

World Premier International Research Center Initiative (WPI)

FY2011 WPI Project Progress Report (Post-Interim Evaluation)

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Research Center	International Center for Materials Nanoarchitectonics (MANA)	Center Director	Masakazu Aono

Summary of State of WPI Center Project Progress (write within the space of this page)

Research of the world's highest level: The following selection from among our research accomplishments represents the vanguard of nanotechnology and materials science: A) Revolutionary nanomaterials created by "nanosheet technology", B) Novel "low-dimensional" superconductors, C) Nano-power generation/conversion/storage nanomaterials and systems, D) Boron nitride (BN) "white" nanotubes and nanosheets, E) Revolutionary nanodevices, F) Novel nanoscale characterization/analysis methods, G) Nano-life related materials research, H) Theoretical nanoscience. Although the research at MANA is conducted in the four research fields of Nano-Materials, Nano-System, Nano-Green and Nano-Bio, most of the foregoing research results from collaborative studies in two or three different research fields.

Fusion of various research fields: In order to promote research fusion at MANA, we have set up funding programs such as our Grand Challenge Research Program and Inter-field Projects. The latter specifically aims to enhance the interaction between nano-bio and other fields, and theory and experimentation. MANA researchers are involved in eight of the 11 NIMS InterUnit Seeds Development Research Grants of FY2011. To bring together researchers from different fields, MANA holds frequent seminars and a Grand Challenge Meeting once or twice a year. These meetings have proven to be highly beneficial in the fusion of various fields and in motivating young researchers to tackle new challenges.

Globalization: The Center employs 206 researchers, of which 116 or 56% are foreign nationals. Despite the Great East Japan Earthquake and subsequent nuclear power plant incident, the percentage of foreign researchers has not changed. To strengthen Nano-bio programs, Prof. Francoise Winnik of the University of Montreal was appointed a Principal Investigator in April 2011. To promote the unique concept of nanoarchitectonics and raise MANA's profile, two special issues on MANA were published in *Advanced Materials* and *Science and Technology of Advanced Materials*, and MANA began announcing its research worldwide with the launch of its English newsletter the *MANA Research Highlight*.

Organizational reforms: MANA's role in promoting some of the NIMS system reforms is clearly positioned in NIMS' third five-year plan. The item "building international networks and bases for international research" states that MANA's "experience in developing an international research environment and recruiting and training young researchers will be reflected in NIMS' internationalization efforts made as a whole."

The center's future development over the mid- to long term: MANA was formally incorporated into one of the three priority R&D fields within NIMS' third five-year plan, and has become one of NIMS' research divisions. When the next five-year plan commences, MANA will continue to function as a core research division in charge of one of NIMS' strategic research fields and maintain the overall 200-strong body of researchers including between 80 and 90 of MANA's PIs, MANA Scientists and Independent Scientists. After the WPI funding period ends, MANA will receive operations subsidies from NIMS and its researchers will seek out external funding in order to maintain the Center's size and level of research activity.

1. Conducting research of the highest world level

We take pride in our having conducted world-class materials research in the five years that have passed since MANA was launched. Our materials research covers a wide sweep of programs from basic studies to advanced applications. Also, we regard theoretical/computational research and the development of novel research equipment as important activities. All research is conducted on the basis of “materials nanoarchitectonics”, which we regard as an essentially important concept for new materials development. The high quality of our research is reflected in the various parameters presented later in the supplementary materials in the appendices.

The following is a brief description of MANA accomplishments. MANA conducts research in the four fields of Nano-Materials, Nano-System, Nano-Green and Nano-Bio. Most of the projects below represent the outcome of studies bridging several different research fields.

A) Revolutionary nanomaterials created by “nanosheet technology”

MANA has developed a unique method to create novel materials, which is now well known as “nanosheet technology”. The method consists of exfoliating layered compounds into unilamellar nanosheets and re-stacking the nanosheets in a designated order to create a new material with a novel characteristic. By this method, we have created numerous revolutionary nanomaterials, a few of which are shown below.

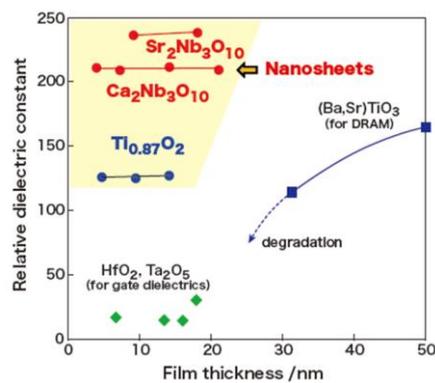
a. *World’s-highest-dielectric-constant thin films*

We have developed $\text{Sr}_2\text{Nb}_3\text{O}_{10}$ and $\text{Ca}_2\text{Nb}_3\text{O}_{10}$ nanosheet films with a thickness of about 10 nm. They demonstrate the world’s highest dielectric constant of more than 200. These materials hold promise as a gate insulator of future field effect transistors (FETs) (Fig.1).

b. *Surprising ferroelectric ultrathin films*

The LaNb_2O_7 and $\text{Ca}_2\text{Nb}_3\text{O}_{10}$ nanosheet films are usually paraelectric,

but, surprisingly enough, their hetero-assembled (superlattice) film becomes ferroelectric. This behavior may be ascribed to the formation of soft interface between the two different nanosheets, resulting in loss of centrosymmetry.



M. Osada et al., *Adv. Funct. Mater.* 21 (2011) 3482.

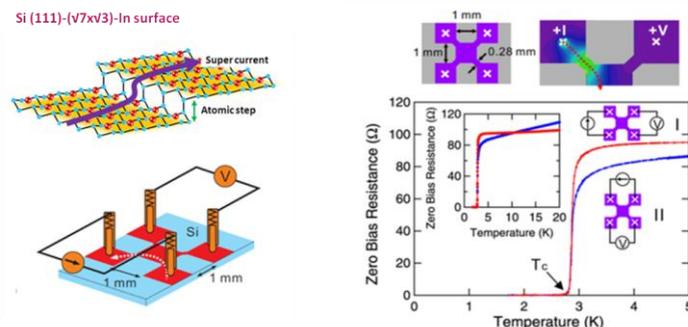
Fig. 1 Revolutionary nanomaterials created by “nanosheet technology”.

B) Novel “low-dimensional” superconductors

We have discovered various novel superconductors. Three examples are shown below.

a. *World’s first observation of surface macroscopic superconducting current*

Macroscopic superconducting current through a solid surface has been observed for the first time. Namely, the (111) surface of silicon modified with a small amount of indium, i.e. the $\text{Si}(111)\sqrt{7}\times\sqrt{3}\text{-In}$ surface, allows superconducting current to flow over a millimeter distance. This is surprising because numerous atomic steps existing on the surface do not disturb the transport of Cooper pairs of electrons. Systematic measurements of critical current and further analysis suggest that each surface atomic step works as a Josephson junction (Fig. 2).



T. Uchihashi et al., *Phys. Rev. Lett.* **107** (2011) 207001.

Fig. 2 Novel "low-dimensional" superconductors.

b. Flexible fibriform superconductor

We have developed flexible fibriform nanowhiskers made of C_{60} molecules. The C_{60} nanowhiskers can be doped with potassium (K) by heating the nanowhiskers in the vapor of K. Interestingly, a Meissner effect is observed for the K-doped C_{60} nanowhiskers at temperatures below about 15 K, indicating that the nanowhiskers are superconducting below the temperature.

c. Ultrathin film superconductor

Recently, we have discovered $FeTe_{1-x}Se_x$, a superconductor with a superconducting temperature (T_c) of about 15 K. Interestingly, even when the material is in the form of an ultrathin film with a thickness as small as 20 nm, T_c is unchanged as compared with bulk $FeTe_{1-x}Se_x$.

C) Nano-power generation/conversion/storage nanomaterials and systems

One of the main concerns of MANA is the generation/conversion/storage of "power" at the nanoscale, where the term "power" represents "usable energy". We have developed various nanomaterials and nanosystems for this purpose. Here are several examples of this cutting-edge technology.

a. World's highest photo-catalytic efficiency

A new material was developed by incorporating phosphor (P) block element into a simple silver oxide (Ag_2O) with a narrow band gap. The new photocatalytic material, Ag_3PO_4 , demonstrates an extremely high quantum yield ($\sim 90\%$ for photons with a wave length of ~ 420 nm) regarding water oxidation as well as organic contaminates decomposition under visible light. This study not only supplies a new strategy for developing visible-light-driven photocatalysts, but also shows a giant step toward realizing an artificial photosynthetic system.

b. Nanogenerators for self-powering nanosystems

We have developed a simple and effective approach called the scalable sweeping-printing-method for fabricating a flexible high-output nanogenerator (HONG) that can effectively harvest mechanical energy for driving a small commercial electronic component. The HONG consists of two main steps. In the first step, the vertically-aligned ZnO nanowires (NWs) are transferred to a receiving substrate to form horizontally-aligned arrays. Then, parallel stripe type electrodes are deposited to connect all of the NWs together. Using a single layer of HONG structure, an open-circuit voltage of up to 2.03 V and a peak output power density of ~ 11 mW/cm² have been achieved. The generated electric energy was effectively stored utilizing capacitors, and it was successfully used to light a commercial light-emitting diode (LED), landmark progress toward building self-powered devices by harvesting energy from the environment.

D) Boron nitride (BN) “white” nanotubes and nanosheet

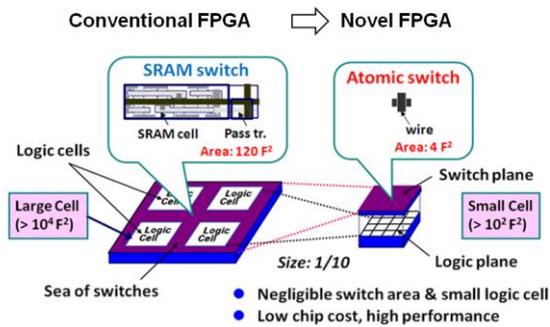
We have studied how to prepare boron nitride (BN) nanotubes and nanosheet (monomolecular layer) and have measured their physical properties comprehensively by transmission electron microscope (TEM). BN nanotubes and nanosheet are similar to carbon nanotubes and graphene in structure, but their electrical is far less than carbon nanotubes and graphene; we therefore call them “white” nanotubes and graphene. Recently, we have developed a new BN nanosheet synthesis process which we call “chemical blowing”. The nanosheet with thickness of 1-2nm can be created with high yield. We have also found that BN nanotubes have a high tensile strengths (~50 times stronger than steel) and BN nanosheet (“white” graphene) is a semiconductor.

E) Revolutionary nanodevices

MANA has developed various novel devices for the innovation of information and communication technology and has succeeded to materialize several new promising atomic, molecular and quantum devices as follows.

a. Atomic switches as “Beyond CMOS” memory and logic devices

The atomic switch is a unique switching device developed by MANA. Compared with the conventional CMOS transistor switch, the atomic switch is characterized by a nonvolatile character, simple structure, small size and low power consumption. In collaboration with NEC Corp., we have studied the use of atomic



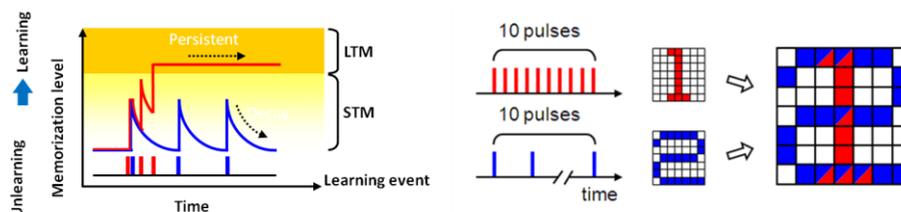
E.g., T. Hasegawa et al., *Adv. Mater.* 24 (2012) 252.

Fig. 3 Practical application of atomic switches to materialize compact FPGA.

switches to fabricate a compact and high-performance field-programmable gate array (FPGA) and reached the technological level necessary for commercialization (Fig. 3).

b. Atomic switches for neuromorphic computational network circuits

Memory is believed to occur in the human brain as a result of two types of synaptic plasticity: short-term plasticity (STP) and long-term potentiation (LTP). STP is achieved through the temporal enhancement of a synaptic connection, which then quickly decays to its initial state. However, repeated stimulation causes a permanent change in the connection to achieve LTP; shorter repetition intervals enable efficient LTP formation from fewer stimuli. Development of artificial (inorganic) synapse that emulates the STP and LTP behaviours is the key-issue in the realization of the Brain-type computer, which we have achieved using an Ag₂S-based gap-type atomic switch (Fig. 4). Namely, pulse input with a lower repetition rate only caused the temporal increase in conductance, corresponding to the STP-mode. Conversely, pulse input with a higher repetition rate achieved a persistent transition to the higher conductance state, corresponding to the LTP mode. The synaptic behaviours are useful for developing artificial neural networking systems made of all solid-state devices, which do not require any pre-programming. Preliminary studies have been made with promising results.

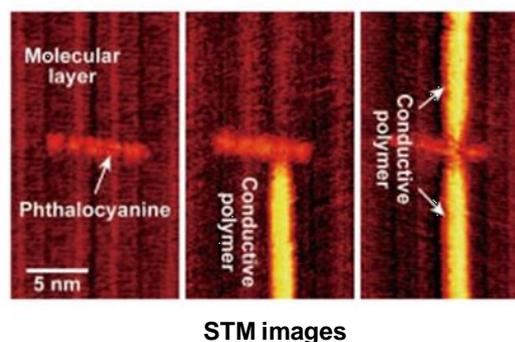


T. Ohno et al., *Nature Mater.* 10 (2011) 591.

Fig. 4 Application of synaptic characteristics of atomic switch.

c. Novel molecular devices

We have found the following surprising fact for a C_{60} thin film. Two adjacent C_{60} molecules at any designated position in the film can be chemically bound into a dimer by the tip of the scanning tunneling microscope (STM), and moreover, if the polarity of voltage applied to the tip is reversed, the C_{60} dimer is dissociated reversibly. As an application of this phenomenon, we have demonstrated ultradense data storage with a bit density of 190 Tbit/in².



Y. Okawa et al., *J. Am. Chem. Soc.* 133 (2011) 8227.

Fig. 5 Novel molecular devices toward single-molecular electronics

We have developed a method to create a single conductive linear polymer chain (polydiacetylene) at designated positions by initiating chain polymerization of monomers (diacetylene) with a scanning tunneling microscope (STM) tip. Using this method, we have studied construction of a two-terminal nanowiring for a single phthalocyanine molecule and have succeeded in making nanowiring through chemical soldering or firm covalent bonding (Fig. 5).

d. Novel quantum devices

MANA has developed a superconductor-based light emitting diode (LED). In this LED, electron Cooper pairs in a superconductor recombine with normal holes in a semiconductor emitting quantum-mechanically entangled photon pairs. This LED is expected to be the key device in quantum information technology because of its promising giant oscillator strength due to the large coherence volume of the superconducting pairs together with the possibility of the on-demand generation of entangled photon pairs.

