amount of each grant.

Grants-in Aid for Scientific Research A
・Y. Okawa: Functional measurement of mono-molecular devices with conductive polymers wiring [Budget: 43,290,000Yen]

Grants-in Aid for Scientific Research B
・H. Kobayashi: Multi control of nano-fiber structural materials for regeneration medicine and application to regeneration of cornea [Budget: 14,170,000Yen]
・Renzhi MA: Synthesis of new nano hydro-oxide materials having redox activity and development of electrochemical energy devices [Budget: 12,220,000Yen]
・T. Hasegawa:Research on neoron movement using atom transfer type devices [Budget: 14,950,000Yen]
・Y. Wakayama: Development of many - valued logic devices using molecular nano wires [Budget: 14,430,000Yen]
・T. Tsuruoka: Analysis and controlling of nano-ionics phenomena in oxide/metal hetero boundary [Budget: 14,820,000Yen]

Grants-in Aid for Scientific Research for Young Scientists A
・K. Tashiro: Materials science on metal complex array [Budget:27,040,000 Yen]

Basic Research Programs (PRESTO)
・L. Sang: Multi-band engineering of group 3 nitrides aiming at high performance photoelectric conversion devices [Budget: 6,370,000 for FY2012]

・T. Masuda: Analysis of oxide reducing reaction mechanism by insitu XPS measurement on solid-liquid boundary [Budget: 3,900,000 for FY2012]

JST Revitalization Promotion Program
・G. Chen: Development of fabrication apparatus system for medical porous materials [Budget: 6,500,000 for FY2012]

Ibaraki medical engineering collaboration promotion program
・G. Chen: Research development on regenerative medical devices for congenital infantile surgery [Budget: 14,000,000]

3. International research conferences or symposiums held to bring world's leading researchers together

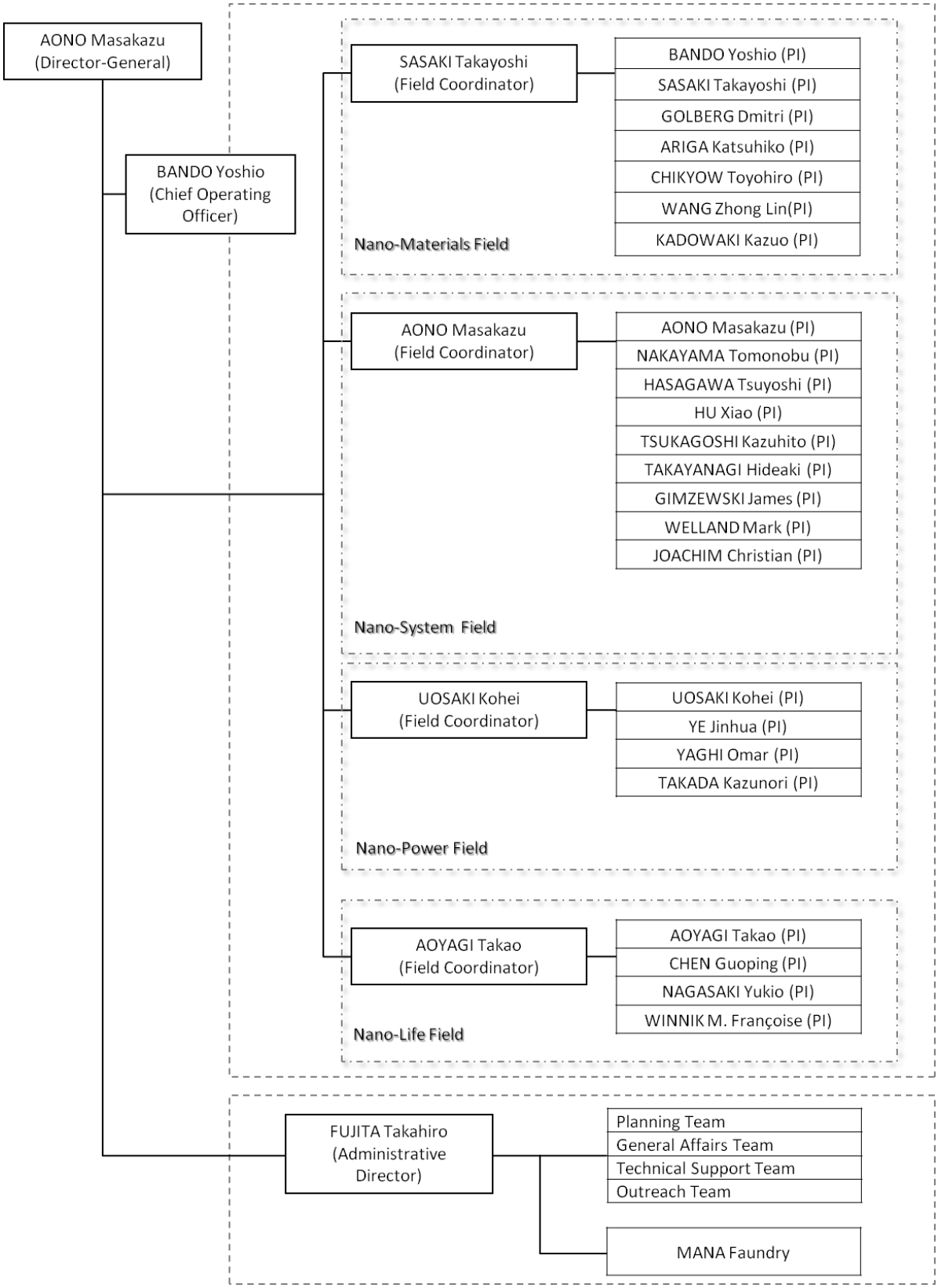
- Indicate the number of international research conferences or symposiums held in FY2012 and give up to three examples of the most representative ones using the table below.

