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

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

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

In FY2012, AIMR achieved big progress in mathematics – materials science collaboration which creates new materials science by injection of the mathematical viewpoint under the leadership of the new Center Director (mathematician) and the new Administrative Director (theoretical physicist). AIMR set up an "Interface Unit" consisting of young researchers who can bridge the gap between mathematics and materials science. Due to this attempt, the opportunities for active exchange between researchers with different backgrounds increased, and now we are ready to step up to the next stage where we can develop science of higher quality. The role of the interface researchers has gradually changed into leading the interdisciplinary fusion research on their own initiative and some papers have been submitted from the interdisciplinary teams. Although creation of a completely new scientific field takes time, results are beginning to be produced steadily. In internationalization, Joint Laboratories were established at the satellites and AIMR researchers have been placed at the Joint Laboratories so that cooperation and joint research between AIMR and the satellites have substantially progressed. AIMR also made a network of materials science inside Tohoku University and set up a cooperation system for research exchange and sharing equipment. Moreover, as an organizational reform, AIMR established a "Research Support Center" and the depth of the research support at AIMR increased more than ever. These efforts led to the following specific achievements.

"Conducting research of the highest world level"

The researchers of AIMR are continuously producing research results with the highest quality and impact, from basic research to application, in the materials science field. In 2012, AIMR researchers published 298 papers, with many appearing in high-impact journals. AIMR's full-time researchers gave 103 invited presentations at international meetings and received high level international and domestic scientific awards in FY2012. This indicates visible activity of AIMR researchers in the global research stage. AIMR researchers obtained 2.4 billion yen in total in FY2012 as external research funds, indicating that AIMR's science level is highly rated both inside and outside of Japan.

"Advancing fusion of various research fields"

AIMR rearranged the organizational structure promoting mathematics – materials science collaboration by establishing an "Interface Unit" consisting of independent young theoretical physicists and chemists who can bridge the gap between mathematics and materials science. This new structure showed synergistic effects with the three Target Projects set in late FY2011 and interdisciplinary fusion at AIMR has largely progressed. Several emerging results of mathematics – materials science collaboration have already been obtained.

“Globalization of the Institution”

In order to strengthen the cooperation with overseas satellites, AIMR established Joint Laboratories at the University of Cambridge and the University of California, Santa Barbara and made a system to accelerate international joint research. The International Symposium (AMIS2013) held in February 2013 gathered 240 participants from 14 countries (regions), and the GI^3 (Global Intellectual Incubation and Integration) Laboratory Program and Global Brain Circulation Program promoted personal exchanges between AIMR (or other departments of Tohoku Univ.) and overseas partner institutions. Moreover, AIMR helped non-Japanese researchers apply for external research funds in order to create an environment attracting foreign researchers. The Public Relations & Outreach office was further reinforced to enhance AIMR’s international publicity and visibility.

“Implementing organizational reforms”

In FY2012, AIMR established new programs and systems, for example, the "Brain Circulation Program", "Research Support Center", double affiliation researcher employment and “AIMR Fund (donation to AIMR)”. These new systems gave ripple effects to the host institution and a "Project Team" under the Executive Vice President (for Research and Environmental Security) was established to discuss constructing a new framework which will develop the host institution into a world's highest standards university. The Research Support Center, which started to be built in late FY2011, has been almost completed and provides a lot of services such as common equipment. The Researcher Support Office which is one part of the Research Support Center began a mentoring service by senior researchers, which provides opportunities for young researchers to increase their research skills in writing papers, making good presentations, and so on. The status and treatment of the researchers of AIMR including the overseas institutions (satellites) were reconsidered and personnel issues such as an employment agreement form were standardized. In order to increase the invited foreign researchers’ convenience and simplify the paperwork, AIMR realized the liquidation denominated in foreign currencies concerning charges forward for overseas traveling expenses. Furthermore, AIMR is developing a new system to send airline tickets directly to foreign researchers.

“Mid- to Long-Term Objectives”

Our mid-term objective is to promote ongoing mathematics – materials science collaboration and establish new materials science by which we can design new functional materials based on prediction. Our long-term objective is to contribute to society through creating revolutionary Green Materials for “energy harvesting,” “energy saving” and “environmental clean-up.” The mathematics – materials science collaboration established as a world-first by AIMR will attract attention from the world including mathematical science institutes outside Japan, form a community promoting new materials science led by AIMR, and serve as a creative domain filled with the energy of talented and enthusiastic researchers.