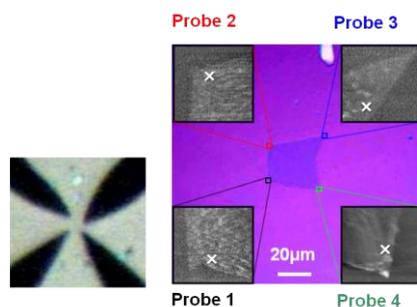
We have also developed an ultimate superconducting quantum interference device (SQUID), i.e. a nano-SQUID, which can detect even single or several spins. We have clarified the quantum interaction between a nano-SQUID with embedded quantum dots and spins in the quantum dots. This leads to the implementation of an entangled state between a superconducting qubit and spin qubit. The combination of these qubits is a promising candidate for a quantum interface that will be indispensable in the future quantum information network.

F) Novel nanoscale characterization/analysis methods

a. Multiple-probe scanning probe microscopes

We have been conducting a series of pioneering work for the development of multiple-probe scanning tunneling microscopes (MP-STMs) and atomic force microscopes (MP-AFMs). Recently, we have developed a

quadruple-probe AFM (QP-AFM) in which four conductive AFM probes are operated independently and simultaneously in frequency modulation mode using tuning-fork type sensors. By using this QP-AFM, we have succeeded to make four-probe measurement of the electrical conductivity of a flake of graphene put on an insulating substrate (SiO_2) (Fig. 6).



T. Nakayama et al., *Adv. Mater.* 24 (2012) 1675.

Fig. 6 Four-probe measurement of the resistivity of a single layer graphene

b. *Novel ultrasensitive/ultraparallel molecular sensors*

We have developed a membrane-type surface stress sensor (MSS), which is useful for high-sensitivity sensing of various analytes ranging from gaseous to biological molecules. The analyte-induced isotropic surface stress on the membrane is efficiently transduced onto the piezoresistive beams as an amplified uniaxial stress. Experimental evaluation of a first prototype MSS demonstrates an ultrahigh sensitivity which is more than 20 times higher than that of a standard piezoresistive cantilever and comparable to that of optically read-out cantilevers. To demonstrate the capability of MSS for ultraparallel sensing, we have microfabricated a 2D array of MSS. By using this 2D MSS as a gas sensor, we succeeded in “visualizing smells” in real-time by converting signals from each channel in the 2D array into colored-pixels of the “picture.”

G) Nano-life related materials research

a. *Novel bioimaging method*

Using the surface modification technique, several types of nanoparticles were prepared for bioimaging. Er-doped yttrium oxide ($\text{Er:Y}_2\text{O}_3$) nanoparticle emits not only near infrared (NIR) light but visible light under NIR excitation. The latter emission is called infrared-to-visible upconversion (UC) emission. Poly(ethylene glycol) (PEG)-based PEG-b-poly(vinylbenzyl phosphoric acid) (PEG-b-PVBP) stabilized the UC-nanoparticle, which can be utilized as near-infrared bioimaging tools. PEG-b-PVBP also stabilized ion oxide and can be utilized in vivo. Ion oxide nanoparticles thus prepared can be utilized as an MRI imaging probe as well as magnetite-assisted hyperthermia.

H) Theoretical nanoscience

a. *Manipulation of quantum entanglement of nonlocal electron pairs*

We propose to measure Josephson current which is purely contributed from entangled electron pairs, by either co-tunneling or split-tunneling. In order to figure out how much split Cooper pairs contribute to the total Josephson current, the oscillation of maximal Josephson current is detected with response to the magnetic flux applied through the area enclosed by the two paths. When the contribution from split Cooper pairs equals to that from co-tunneling ones, the oscillation period is $2\Phi_0$, whereas it should be Φ_0 without split tunneling. This measurement gives an unambiguous evidence for the nonlocal quantum entanglement of electrons.

b. *Topological-superconductor Majorana-particle quantum bit system*

In a heterostructure consisting of a superconductor, semiconductor with large spin-orbit coupling and ferromagnetic insulator, if an odd number of fluxes exist in the superconductor, Majorana particles appear in the flux cores and at the edge of the superconductor. If we connect three such heterostructures through a

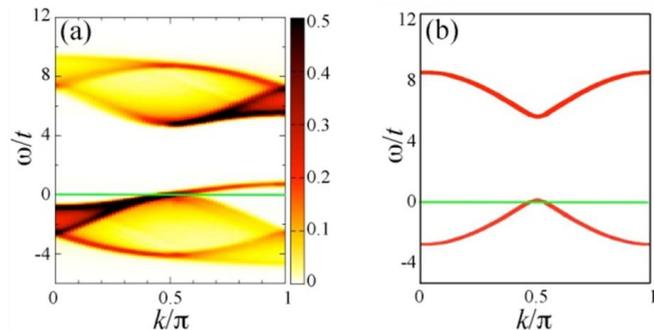
gated pathway, we can control the exchange of Majorana particles between the heterostructures, so that we can make non-Abelian quantum bit operation.

c. Mass-less Leggett mode in three-band superconductors

The Leggett mode associated with out-of-phase oscillations of the superconducting phase in multiband superconductors usually is heavy due to interband coupling, which makes its excitation and detection difficult. We found the existence of a massless Leggett mode in three-band superconductors with time-reversal-symmetry breaking. The mass of this Leggett mode is small close to the time-reversal-symmetry-breaking transition and vanishes at the transition point, and thus locates within the smallest superconducting energy gap, which makes it stable and detectable, e.g., by means of the Raman spectroscopy. The thermodynamic consequences of this massless mode and possible realization in iron-based superconductors also attract our attention.

d. Loss of charge character in Mott transition

By using exact solutions and numerical simulations, single-particle spectral properties near the Mott transition are investigated in the one-dimensional Hubbard model. The results show pseudogap, hole-pocket behaviors, anomalous spectral-weight transfer, and the upper Hubbard band, which are reminiscent of anomalous features



M. Kohno, *Phys. Rev. Lett.* **108** (2012) 076401-1.

Fig. 7 Theoretical studies of Loss of charge character in Mott transition

observed in cuprate high- T_c superconductors. In contrast with conventional metal-to-band-insulator transitions, the Mott transition turned out to be characterized as a loss of charge character from the mode having both spin and charge characters, while the spin part remains almost unchanged. Or, from the insulating side, the Mott transition is characterized by the emergence of a gapless mode whose dispersion relation extends up to the order of hopping integral t [spin exchange J] in the weak [strong] interaction regime (Fig .7).

2. Advancing fusion of various research fields

Since the start of MANA of five years ago, we have regarded the fusion of different research fields as a key to accomplish advanced research. MANA's research organization consisting of four research fields itself is designed so as to promote the fusion of different research fields. Namely, generally speaking, basic research in Nano-Materials and Nano-System fields is fused to application research in Nano-Green and Nano-Bio fields. We believe this scheme has worked considerably well particularly over the past two years. 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.

In order to promote research fusion at MANA, we have established a variety of programs.

The MANA Grand Challenge Research Program was launched in FY2011 as a way to encourage researchers to undertake innovative, "outside-the-box" interdisciplinary research not only limited to materials science. This initiative sought applications for risky yet challenging topics that matched the concept of nanoarchitectonics; seven applications were accepted.

MANA Seminars have been held on a frequent basis since our inception. At these seminars, researchers

from both within and outside MANA present hot research topics and engage in discussions with MANA researchers of different fields. Thus, each seminar comes into its own as a true "melting pot." As a result, the seminars play a key role in promoting field integration.

Once or twice a year, MANA holds a "camp"-type approach called "Grand Challenge Meetings." About twenty MANA researchers are selected from among those who are 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. We have observed that this meeting proves remarkably useful for triggering fusion research between MANA's scientists in different research fields.

Furthermore, we launch inter-field projects to promote more joint research among the four fields including those developing interaction between nano-bio and nano-materials/nano-system, and theory and experiment. With the same objective in mind, MANA's host institution, NIMS, began the InterUnit Seeds Development Research Grants in FY2011, and MANA researchers are currently involved in eight of the 11 projects initially selected.

At MANA, various interesting fusion studies have been carried out. The following section introduces three examples of ongoing fusion research that is attracting attention.

1) Fusion research between nanobiology and nanotechnology

This is a shining example of fusion research in MANA. Prof. Winnik of the University of Montreal is an authority of near-infrared (IR) in-vivo bioimaging. She became a PI at MANA a year ago. After arriving, she recognized that fusing research with Dr. Naoto Shirahata (who developed novel nanoparticles that are active in near-IR region) and Dr. Tadaaki Nagao (who has made advanced studies of plasmonic nano-antenna in the near-IR region), could open the way to development of a new method of highly-sensitive near-IR in-vivo bioimaging. Already, a close collaboration has started.

2) Fusion research between theoretical nanoscience and nanotechnology

Dr. Xiao Hu, a MANA PI, recently made the following theoretical prediction which is attracting great 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, a MANA scientist, has observed macroscopic superconducting current through a certain solid surface (a Si surface modified with a small amount of In) for the first time. If these two studies are fused, the quantum bit without decoherence mentioned above will be materialized relatively easily.

3) Fusion research between fuel cell technology and nanoelectronic device technology

MANA maintains its own nanofabrication facilities, the MANA Foundry. Well equipped with fabrication and analytical equipment, the foundry's clean rooms provide a comprehensive nanofabrication environment for nearly all kinds of research in-house. The head of the MANA Foundry, Dr. Toshihide Nabatame, has much experience in various kinds of nanofabrication. Dr. Daniele Pergolesi, a MANA scientist who has studied solid oxide fuel cells extensively, recently reported the world's highest value of proton conductivity in his $\text{BaZr}_{1-x}\text{Y}_x\text{O}_{3-y}$ sample. Dr. Nabatame has used this sample to fabricate a novel non-volatile field effect transistor demonstrating promising preliminary results. This is the outgrowth of the MANA Fusion Research Program launched in FY2009.

3. Globalization of the institution

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

As of March 31, 2012, the Center employs 206 researchers, of which 116, or 56%, are foreign nationals. 45 of these researchers, or 22%, are women.

Due to the Great East Japan Earthquake and subsequent nuclear power plant incident, approximately 2/3 of the research staff evacuated Japan temporarily, but almost all of them returned to MANA so the percentage of foreign researchers has not changed.

That being said, the number of foreign researchers visiting MANA fell drastically for a period of time after the disaster. In the first half of FY2011, visitor numbers fell by one-third year-on-year, and the decrease in visitors from Europe and the United States was nearly 90%. Visitor numbers have been recovering in the second half of the year.

To strengthen Nano-bio, Prof. Winnik from the University of Montreal was appointed as a Principal Investigator in April 2011. Prof. Winnik is a world-renowned researcher in the fields of polymer science, interfacial chemistry and nanoscience, and she serves as the Executive Editor of *Langmuir*, the journal of the American Chemical Society. Concurrent with her appointment, a new satellite was established at the University of Montreal. Prof. Winnik has labs at both MANA and the University of Montreal, and her teaching load was reduced to zero to allow her to focus her energies entirely on research. In FY2011, Prof. Winnik spent 146 days conducting research at MANA. Going forward, she plans to spend approximately five months out of the year conducting her research at MANA.

One of MANA's missions is to become a hub and build a network connecting the world's nanotechnology centers. In FY2011, the Center concluded new MOUs with six foreign research institutes, bringing the total number of MOUs to 36. The Center holds workshops with these institutes and engages in joint research and personnel exchange with them.

MANA Research Workforce (as of March 31, 2012)

Position	Number	Non-Japanese	Female
Principal Investigators	25	10	2
MANA Scientists	58	7	8
Independent Scientists	9	2	0
ICYS Researchers	11	8	1
MANA Research Associates	43	40	15
JSPS Fellows	16	12	3
Junior Researchers*	44	37	16
Total	206	116	45

*PhD Students

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

In FY2011, special issues on MANA were published in two original journals, thereby publicizing the unique concept of nanoarchitectonics and raising MANA's profile. One was a special issue of *Science and Technology of Advanced Materials* (August 2011; impact factor: 3.226), a journal edited and published by MANA's host organization NIMS, and the other was a special issue of *Advanced Materials* (January 2012; impact factor: 10.880), a journal published by John Wiley & Sons.

In the past, MANA only issued domestic press releases on its excellent research results, but in FY2011 the Center began publicizing its research worldwide with an English newsletter called *MANA Research Highlight*. The newsletter, which contains English articles written by the former editor of *Nature Nanotechnology*, is distributed to over 4,000 media outlets and science journalists and to about 2,000 MANA mailing list members. Particularly outstanding research results are sent to 10,000 researchers around the globe via *Science* e-mail alerts. With these efforts, we are working to increase MANA's name recognition throughout the global science community.

- 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.

Under the 3D System, MANA Scientists and Independent Scientists receive mentoring from renowned researchers from foreign research institutes. They visit their mentors to obtain research advice and are encouraged to pursue independent research. This system is incredibly effective in producing international and interdisciplinary young researchers. In April 2011, two MANA Scientists and three Independent Scientists were promoted to Group Leader positions based on their achievements.

A new system will be launched in FY2012 in which outstanding young researchers under the age of 45 who have excellent future potential and can be expected to engage in activities equivalent to Principal Investigators are named Associate Principal Investigators. This is a career track position that can eventually lead to promotions to Principal Investigator or Group Leader, and the objective is to have young researchers undertake their research with higher goals in mind.

114 of the Center's 206 researchers are post-doc researchers and graduate students, of which 97, 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.

4. Implementing organizational reforms

MANA is clearly positioned and has an important role in NIMS' third five-year plan, which came into effect in April 2011, with regard to two of NIMS' four missions; namely, promotion of fundamental research and training and improved qualification of researchers. Furthermore, the item "building international networks and bases for international research" within the five-year plan states that MANA's "experience in developing an international research environment and recruiting and training young researchers will be reflected on internationalization efforts made by NIMS as a whole." Thus, MANA's role in promoting some of NIMS system reforms is clearly positioned in the five-year plan.

In terms of the recruitment and training of young researchers, the Independent Scientist and ICYS Researcher systems, in which researchers conduct independent research without belong to a specific group, have posted good results. In particular, the 3D System, which encourages young researchers to train abroad and pursue interdisciplinary research under the tutelage of top-tier mentors, has contributed greatly to developing global perspective in these researchers. NIMS also encourages young researchers to partake in long-term research abroad. It plans to extend the maximum length of research abroad from one to two years and has recently begun giving research abroad participants preferential treatment on their performance evaluations.

In addition, ICYS has proven successful as a system for selecting and training young outstanding post-doc researchers from around the world and handpicking the best candidates for permanent researcher positions at NIMS. In FY2011, seven ICYS Researchers competed for permanent positions at NIMS, and three were successful. This is an extremely high pass rate when considering that the rate of competition for publicly-offered positions is several dozen times higher. This is proof that ICYS functions very well as a tenure-track system that allows outstanding young researchers to gain experience conducting independent research in fixed-term positions.