FY 2012: 11 meetings

Major examples (meeting title and place held)	Number of participants
Title: MANA International Symposium 2013 Date: February 27 – March 1, 2013 Place: Epochal Tsukuba, Japan	From domestic institutions: 372 From overseas institutions: 42
Title: The 2nd Canada-Japan Nanotechnology Workshop 2013 Date: January 29 – 30, 2013 Place: Tokyo big sight, Japan	From domestic institutions: 66 From overseas institutions: 38
Title: PCCP-MANA Symposium on Nanotechnology Materials and Physical Chemistry Date: October 2, 2013 Place: NIMS	From domestic institutions: 99 From overseas institutions: 7

4. Center's management system

- Please diagram management system in an easily understood manner.
- If any changes have been made in the management system from that in the"Post-interim evaluation revised center project," please describe them. Please describe any changes made in the administrative director, head of host institution, and officer(s) in charge at the host institution (e.g., executive vice president for research)

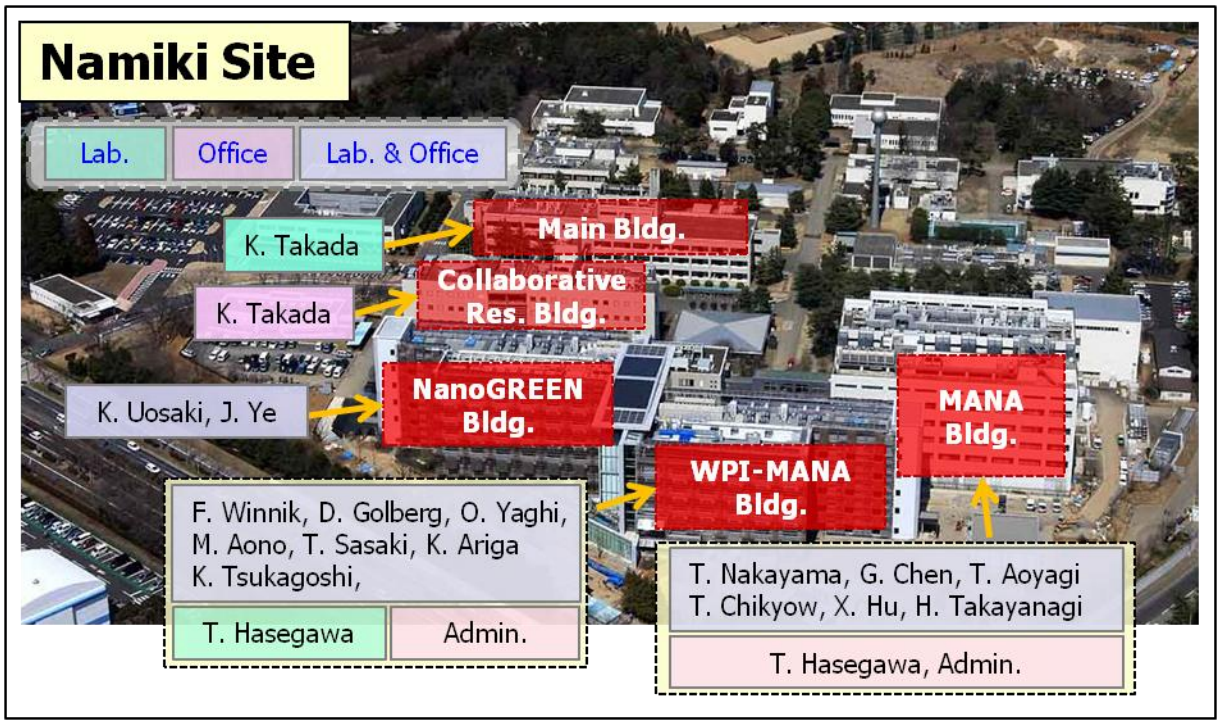


5. Campus Map

- Please draw a simple map of the campus showing where the main office and principle investigator(s) are located.