In order to accomplish these objectives, the host institute Tohoku University has decided to maintain AIMR as a world top level research center for innovative materials science even after the end of the WPI program. Tohoku University has already established a Project Team and is drawing up the plan to implement the reform of the personnel system and establish the organization for Advanced Studies (tentative name). The Project Team has evaluated the outcomes of AIMR so far and the advantages for Tohoku University to keep AIMR, and has started to discuss deeply the sustainable organizational framework of AIMR and the number of researchers.

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

1. Conducting research of the highest world level

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

In FY2012, Professor Hideo Ohno (magnetic semiconductor), Professor Eiji Saitoh (spin current), Professor Shin-ichi Orimo (hydrogen functional materials), Professor Seiji Samukawa (device process), and Professor Tomasz Dietl (spintronics theory) were newly appointed as PIs, and the research capabilities in spintronics and the energy materials field were increasingly strengthened. AIMR is maintaining the highest level in the materials research field in the world. In 2012 AIMR researchers published 298 papers, with many appearing in high-impact journals such as *Nature Materials*, *Nature Nanotechnology*, *Nature Physics*, *Nature Communications*, *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, *Advanced Materials*, *Physical Review Letters (PRL)*, *Applied Physics Letters (APL)*, *Journal of the American Chemical Society (JACS)*, and *Lab on a Chip*, the best journals in the field of general sciences, materials science, physics, applied physics, chemistry, and devices. AIMR’s full-time researchers gave 103 invited presentations at international meetings in FY2012, with many being plenary lectures and keynote presentations. In addition, researchers at AIMR have received domestic and international scientific awards, including the Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (MEXT) (Y. Nishiura PI), the third Biochemical Engineering Journal Young Investigator Award (A. Khademhosseini Junior PI), the 2012 IEEE David Sarnoff Award by the IEEE (H. Ohno PI), the 11th GSC (Green & Sustainable Chemistry) Award awarded by the Minister of Education, Culture, Sports, Science and Technology (T. Adschiri PI), the 11th DOCOMO Mobile Science Prize (E. Saitoh PI), a Fellow of the American Physical Society (APS) (H. Ohno PI), and the SCEJ (The Society of Chemical Engineers, Japan) Society Award (Ikeda- Kamesaburo Award) (T. Adschiri PI). AIMR maintains external research funds greater than 2 billion yen every fiscal year (about 2.4 billion yen in total in FY 2012; more than 5% of the whole Tohoku University), indicating the high evaluation of AIMR’s science level.

As described in the next section “Advancing fusion of various research fields”, top level researchers from materials science, physics, chemistry, engineering, and mathematics are gathering at AIMR. Therefore, the outcomes of research at AIMR vary widely from basic studies to applications. Our research starts from observation and control of atoms and molecules and aims to contribute to society through creating new functional materials and device/systems using them. Therefore AIMR thinks it is important to reveal the relationship between microscopic phenomena and macroscopic properties and functions of the materials and connect them. Our research outcomes can be put into the following four categories based on a viewpoint of the hierarchy of structures and functions of materials (Figure 1): **(1) observe and understand atoms and molecules**, **(2) control atoms and molecules**, **(3) create new materials**, and **(4) create new devices and systems**. The representative research results are listed below.