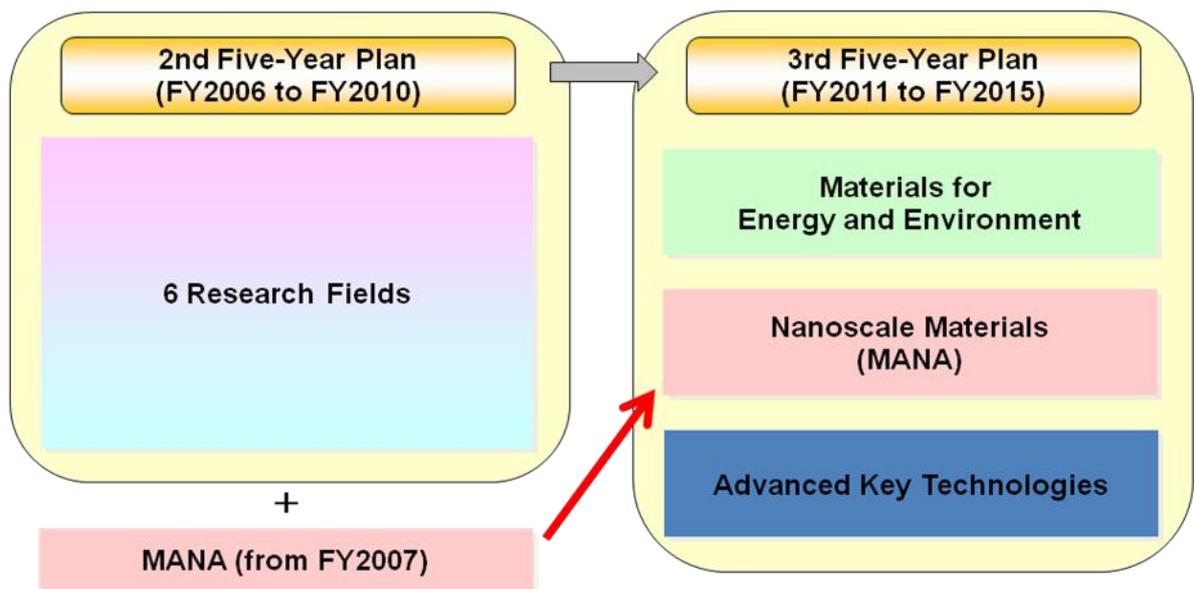
NIMS is working to make operating systems throughout the organization bilingual, and has made efforts to raise the English abilities of its administrative staff. Since FY2010, NIMS has been placing priority on hiring employees with strong English ability. NIMS also uses operations subsidies to provide English conversation lessons, correspondence education and overseas language training geared toward young permanent staff. Every year, staff members are required to sit TOEIC exams to check their language proficiency. A dramatic increase in the average score over the past two years, from 381 to 462, points to the effectiveness of this training.

These reforms show that the various system reforms and efforts to change employee awareness that MANA has implemented within its organization thus far are showing progressive penetration into the host institution.

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

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

MANA’s development of innovative new materials based on nanoarchitectonics was formally incorporated into one of the three priority R&D fields within NIMS’ third five-year plan, which came into effect in April 2011, and MANA has become one of NIMS’ research divisions. Research fields will also be reviewed in FY2016 when the next five-year plan commences, and MANA will continue to exist as a core research division in charge of one of NIMS’ strategic research fields.



MANA’s position in NIMS

Principal Investigator numbers will be kept around 20, and all PIs will be NIMS permanent researchers. As needed, young researchers may be appointed as PIs to invigorate the Center. MANA will continue using the networks it has developed during the WPI funding period to foster active exchange with research institutes around the globe. Overseas satellites will be established when deemed necessary.

The Associate PI, Independent Scientist and ICYS systems will be maintained since they are effective tools for the retention and training of young researchers. The 3D System for young researchers will also be maintained as an extension of the NIMS research abroad scheme.

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

Between 80 and 90 of MANA's PIs, MANA Scientists and Independent Scientists are already tenured NIMS researchers. We will maintain this number going forward as well as the overall 200-strong body of researchers, including post-doc researchers and graduate students. Personnel expenses for tenured researchers involved in MANA will be covered by NIMS operations subsidies, while external funding aside from operations subsidies will be used to hire post-doc researchers, graduate students and other fixed-term researchers.

One issue that remains is acquiring MANA operating expenses to cover personnel expenses for staff, expenses for the 3D System and other young researcher training programs, and expenses for symposia and other outreach events. MANA and its host institution NIMS will discuss those administrative duties that can be transferred to NIMS, all while ensuring that the level of activity in the Center does not decrease.

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

As mentioned earlier, after the WPI funding period ends, MANA will receive operations subsidies from NIMS and its researchers will seek out external funding in order to maintain the Center's size and level of research activity. However, since there is no prospect of increased operations subsidies, for MANA to maintain the same level of activity as a "World Premier International Research Center" will absolutely require a constant stream of external funding to the tune of at least 2 billion yen as well as the creation of a system for allocating those funds to post-doc researcher hiring and research project expenses.

6. Others

In March 2012, the construction of a new research facility (14,777m²) located next to the current MANA Building was completed. This new facility is comprised of two buildings, the WPI-MANA Building and the NanoGREEN Building, with MANA occupying the entire WPI-MANA Building and part of the NanoGREEN Building. With this, all of MANA's researchers are now concentrated in three adjacent buildings.

The new building was designed to promote interdisciplinary research. To transform the standard practice of researchers "putting up walls" and promote communication, partitions were used as little as possible in the offices and labs with glass partitions used only where necessary. On each floor, the office layout was designed so that researchers from two or three different fields, not just researchers in a single discipline, occupy the same space.

The glass-walled atrium connecting the WPI-MANA and NanoGREEN building also serves to encourage interaction among researchers. The Cafeteria on the first floor and the Interaction Spaces on the second

through fifth floors are expected to promote exchange both among MANA researchers and with visiting researchers and company engineers who gather in the NanoGREEN Building.

The Auditorium on the first floor of the WPI-MANA Building has a tiered theater with 97 seats, a large screen and the latest video projection equipment, and it will likely become a venue for lively discussions in workshops and seminars.

The transfer of offices and labs to the new buildings is scheduled to be completed by the summer of 2012.



Front façade of the new building

7. Center's response to interim evaluation

1) In comparison to other WPI centers, MANA's goals seem modest and not "earthshaking" outside of the material science community. It needs to create greater exposure outside of that field.

MANA is focusing its research resources on the three challenging, top priority research topics of neuromorphic computational circuits, room temperature superconductors and artificial photosynthesis.

The MANA Grand Challenge Research Program was launched in FY2011 as a way to encourage researchers to undertake innovative, "outside-the-box" interdisciplinary research not only limited to materials science. This initiative sought applications for risky yet challenging topics that matched the concept of nanoarchitectonics; seven applications were accepted. MANA will continue to provide financial assistance for groundbreaking research proposals.

2) Nano-bio is still not well adopted in MANA, in which "nanoarchitectonics" expertise is not intensively used. Further efforts are needed to advance highly competitive research subjects, e.g., nano-DDS and drug-eluting stent.

By conducting joint research combining materials, nanotechnology and biology, Nano-bio will pursue basic research oriented toward human-related nano-biotechnology, specializing in bioimaging, nanomedicine, regenerative medicine and bio-nanointerfaces, with the hope that this will lead to clinical

trials. In line with this, MANA plans to change the name of this research field from Nano-bio to Nano-life.

To encourage original Nano-bio research rooted in nanoarchitectonics, a research fund to bolster the field of Nano-bio will be established. Within this framework, MANA will promote interdisciplinary research involving its strong areas of Nano-materials and Nano-system.

3) More theoreticians should be integrated into the projects in order to guide and support the research.

In April 2011, the Nano-System Computational Science Group was established, and MANA Independent Scientist Dr. Yoshitaka Tateyama was named Group Leader. Dr. Tateyama is a computer scientist who is currently actively engaged in joint research projects with experimental researchers from within and outside of MANA. To strengthen this group's activities, MANA researchers with computer science expertise are scheduled to be appointed to the group in April 2012.

MANA also plans to involve more theoreticians, including those from foreign research institutes, in its research projects.

Furthermore, a research fund to promote the integration of theory and practice will be established in FY2012, and materials research supported by theoreticians will be pursued.

4) There is a concern about so few PIs choosing to take sabbaticals to high quality foreign laboratories and institutions staffed with high-caliber researchers.

Not only does MANA invite researchers from overseas, it also encourages its own researchers to take initiative and go abroad.

This policy applies to young researchers as well as Principal Investigators, and the period of stay will be extended from one month to two years. In FY2011, MANA sent Dr. Yoshiyuki Yamashita to MINATEC in France for one year. In FY2012, MANA plans to send a handful of researchers, including Principal Investigators and Independent Scientists, for long-term research abroad. NIMS also supports research abroad initiatives by giving participants preferential treatment on their performance evaluations.

5) MANA relies on support by NIMS. Especially, shared use of big equipment and delivery of high-quality starting materials are essential for research at MANA. The high percentage of foreign scientists at MANA can only be maintained if the technical support by NIMS continues.

NIMS continues to provide its full support to the administration of MANA. In FY2011, as with previous years, NIMS provided financial support for research project fees and MANA Foundry operating expenses as well as operations subsidies to be used at MANA's discretion.

8. Center's response to the site-visit report used in the interim evaluation

1) Nano-bio

- Since there are many institutes and universities where bio materials are treating for many applications, it is very important to clarify the identity of MANA compared to others.

To create an identity for Nano-bio research at MANA, the name of the field will be changed to Nano-life, and Nano-life will pursue basic research oriented toward human-related nano-biotechnology, specializing in bioimaging, regenerative medicine and the like, with the hope that this will lead to clinical trials (See 7.2 for

a partial explanation).

2) Theoretical approaches

- It is recommended that efforts be maintained to continually incorporate theory, ranging from physics, chemistry, biology to mathematics, in order to form a powerful infrastructure that can frame difficult problems in a conceptual structure and to aid in visualizing and interpreting data via advanced theory simulations. This has the potential to lift simple materials development and device building into highly powerful science.

The new Computational Science Group was established in FY2011, and an Independent Scientist with a passion for experiments and collaboration was named Group Leader. MANA also plans to involve more theoreticians, including those from foreign research institutes, in its research projects. We will also pursue theoretician-supported materials research by establishing a research fund to promote the integration of theory and practice (See 7.3 for a partial explanation).

3) Collaboration

- Much more collaboration among the 4 groups should be enhanced. Each group seems to be working rather independently.

We will expand opportunities for the exchange of information among researchers by holding Grand Challenge Meetings and MANA Seminars, and we will promote more joint research among the four fields by launching inter-field projects. With the same objective in mind, MANA's host institution NIMS began the InterUnit Seeds Development Research Grants in FY2011, and MANA researchers are currently involved in eight of the 11 projects initially selected.

- The interaction with the local institutions within the science city Tsukuba, typically the nanotechnology group of AIST, should be promoted to be recognized as a real hub of nanotechnology.

We will cooperate with AIST's Green Nanoelectronics Center (Director: Dr. Naoki Yokoyama) and the Tsukuba Innovation Arena for Nanotechnology (TIA-nano), among others, as we push forward with efforts to collaborate with research institutions within the Tsukuba area.

- Some collaboration with industry seems to be successful and the achievement might have the innovative nature of the society. These activities could be more emphasized.

In FY2011, MANA researchers conducted 50 joint research projects with private companies, and secured a total of 145 million yen in funding. These researchers are currently conducting basic research towards the commercialization of said output. While the details of the joint research must be kept confidential, we will publicize these efforts by announcing—where possible—the outcomes of these research endeavors in the newsletter and on the homepage.

4) Grand Challenge

- It is recommended to establish second-term strategy more clearly. It should include mission, strategy and road map.

MANA will indicate a clear research strategy before the second term begins. In particular, we will declare our aim to realize three major research goals, namely, 1) neuromorphic computational circuits, 2) room temperature superconductors, and 3) artificial photosynthesis, as well as our intention to pursue challenging materials science projects that will be game-changing for MANA.

- As the research objectives, the development of new materials, that is potential forte to NIMS, has been emphasized. We expect to reinforce the contribution from the materials research sides to the activity in Nano-green and Nano-bio fields. These directions are not easy to be practiced, but if they have been issued in good shape so as to explore unconventional aspects, the reputation of this institute as an innovative center will be raised.

MANA has a stellar track record in developing novel nano-materials, such as nano-sheets, nano-tubes and supramolecules, and will put these achievements to work to advance research in the fields of Nano-green and Nano-bio. To do this, MANA will launch inter-field projects to further strengthen ties among the fields of Nano-materials, Nano-green and Nano-life.

- It is recommended that each thrust lay out the major challenges blocking quantum leap progress, even if they seem insoluble. This will give some impetus to dreaming of solutions and put the work on a potential path for breakthroughs as opposed to just doing similar things over and over hoping for an accidental breakthrough. It would be good to see each presentation started off or ended with what are the grand challenges in the field for the thrust and are any ideas on the table to solve the grand challenges.

By eliciting the issues inhibiting quantum leaps in each research field, we will find ways to solve these problems and undertake challenging research that will generate breakthroughs. Several PIs are scheduled to give presentations to clearly explain these issues and initiatives at the next site visit.

List of Center's Research Results and Main Awards

A. Published Papers

- List in order of most recent the Center's papers published in refereed journals during FY2011.
- For each, write the paper title; author name(s); journal name, volume, page(s); and publication year. If there are a few authors, underline those affiliated with the Center. (Any order may be used as long as format is the same.)
- If there are many authors, show and underline those affiliated with the Center, cutting out the names of other authors as deemed appropriate.
- For the most important papers, shade in the number block. For papers giving the results of fusion research, underline the number in the block.
- If the list exceeds this form, please add extra pages.