Campus Map
World Premier International Research Center (WPI) Initiative

WPI Center for Materials Nanoarchitectonics
National Institute for Materials Science



6. FY2012 Project Expenditures (the exchange rate used: 1USD=100JPY)

i) Overall project funding

Cost Items	Details	Costs (10,000 dollars)
Personnel	Center director and Administrative director	37
	Principal investigators (no. of persons):14	171
	Other researchers (no. of persons):180	935
	Research support staffs (no. of persons):7	49
	Administrative staffs (no. of persons):22	80
	Total	1,272
Project activities	Gratuities and honoraria paid to invited principal investigators	21
	Cost of dispatching scientists (no. of persons):3	8
	Research startup cost (no. of persons):24	92
	Cost of satellite organizations (no. of satellite organizations):	83
	Cost of international symposiums (no. of symposiums):1	6
	Rental fees for facilities	0
	Cost of consumables	23
	Cost of utilities	194
	Other costs	81
	Total	508
Travel	Domestic travel costs	1
	Overseas travel costs	12
	Travel and accommodations cost for invited scientists (no. of domestic scientists):33 (no. of overseas scientists):63	28
	Travel cost for scientists on secondment (no. of domestic scientists):0 (no. of overseas scientists):15	4
	Total	45
Equipment	Depreciation of buildings	351
	Depreciation of equipment	946
	Total	1,297
Other research projects	Projects supported by other government subsidies, etc.	692
	Comissioned research projects, etc.	405
	Grants-in-Aid for Scientific Research, etc.	295
	Total	1,392
Total		4,514

Ten thousand dollars

WPI grant		1,344
Costs of establishing and maintaining facilities in FY 201		0
Cost of equipment procured		565
Ultra high vacuum STM apparatus		
Number of units: 1	Costs	23
Full automatic gas adsorption measurement equipment		
Number of units: 1	Costs	12
Automatic pit measurement image processing system		
Number of units: 1	Costs paid:	12
Vacuum vapor deposition apparatus(system) by multi-target method		
Number of units: 1	Costs paid:	12
Circular dichroism dispersion meter		
Number of units: 1	Costs paid:	12
Surface plasmon resonance system		
Number of units: 1	Costs paid:	9
LD excitation Nd:YLF green laser Darwin-527-40M/W-W cooler (for Titan)		
Number of units: 1	Costs	7
Infrared evaluation apparatus for solid/liquid boundary structure		
Number of units: 1	Costs	7
Imaging Plate system		
Number of units: 1	Costs paid:	6
High precision differential scanning calorimeter		
Number of units: 1	Costs paid:	5
Mini Scanning electron microscope		
Number of units: 1	Costs paid:	5
Thermostatic and constant humidity atmospheric film-forming apparatus		
Number of units: 1	Costs paid:	5
Fluoro spectro Photometer		
Number of units: 1	Costs paid:	4
Number of units: 1	Costs paid:	60
Others		386

ii) Costs of Satellites and Partner institutions

(Exchange Rate: JPY/USD=100)

Cost Items	Details	Costs (10,000 dollars)
Personnel	Principal investigators (no. of persons):1	
	Other researchers (no. of persons):16	
	Research support staffs (no. of persons):2	
	Administrative staffs (no. of persons):3	
	Total	58
Project activities		5
Travel		2
Equipment		5
Other research projects		14
Total		84

Status of Collaboration with Overseas Satellites

1. Coauthored Papers

- List the refereed papers published in FY2012 that were coauthored between the center's researcher(s) in domestic institution(s) and overseas satellite institution(s). List them by overseas satellite institution in the below blocks.
- Transcribe data in same format as in Appendix 1. Italicize the names of authors affiliated with overseas satellite institutions.
- For reference write the Appendix 1 item number in parentheses after the item number in the blocks below.

Overseas Satellite 1: University of Los Angeles California(UCLA), USA (Total: 5 papers)

No.	Author names and details
1-(11)	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
1-(208)	A. Nayak, T. Ohno, T. Tsuruoka, K. Terabe, T. Hasegawa, *J.K. Gimzewski*, M. Aono, *Controlling the Synaptic Plasticity of a Cu_2S Gap-Type Atomic Switch*, Advanced Functional Materials **22**(17), 3606 (2012). doi: 10.1002/adfm.201200640
1-(266)	A.Z. Stieg, A.V. Avizienis, H.O. Sillin, C. Martin-Olmos, M. Aono, *J.K. Gimzewski*, *Emergent Criticality in Complex Turing B-Type Atomic Switch Networks*, Advanced Materials **24**(2), 286 (2012). doi: 10.1002/adma.201103053
1-(370)	R. Yang, K. Terabe, G. Liu, T. Tsuruoka, T. Hasegawa, *J.K. Gimzewski*, M. Aono, *On-Demand Nanodevice with Electrical and Neuromorphic Multifunction Realized by Local Ion Migration*, ACS Nano **6**(11), 9515 (2012). doi: 10.1021/nn302510e
	A.V. Avizienis, C. Martin-Olmos, H.O. Sillin, M. Aono, *J.K. Gimzewski,* A.Z. Stieg, *Morphological Transitions from Dendrites to Nanowires in the Electroless Deposition of Silver,* CRYSTAL GROWTH & DESIGN **13**(2), 465(2013). doi: 10.1021/cg301692n

Overseas Satellite 2: Georgia Institute of Technology(GIT), USA (Total: 2 papers)