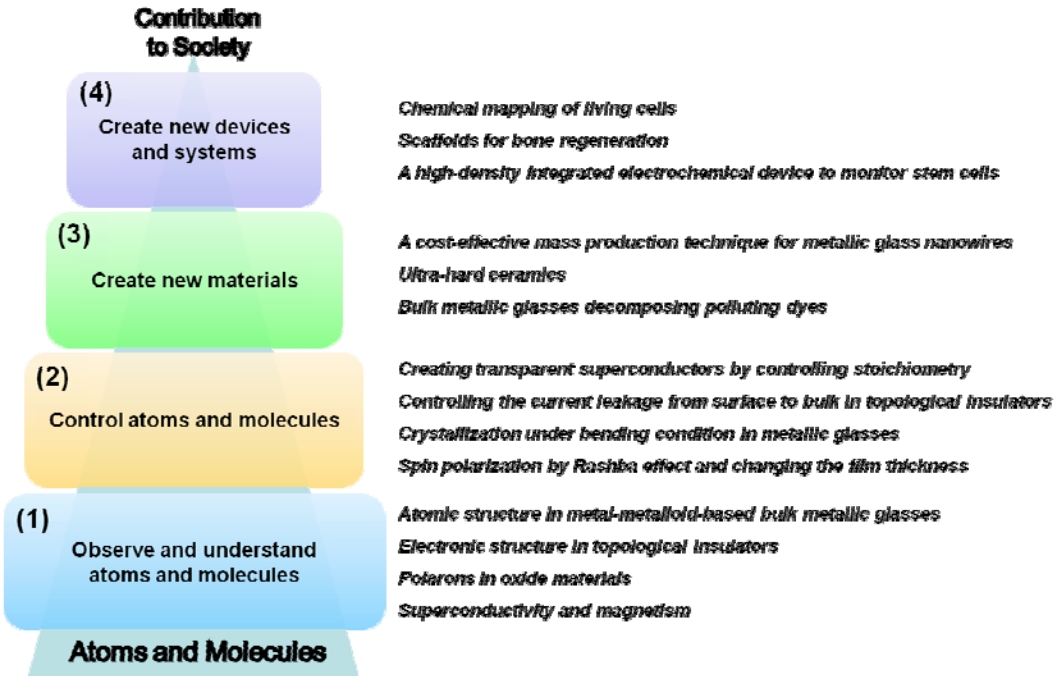

Figure 1 Outcomes obtained at AIMR in FY2012, listed from basic research (bottom) to applications (top).

(1) Observe and understand atoms and molecules

Atomic structure in metal-semimetal-based bulk metallic glasses

Bulk metallic glasses are classified as either metal-metal-based glasses or metal-semimetal-based glasses. The atomic structure of metal-semimetal-based glasses is still intriguing and remains a matter of debate though the structure simply maximizes the atomic packing in metal-metal-based glasses. The situation is much more complex for metal-semimetal-based glasses because semimetal atoms tend to saturate their charge through covalent and coordination bonds and disrupt the dense packing of the metal atoms. The problem was metallic atoms show maximum atomic packing structure even under such restricted conditions by the existence of semimetal atoms. AIMR researchers solved the puzzle by describing a hybrid between a covalent-bond mediated structure and a densely-packed icosahedron structure for a model metal-semimetal glass, palladium–nickel–phosphorus, by X-ray diffraction experiments and *ab initio* molecular dynamics simulations. These findings may be a universal structural model for metal–semimetal glasses.

P. F. Guan, T. Fujita, A. Hirata, Y. H. Liu and M. W. Chen, Structural origins of the excellent glass-forming ability of $Pd_{40}Ni_{40}P_{20}$*.* ***Physical Review Letters 108****, 175501 (2012).*

Electronic structure in topological insulators

Topology is a concept of the fundamental relationships between the properties of geometrically different objects. Most recently, in solid state physics, attention has been focused upon the interesting properties of topological insulators which consist of an insulating bulk with conducting surfaces. This unique topological property arises from the time-reversal symmetry of a material's electronic states. AIMR researchers have discovered an interesting class of crystalline tin telluride-based topological insulators whose properties arise from a combination of both time-reversal and crystal symmetry by using high-resolution angle-resolved photoemission spectroscopy. This discovery marks a new way of finding topological insulators and provides significant implications for the development of innovative electronic devices.

Y. Tanaka, Z. Ren, T. Sato, K. Nakayama, S. Souma, T. Takahashi, K. Segawa and Y. Ando, Experimental realization of a topological crystalline insulator in SnTe. ***Nature Physics 8****, 800–803 (2012).*

Polarons in oxide materials

Although charge trapping in oxide materials play an important role critical to a variety of technologies, accurately predicting the nature of charge trapping in oxides has remained an unmet challenge. AIMR researchers have developed a new calculational approach to predict unexpected aspects of charge localization (trapping) in oxides. Calculations of charge trapping generally rely on density functional theory (DFT). However, the model in which electrons interact with themselves electrostatically (self-interaction) is physically incorrect and leads to inaccurate predictions of charge trapping in materials. The researchers carried out calculations of charges localized in hafnium oxide and zirconium oxide using a version of DFT that includes cancellation of such self-interaction. Using this method, they found that polarons (the charge dressed with the lattice distortions) prefer to stay in oxide layers with triply coordinated oxygen atoms. It is an unexpected result that such two-dimensional behavior has been found in a simple binary oxide and this will lead to a new investigative approach of the particular physics involved.