No.	Author names and details
1	<p><i>Enhanced tissue penetration-induced high bonding strength of a novel tissue adhesive composed of cholesteryl group-modified gelatin and disuccinimidyl tartarate,</i> <u>M. Matsuda, M. Ueno, Y. Endo, M. Inoue, M. Sasaki, T. Taguchi</u> COLLOIDS AND SURFACES B-BIOINTERFACES 91, 48-56 (2012). doi:10.1016/j.colsurfb.2011.10.030</p>
2	<p><i>Immobilization of chiral amide derived from (1R,2S)-(-)-norephedrine over 3D nanoporous silica for the enantioselective addition of diethylzinc to aldehydes</i> <u>U. Balakrishnan, N. Ananthi, S. Velmathi, M. Benzigar, S. Talapaneni, S. Aldeyab, K. Ariga, A. Vinu</u> MICROPOROUS AND MESOPOROUS MATERIALS 155, 40-46(2012). doi:10.1016/j.micromeso.2012.01.005</p>
3	<p><i>Luminescence properties of SiC/SiO₂ core-shell nanowires with different radial structure,</i> <u>F. Fabbri, F. Rossi, G. Attolini, G. Salviati, B. Dierre, T. Sekiguchi, N. Fukata</u> MATERIALS LETTERS 71[15], 137-140 (2012). doi:10.1016/j.matlet.2011.12.059</p>
4	<p><i>n-ZnO/p-Si 3D heterojunction solar cells in Si holey arrays,</i> <u>X. Zhang, D. Golberg, Y. Bando, N. Fukata</u> NANOSCALE 4[3], 737-741 (2012). doi:10.1039/c2nr11752e</p>
5	<p><i>Wet Chemical Synthesis of Nitrogen-Doped Graphene towards Oxygen Reduction Electrocatalysts without High-Temperature Pyrolysis,</i> <u>Y. Zhang, K. Fugane, T. Mori, L. Niu, and J. Ye,</u> JOURNAL OF MATERIALS CHEMISTRY 22, 6575-6580 (2012).</p>
6	<p><i>Electrochemical Coupling Layer-by-layer,</i> <u>M. Li, S. Ishihara, Q. Ji, Y. Ma, J. P. Hill, K. Ariga</u> CHEMISTRY LETTERS 41, 383-385 (2012). doi:10.1246/cl.2012.383</p>
7	<p><i>Growth of single-crystal Ca₁₀(Pt₄As₈)(Fe_{1.8}Pt_{0.2}As₂)₅ nanowhiskers with superconductivity up to 33 K,</i> <u>J. Li, J. Yuan, T. Daiming, S. Zhang, L. Mengyue, Y. Guo, Y. Tsujimoto, T. Hatano, S. Arisawa, D. Golberg, H. Wang, K. Yamaura, E. Muromachi</u> JOURNAL OF THE AMERICAN CHEMICAL SOCIETY. 134, 4068-4071 (2012). doi:10.1021/ja212067g</p>
8	<p>Detection of p53 gene point mutation using sequence-specific molecularly imprinted PoPD electrode, <u>T. A. Deshpande SR, H. Kobayashi, T. Biosens.</u> BIOELECTRON 35[1], 224-9. (2012).</p>
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10	<i>Solution-processed organic crystals for field-effect transistor arrays with smooth semiconductor/dielectric interface on paper substrates,</i> L. Yun, C. Liu, X. Yong, T. Minari, P. Darmawan, K. Tsukagoshi ORGANIC ELECTRONICS 13 [3], 815-819 (2012). doi:10.1016/j.orgel.2012.01.021
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18	<i>Recrystallization and Reactivation of Dopant Atoms in Ion-Implanted Silicon Nanowires</i> H. Oh, H. Lu, N. Kawazoe, G. Chen JOURNAL OF BIOACTIVE AND COMPATIBLE POLYMERS . 27 [2], 97-106 (2012).
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458	<i>Unusual in vitro degradation behavior of physically cross-linked liposome gel network</i> , Z. Rao, <u>T. Taguchi</u> , POLYMER DEGRADATION AND STABILITY 96 , 1111 (2011). doi: 10.1016/j.polymdegradstab.2011.03.002
459	<i>Putting the 'N'in ACENE: Pyrazinacenes and their structural relatives</i> , G.J. Richards, J.P. Hill, T. Mori, K. Ariga, ORGANIC & BIOMOLECULAR CHEMISTRY 9 , 5005 (2011). doi: 10.1039/c1ob05454f
460	<i>Crystallization and Morphology of Glassy Sanbornite</i> , Y. Takahashi, R. Ihara, T. Fujiwara, <u>M. Osada</u> , KEY ENGINEERING MATERIALS 485 , 301 (2011). doi: 10.4028/www.scientific.net/KEM.485.301
461	<i>Classical Boolean logic gates with quantum systems</i> , N. Renaud, <u>C. Joachim</u> , JOURNAL OF PHYSICS A 44 , 155302 (2011). doi: 10.1088/1751-8113/44/15/155302
462	<i>Supercritical hydrothermal synthesis of hydrophilic polymer-modified water-dispersible CeO₂ nanoparticles</i> M. Taguchi, S. Takami, T. Adschiri, <u>T. Nakane</u> , K. Sato and T. Naka, CRYSTENGCOMM 13 [8], 2841-2848 (2011). doi: 10.1039/c0ce00467g

463	<i>Anode Supported Protonic Solid Oxide Fuel Cells Fabricated Using Electrophoretic Deposition</i> , M. Zunic, L. Chevallier, E. Di Bartolomeo, A. D'Epifanio, S. Licocchia, E. Traversa, FUEL CELLS 11 , 165 (2011). doi: 10.1002/fuce.200900104
464	<i>Activity of oxygen reduction reaction on small amount of amorphous CeOx promoted Pt cathode for fuel cell application</i> K. Fugane, T. Mori, D. R. Ou, A. Suzuki, H. Yoshikawa, T. Masuda, K. Uosaki, Y. Yamashita, S. Ueda, K. Kobayashi, N. Okazaki, I. Matolinova and V. Matolin, ELECTROCHIMICA ACTA 56 [11], 3874-3883 (2011). doi: 10.1016/j.electacta.2011.02.034
465	<i>Synthesis of mesoporous composite materials of nitrogen-doped carbon and silica using a reactive surfactant approach</i> , J.P. Paraknowitsch, Y. Zhang, A. Thomas, JOURNAL OF MATERIALS CHEMISTRY 21 , 15537 (2011). doi: 10.1039/C1JM11633A
466	<i>A density functional theory study of Mn nanowires on the Si(001) surface</i> , A.M.P. Sena, D.R. Bowler, JOURNAL OF PHYSICS: CONDENSED MATTER 23 , 305003 (2011). doi: 10.1088/0953-8984/23/30/305003
467	<i>Picoscale science and nanoscale engineering by electron microscopy</i> , Z.L. Wang, JOURNAL OF ELECTRON MICROSCOPY 60 , S269 (2011). doi: 10.1093/jmicro/dfr027
468	<i>Metal-Dependent and Redox-Selective Coordination Behaviors of Metalloligand [Mo^V(1,2-benzenedithiolato)₃]⁻ with Cu^I/Ag^I Ions</i> , T. Matsumoto, H.C. Chang, A. Kobayashi, K. Uosaki, M. Kato, INORGANIC CHEMISTRY 50 , 2859 (2011). doi: 10.1021/ic102070c
469	<i>Conjugation of organic-metallic hybrid polymers and calf-thymus DNA</i> J. Li, Z. Futera, H. Li, Y. Tateyama, M. Higuchiinghua PHYSICAL CHEMISTRY CHEMICAL PHYSICS 13 , 4839-4841 (2011). doi: 10.1039/c0cp02037k
470	<i>Encapsulated Inorganic Nanostructures: A Route to Sizable Modulated, Noncovalent, On-Tube Potentials in Carbon Nanotubes</i> , A. Ilie, J.S. Bendall, K. Nagaoka, S. Egger, T. Nakayama, S. Crampin, ACS NANO 5 , 2559 (2011). doi: 10.1021/nn102189w
471	<i>Towards single cell heat shock response by accurate control on thermal confinement with an on-chip microwire electrode</i> , P. Ginet, K. Montagne, S. Akiyama, A. Rajabpour, A. Taniguchi, T. Fujii, Y. Sakai, B. Kim, D. Fourmy, S. Volz, LAB ON A CHIP 11 , 1513 (2011). doi: 10.1039/C0LC00701C
472	<i>Coaxial Electro spray Formulations for Improving Oral Absorption of a Poorly Water-Soluble Drug</i> , S. Zhang, K. Kawakami, M. Yamamoto, Y. Masaoka, M. Kataoka, S. Yamashita, S. Sakuma, MOLECULAR PHARMACEUTICS 8 , 807 (2011). doi: 10.1021/mp100401d
473	<i>Unipolar resistive switching in high-resistivity Pr_{0.7}Ca_{0.3}MnO₃ junctions</i> , S.L. Li, J. Li, Y. Zhang, D.N. Zheng, K. Tsukagoshi, APPLIED PHYSICS A 103 , 21 (2011). doi: 10.1007/s00339-011-6313-4
474	<i>Control of device parameters by active layer thickness in organic field-effect transistors</i> , M. Kano, T. Minari, K. Tsukagoshi, H. Maeda, APPLIED PHYSICS LETTERS 98 , 073307 (2011). doi: 10.1063/1.3555463
475	<i>Memristive operations demonstrated by gap-type atomic switches</i> , T. Hasegawa, A. Nayak, T. Ohno, K. Terabe, T. Tsuruoka, J.K. Gimzewski, M. Aono, APPLIED PHYSICS A 102 , 811 (2011). doi: 10.1007/s00339-011-6317-0
476	<i>Atomic Force Microscopy Reveals Drebrin Induced Remodeling of F-Actin with Subnanometer Resolution</i> , S. Sharma, E.E. Grintsevich, M.L. Phillips, E. Reisler, J.K. Gimzewski, NANO LETTERS 11 , 825 (2011). doi: 10.1021/nl104159v

477	<i>Cation off-stoichiometric SrMnO_{3-δ} thin film grown by pulsed laser deposition,</i> S. Kobayashi, Y. Tokuda, <u>T. Ohnishi</u> , T. Mizoguchi, N. Shibata, Y. Sato, Y. Ikuhara, T. Yamamoto, JOURNAL OF MATERIALS SCIENCE 46 , 4354 (2011). doi: 10.1007/s10853-010-5103-2
478	<i>Preparation of Open Porous Hyaluronic Acid Scaffolds for Tissue Engineering Using the Ice Particulate Template Method,</i> Y.G. Ko, H.H. Oh, <u>N. Kawazoe</u> , T. Tateishi, <u>G. Chen</u> , JOURNAL OF BIOMATERIALS SCIENCE, POLYMER EDITION 22 , 123 (2011). doi: 10.1163/092050609X12580983951602
479	<i>Optically Patternable Polymer Films as Model Interfaces to Study Cellular Behaviour on Topographically Structured Materials,</i> C. Minelli, <u>A. Yamamoto</u> , M.J. Kim, JOURNAL OF BIOMATERIALS SCIENCE 22 , 577 (2011). doi: 10.1163/092050610X488223
480	<i>Seed-assisted growth of one-dimensional nanostructures,</i> in Handbook of Innovative Nanomaterials - From Syntheses to Applications T.Y., Zhai, L. Li, X.S. Fang, Y. Bando, D. Golberg, Editors: <u>X.S. Fang</u> , L. Wu; PAN STANFORD PUBL. LTD. (2011). ISBN: 9789814303897
481	<i>Topochemical Synthesis of Co-Fe Layered Double Hydroxides at Varied Fe/Co Ratios: Unique Intercalation of Triiodide and Its Profound Effect,</i> R. Ma, J. Liang, <u>K. Takada</u> , <u>T. Sasaki</u> , JOURNAL OF THE AMERICAN CHEMICAL SOCIETY 133 , 613 (2011). doi: 10.1021/ja1087216
482	<i>Enhanced Logic Performance with Semiconducting Bilayer Graphene Channels,</i> S.L. Li, H. Miyazaki, H. Hiura, <u>C. Liu</u> , <u>K. Tsukagoshi</u> , ACS NANO 5 , 500 (2011). doi: 10.1021/nn102346b
483	<i>Volatile/Nonvolatile Dual-Functional Atom Transistor,</i> <u>T. Hasegawa</u> , Y. Itoh, H. Tanaka, T. Hino, T. <u>Tsuruoka</u> , <u>K. Terabe</u> , H. Miyazaki, <u>K. Tsukagoshi</u> , T. Ogawa, S. Yamaguchi, <u>M. Aono</u> , APPLIED PHYSICS EXPRESS 4 , 015204 (2011). doi: 10.1143/APEX.4.015204
484	<i>Origin of low-frequency noise in pentacene field-effect transistors,</i> Y. Xu, <u>T. Minari</u> , <u>K. Tsukagoshi</u> , J. Chroboczek, F. Balestra, G. Ghibaudo, SOLID-STATE ELECTRONICS 61 , 106 (2011). doi: 10.1016/j.sse.2011.01.0

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

- List up to 10 main presentations during FY2011 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	<u>Dmitri GOLBERG</u> <i>High-resolution transmission electron microscopy as a tool for nanomaterial property studies</i> 22nd Australian Conference on Microscopy and Microanalysis, Perth, WA Australia 5-9 February 2012
2	<u>Yoshio BANDO</u> <i>One dimensional inorganic nanomaterials and their applications</i> International Conference on Advanced Nanomaterials and Nanotechnology, Guwahati, India 8-10 December 2011
3	<u>Tsuyoshi HASEGAWA</u> <i>Atom/ion movement controlled three-terminal atomic switch</i> Trends in Nanotechnology International Conference (TNT2011), Tenerife, Spain 21-25 November 2011
4	<u>Kazuhito TSUKAGOSHI</u> <i>Solution-processable organic single crystal array for high performance organic transistor</i> 7th IUPAC International Conference on Novel Materials and Their Synthesis, Shanghai, China 16-21 October 2011
5	<u>Kazunori TAKADA</u> <i>Cathode/Electrolyte Interface in Solid-State Lithium Battery with Sulfide Electrolyte</i> The 62nd Annual Meeting of the International Society of Electrochemistry, Niigata, Japan 11- 15 September 2011
6	<u>Kohei UOSAKI</u> <i>Preparation of atomically and molecularly controlled electrocatalyst</i> IUPAC 2011, San Juan, USA July 30 - August 7 2011
7	<u>Jinhua YE</u> <i>Nano Photocatalysts for Solar Chemical Conversion and Environmental Remediation</i> The 9th International Meeting of Pacific Rim Ceramic Societies, Queensland, Australia 10-14 July, 2011
8	<u>Katsuhiko ARIGA</u> <i>Hand-Operating Nanotechnology for Soft Supramolecular Materials at Interface</i> International Conference on Materials for Advanced Technologies(ICMAT2011) , Suntec, Singapore 26 June - 1 July 2011
9	<u>Takao AOYAGI</u> <i>Smart biomaterials with dynamically tunable stiffness for tissue engineering</i> International Conference on Materials for Advanced Technologies(ICMAT2011) , Suntec, Singapore 26 June - 1 July 2011
10	<u>Masakazu AONO</u> <i>RECENT PROGRESS IN THE ATOMIC SWITCH</i> 2011 MRS Spring Meeting, San Francisco, USA 25 – 29 April 2011

H. Major Awards

- List up to 10 main awards received during FY2011 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	<u>Takayoshi SASAKI</u> Chemical Society of Japan Academic Prize (by The Chemical Society of Japan) February 2012
2	<u>Yoshio BANDO, Dmitri GOLBERG</u> Third Thomson Reuters Research Front Award for 2011 (by Thomson Reuters) February 2012
3	<u>Françoise M. Winnik</u> Macromolecular Science and Engineering Award of the Chemical Institute of Canada 2012 (by Chemical Institute of Canada) January 2012
4	<u>Katsunori WAKABAYASHI</u> Sixth Young Scientist Award of the Physical Society of Japan (by Physical Society of Japan) November 2011
5	<u>Daniele Pergolesi, Emiliana Fabbri, Enrico Traversa</u> American Ceramic Society Ross Coffin Purdy Award 2011 for the best paper on ceramics published in 2010 (by American Ceramic Society, USA) October 2011
6	<u>Tadaaki NAGAO</u> The Fellow of the Institute of Physics, UK (by the Institute of Physics, UK) August 2011
7	<u>Mark E. WELLAND</u> Knighthood in the Queen's Birthday Honors list (by Queen's Birthday Honours, UK) June 2011
8	<u>Naoto SHIRAHATA, Yoshio SAKKA</u> Award of the Outstanding Papers 2010, published in the JCeSJ (by Journal of the Ceramic Society of Japan) May 2011
9	<u>Jun NAKANISHI</u> Young Scientist's Prize for the Commendation of Science and Technology (by Ministry of MEXT) April 2011
10	<u>Katsuhiko ARIGA</u> NIMS President's Research Award (by NIMS) April 2011

FY 2011 List of Principal Investigators

NOTE:
 • Underline names of investigators who belong to an overseas research institution. Place an asterisk (*) by names of investigators considered to be ranked among world's top researchers.
 • In case of researchers not listed in initial plan or the latest report, attach "Biographical Sketch of a New Principal Investigator".