No.	Author names and details
2-(55)	N. Fukata, M. Mitome, T. Sekiguchi, Y. Bando, M. Kirkham, J.I. Hong, *Z.L. Wang*, R.L. Snyder, *Characterization of Impurity Doping and Stress in Si/Ge and Ge/Si Core–Shell Nanowires*, ACS Nano **6**(10), 8887 (2012). doi: 10.1021/nn302881w
2-(395)	G. Zhu, Y. Zhou, S. Wang, R. Yang, Y. Ding, X. Wang, Y. Bando, *Z.L. Wang*, *Synthesis of vertically aligned ultra-long ZnO nanowires on heterogeneous substrates with catalyst at the root*, Nanotechnology **23**(5), 055604 (2012). doi: 10.1088/0957-4484/23/5/055604

Overseas Satellite 3: CNRS, France (Total: 1 paper)

No.	Author names and details
3-(122)	N. Kodama, T. Hasegawa, T. Tsuruoka, *C. Joachim*, M. Aono, *Electronic State Formation by Surface Atom Removal on a MoS_2 Surface*, Japanese Journal of Applied Physics **51**(6), 06FF07 (2012). doi: 10.1143/JJAP.51.06FF07

Overseas Satellite 4: University of Cambridge, UK (Total: 1 paper)

No.	Author names and details
5-(258)	K. Sodeyama, M. Sumita, C. O'Rourke, U. Terranova, A. Islam, L. Han, *D.R. Bowler*, Y. Tateyama, *Protonated Carboxyl Anchor for Stable Adsorption of Ru N749 Dye (Black Dye) on a TiO_2 Anatase (101) Surface*, Journal of Physical Chemistry Letters **3**(4), 472 (2012). doi: 10.1021/jz201583n

Overseas Satellite 5: University of Montreal, Canada (Total: 0 paper)

2. Status of Researcher Exchanges

- Using the below tables, indicate the number and length of researcher exchanges in FY2012. Enter by institution and length of exchange.
- Write the number of principal investigator visits in the top of each space and the number of other researchers in the bottom.

Overseas Satellite 1: University of Los Angeles California(UCLA), USA(Prof. James K. Gimzewski)

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	0 0	0 0	0 0	0 0	0 0

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	2 1	4 7	0 0	0 0	6 8

Overseas Satellite 2: Georgia Institute of Technology(GIT), USA(Prof. Zhong Ling Wang)

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	0 0	0 1	0 0	0 0	0 1

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	1 0	0 0	0 0	0 0	1 0

Overseas Satellite 3: CNRS, France(Prof. Christian Joachim)

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	0 0	0 0	0 0	0 0	0 0

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	2 0	0 0	0 0	0 0	2 0

Overseas Satellite 4: University of Cambridge, UK(Prof. Mark E. Welland)

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	0 0	0 1	0 0	0 0	0 1

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	1 0	0 5	0 0	0 0	1 5

Overseas Satellite 5: University of Montreal, Canada(Prof. Françoise M. Winnik)

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	1 3	0 0	0 0	0 0	1 3

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	0 1	0 1	4 0	0 1	4 3

FY 2012 Visit Records of World Top-caliber Researchers from Abroad

Researchers Total:43

Name (Age)	Current affiliation (Position title, department, organization)	Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
James Gimzewski (60)	Distinguished Prof., Director, UCLA CNSI Nano & Pico Charact. Core Facility. Scientific Director, UCLA Art|Sci Center	Ph.D., Physical Chemistry	2002 Fellow, World Innovation Foundation 2001 Fellow Royal Acad. of Eng., UK 2001 Dudell Medal and Prize 2000 IBM Sixth Inv. Achiev. Plateau Award 1998 The 'Wired 25' Award, 1997 Feynman Prize in Nanotechnolog 1997 IBM Outstanding Innovation Award	4/17-28 8/21-9/14 10/2-5 12/11-21 2/25-3/3 3/19-23	PI
Francoise Winnik (60)	Professor, Pharmacy & Dept. of Chemistry, Univ. Montreal,	Ph.D., Bio chemistry	2006 Clara Benson Award (Canadian Institute of Chemistry) 2009 Doolittle award, PMSE division of the ACS 2008-present Executive editor, Langmuir	4/22-5/26 8/22-9/6 9/30-12/14 1/27-4/4	PI
Christophe Tribet	The École normale supérieure (ENS), Director of Research	Ph.D., Bio chemistry		5/7	Seminar
Neil Furlong (64)	Emeritus Professor, RMIT University	Ph.D., Surface Chemistry	1987 Fellow, Australian Acad. Tech. Sci.&Eng 1987 Grimwade Prize 1997 CSIRO Directors Res. Prize 1999 CSIRO Res. Medal 2002 Australian Gov. Centenary Medal	5/10-11 3/14-20	Workshop
Tom Healy (76)	Prof. Fellow & Chair of Sci. Board, PFP Centre, Univ. of Melbourne	Ph.D., Colloid Chem. Aqueous interfaces Adpt. Materials processing fundamentals.	2005 Australasian Instit. Mining &Metal 40Y Membership Award 2007 A.M.Gaudin Award 2009 Inaugural Nature Lifetime Achiev. Award 2010 Sir Eric Rideal Medallist	5/10-11	Workshop
Allan S. Hoffman (81)	Professor Emeritus, University of Washington	Chem.Eng., Smart Polymers	2007 Founder's Award, (Lifetime Achievement Award) 2006 Inter. Award (Soc. Polym Sci. Japan 2005 National Acad. of Eng. for "Pioneering Work on the Med. Uses of Polymeric Mat.s"	5/17	Workshop