K. P. McKenna, M. J. Wolf, A. L. Shluger, S. Lany and A. Zunger, Two-dimensional polaronic behavior in the binary oxides m-HfO_2 and m-ZrO_2. ***Physical Review Letters 108****, 116403 (2012).*

Superconductivity and magnetism

Superconductivity originates from the condensation of electron pairs that can roam a crystal without losing energy. In conventional superconductors it has been revealed that the formation of such electron pairs is facilitated by vibration of atoms in the crystal lattice. However, in high-temperature superconductors other factors including magnetism seem to play a role, despite conventional theory determining that magnetism and superconductivity cannot coexist. AIMR researchers studied 1*T*-TaS_2, a material consisting of layers of the elements tantalum (Ta) and sulfur (S), as well as its iron-doped derivatives, by use of high-resolution angle-resolved photoemission spectroscopy (ARPES). At lower temperatures the tantalum atoms in 1*T*-TaS_2 rearrange into a so-called 'Star of David' pattern and exhibit an insulating behavior in which periodic variations in the density of electrons known as charge-density waves (CDWs) arise across the material. Typically, superconductivity and the CDW state are considered to be mutually exclusive and the researchers found that when some of the tantalum atoms were replaced with iron, superconductivity could occur. This explains how the superconductivity and competing magnetism work together and coexist together.

R. Ang, Y. Tanaka, E. Ieki, K. Nakayama, T. Sato, L. J. Li, W. J. Lu, Y. P. Sun and T. Takahashi, Real-space coexistence of the melted Mott state and superconductivity in Fe-substituted 1T-TaS_2. ***Physical Review Letters 109****, 176403 (2012).*

(2) Control atoms and molecules

Creating transparent superconductors by controlling stoichiometry

Composite oxides exhibit intriguing physical properties, such as superconductivity and magnetism, which make them promising components for a wide range of devices including transistors and batteries. Control of the stoichiometry of these materials, that is, the sophisticated structure in which the atomic number ratio which makes up the materials follows the chemical formula, is an essential requirement for achieving high performance. AIMR researchers have studied the growth of two interesting spinel lithium titanate oxides and succeeded in creating superconducting thin films which also have a high level of transparency by precise control and optimization of the stoichiometry of these materials. They first focused on $Li_4Ti_5O_{12}$ commonly used as an electrode in lithium-ion batteries and found that they could obtain $LiTi_2O_4$ thin films with low oxygen partial pressure during pulsed laser deposition (PLD). Furthermore, they found that these thin films showed high electrical conductivity at room temperature as well as a transparency of up to 70%. In addition, they exhibited a superconducting temperature of 13 K, a record high for such a thin film. This is quite a good example of unexpected success achieved from a different purpose of research.

A. Kumatani, T. Ohsawa, R. Shimizu, Y. Takagi, S. Shiraki and T. Hitosugi, Growth processes of lithium titanate thin films deposited by using pulsed laser deposition. ***Applied Physics Letters 101****, 123103 (2012).*

Controlling the current leakage from surface to bulk in topological insulators

In ideal topological insulators, the bulk volume does not pass any current though the surface is highly conductive. However, the bulk of a topological insulator often has defects through which current can flow. This bulk current can obscure surface currents whose behavior is the intended subject of the experiment. By using BSTS, a material made from bismuth, antimony, tellurium and selenium, for a measurement sample, AIMR researchers showed that manipulating the composition of a topological insulator can keep its bulk conductivity low while also allowing the surface current to be tuned between positive and negative charge carriers. They also revealed that this compositional control can also be used to adjust the energy of the surface charge carriers through angle-resolved photoemission spectroscopy (ARPES). This research will lead to observations of a variety of exotic quantum effects.

T. Arakane, T. Sato, S. Souma, K. Kosaka, K. Nakayama, M. Komatsu, T. Takahashi, Z. Ren, K. Segawa and Y. Ando, Tunable Dirac cone in the topological insulator $Bi_{2-x}Sb_xTe_{3-y}Se_y$*.* ***Nature Communications 3****, 636 (2012).*

Crystallization under bending condition in metallic glasses

In metallic glasses atoms are arranged in no particular long-range order. However, crystalline regions have been found to form in some metallic glasses when the material is bent and its reason has remained unclear. AIMR researchers have recently undertaken a combined experimental and theoretical study, and presented a model that explains this behavior. They investigated a ribbon of the metallic glass, $Pd_{40}Cu_{30}Ni_{10}P_{20}$ by a high-resolution X-ray microscope and succeeded in obtaining the data of such crystallization process more accurately than before. This study revealed that compression alone is not sufficient for crystallization and a wide supercooled-liquid region is also required to bring crystallization. This finding indicates that crystallization under bending leads to a hardening of the material, which may prevent metallic glasses from failing under compression.