<Results at the end of FY2011>									
Principal Investigators Total:25									
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 <u>AONO, Masakazu*</u> (67)	Director-General, International Center for Materials Nanoarchitectonics (MANA)	Ph.D. Tokyo Univ (1972) NanoScienc e and Nanotechno logy	60%	15%	15%	10%	10/1/2007	a) usually stays at the center	-
BANDO, Yoshio*(64)	Chief Operating Officer, International Center for Materials Nanoarchitectonics (MANA)	Ph.D. Osaka University, 1975 Nanomateri als and Transmissio n electron microscope	70%	30%	0%	0%	10/1/2007	a) usually stays at the center	-
ARIGA, Katsuhiko*(49)	International Center for Materials Nanoarchitectonics (MANA)	Dr. Eng. Tokyo Institute of Technology , 1990 Supramolec ular Chemistry and Surface Science	100%	0%	0%	0%	10/1/2007	a) usually stays at the center	-

HU, Xiao (50)	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* (49)	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 (49)	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*(56)	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* (51)	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*(60)	Professor, Tokyo University of Science, Department of Applied Physics	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*(59)	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*(52)	Professor, Department of Materials Science and 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	-
<u>GIMZEWSKI, James K. *(60)</u>	Distinguished 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 3 times a year, at UCLA satellite usually	To have charge of research themes of MANA
<u>WELLAND, Mark E. *(56)</u>	Professor, University of Cambridge	Ph.D. (Physics) University of Bristol 1984 Nanoscience and nanofabrication	15%	6%	65%	14%	10/1/2007	b) stays at UCAM satellite usually	To have charge of research themes of MANA

<u>WANG, Zhong Lin *(50)</u>	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 twice a year, at GIT satellite usually	To have charge of research themes of MANA and to accept a young researcher from MANA (1 month)
<u>JOACHIM Christian*(54)</u>	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 Nanoscience	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
<u>YAGHI, Omar* (47)</u>	Professor, Dept. of Chemistry and Biochemistry, University of California, Los Angeles	Ph.D.(University of Illinois, 1990) Nanostructure of Organic materials	30%	0%	60%	10%	3/10/2008	b) stays at the center twice a year, at UCLA usually	To supervise a research group in MANA
<u>UOSAKI, Kohei* (65)</u>	International Center for Materials Nanoarchitectonics (MANA)	Ph. D. Surface Physical Chemistry	80%	20%	0%	0%	7/1/2008	a) usually stays at the center	-
<u>NAKAYAMA, Tomonobu (50)</u>	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	-

ENRICO TRAVERSA* (52)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D., Inorganic Materials	100%	0%	0%	0%	1/1/2009	a) usually stays at the center	-
TSUKAGOSHI, Kazuhito (44)	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* (50)	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* (52)	International Center for Materials Nanoarchitectonics (MANA)	Ph.D., Biomaterials	70%	0%	20%	10%	9/1/2010	a) usually stays at the center	-
CHEN, Guoping (46)	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 (52)	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* (60)	Faculty of Pharmacy and Department of Chemistry, University of Motreal, Canada	Ph.D.(Chemistry), ,University of Toronto(1979), Polymer Chemistry and Photochemistry	40%	10%	40%	10%	4/1/2011	b) stays at the center three times a year, at University of Motreal usually	To have charge of research themes of MANA
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Researchers unable to participate in project in FY 2011

Name	Affiliation (Position title, department, organization)	Starting date of project participation	Reasons	Measures taken
SAKKA, Yoshio*(55)	International Center for Materials Nanoarchitectonics (MANA)	10/1/2007	Was assigned to handle the national strategic fields of environment, energy and element strategy under the NIMS 3 rd Mid-Term Program.	
HONO, Kazuhiro*(51)	International Center for Materials Nanoarchitectonics (MANA)	10/1/2007	Same as above	
OHASHI, Naoki (45)	International Center for Materials Nanoarchitectonics (MANA)	10/1/2007	Same as above	
FUJITA, Daisuke (50)	International Center for Materials Nanoarchitectonics (MANA)	10/1/2007	Same as above	
HAN Liyuan (54)	International Center for Materials Nanoarchitectonics (MANA)	10/1/2008	Same as above	
KITAMURA, Kenji*(62)	International Center for Materials Nanoarchitectonics (MANA)	10/1/2007	Was engaged in a process of continuous reform to strengthen Nano-Bio as its PI	

Biographical Sketch of a New Principal Investigator

Name (Age)	Guoping Chen (46)
<i>NOTE: Place an asterisk (*) by the name of investigators considered to be ranked among the world's top researchers.</i>	
Current affiliation (Position title, department, organization)	Principal Investigator, International Center for Materials Nanoarchitectonics (MANA), National Institute for Materials Science
Academic degree, specialty	Ph.D. (Kyoto Univ.), Biomaterials
Research and education history April 2011- Principal Investigator, MANA, National Institute for Materials Science January 2007-March 2011, Group Leader, Biomaterials Center, National Institute for Materials Science April 2004-December 2006, Senior Researcher, Biomaterials Center, National Institute for Materials Science October 2003-March 2004, Senior Researcher, Tissue Engineering Research Center, National Institute of Advanced Industrial Science and Technology October 2000-September 2003, Researcher, Tissue Engineering Research Center, National Institute of Advanced Industrial Science and Technology April 1998-September 2000, Postdoctoral Fellowship, National Institute for Advanced Interdisciplinary Research April 1997-March 1998, Postdoctoral Fellowship, Graduate School of Material Science, Nara Institute of Science and Technology March 1997, Doctor of Engineering, Graduate School of Engineering, Kyoto University	
Achievements and highlights of past research activities <i>(Describe qualifications as a top-caliber researcher if he/she is considered to be ranked among the world's top researchers.)</i> In the development of porous scaffolds for tissue regeneration, hybrid scaffolds of biodegradable synthetic polymers and naturally derived polymers were developed by a novel hybridization method. The hybrid scaffolds combine the advantages of both types of polymers. The hybrid scaffolds were highlighted twice by Nature Bio News because of their superior mechanical property and biocompatibility to the conventional porous scaffolds. The hybrid scaffolds have been demonstrated useful for regeneration of cartilage tissue with adjustable size. Another novel method was developed by using ice particulates as a template to prepare porous scaffolds with precisely controlled porous structures. Funnel-like porous scaffolds that facilitated homogeneous cell distribution and tissue regeneration were prepared by this method. Furthermore, highly functional autologous scaffolds and stepwise development-mimicking matrices were developed for the first time in the world by using cell-derived extracellular matrices. The autologous scaffolds have excellent biocompatibility and can avoid immune reaction and inflammation. The stepwise matrices mimic the <i>in vivo</i> micro- and nano-environment of tissue development process and can be used as novel cell culture models. In addition, photo-reactive polymers were synthesized and used for preparation of micropatterns of functional polymers and bioactive molecules by photolithography. The micropatterns were successfully used to control stem cell functions such as cell adhesion, shape and differentiation. Until now, 165 original and review papers, and book chapters including 127 in English have been published and 21 patents have been documented. The papers have been cited for more than 1920 times with an H-index of 25. More than 50 keynotes and invited lectures have been delivered. Several awards such as the Young Scientist Award from the Japanese Biomaterials Society in 2001, the Original Award from the Japanese Society of Artificial Organs in 2002, the Best E-poster in the Basic Science from the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine in 2003, the Tsukuba Award of Chemical, Bio-Technology from the Tsukuba Foundation for Chemical and Bio-Technology in 2005, and the Best Research and Collaboration Award from the Science Academy of Tsukuba in 2010 have been awarded.	
Achievements	
(1) International influence <i>a) Guest speaker, chair, director, or honorary member of a major international academic society in the subject field, b) Holder of a prestigious lectureship, c) Member of a scholarly academy in a major country, d) Recipient of an international award(s), e) Editor of an influential journal etc.</i> Invited lectures in recent 4 years 1. International Symposium on Molecular Nanotechnology, 2010/12/01-02, Nara, Japan. 2. 11 th IUMRS International Conference in Asia, 2010/09/25-28, Qingdao, China. 3. 6th International Symposium on High-Tech Polymer Materials, 2010/11/07-11, Xiamen, China. 4. 2010 International Symposium of Materials on Regenerative Medicine, 2010/11/03-05, Taiwan.	

5. 1st International Conference on Quality Control of Biomaterials and Tissue engineering Products, 2009/09/28-29, Tianjin, China.
6. 8th ICRS World Congress, May 23 - 26, 2009/05/23-26, Miami, USA.
7. The 9th International Symposium on Ceramic Materials and Components for Energy and Environmental Applications, 2008/11/10-14, Shanghai, China.
8. TERMIS-AP Meeting 2008/11/07-08, Taiwan
9. 5th International Symposium on High-Tech Polymer Materials, 2008/10/26-31, Beijing, China.
10. European Materials Research Society Fall Meeting 2008/09/15-19, Warsaw, Poland.
11. 1st Asian Biomaterials Congress, 2007/12/06-08, Tsukuba, Japan.
12. International Workshop Multidimensional Interfaces in Functional Tissue Engineering, 2007/08/28-29, Walton, UK.
13. 5th Asian International Symposium on Biomaterials, 2006/11/15-18, Xiamen, China.
14. CIMTEC 2006/06/04-09, Sicily, Italy.

Council membership

Council member, Tissue Engineering and Regenerative Medicine International Society's Asian-Pacific Chapter, 2011/1~

Chair

1. 11th IUMRS International Conference in Asia, 2010/09/25-28, Qingdao, China.
2. World Congress Gene 2009, 2009/12/05 - 2009/12/07, Foshan, China
3. 1st International Conference on Quality Control of Biomaterials and Tissue engineering Products, 2009/09/28-29, Tianjin, China.
4. The 9th International Symposium on Ceramic Materials and Components for Energy and Environmental Applications, 2008/11/10-14, Shanghai, China.
5. European Materials Research Society Fall Meeting 2008/09/15-19, Warsaw, Poland.
6. TERMIS-AP Meeting 2007/12/03-04, Tokyo, Japan.
7. 1st Asian Biomaterials Congress, 2007/12/06-08, Tsukuba, Japan.
8. CIMTEC 2006/06/04-09, Sicily, Italy.

Guest Professor, Shanghai Institute of Ceramics, Chinese Academy of Sciences, China.

Regional Editor, Journal of Biomaterials and Tissue Engineering

(2) Receipt of large-scale competitive fundings (*Large-scale competitive funds (over past 5 years)*)

1. "Establishment of Methods for Evaluation of Tissue Engineering Materials and Tissues", 52 million yen/year, MEXT, 2005-2008, member.
2. "Research and Development of Three-Dimensional Complex Organoid", 28.5 million yen/year, NEDO, 2006-2009, member.
3. "Preparation of Highly Functional Hybrid Scaffolds of Biodegradable Synthetic Polymers and Collagen", 45.5 million yen, JST, 2009-2010, representative.

(3) Article citations (*Titles of major publications, and number of citations.*)

- Scaffold design for tissue engineering: 139
- Growth factor combination for chondrogenic induction from human mesenchymal stem cell: 122
- A biodegradable hybrid sponge nested with collagen microsponges: 110
- Hybrid biomaterials for tissue engineering: a preparative method of PLA or PLGA-collagen hybrid sponge: 76
- Patterned Immobilization of thermoresponsive polymer: 87
- The use of a novel PLGA fiber / collagen composite web as a scaffold for engineering of articular cartilage tissue with adjustable thickness: 61
- Preparation of poly(L-lactic acid) and poly(DL-lactic-co-glycolic acid) foams by use of ice microparticulates: 57

(4) Others (*Other achievements that indicate qualification as a top-caliber researcher, if any.*)

Co-advisor of Thai Royal Golden Jubilee Ph.D. Program, 2002-2005

Biographical Sketch of a New Principal Investigator

Name (Age)	Toyohiro Chikyow (52)
<i>NOTE: Place an asterisk (*) by the name of investigators considered to be ranked among the world's top researchers.</i>	
Current affiliation (Position title, department, organization)	National Institute for Materials Science (NIMS) MANA Nano-Electronics Materials Unit, managing director
Academic degree, specialty	Ph.D (ECE) Semiconductor and electric materials
<p>Research and education history</p> <p>1985-89 : Thermal stability of electrode on Si LSI</p> <p>1989-99 : Quantum dots formation and ordering by droplet epitaxy with focused ion beam</p> <p>1999-2006 : Combinatorial material exploration and technology : application for gate stack materials.</p> <p>2006-2011 : Fundamental research on functional materials on semiconductor substrates and others</p> <p>2011- : New materials discovery for future nano electronics and others</p> <p>1993-1994 : Visiting researcher , Norrh Carolina State University.</p> <p>1995- : Affiliate professor , MSE , University of Washington</p> <p>2009- : Professor Joint graduate school of NIMS- Waseda University.</p>	
<p>Achievements and highlights of past research activities <i>(Describe qualifications as a top-caliber researcher if he/she is considered to be ranked among the world's top researchers.)</i></p> <p>1)1989~99 : Research on quantum dots formation by droplet epitaxy. In this research, AlGaAs surface was terminated by Se or other group VI elements to suppress the reactivity of the surface and self aligned GaAs quantum dots were formed by Ga droplets followed by As supply. By removing Se on the top surface by low energy focused ion beam, the nucleation sites for GaAs quantum dots were fabricated to make quantum dots alley on the surface. This low energy focused ion beam was also used to make GaN micro crystals by Ga droplet formation followed by nitrogen radical beam.</p> <p>2) 1999~2006 : The leading research program "Combinatorial Materials Exploration and Technology" started in 1999 and gate stack materials research using combinatorial method begun at the same time. In this research, high-k and metal gate materials were studied and new amorphous high-k oxide of HfAlYOx was found. As a outreach activity, collaboration with Selete has been done for charactering carbon and boron effect to high-k materials. Due to this contribution , "Selete Award" was given to the members in 2004. In addition, GaN epitaxial growth wad demonstrated by MnS buffered layer on Si.</p> <p>3) 2006~2011 : More advanced research for gate stack materials were achieved and newly design characterization tool was developed for invaded defect characterization. As a new high-k oxide, CeAlSiOx was found. This oxide had a higher dielectric constant of 27 and showed direct contact to Si substrate, As a new metal gate materials, amorphous metal alloys were proposed and Pt-W, Ru-Mo and TaC-Y were proved to be candidates for the future nano CMOS gate materials. To characterize the invaded defets, EBIC was employed and it was succeeded to visualize the defects for the first time. The EBIC results also indicated that nitride or carbonate metal gate did not cause defect in high-k. As for the metal gate research, Pt-W, Ru-Mo and TaC-Y systems were synthesized by combinatorial method and these system were found to be the candidates for the futute nano electronics because of their work function tenability and interface stability. As for additional research, BN/Si hetero structure was made by plasma and laser assisted CVD and it showed a photo voltaic property. Some molecules are invaded in gate oxide to develop a charge trap. Due to this charge modulation, a new non volatile memory was demonstrated.</p> <p>4) To encourage collaboration with industry, a research network, "High-k net" was organized and this network was noticed as the most succeeded scheme in semiconductor industries.</p>	
Achievements	