David Lewis (53)	Director, Flinders Cent. NanoScale Sci.&Tech. Flinders Univ., Australia	Physical Chem. Polymer Science	2003 Fellow of the Royal Austrl Chem. Inst. 2005 CSIRO Look Out Award, 2005. 2006 Polymer Div. (RACI) Citation for contributions to the Optical Industry and RACI	6/4-7	Collaboration research
Joseph Shapter (49)	Dean, School of Chem. &Phys. Sci. Flinders University	Physi. Chem. Nanotechnology, Chemistry	2009 ATLC Award 2007 Carrick Institute Citation for Outstanding Contributions to Student Learning 2003 Flinders Vice-Chancellor Award	6/4-7	Collaboration research
Andrea Russell (48)	Deputy Head Chem., Univ. of Southampton	Ph.D., Anal.Chem., Chem. Engineering, PEM fuel cells	Fellow of the Royal Society of Chemistry and Higher Education Academy.	6/11	Seminar
Vincent S. J. Craig (41)	Head of the Dept of Applied Mathematics, Australian National Univ.	Physics	Over 70 fully referees journal papers which have been cited over 2600 times for a H factor of 25.	7/1-4	Collaboration research
Dragan Damjanovic (54)	Professor, the Lab. of Ceramics, (EPFL)	Ceramics, Piezoelectric, dielectric& ferroelectric prop. of ceramics	2007 ISIF outstanding achievement award 2009 Ferroelectrics Recognition Award IEEE UFFC Soc. 2009 Fellow of IEEE	7/19	Inspection
Lian-Mao Peng (51)	Director, Key Lab.Phys.& Chem. of Nanodevices, Peking University	Physics	2003 Li Xun Prize, Inst of Metal 2008 Thomson Reuters Res.Fronts Award 2010 Lizhao Qian Awards, Chinese Elect.Micro.Soc.	8/5-11	Collaboration, discussion
Cristian Joachim (55)	Director of Research, Centre National de la Recherche Scientifique (CNRS)	Mathematical Physics, Quantum Physics	1991 IBM France prize in Material Science 1997 & 2005 Feynman prize in Nanotechnology 1999 Nanotech. prize, French Nanotech. Club. 1999 Fellow of the Inst of Physics (London)	8/19-25 2/24-3/1	PI
Jacques Prost (65)	Director-General, ESPCI ParisTech	Physics, Biological Phys.	1990-1999 Scientific advisor to Elf Aquitaine, 2007 Member of the French Acad. Sci.	9/18	Inspection
David Nesbitt (59)	Professor, Univ. of Colorado at Boulder	Ph.D., Spectroscopy, dynamics, kinetics of fundamental molecule, bio –molecular& nanoparticle systems	1991 APS Fellow 1995 Edward Uhler Condon Award (NIST) 1997 Earle K. Plyler Prize 1999 Alex.von Humboldt Senior Scientist Award 2005 RSC Fellow 2009 Presidential Rank Award, ACS Fellow, JILA Fellow.	9/30-10/1	Symposium

Graham Hutchings (62)	Vice-Chancellor for Research, Cardiff University	Chemistry	2004 IChemE Entech Medal 2005 RSC 2004 Award for Heterogeneous Catalysis. 2005 Award for Applied Catalysis. EFCATS 2007 IChemE Environwise Prize of Green Chemistry 2009 RSC Award for Interfaces and Surfaces 2011 IPMI Henry J. Albert Award	9/30-10/1	Symposium
Marie-Paule Pileni (70)	Director, Mesoscopic & Nanometric Materials Lab., Chair of Inst. Univ. De France Univ. P & M Curie Paris VI	Physics, Nanomaterials, Phys.Chem. in Condensed matter	2009 Member of the Academia Europaea, 2005 Fellow of the RSC. 2006 Emila Valori Award,2005 Blaise Pascal Medal,2004 Descartes-Huygens Prize 2000 Langmuir award	9/30-10/1	Symposium
Mark Welland (57)	University of Cambridge	Ph.D., physics	2011 Knighted on Queen's Birthday Honours 2002 Fellowships of the RS and RAEng.	10/2-10/5	PI
Debes Bhattacharyya (67)	Director, Centre for Adv. Composite Mat. The University of Auckland	Ph.D., Advanced Composite Materials	FRSNZ, Distinguished Fellow of IPENZ,	10/3	Inspection
Robert Short (50)	Director: Mawson Institute/Dean: Research	Ph.D., Phys.Chem., Biomaterials, Tissue Eng., Plasma & plasma polymerisation	2004 Fellow of the RSC (FRSC) 2004 UK Society for Biomaterials' 2nd highest prize	10/5	Seminar
Yuri Grin (57)	Director, Max Planck Institut for Chem. Phys. of Solids	Chemical Metal Science		10/18-21	Collaboration, Discussion
Margret M. Hyland	Deputy Dean of Eng., University of Ackland	Chemistry, Surface Engineering	2005 Light Metals Award	10/31.	Inspection
Mervyn Miles, FRS	Director, Centre for Nanoscience & Quantum Information at Univ. of Bristol	AFM	2005 Royal Society Wolfson Research Merit Award 2011 Fellow of the Royal Society	10/31	Workshop
R.P.H. Chang, (68)	Director, Materials Research Institute, Northwestern Univ.	Plasma Phys. Nanostructured C Sheets, Tubes and Molecules:	2008 MRS President 1987 MRS Fellow/Woody Award 2005 American Vacuum Soc. Fellow, NSF Director's Distinguished Teaching Scholar Award	11/6-7	Inspection
Hung-Duen Yang (52)	President, National Sun Yat-sen Univ.	Physics	Deputy Minister, National Science Council, ROC	11/22	Inspection