A. R. Yavari, K. Georgarakis, J. Antonowicz, M. Stoica, N. Nishiyama, G. Vaughan, M. W. Chen and M. Pons, Crystallization during bending of a Pd-based metallic glass detected by X-ray microscopy. ***Physical Review Letters 109****, 085501 (2012).*

Spin polarization by Rashba effect and changing the film thickness

Traditionally, the production of spin-polarized electrons involved ferromagnetic materials, in which spins are naturally aligned. For device applications, however, electric fields are often preferred to magnetic ones. Researchers are attempting to use 'spin–orbit coupling' which connects the charge of an electron with its spin for spin polarization. The Rashba effect is one of the typical examples to achieve the purpose. AIMR researchers have studied the Rashba effect in very thin films of the metal bismuth. They deposited films of thickness ranging from 16 to 80 atomic layers on a silicon surface and observed that the spin-polarizing effect was at work not only on the surface, but also at the interface between the metal film and the silicon substrate. They also showed that the degree of polarization is tunable through the thickness of the films. These materials hold great promise for future applications in next-generation spintronics devices, for enhancing spin-polarized currents, and for fundamental studies of novel quantum effects.

A. Takayama, T. Sato, S. Souma, T. Oguchi and T. Takahashi, Tunable spin polarization in bismuth ultrathin film on Si(111). ***Nano Letters 12****, 1776–1779 (2012).*

(3) Create new materials

A cost-effective mass production technique for metallic glass nanowires

In spite of the unique properties of exceptional mechanical strength, high elasticity, and resistance to mechanical wear of metallic glasses, the mass production of nanoscale structures of metallic glass has been difficult due to the lack of practical techniques. AIMR researchers recently discovered a new, cost-effective technique to produce metallic glass nanowires that yields at least a few hundred million nanowires per gram of material. They used "gas atomization", commonly used in the production of metallic powders; molten metal flows from the nozzle of a crucible and is

crushed by high-speed gas at the exit. By cooling the molten alloy to below its melting point to achieve "supercooling" state and increase the viscosity of the melt stream prior to the gas atomization process, the researchers could obtain long metallic glass nanowires with diameters of 50–2,000 nanometers. Since nanowires have a large specific surface area, they are more catalytically active per gram of material, one of the goals of green chemistry. In future, such metallic glass nanowires may also be formed from magnetic elements, which could have useful applications in the design of miniature devices with a high-frequency impedance response to a changing magnetic field.

K. S. Nakayama, Y. Yokoyama, T. Wada, N. Chen and A. Inoue, Formation of metallic glass nanowires by gas atomization. ***Nano Letters 12****, 2404–2407 (2012).*

Ultra-hard ceramics

Despite being hard enough to repel bullets, boron carbide ceramics suffer from a critical brittleness that leads them to fracture at low stress levels. This is because ceramics are commonly made through the process of sintering which heats compressed powders to a temperature just below their melting point and it also generates a variety of crystal grain structures, which may act as fracture initiation points. However, AIMR researchers discovered a way to enhance the durability of boron carbide by synthesizing it into a 'nanocrystalline' ceramic with plastic deformation capabilities. They lowered the sintering temperature and used intense pressures to form the boron carbide crystallites with uniform grain sizes, with the expectation that this would reduce brittleness. In addition, they found that tiny irregularly-shaped nanopores as well as thin amorphous carbon layers coated the crystal and nanopore surfaces and they helped to lubricate the crystal grains, enabling them to slide during compression and therefore tolerate greater pressures.

K. M. Reddy, J. J. Guo, Y. Shinoda, T. Fujita, A. Hirata, J. P. Singh, J. W. McCauley and M. W. Chen, Enhanced mechanical properties of nanocrystalline boron carbide by nanoporosity and interface phases. ***Nature Communications 3****, 1052 (2012).*

Bulk metallic glasses decomposing polluting dyes

Although synthetic dyes with long-lasting vivid colors are valuable, these attributes also make it difficult to clean up these compounds when they slip into wastewater systems and become pollutants. For example, 'Azo' dyes resist degradation from bacterial or carbon sorption treatments. AIMR researchers have recently described a way to degrade azo dyes with far greater efficiency than current techniques, using amorphous magnesium–zinc metallic glass powders. One of the best ways to decompose azo dyes is by using 'zerovalent' metals. However, although zerovalent metals are especially effective in removing organic contaminants from water, they have poor corrosion resistance and are eventually consumed by the aqueous environment. Thus they made metallic glass ribbons of magnesium and zinc and succeeded in obtaining a densely packed surface giving excellent durability. This success opens up a broad field for metallic glass applications.