(1) International influence

- 1) 2003 Selete Award
- 2) 2005 : 'Best Young Researcher of Materials Chemistry', Japan Institute for Metals.
- 3) 2005 : "OHM Technology Award" ,The Promotion Foundation for Electrical Science and Engineering
- 4) 2006 : invited talk at Materials Research Society Fall meeting.
- 5) 2008 : Invited talk at " Science Forum "
- 6) 2010 : Invited talk at the Institute of Electrical Engineering of Japan
- 7) 2007- : Editorial board member of Materials Research & report (Elsevier)

(2) Receipt of large-scale competitive fundings (*Large-scale competitive funds (over past 5 years)*)

- 1) NEDO International Collaboration Program: delegate (total 90 M ¥)
- 2) CREST : assisting member (130 M¥)
- 3) JSPS : delegate (40 M¥)
- 4) NEDO MIRAI project: assisting member (20 M¥)
- 5) MEXT Promotion Fund: assisting member (130 M¥)
- 6) NEDO Nano materials Fund: delegate (98 M¥)
- 7) JST Japan-Korea-China Fund : delegate (12 M¥)
- 8) Other Funds: assisting member (3M ¥)

(3) Article citations (*Titles of major publications, and number of citations.*)

○Room-Temperature Ferromagnetism in Transparent Transition Metal-Doped Titanium Dioxide:

Science 291 854-856 (2001) citation 1274

○New MBE growth method for InSb quantum well boxes:

J. Cryst. Growth 111 688-692 (2001) citation 133

○Anomalous Hall effect governed by electron doping in a room-temperature transparent ferromagnetic semiconductor:

Nature Materials 3 221-224 (2004) citation 126

○Novel Germanium-Based Magnetic Semiconductors: Phys.Rev.Lett.91 177203-06 (2004)

citation 93

○Blue and ultraviolet cathodoluminescence from Mn-doped epitaxial ZnO thin films : Appl.Phys.Lett.,83 39-41 (2003) citation 73

○Reaction and regrowth control of CeO₂ on Si(111) surface for the silicon - on - insulator structure : Appl.Phys.Lett., citation 66○First-principles studies of the intrinsic effect of nitrogen atoms on reduction in gate leakage current through Hf-based high-*k* dielectrics:Appl.Phys.Lett.,86 143507-9 (2005) citation 60○Oxygen Vacancy Induced Substantial Threshold Voltage Shifts in the Hf-based High-*K* MISFET with p+poly-Si Gates -A Theoretical Approach:Jpn.J.Appl.Phys.43 L1413-15 (2004), citation 60(4) Others (*Other achievements that indicate qualification as a top-caliber researcher, if any.*)

Dr.Chikyow has been contributing the combinatorial synthesis and high throughput characterization. Based on the technology and patents, he and his collaborator established a venture company " COMET Inc. " as a NIMS certificated venture company in December, 2007. This company is dedicating itself to more than 50 Japanese industries in materials developments and related service. In 2001. This COMET Inc. achieved a first positive figure in a single- year basis.

Biographical Sketch of a New Principal Investigator

Name (Age)	Françoise M. Winnik* (60)
<i>NOTE: Place an asterisk (*) by the name of investigators considered to be ranked among the world's top researchers.</i>	
Current affiliation (Position title, department, organization)	Professor, Faculty of Pharmacy and Department of Chemistry, University of Montreal, Montreal QC Canada
Academic degree, specialty	PhD, Polymer Chemistry and Photochemistry
Research and education history 1974: Diplome d' ingénieur chimiste, Mulhouse , France 1975: Master in Science, Chemistry, University of Toronto, Canada 1979: PhD, Chemistry, University of Toronto, Canada 1979–81: Post-doctoral fellow, Medical Genetics, University of Toronto, Canada 1981–93: Research Scientist, Xerox Research Centre of Canada, Mississauga, Canada 1993–2000: Associate Professor, Chemistry, McMaster University, Hamilton, Canada 2000– :Professor, Université de Montreal, Montreal, Canada	
Achievements and highlights of past research activities <i>(Describe qualifications as a top-caliber researcher if he/she is considered to be ranked among the world's top researchers.)</i> 36 patents (US), 256 publications in refereed journals, 31 book chapters ISI web of science:h-index: 47 , total citations /year: 2009: 867; 2010: 1024,	
Achievements	
(1) International influence <i>a) Guest speaker, chair, director, or honorary member of a major international academic society in the subject field, b) Holder of a prestigious lectureship, c) Member of a scholarly academy in a major country, d) Recipient of an international award(s) , e) Editor of an influential journal etc.</i> Executive editor, Langmuir, American Chemical Society Publications, since 2008; associate editor 2000–2008 Member of the board: Pacific Polymer federation Invited professor : Ecole Supérieure de Physique et Chimie Industrielle de Paris, Paris, France(2005), Kyoto University, Tokyo Dental and Medical University, ; Global COE Invited professor (Tokyo Institute of Technology, Osaka University) Docent (invited lecturer) University of Helsinki, since 2003. Key note speaker: Pacific polymer conference , Cairns, 2009 plenary speaker: Argentine/Chilean polymer symposium, 2009 (average 15 invited presentations/y) Clara Benson Award (Canadian Institute of Chemistry, 2006 (distinguished contribution to chemistry of a woman Doolittle award, PMSE division of the ACS 2009 Fellowship (long term) Japanese society for the promotion of science (2010)	
(2) Receipt of large-scale competitive fundings <i>(Large-scale competitive funds (over past 5 years))</i> Nanomaterials and Microsystems for biomedical imaging (Group grant, Canadian foundation for innovation , 2007, CN\$ 8,140,000 Asymmetrical field flow fractionation system (equipment, NSERC, 2007, CN\$ 147,000)	

Biocompatible poly(amphiphiles) for engineered antibody fragments (2011–2013, NSERC, CN\$ 100,000/y)
 Self-assembly of amphiphilic polymers in water (2011–2015, NSERC CN\$145,000/yr
 (see attached Document for all my grants over the last 5 years)

(3) Article citations (*Titles of major publications, and number of citations.*)

- E. Hutter, S. Boridy, S. Labrecque, M. Lalancette-Hebert, J. Kriz, F. M. Winnik, D. Maysinger, *Microglial response to gold nanoparticles*, ACS Nano, 2010, 4, 2595-2606. **(5)**
- M. A. Cohen Stuart, W.T. S. Huck, J. Genzer, M. Müller, C. Ober, M. Stamm, G. B. Sukhorukov, I. Szleifer, V. V. Tsukruk, M. Urban, F. M. Winnik, S. Zauscher, I. Luzinov, S. Minko, *Emerging applications of stimuli-responsive polymer materials*, Nature Materials, 2010, 9, 101-113. **(88)**
- S Besner, A.V. Kabashin, F. M. Winnik and M. Meunier *Synthesis of size-tunable polymer-protected gold nanoparticles by femtosecond laser ablation and seed growth* J. Phys. Chem. C (2009) 113(22) 9526-9531. **(12)**
- F. Segui, X. P. Qiu, F. M. Winnik, *An efficient synthesis of telechelic poly(N-isopropylacrylamides) and its application to the preparation of $\langle \uparrow \rangle$ -dicholesteryl and $\langle \uparrow \rangle$ -dipyrenyl polymers*. J. Pol. Sci, Part A: Pol. Chem., 2008, 46(1), 314-326. **(27)**
- X.-P. Qiu, F. Tanaka, F. M. Winnik, *Temperature-Induced Phase Transition of Well-Defined Cyclic Poly(N-isopropylacrylamide)s in Aqueous Solution*. Macromolecules, 2007, 40, 7069-7071. **(61)**
- S. J. Cho, D. Maysinger, M. Jain, B. Roeder, S. Hackbarth, F. M. Winnik, *Long-Term Exposure to CdTe Quantum Dots Causes Functional Impairments in Live Cells*. Langmuir, 2007, 23(4), 1974-1980. **(139)**
- X.P. Qiu, F. M. Winnik* *Facile and efficient one-pot transformation of RAFT polymer end groups via a mild aminolysis/Michael addition sequence* Macromol. Rapid Commun., 2006, 27, 1648-1653. **(69)**
- P. Kujawa, F. Tanaka, F. M. Winnik, *Temperature-dependent properties of telechelic hydrophobically modified poly(N-isopropylacrylamides) in water: evidence from light scattering and fluorescence spectroscopy for the formation of stable mesoglobules at elevated temperatures* Macromolecules, 2006, 39(8), 3048-3055. **(60)**
- S. Mansouri, Y. Cui e, F. M. Winnik, Q. Shi, P. Lavigne, M. Benderdour, E. Beaumont, J. C. Fernandes *Characterization of folate-chitosan-DNA nanoparticles for gene therapy*, Biomaterials (2006) 27, 2060-2065. **(87)**
- P. Kujawa, F. Segui, S. Shaban, C. Diab, Y. Okada, F. Tanaka, F. M. Winnik *Impact of end-group association on the thermosensitive properties of hydrophobically modified telechelic poly(N-isopropylacrylamides) in water*, Macromolecules (2006) 39, 341-348. **(107)**
- J. Loric, S. J. Cho, F. M. Winnik, D., Maysinger *Unmodified cadmium telluride quantum dots induce reactive oxygen species formation leading to multiple organelle damage and cell death*, Chem. Biol. (2005) 12, 1227-1234 **(147)**.
- J. Lovric, S. J. Cho, F. M. Winnik, D., Maysinger, *Unmodified cadmium telluride quantum dots induce reactive oxygen species formation leading to multiple organelle damage and cell death*, Chem. Biol. (2005) 12 (11) 1227-1234. **(192)**
- B. Thierry, P. Kujawa, C. Tkaczyk, F. M. Winnik, L. Bilodeau, M. Tabrizian, *Delivery platform for hydrophobic drugs: prodrug approach combined with self-assembled multilayers*, J. Am. Chem. Soc (2005) 127. 1626-1627 **(83)**

(4) Others (*Other achievements that indicate qualification as a top-caliber researcher, if any.*)

Records of FY2011 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 2011	Final goal (Date: October, 2014)
Researchers	200 <120, 60%> [50, 25%]	206 <116, 56%> [45, 22%]	200 <120, 60%> [50, 25%]
Principal investigators	25 <10, 40%> [2, 8%]	25 <10, 40%> [2, 8%]	25 <10, 40%> [2, 8%]
Other researchers	175 <110, 63%> [47, 27%]	181 <106, 59%> [43, 24%]	175 <110, 63%> [47, 27%]
Research support staffs	12	8	12
Administrative staffs	18	18 (18, 100%)	18
Total	230	232	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 hire Dr. Henzie from the University of California, Berkeley as an Independent Scientist

Personnel transfers

- Independent Scientist Dr. Vinu joined the University of Queensland University in Australia as a full professor (Period of research at MANA: 2007.10-2011.7)
- MANA Scientist Dr. Fabbri joined the Paul Scherrer Institute in Switzerland (Period of research at MANA: 2009.1-2012.1)

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	Kazuo KADOWAKI Yukio NAGASAKI	
Tokyo University of Science	Hideaki TAKAYANAGI	
University of Cambridge	Mark E. Welland	
UCLA	James K. Gimzewski	
Georgia Institute of Technology	Zhong Lin Wang	
CNRS	Christian Joachim	
University of Motreal	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, Italy		
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		
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		
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 FY2011:

Total: 1,130 Million yen

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

Grants-in Aid for Scientific Research on Priority Areas

- K. Uosaki: Analysis of bio grain boundary function by vibration microscopy [Budget:3,250,000Yen]
- M. Osada: Fabrication of multiple inorganic nano sheets and function of bio-minetic integrated sheets [Budget:6,110,000Yen]
- Y. Wakayama: Memory function of different molecule layers and fusion into silicon process [Budget:4,420,000Yen]

Grants-in Aid for Scientific Research A

- E. Traversa: Micro fuel cell devices activating at 350oC[Budget: 41,470,000Yen]

Grant-in-Aid for challenging Exploratory Research

- M. Ebara: Fabrication of smart particles and its therapy to acute inflammation using minetics of apoptosis cells [Budget: 3,640,000Yen]

Grants-in Aid for Scientific Research for Young Scientists A

- G. Yoshikawa: Fussy smell sensors by DNA film on ultra high sensitive piezo resisting devices [Budget:22,360,000 Yen]
- R. Hayakawa: Fabrication of multi functional memories by combining of silicon process [Budget: 21,060,000Yen]

Basic Research Programs (PRESTO)

- Y. Tateyama: Electron transport and excitation at grain boundaries of solar cells and light catalysts at activating condition by first principle statistic dynamics [Budget: 1,300,000 for FY2011]

Strategic International Research Cooperative Program

- T. Hasegawa: Faradaic currents and ion transfer numbers in electrochemical atomic switches[Budget: 2,500,000Yen for FY2011]
- T. Hasegawa: Nonvolatile atom transistors and low-power logic systems [Budget: 50,000,00Yen for FY2011]

Adaptable and Seamless Technology transfer Program through target-driven R&D(A-STEP)

- T. Chikyow: Fabrication of ZnO green LED with super low electric power consumption on Si base [Budget: 20,800,000 Yen]

Funding Program for World-Leading Innovative R&D on Science and Technology(FIRST)

- T. Aoyagi: Cell selection technology for high-purification of largely cultivated and differentiate cells [Budget:22,000,000Yen]