Duncan Moore (64)	Rudolf and Hilda Kingslake Prof., University of Rochester	Optical Eng., Biomedical Eng.	1999 National Eng. Award of AAES 2001 Optical Soc. America Leadership Award. 2006 Gold Medal of Intenal Soc.Opt.Eng. 2009 Edwin H. Land Medal	11/28	Seminar
Herbert Zeisel	Head of Division, New Materials, Nanotechnology, BMBF	New Materials, Nanotechnology		12/5	Inspection
Markus Niederberger (42)	Chair of the Lab. for Multifunctional Materials, ETHZ	Chemistry	2011 ISI list of the 100 most-cited materials scientists 2011 Fellow of RSC	12/17-22	Collaboration & Discussion
Ivan K Schuller (64)	Professor, UCSD	Superlattices, Nanostructures Vortices Org. Semi -conductors Insulating Thin Films	1999 Wheatley Award APS 2000 Alex. von Humboldt Prize 2003 Adler Award APS, MRS Medal 2004 Lawrence Award 2008 U.S.&Belgian Phys.Share Somiya Award	12/17-22	Collaboration & Discussion
Bernard Chenevier	Director of Research, Director of LMGP, CNRS			12/20	Inspection
Pierangelo Groening (52)	Head, Dept 'Adv. Mat. & Surfaces' Empa	Surface, Plasma Tech., Adhesion & Friction Photoemission Spectr, REM		1/29	Inspection
George Bednorz (62)	IBM Fellow	Physics	1987 Nobel Prize in Phys.	2/24-3/2	Symposium
Nazario Martin (56)	Vice-director, Inst. for Adv. Studies in Nanoscience of Madrid	Molecular Science, Supramolecular chem. of C nanostructures	2006-2012 President of Spanish RSChem. 2007 DuPont Prize 2012 Gold Medal and Research Award 2012 Jaime Award, EuCheMS Lecture Award	2/25	Inspection
Zhong-Lin Wang (51)	High tower chair of Mat. Sci. & Eng. Georgia Inst. of Tech.	Ph.D., Nanoscience and nanotechnology	2001 S.T. Li prize 2000 Georgia Tech Faculty Res. Award 1999 Burton Medal 1998 U.S. NSF CAREER award	2/27-3/1	PI
Andrew A. Gewirth (53)	Univ. of Illinois Director, School of Chemistry	Structure, reactivity of surfaces & interfaces	1993 Alfred P. Sloan Fellowship 1993 DOE Outstanding Accomplishment in Materials Science 1991 Fellow, UIUC Center for Advanced Study	2/26-3/1	Symposium

Nate Lewis (60)	George L. Argyros Professor of Chemistry, CalTech	Artificial photosynthesis	1990 Fresenius Award 1991 ACS Award 2003 Princeton Environmental Award 2008 Michael Faraday Medal of RSE	2/26-27	Symposium
Buddy Ratner (67)	Michael L. & Myrna Darland Endowed Chair in Technology Commercializati on University of Washington	Biomaterials and regenerative medicine	2004 Founders Award 2006 C. William Hall Award 2008 BMES Pritzker Distinguished Lecturer Award 2009 Acta Biomaterialia gold medal 2011 Pierre Galletti Award	2/26-3/1	Symposium
Anthony K. Cheetham, FRS (67)	Goldsmiths' Professor of Materials Science, Univ. of Cambridge	Functional Inorganic and Hybrid Materials	1982 Corday-Morgan Medal & Prize of RSC 1988 Solid State Chemistry Award of RS 1994 Fellow of the Royal Society 2011-present Vice President, Royal Society	2/27-3/5	Chair of Evaluation Committee
Samuel Stupp (62)	Director, Inst. for Bionanotech. in Medicine, Northwestern University	Self-assembling org. mat., Focusing on functions relevant to Energy and Medicine	2012 ACS Ronald Breslow Award 2011 Thomson Reuters Top 100 Chemists for 2000-2010 2009 Fellow, Materials Research Society	2/27-3/1	Symposium
Rodny Ruoff (53)	Cockrell Family Regents Chair , University of Texas at Austin	Energy &Environment Novel mterials, Tech. trans. Tools &method for Biomedical Science.	16th most cited materials scientist of top 100 most cited(2000-2010) Fellow, MRS Fellow, APS Fellow AAAS	2/28-3/5	Evaluation Committee Member
Michelle Y. Simmons (45)	Director of the Atomic Fabrication Facility, Univ. of New South Wales	Materials drivers for high tech IT, communications and sensor applications	Advisory Board of ACS Nano Letters & Nanotechnology; Australian Res. Council Federation Fellow 2012 NSW Scientist of the Year	2/28-3/1	Symposium
Geoff Stevens	Associate Dean of Chem. & Biomolecular Eng. The University of Melbourne	Particularly solvent extraction, interfacial phenomena and emulsion stability	2005 ExxonMobil Award of Excellence in Chem. Eng. 2003 Fellow of the Australian Acad. Tech. Sci. & Eng	3/6	Inspection
Kenneth J Shea (66)	Regents Faculty Fellow University of California Irvine	Synth. Organic polymer Mat. Chemistry	NIH Senior International Fellow, Winston Churchill College Overseas Fellow, Fellow of the American Association for the Advancement of Science, Arthur C. Cope Scholar Award	3/14-20	Workshop