J.-Q. Wang, Y.-H. Liu, M. W. Chen, D. V. Louzguine-Luzgin, A. Inoue and J. H. Perepezko, Excellent capability in degrading azo dyes by MgZn-based metallic glass powders. ***Scientific Reports 2****, 418.*

(4) Create new devices and systems

Chemical mapping of living cells

Electroactive and short-lived species that are released and consumed by cells, including neurotransmitters and reactive oxygen-based molecules, are central to cell metabolism, but their detection at cell surfaces and interfaces remains challenging. AIMR researchers have recently developed a high-resolution, non-invasive imaging method called voltage-switching mode–scanning electrochemical microscopy (VSM–SECM) and succeeded in acquiring high-resolution topographical and electrochemical images of living cells simultaneously. In order to prevent damage to the living cells, they used faradaic current, which is generated by the reacting electroactive species, to control the

motion of the electrode, and continuously prevent it from touching the substrate surface. Moreover, they fabricated nanometer-sized glass-insulated carbon electrodes that allow for high-resolution imaging. The next challenge is to monitor the release-related changes in neuron topography.

Y. Takahashi, A. I. Shevchuk, P. Novak, B. Babakinejad, J. Macpherson, P. R. Unwin, H. Shiku, J. Gorelik, D. Klenerman, Y. E. Korchev and T. Matsue. Topographical and electrochemical nanoscale imaging of living cells using voltage-switching mode scanning electrochemical microscopy. ***Proceedings of the National Academy of Sciences USA 109****, 11540–11545 (2012).*

Scaffolds for bone regeneration

Bone health hinges on the assembly of various cells, including osteoblasts and osteoclasts, into well-defined functional structures that manage bone-specific tasks in the body, such as cell growth, differentiation and protein secretion. However, tumor-induced injuries and other bone-related diseases hinder these self-regulated, sophisticated tasks. To address these conditions it is essential to develop tissue engineering approaches that direct cell behavior. AIMR researchers have recently developed micropatterns that serve as scaffolds for bone regeneration. The patterns consist of polymer microspheres filled with drug or protein molecules that are regularly interspaced. Prevalent methods for directing cell behavior exploit either chemical and biological signals or topographical cues, but using each of these methods separately has proven ineffective. By combining both approaches into microsphere patterns, the researchers have taken advantage of chemical and physical stimulations at the same time. This combined chemical–topographical strategy also can be used to study muscle and blood vessel cells for potential regenerative therapies of cardiac tissues as well as for bone repair.

X. Shi, S. Chen, J. Zhou, H. Yu, L. Li and H. Wu, Directing osteogenesis of stem cells with drug-laden, polymer-microsphere-based micropatterns generated by Teflon microfluidic chips. ***Advanced Functional Materials 22****, 3799–3807 (2012).*

A high-density integrated electrochemical device to monitor stem cells

Embryonic stem cells (ES cells) are useful cells which can differentiate into various cells. Although traditional methods of culturing cells have used two-dimensional cell cultures, a three-dimensional environment has emerged as more appropriate for cell culture as it replicates the biological milieu where stem cells can grow into a variety of different tissue structures. AIMR researchers recently have built an integrated electrochemical device that monitors the activity and differentiation of stem cells in an embryoid body. Detection is achieved using an array of 256 (16×16) electrochemical sensors with only 32 (16+16) bonding pads for external connection, placed at the base of deep microwells which enables spatially-resolved measurements. This electrochemical sensor density is the highest in the field of electrochemical lab-on-a-chip devices. The researchers quantified cellular activity from embryoid bodies on the array by collecting local current signals based on ‘redox cycling’. They succeeded in getting the signal of the differentiation of the stem cells, and the device will therefore be useful to screen embryoid bodies’ differentiation levels.