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

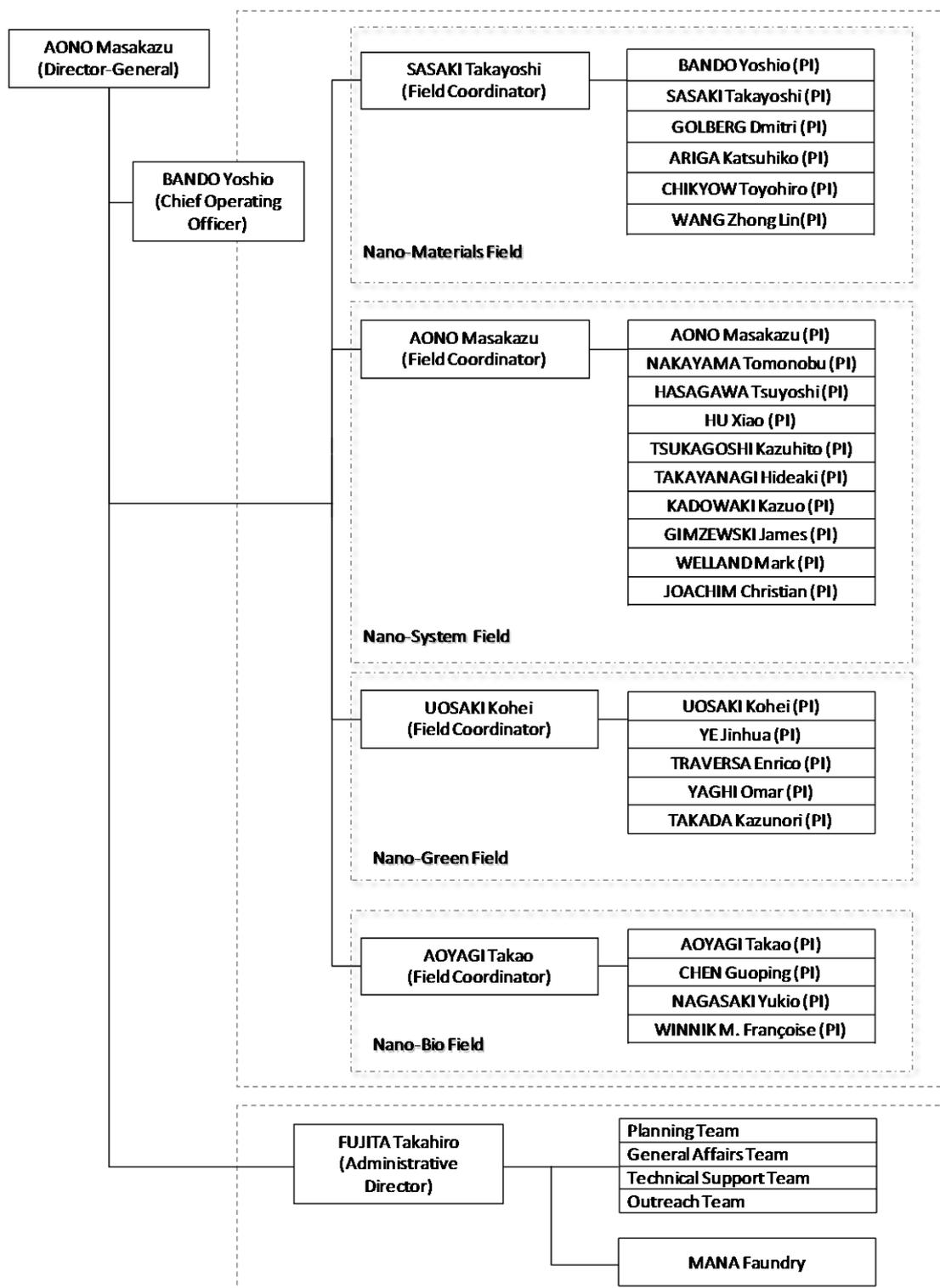
- Indicate the number of international research conferences or symposiums held in FY2011 and give up to three examples of the most representative ones using the table below.

FY 2011: 6 meetings	
Major examples (meeting title and place held)	Number of participants
Title: MANA International Symposium 2012 Jointly with ICYS Date: February 29 – March 2, 2012 Place: Epochal Tsukuba, Japan	From domestic institutions: 276 From overseas institutions: 130
The 3rd NIMS(MANA)-Waseda International Symposium Date: November 1, 2011 Place: Waseda University	From domestic institutions: 70 From overseas institutions: 10
NIMS/MANA – Flinders University Joint Symposium on Nanoscience and Nanotechnology Date: October 31, 2011 Place: NIMS	From domestic institutions: 80 From overseas institutions: 20

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)

※The host institution named a new executive director in charge of MANA on April, 2011.



5. Campus Map

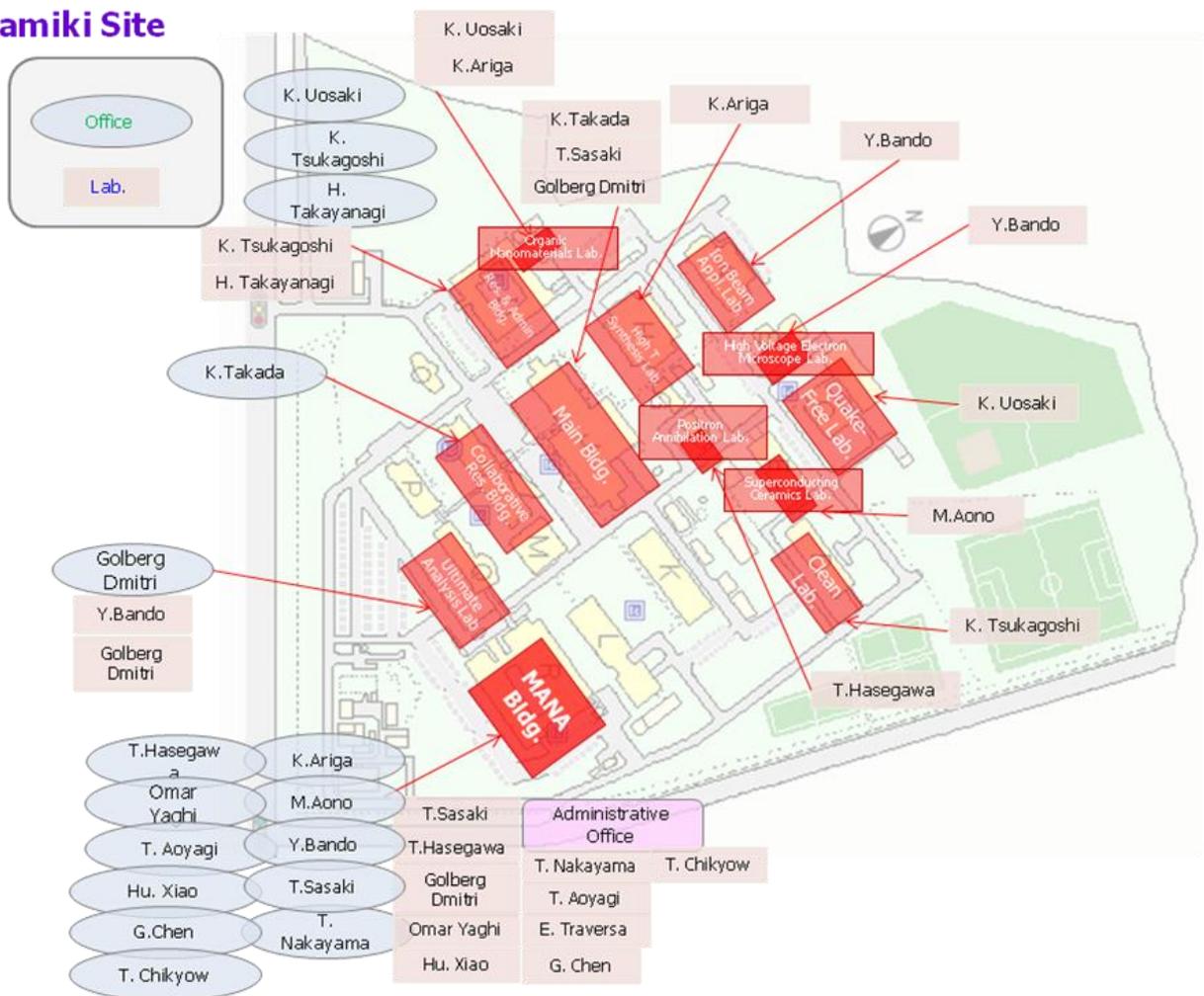
- Please draw a simple map of the campus showing where the main office and principle investigator(s) are located.

Campus Map World Premier International Research Center (WPI) Initiative

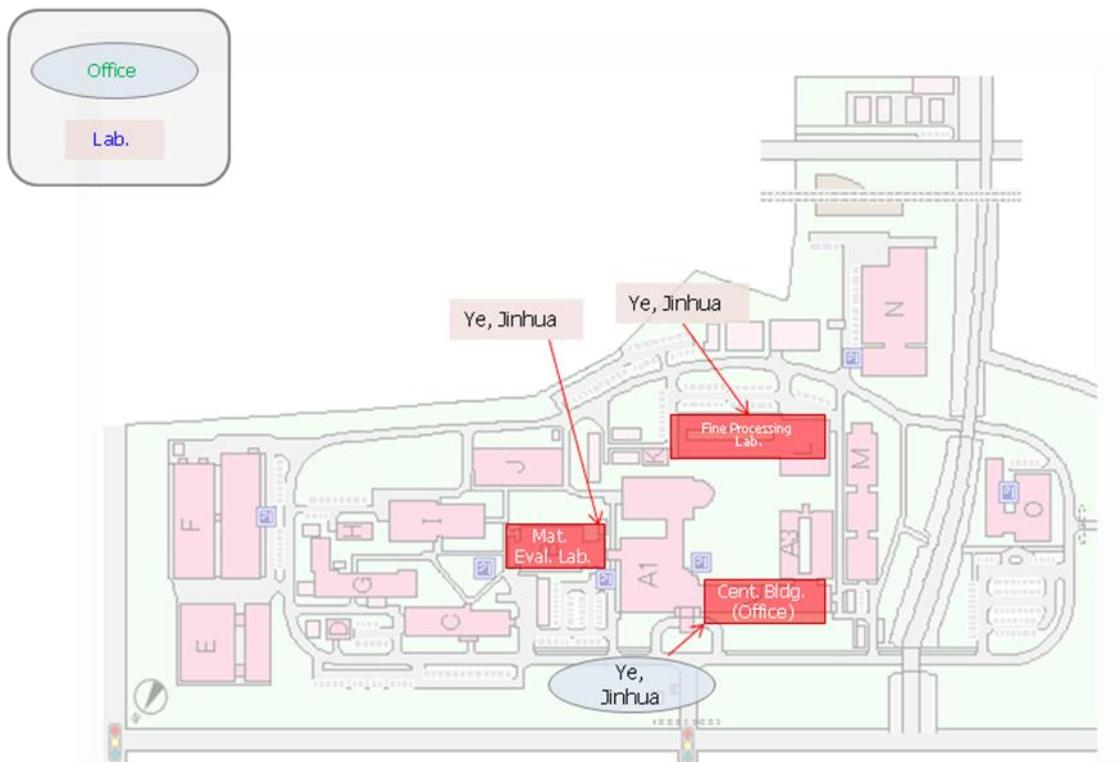


WPI Center for Materials Nanoarchitectonics
National Institute for Materials Science

Namiki Site



Sengen Site



6. FY2011 Project Expenditures (the exchange rate used: 1USD=80 JPY)

i) Overall project funding

Cost Items	Details	Costs (10,000 dollars)
Personnel	Center director and Administrative director	44
	Principal investigators (no. of persons):14	228
	Other researchers (no. of persons):145	1131
	Research support staffs (no. of persons):6	48
	Administrative staffs (no. of persons):18	105
	Total	1556
Project activities	Gratuities and honoraria paid to invited principal investigators (no. of persons):39	21
	Cost of dispatching scientists (no. of persons):2	13
	Research startup cost (no. of persons):28	113
	Cost of satellite organizations (no. of satellite organizations):7	95
	Cost of international symposiums (no. of symposiums):1	8
	Rental fees for facilities	0
	Cost of consumables	35
	Cost of utilities	189
	Other costs	91
Total	565	
Travel	Domestic travel costs	1
	Overseas travel costs	16
	Travel and accommodations cost for invited scientists (no. of domestic scientists):12 (no. of overseas scientists):35	63
	Travel cost for scientists on secondment (no. of domestic scientists):0 (no. of overseas scientists):12	5
	Total	85
	Equipment	Depreciation of buildings
Depreciation of equipment		1091
Total		1530
Other research projects	Projects supported by other government subsidies, etc.	906
	Commissioned research projects, etc.	325
	Grants-in-Aid for Scientific Research, etc.	331
	Total	1562
Total		5298

Ten thousand dollars

WPI grant		1693
Costs of establishing and maintaining facilities		0
Cost of equipment procured		493
Number of units: 1	Costs	14
paid:		
Zeta potential and particle size analysis system		
Number of units: 1	Costs	15
Powder X-ray diffraction system		
Number of units: 1	Costs paid:	9
Super micro ferroelectrics evaluation apparatus		
Number of units: 1	Costs paid:	19
Variable environment prober system		
Number of units: 1	Costs paid:	26
Multi-channel and variable-temperature nano system measurement apparatus		
Number of units: 1	Costs paid:	4
Optical microscope		
Number of units: 1	Costs	10
Semi-conductor device analyzer		
Number of units: 1	Costs	18
Modification of FIB apparatus to high electricity and low speed		
Number of units: 1	Costs paid:	18
Ultra violet-visible-infrared light spectroscopy		
Others		360

ii) Costs of Satellites and Partner institutions

Cost Items	Details	Costs (10,000 dollars)
Personnel	Principal investigators (no. of persons):1	/
	Other researchers (no. of persons):14	
	Research support staffs (no. of persons):3	
	Administrative staffs (no. of persons):4	
	Total	69
Project activities		10
Travel		3
Equipment		3
Other research projects		11
Total		96

Status of Collaboration with Overseas Satellites

1. Coauthored Papers

- List the refereed papers published in FY2011 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
1-74	Emergent Criticality in Complex Turing B-Type Atomic Switch Networks A. Z. Stieg, A. V. Avizienis, H. O. Sillin, C. Martin-Olmos, M. Aono, <i>J. K. Gimzewski</i> ADVANCED MATERIALS 24 [2] 286–293(2012) DOI: 10.1002/adma.201103053
1-110	<i>Sensory and short-term memory formations observed in a Ag₂S gap-type atomic switch,</i> T. Ohno, T. Hasegawa, A. Nayak, T. Tsuruoka, <i>J. K. Gimzewski</i> , M. Aono, APPLIED PHYSICS LETTERS 99 , 203108 (2011). doi: 10.1063/1.3662390
1-221	<i>Short-term plasticity and long-term potentiation mimicked in single inorganic synapses,</i> T. Ohno, T. Hasegawa, T. Tsuruoka, K. Terabe, <i>J.K. Gimzewski</i> , M. Aono, NATURE MATERIALS 10 , 591 (2011). doi: 10.1038/NMAT3054
1-352	<i>Chemical Wiring and Soldering toward All-Molecule Electronic Circuitry,</i> Y. Okawa, S.K. Mandal, C. Hu, Y. Tateyama, S. Goedecker, S. Tsukamoto, T. Hasegawa, <i>J.K. Gimzewski</i> , M. Aono, JOURNAL OF THE AMERICAN CHEMICAL SOCIETY 133 , 8227 (2011). doi: 10.1021/ja111673x
1-473	<i>Memristive operations demonstrated by gap-type atomic switches,</i> T. Hasegawa, A. Nayak, T. Ohno, K. Terabe, T. Tsuruoka, <i>J.K. Gimzewski</i> , M. Aono, APPLIED PHYSICS A 102 , 811 (2011). doi: 10.1007/s00339-011-6317-0

Overseas Satellite 2: Georgia Institute of Technology(GIT), USA
(Total: 1 paper)

No.	Author names and details
1-46	<i>Synthesis of vertically aligned ultra-long ZnO nanowires on heterogeneous substrates with catalyst at the root,</i> G. Zhu, Y. Zhou, S. Wang, R. Yang, Y. Ding, X. Wang, Y. Bando, Z. I. Wang Nanotechnology 23 055604(2012) doi: 10.1088/0957-4484/23/5/055604

Overseas Satellite 3: University of Cambridge, UK
(Total: 1 paper)