State of Outreach Activities

- Using the table below, show the achievements of the Center's outreach activities in FY2012 (number of activities, times held).
- Describe those activities that have yielded novel results or that warrant special mention in the "Special Achievements" space below.
- In appendix 7, list and describe media coverage (e.g., articles published, programs aired) in FY2012 resulting from press releases and reporting.

Activities	FY2012 (number of activities, times held)
PR brochure, pamphlet	5
Lectures, seminars for general public	7
Teaching, experiments, training for elementary and secondary school students	12
Science cafe	1
Open houses	2
Participating, exhibiting in events	2
Press releases	21
Research Highlight	3

〈Special Achievements 〉

Program for High School Students

In August, we hosted the JST-sponsored Summer Science Camp, a hands-on retreat for high school students interested in science and technology. Based on the theme "Experience the Nano-World First Hand", students conducted observations using a transmission electron microscope and a scanning electron microscope and engaged in nano-manufacturring in a clean room. MANA produced an original, easy-to-understand textbook for the camp and distributed it to the participants. By joining the camp, the high school students deepened their interest in science.

MANA planned and implemented this year's WPI Joint Symposium, which was held in Tsukuba in November. We visited local high schools to ask their students to attend and successfully developed a network of local high school science teachers.

At MANA, we operate events that tend to be one-off activities with care to help create a knock-on effect. For example, some of the students who participated in the aforementioned Summer Science Camp also attended the WPI Joint Symposium. In addition, some of our foreign researchers went back to the high schools we visited to give JSPS "Science Dialogue" lectures.

Publication of "MANA's Five-year Journey"

On the occasion of MANA's 5th anniversary, we created English and Japanese booklets outlining the first five year's of MANA. To pique our readers' interest, we designed the booklet around the concept of a "MANA Exhibit", and we introduced each research finding and activity over the past five years as pieces in the exhibit. We created a CD-ROM of the English version and used our global network to distribute it far and wide.

Development of e-Book

To provide an easy-to-understand explanation of the work "Blood diagnosis using smart polymers", one of the research outcomes of the Nano-Life field, we created an animated video showing how antibodies capture viruses that have infected the body and how antibody-smart polymer conjugates purify and enrich the captured viruses. We used these as part of an e-book for high school students, and it garnered much praise at the Science and Technology Festa held in Kyoto in March.

Publication of the Newsletter

We publish a newsletter called CONVERGENCE three times a year and distribute 3,500 copies worldwide. After conducting a reader survey, we found the newsletter was much more popular overseas and that our readers particularly liked the section on research findings.

Other

・We co-sponsored an idea contest for high school students called "Challenge the Future" with AIMR.
・We hosted a booth at the 2013 AAAS Annual Meeting.
・We upgraded the official MANA homepage.

FY 2012 List of Project's Media Coverage

- Select main items of coverage, and list them within these 2 pages.