K. Ino, T. Nishijo, T. Arai, Y. Kanno, Y. Takahashi, H. Shiku and T. Matsue, Local redox-cycling-based electrochemical chip device with deep microwells for evaluation of embryoid bodies. ***Angewandte Chemie International Edition 51****, 6648–6652 (2012).*

Aside from the above, many high-level results were obtained in FY2012. For example, new mechanisms of devices using spin have been discovered and the realization of new energy efficient electronic devices can be expected. With respect to the similar structure found in metallic glass and polymer glass by atomic force microscopy in FY2011, further study has been carried out and in FY2012, it is almost clarified that they are a common structure though these structures are referred to by different terms in the metallurgy field and polymer field. The importance of

research using mathematics to reveal these common structures and common principles will increase considerably.

2. Advancing fusion of various research fields

Since FY2009 AIMR has provided the "Fusion Research Program" to help researchers promote interdisciplinary fusion research. So far, 54 proposals have been accepted (13, 14, 17, and 10 proposals in FY2009 (first half), FY2009 (latter half), FY2010, and FY2011, respectively). In FY2012, 18 research subjects were accepted from 26 applications and seed money has been provided. In FY2012, mathematics – materials science collaboration was started in earnest and the number of accepted fusion research projects was increased to support the initial stage of such collaboration. Researchers who were provided the fusion research funds in FY2011 were offered an opportunity to make a presentation of results from their projects at Tea Time in FY2012 so that the results could be shared with other researchers and inspire more new ideas for fusion research.

The details of the progress in mathematics – materials science collaboration will be described later. Due to the stimulation of mathematicians and theoreticians, the fusion researches among the existing four research groups for Bulk Metallic Glasses (BMG), Materials Physics, Soft Materials, and Device/System have been accelerated effectively. The researchers of AIMR have frequently organized seminars without any barrier between the research fields and interdisciplinary fusion research encouraged by these efforts have been clearly bringing new insights. The progress of interdisciplinary research in AIMR is described below with examples of such results.

Metallurgy and chemistry: "the role of kink" for high catalytic activity of nanoporous gold

Although catalytic activity of gold towards molecular oxygen is attracting much attention, the underlying mechanism for this catalytic activity remains unclear. **The fusion research team consisting of metallurgists and chemists at AIMR** recently has captured new evidence that small defects on gold surfaces are active sites for CO oxidation reactions. By developing state-of-the-art techniques to watch surface atomic structures evolve as catalysis occurs, they also discovered that impurity atoms play critical roles in stabilizing the defect sites. This finding will be able to boost the longevity and activity of gold catalysts. This time they investigated nanoporous gold because it has a three-dimensional, free-standing architecture of curved nanopores making it ideal to study gold catalysis without interference from other materials. Using the spherical-aberration-corrected scanning transmission electron microscopy (Cs-corrected STEM) and by carefully controlling gas pressures, they performed *in situ* characterizations during a CO oxidation reaction. The high-resolution images revealed that nanoporous gold's surface structure consists of flat, close-packed terraces separated by single-atom steps. Along bent portions of the nanopores, these steps fall out of alignment and become 'kinks' of under-coordinated gold atoms, which are exceedingly active sites for chemical oxidation.

T. Fujita, P. Guan, K. McKenna, X. Lang, A. Hirata, L. Zhang, T. Tokunaga, S. Arai, Y. Yamamoto, N. Tanaka, Y. Ishikawa, N. Asao, Y. Yamamoto, J. Erlebacher and M. W. Chen, Atomic origins of the high catalytic activity of nanoporous gold. ***Nature Materials 11****, 775–780 (2012).*

Metallurgy and chemistry: nanoporous gold catalysts for variety of chemical reactions

Nanoporous gold catalysts have recently gained popularity due to their long lifetime and green technology. They have proved to be efficient in highly selective oxidation reactions, such as the conversion of an alcohol group (consisting of a C–OH moiety with a single carbon–oxygen bond) to a carbonyl group (a double-bonded carbon–oxygen moiety). Until recently, however, nanoporous gold was thought to be inactive for reductive hydrogenation reactions. **The fusion research team consisting of metallurgists and chemists at AIMR** recently has shown that this catalyst can be used in the selective hydrogenation of alkynes to alkenes, where carbon–carbon triple bonds are reduced to double bonds. Interestingly, the reaction is both chemoselective and Z-selective. This means that in addition to it not

progressing all the way to a single bond, the two hydrogen atoms added to the alkyne moiety are always placed on the same side of the bond, forming what is known as a Z-alkene. It is expected that nanoporous gold will not only be used in the selective reduction of various functional groups, but will also open opportunities for applications in more complicated heterogeneous catalytic methodologies for clean chemical synthesis.