No.	Author names and details

1-42	Protonated Carboxyl Anchor for Stable Adsorption of Ru N749 Dye (Black Dye) on a TiO ₂ Anatase (101) Surface K. Sodeyama, M. Sumita, C. O'Rourke, U. Terranova, A. Islam, L. Han, <i>D. R. Bowler</i> , Y. Tateyama <i>The Journal of Physical Chemistry Letters</i> 3 , 472-477 (2012). doi: 10.1021/jz201583n
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2. Status of Researcher Exchanges

- Using the below tables, indicate the number and length of researcher exchanges in FY2011. 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
FY2011	1 0	0 0	0 0	0 0	1 0
Total	1 0	0 0	0 0	0 0	1 0

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2011	1 0	2 2	0 0	0 0	3 2
Total	1 0	2 2	0 0	0 0	3 2

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
FY2011	0 0	0 2	0 0	0 0	0 2
Total	0 0	0 2	0 0	0 0	0 2

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2011	1 0	0 0	0 0	0 0	1 0
Total	1 0	0 0	0 0	0 0	1 0

Overseas Satellite 3: CNRS, Toulouse, 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
FY2011	0 0	0 0	0 0	0 0	0 0
Total	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
FY2011	3 0	0 0	0 0	0 0	3 0
Total	3 0	0 0	0 0	0 0	3 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
FY2011	3 0	0 0	0 0	0 0	3 0

Total	3 0	0 0	0 0	0 0	3 0
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<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2011	0 1	0 1	0 0	0 0	0 1
Total	0 1	0 1	0 0	0 0	0 1

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
FY2011	0 0	0 1	0 0	0 0	0 1
Total	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
FY2011	0 0	0 0	3 0	0 0	3 0
Total	0 0	0 0	3 0	0 0	3 0

FY 2011 Visit Records of World Top-caliber Researchers from Abroad

Researchers Total:23

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)
Mark Welland (56)	Ministry of Defense, Chief Scientific Advisor Prof. of Univ. of Cambridge Head of IRC, UC	Ph.D Nano Science	2002:Director IC in Nanotech Fellow, Royal Society Fellow, Royal Acad. of Engineering, Fellow, Inst. of Physics	May 31	PI
Winnik Francois (60)	University of Montreal	Ph.D. Biochemistry	2008-present Executive editor, Langmuir	June8-July 7 Oct.17-Dec. 16 Jan.29-Mar.23 144days	PI
James Gimzewski (60)	Distinguished Prof., Chem. & Biochem. Dept, Director, UCLA CNSI Nano & Pico Charact. Core Facility Scientific Director, UCLA Art Sci Center	Ph.D. Nano science	2009 Fellow,Royal Soc. the highest award 1997 Feynman Prize in Nanotechnology, 1997 The Discover Award for Emerging Fields, 1998 'Wires 25' Award Fellow of the Institute of Physics Royal Academy of Engineering,	June 21-July 6 Oct.15-19 Feb.26-Mar.6 29days	PI
Christian Joachim (54)	First Class Director of CNRS, Head of the molecular Nanoscience & Picotechnology CEMES/CNRS,	Ph.D. Molecular Science	1988 Chem. Phys prize of FCS 1991 IBM France prize 1997 Feynman prize 1999 Nanotechnology prize 1999 Fellow of the Inst. Phys. (London).	July 24-30 Dec.11-16 Feb.26-Mar.2 19days	PI
Omar Yaghi (47)	UC Berkeley Chemistry	Pd.D Design and construction of chemical structures	Named among the top 2 most cited chemists worldwide, having achieved more than 200 citations per paper for over 100 papers (2000-2011)	July27-30 4days	PI
Jonathan L Sessler (56)	The University of Texas Department of Chemistry and Biochemistry Fellow of Univ. of Texas	Ph.D. Super molecular Chemistry	2011 Royal Society of Chemistry Centenary Award 2009 Fulbright Specialist 2005 Alexander von Humboldt, JSPS Senior Fellowships, 2003 Pollack Award 2011 Izatt-Christensen Award	Sept.11-13 3days	Seminar, discussion
Harry Kroto (73)	Professor, The Florida State University	Ph.D. Spectroscopy, Radioastronomy, C60, Nanoscience	1996 Nobel Prize for Chemistry 2002 Copley Medal 2008 Kavli Lecturer	Sept.16-17 2days	Advisor, Education class
Anthony K. Cheetham (65)	University of Cambridge Department of Materials Science and Metallurgy	Ph.D. Functional Inorganic and Hybrid Materials	1994 Fellow, Royal Soc. 2004 Somiya Award of the IUMRS, 2008 Leverhulme Medal R.S, 2011 Pt Medal of IOM3 ,	Oct.15-Nov.16 Feb.22-Mar.6 61days	Collaborative research Chair of Advisory board

Vinokur Valerii (62)	Fellow Argonne National Laboratory	Macroscopic physics; Quantum electron kinetics, Vortex physics: Soft condensed matter	2003 Alexander v.Humboldt Res. Award 2003 John Bardeen Prize 1998 Fellow, American Phys. Soc. 1998 Univ. Chicago Distinguished Performance Award	Dec 4-9 6days	Research collaboration Seminar
Guy Le Lay (66)	Professor, Université de Provence, UFR Sciences de la Matière, CINaM-CNRS	Ph.D. Nanoscience Graphen, Silicen		Dec. 21	Seminar
Arjum Yodh (52)	Director, LRSM, University of Pennsylvania James M. Skinner Professor of Science	PhD.Chemistry, Condensed matter physics, Biomedical Optics, Atomic, Molecular &optical Science	2000- James M. Skinner Professor of Science, Endowed Chair, Univ. of Pennsylvania 2009- Director, PENN Lab.Res.Stru. of Mat (LRSM) 2009- Director, NSF Mat.Res.Sci. & Eng C (MRSEC) Fellow, Opt. Soc. America Fellow, Amer.Phys. Soc.	Dec.22	Inspection
John Ryan (65)	University of Oxford Clarendon Laboratory	Ph.D. molecular motors, membrane proteins, single-molecule electronics and photonics	Science Advisor to the House of Commons Select Committee on Sci.&Tech. Advisor to the Prog. on Emerging Nanotech. at the Woodrow Wilson Internal Cent for Scholars (Washington, DC)	Jan 16-21 6days	Seminar and discussion
David Caben (64)	Prof. Weizmann Institute of Science	Ph.D. Alternative Energy, Molecular and Molecule-based optoelectronics	1998 Polish Jew. Soldiers (London, UK) prize 2003 Edwards Research Excellence Prize	Jan.18-21 4days	Seminar and discussion
John Singleton (51)	LANL LANL fellow	PhD. High Magnetic Field Science	2010 Top 10 Story 2010 2010 Who's Who in Technology Honoree 2009 Fellow of the Institute of Physics 2004 American Physical Society Fellow	Jan 17-24 8days	Seminar and discussion
Bjørn Hafskjold (65)	Dean , Norwegian University of Science and Technology (NTNU)	Ph.D Computer simulation offluids, Oil/Water/gas separator design and operation, Modelling of HC mixtures.		Feb.10	Inspection
Tord Claeson (73)	Prof. Chalmers Univ. of Tec.	PhD. Microtechnology and Nanoscience	Royal Swedish Academy of Science member	Feb.7	Inspection
Zong-Lin Wang (50)	High tower chair of Mat,Sci.&Eng. Geogia Inst. of Tech., Director of CNC	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	Feb.19-22 4days	PI
Ei-ichi Negishi (76)	Herbert C. Brown Distinguished Professor and Teijin Limited Director of the Negishi-Brown Institute-Org.Chem. Purdue University	Ph.D. Chemical reaction	Nobel Prize Chem. 2010 American Acad. of Arts & Sciences, 2011 Order of the Griffin, Purdue Univ., 2011 Japanese Order of Culture, 2010	Feb.28-Mar.3 5days	Invited speaker Symposium

Heinrich Rohrer(76)	Nobel prize winner	Ph.D Physics	1986 Nobel prize Physic	Feb.28-Mar.15 10days	Advisor
Horst Hahn (57)	Executive Director, professor Karlsruhe Institute of Technology (KIT)	Ph.D Material science Nanotechnology	2012 Second BNM Achievement Award	Mar. 1-4	Evaluation Committee
Ayyappanpillai Ajayaghosh (51)	Head, Photosciences and Photonics Group CSIR, NIIST	Ph.D. primarily Functional Organic Materials, Molecular Self-assembly and Molecular Probes	2002, CRSI Medal, (Chem. Res. Soc. India). 2006, Fellow Indian Acad. Sci., Bangalore 2007, Shanti Swarup Bhatnagar Prize 2008, Internal Editorial Adv. Board Member, ACS, Applied Materials & Interface.	Aug.26	Seminar
Jiajun Li (58)	President Tianjin University	Ph.D Metallic materials and composite materials		Oct. 14	Inspection
David Williams (72)	Professor and Director of international Affairs Wake Forest Institute of Regenerative Medicine	Ph.D. Biocompatibility of biomaterials Tissue engineering scaffolds Toxicology of nanostructured material	2012 Acta Biomaterialia Gold Medal Editor-in-Chief of Biomaterials	Mar.1-2	Symposium

State of Outreach Activities

- Using the table below, show the achievements of the Center's outreach activities in FY2011 (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 FY2011 resulting from press releases and reporting.

Activities	FY2011(number of activities, times held)
PR brochure, pamphlet	3 brochures, 1 pamphlet
Lectures, seminars for general public	7
Teaching, experiments, training for elementary and secondary school students	12
Science cafe	0
Open houses	2
Participating, exhibiting in events	3
Press releases	11
Research Highlight	2

Special Achievements

Spreading MANA's Research Outcomes around the World and Raising Our Profile within the Global Science Community

The conventional approach to public relations is to issue press releases to the domestic media when there are remarkable research outcomes. Since these press releases are in Japanese, they fail to reach overseas media outlets, which means there is no information flow that enables one-stop delivery to foreign audiences. To address this issue, MANA began distributing Research Highlight, a series of short English press releases, to well-known journalists via e-mail.

Programs for School Students

In addition to events for high school students in the process of deciding their career paths, MANA also holds programs to get elementary and junior high school students interested in science. In FY2011, MANA held "Idea Contest—Future Challengers" (co-sponsored by WPI-AIMR) and "Summer Science Camp 2011" (co-sponsored by the Japan Science Foundation and NIMS) for high school students as well as "Prof. Kroto's Science Class 2011" (a seminar led by a Nobel Prize Winner) for elementary school students. Coinciding with this, MANA also published a science-themed picture book for children.

Daily Living Guide for Foreigners

As part of our outreach effort, we published a guide entitled "The Challenging Daily Life or How I Came to Love Japanese Culture" to assist foreign researchers and exchange students with everyday life in Japan.

FY 2011 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	2011.04.10	Nikkei Shimbun	The impact of the Great East Japan Earthquake and nuclear accident
2	2011.04.25	Nikkei Shimbun	A Logic Inverter with Graphene Atomic Layer
3	2011.05.09 / 2011.05.20 / 2011.05.31 /	Nikkan Kogyo Shimbun/Kagaku Shimbun/Nikkei Sangyo Shimbun	Chemical Wiring and Soldering of Single Molecules
4	2011.06.10	Nikkan Kogyo Shimbun	Success in changing the color of luminescence of germanium nano-particles
5	2011.06.27 / 2011.07.08	Mainichi Shimbun, Nikkan Kogyo Shimbun, Ibaraki Shimbun, Nikkei Sangyo Shimbun, Nikkei Shimbun/Kagaku Shimbun	New Brain-type Device with Human-like Memorizing and Forgetting Behavior
6	2011.07.07 / 2011.07.13 / 2011.11.4	Kagaku Kogyo Nippo, Nikkan Kogyo Shimbun/ Tekko Shimbun/ Kagaku Kogyo Nippo	Novel Synthesis Process for Nanosized Reduced Titanium Oxide
7	2011.07.15	Nikkan Kogyo Shimbun	World's Highest Performance Nanodielectrics
8	2011.08.10 / 2011.08.11	Nikkan Kogyo Shimbun / Tekko Shimbun , Nikkei Sangyo Shimbun	World-First Localized Dynamic Temperature Profiling Along and Across Carbon Nanotube Interconnects
9	2011.08.30 / 2011.08.31	Nikkei Sangyo Shimbun	Internationalization of MANA, Collaboration between MANA and companies were introduced in the column "Frontier Chie-wo-shiboru"
10	2011.09.22	Nikkan Kogyo Shimbun, Kagaku Kogyo Nippo	Success in Development of Organic Conductive Material Formed at Ultra-High Speed
11	2011.09.30	Nikkan Kogyo Shimbun	Tianjin University and NIMS Conclude a Contract on Joint Research Center for the development of "Advanced Functional Materials for Energy and Environment"

12	2011.10.10	The Nikkei Weekly	From new chips to global warming, MANA seeks material solutions
13	2011.10.17	The Nikkei Weekly	MANA mantra: Work with private sector to create new industries
14	2011.11.04 / 2011.11.18 / 2011.11.28 / 2012.01.25 /	Nikkan Kogyo Shimbun, Nikkei Sangyo Shimbun/ Kagaku Shimbun, Asahi Shimbun/ Nikkei Sangyo Shimbun	World's First Proof of Single Atomic Layer Material with Zero Electrical Resistance
15	2011.11.15, 2011.12.19 / 2012.01.17 / 2012.01.20 /	Kagaku Kogyo Nippo, Nikkan Kogyo Shimbun/ Kagaku Shimbun	Development of "Matrix" Material Controlling Differentiation of Stem Cells
16	2011.12.20 / 2011.12.26 / 2012.01.16 / 2012.01.27 /	Nikkan Kogyo Shimbun, Kagaku Kogyo Nippo/ Nikkei Shimbun, Nikkei Sangyo Shimbun/ Asahi Shimbun/ Kagaku Shimbun	Success in Synthesis of New High Performance Functional Material Mesoporous Prussian Blue Improvement of Cesium Adsorption Performance by Increasing Surface Area
17	2011.12.19	NHK twelve o'clock news	A research result conducted by a research group headed by Yusuke Yamauchi, MANA Independent Scientist was introduced
18	2011.12.23 / 2011.12.26 / 2012.01.06 / 2012.01.13 /	Nikkan Kogyo Shimbun/ Kagaku Kogyo Nippo/ Nikkei Sangyo Shimbun/Kagaku Shimbun	Development of World's First Functional Polymer Nanowire Fabrication Technology by Pulsed Laser Irradiation
19	2012.1.1	NHK BS Premium Program	Three MANA researchers were featured in NHK BS Premium Program "Atom changes life"
20	2012.01.10	Nikkei Sangyo Shimbun	Shape-Memory Surface with Dynamically Tunable Nano-Geometry Activated by Body Heat
21	2012.01.16 / 2012.01.27 /	Nikkei Shimbun/ Tekko Shimbun	Development of next-generation high efficiency solar cells using functionalized silicon nanostructures
22	2012.02.22 / 2012.03.02 / 2012.03.09 /	Nikkei Sangyo Shimbun/ Kagaku Shimbun/ Nikkan Kogyo Shimbun	Nature of Mott Transition Revealed
23	2012.03.28 /	Nikkan Kogyo Shimbun	Dr. Bando received the 3rd Thomson Reuters Research Front Award for 2011