No.	Date	Type media (e.g., newspaper, television)	Description
1	2012.04.02	Asahi Shimbun	The column "extreme technologies to handle minimization" introduced the development of a mono-molecular wiring method by a MANA scientist. (Yuji Okawa)
2	2012.04.05	Yomiuri Shimbun	Development of new mesoporous materials that increase the cesium absorption ratio. (Katsuhiko Ariga, Yusuke Yamauchi)
3	2012.04.10	Kagaku Kogyo Nippo	Development of magnesium alloys with medical bio-absorptive properties. (Akiko Yamamoto)
4	2012.04.30, 2012.05.15	Nikkan Kogyo Shimbun, Nikkei Sangyo Shimbun	Successful observation of solid-electrochemical reaction with atomic resolution enabled by doping of metal ions into a super-ionic conductive material. (Tsuyoshi Hasegawa)
5	2012.05.09, 2012.05.10, 2012.08.28	Nikkan Kogyo Shimbun, Nikkei Sangyo Shimbun, Mainichi Shimbun	Fabrication of New Elastic "Soft Capsule" using Nano-sized Flakes (Katsuhiko Ariga)
6	2012.05.24	Nikkei Sangyo Shimbun	Development of a new type of devices, where inorganic synapses mimic the human brain. (Tsuyoshi Hasegawa)
7	2012.06.07, 2012.06.08	Nikkei Sangyo Shimbun, Nikkan Kogyo Shimbun	Development of Hybrid Porous Scaffold for Bone Regeneration (Guoping Chen)
8	2012.07.06, 2012.07.06, 2012.07.07	Nikkei Shimbun, Nikkei Sangyo Shimbun, Ibaraki Shimbun	NanoGREEN/WPI-MANA Building has been completed.
9	2012.07.27 2012.08.27	Nikkei Sangyo Shimbun	Practical use of the thermo-electric effect in new materials: Research to increase the efficiency of electricity generation from wasted heat and solar cells. (Takao Mori)
10	2012.08.09, 2012.08.10	Kagaku Kogyo Nippo, Kagaku Shimbun	Successful Development of Nanosheets Film Capable for Safe and Highly Effective Gene Transfection into Cells (Qingmin Ji, Tomohiko Yamazaki)
11	2012.08.28	Mainichi Shimbun	Fabrication of New Elastic "Soft Capsule" using Nano-sized Flakes (Qingmin Ji, Katsuhiko Ariga, et al.)
12	2012.09.17 2012.09.19	Nikkan Kogyo Shimbun, Tekko Shimbun	First Success in Development of Novel Alloy Catalyst with Perfectly Intermixing of Atoms Contributing to Improved Efficiency of Residential-Use Fuel Cells (Kohei Uosaki)
13	2012.09.23	Yomiuri Shimbun	Development of "Matrix" Material Controlling Differentiation of Stem Cells (Guoping Chen)

14	2012.9.28	SCIENCE VOL 337	In the column "Satellite Labs Extend Science" in SCIENCE, Dr. Yaghi was featured about a new type of laboratories, where emerging nations seek access to world-class researchers (Omar Yaghi)
15	2012.10.05, 2012.10.18	Kagaku Shimbun, Nikkan Kogyo Shimbun Kagaku Kogyo Nippo	Success in Development of Metal Oxide Film Transistor Necessary in Device Control (Kazuhito Tsukagoshi, Toshihide Nabatame, Keiichi Yanagisawa, RIKEN et al.)
16	2012.11.02	Nikkei Sangyo Shimbun	Development of LED fluorescent materials in the "deep-green" wavelength region based on germanium nanocrystals. (Naoto Shirahata et al.)
17	2012.10.18, 2012.10.19	Mainichi Shimbun Joyo Shimbun, Yomiuri Shimbun,	Dr .Yamauchi received the Tsukuba Encouragement Prize for young researchers (Yusuke Yamauchi)
18	2012.11.16 2012.11.23 2012.11.27	Nikkan Kogyo Shimbun, Kagaku Shimbun, Nikkei Sangyo Shimbun	On-Demand-Type Device with Switchable Functions Responding to the User's Needs (Yang Rui, Kazuya Terabe, James Gimzewski, Masakazu Aono)
19	2012.12.11 2012.12.13	Nikkan Kogyo Shimbun Kagaku Kogyo Nippo	Development of Novel Conduction Control Technique for Graphene (Kazuhito Tsukagoshi)
20	2012.12.21 2012.12.22	Asahi Shimbun, Yomiuri Shimbun Nikkei Shimbun, NHK Shutoken Network, et al.	Millimeter-level naked-eye detection of Cesium location at solid surface (Katsuhiko Ariga)
21	2013.01.14	Academic Newtown Community Cable Service(ACCS, local CATV service in Tsukuba Science City)	Dr. Yamauchi is highlighted on ACCS. He sent messages to new adults having their coming-of-age ceremony (Yusuke Yamauchi)
22	2013.01.20	Yomiuri Shimbun	Dr. Tsukagoshi received the JSPS Prize. (Kazuhito Tsukagoshi)
23	2013.01.23 2013.02.01	Nikkan Kogyo Shimbun Kagaku Shimbun	Success in Theoretical Design of Photocatalyst Enabling Mass Production of Hydrogen (Jinhua Ye)
24	2013.02.07 2013.03.01	Kagaku Kogyo Nippo Kagaku Shimbun	Development of High Sensitivity Detection Method for Diluted Ionic Mercury in Water (Tadaaki Nagao)
25	2013.02.11 2013.03.05 2013.03.22	Asahi Shimbun Nikkan Kogyo Shimbun Kagaku Shimbun	Novel Drug Delivery System Releases Drugs in Response to Compression by the Patient's Hand (Katsuhiko Ariga)
26	2013.02.19	Nikkei Shimbun	Fabrication of fullerene based cubic materials with the potential to create organic thin film solar cells (Katsuhiko Ariga)
27	2013.03.16	CBC (Canadian Broadcasting Corporation)	"The Nano Revolution: Will Nano save the Planet?" NHK Documentary, Broadcast by CBC (James Gimzewski)
28	2013.03.28	Nikkan Kogyo Shimbun	Discovery of New Gigantic Swelling Phenomenon of Layered Crystal Driven by Water (Takayoshi Sasaki)