M. Yan, T. Jin, Y. Ishikawa, T. Minato, T. Fujita, L.-Y. Chen, M. Bao, N. Asao, M. W. Chen and Y. Yamamoto, Nanoporous gold catalyst for highly selective semihydrogenation of alkynes: remarkable effect of amine additives. ***Journal of the American Chemical Society 134****, 17536–17542 (2012).*

Physic, chemistry and surface science: Graphene for the thinnest superconductor

The insertion of substances between its graphene layers to form 'graphite intercalation compounds' (GICs) has been investigated as a method for the storage of lithium atoms within batteries. Interestingly, some GICs can also become superconductors. **The fusion research team consisting of physicists, chemists and surface scientists at AIMR** recently has constructed a carbon-based superconductor C_6Ca at its two-dimensional limit by trapping calcium atoms between just two layers of graphene. Their 'sandwich' material offers the advantages of bulk graphite while being as thin as it can possibly be. Among the known superconducting GICs, C_6Ca is arguably the most interesting as it develops superconductivity at a higher temperature than any other. This research area should help to gain a fundamental understanding of the physical and chemical process relevant to state-of-the-art batteries using graphite as an electrode.

K. Kanetani, K. Sugawara, T. Sato, R. Shimizu, K. Iwaya, T. Hitosugi and T. Takahashi, Ca intercalated bilayer graphene as a thinnest limit of superconducting C_6Ca. ***Proceedings of the National Academy of Sciences USA 109****, 19610–19613 (2012).*

Tissue engineering and device technology: A scaffold for longer-lasting cells

Natural tissues are highly organized structures, often formed from multiple cell types precisely positioned to carry out their required roles. Efforts to mimic these structures in order to create artificial tissues, for example, to help heal parts of the body that have sustained damage from injury or disease, is no simple task. Recently developed techniques such as dielectrophoresis use electric fields to position living cells within a three-dimensional matrix; however, trapping the cells in place while ensuring their long-term viability has proven difficult. **The fusion research team consisting of bioscientists and device scientists at AIMR** recently has developed a highly biocompatible scaffold material that could solve this problem. They selected a semi-natural hydrogel material gelatin methacrylate (GelMA) to use as a tissue scaffold and first confirmed that it was a suitable matrix within which to guide cells into position using dielectrophoresis. Once the cells were in place, the researchers exposed the scaffold to UV light and this triggered a chemical cross-linking reaction within the hydrogel, which forms the polymer matrix and traps the cells in place. Using a photomask, the researchers were able to trap one type of cell in one part of the polymer before introducing and trapping a second cell type within the same scaffold. Crucially, the cells retain long-term viability after the formation of the cross-linked polymer, and readily proliferate over several days. The potential applications of GelMA extend beyond damaged tissue repair to include uses in drug screening models or as bio-actuators.

J. Ramón-Azcón, S. Ahadian, R. Obregón, G. Camci-Unal, S. Ostrovidov, V. Hosseini, H. Kaji, K. Ino, H. Shiku A. Khademhosseini and T. Matsue, Gelatin methacrylate as a promising hydrogel for 3D microscale organization and proliferation of dielectrophoretically patterned cells. ***Lab on a Chip 12****, 2959–2969 (2012).*

These outcomes would have never been obtained if researchers from various fields had not been gathered at AIMR. It is expected that these results will lead to the creation of Green Materials which contribute to "energy harvesting," "energy saving" and "environmental clean-up," and contribute to green society.

Progress in mathematics – materials science collaboration

In FY2012, under the leadership of the new Center Director (mathematician) and new Administrative Director (theoretical physicist), AIMR achieved big progress in mathematics – materials science collaboration which started at the end of FY2010 and its basis was almost completed in FY2011. In FY2012, two more assistant professors were employed in the Mathematics Unit which was established in March 2011. However, we noticed that we need researchers who can bridge the gap between mathematicians and materials scientists because mathematicians and materials scientists use different terms so it was very difficult to understand each other in a short amount of time. Therefore, AIMR established the Interface Unit in FY2012. Six independent young theoretical physicists and chemists and applied mathematicians who have mathematical background and also have the knowledge of materials science were selected through international recruitment and involved in AIMR in early FY2012. The researchers of the Interface Unit play the role of interpreters between mathematicians and materials scientists as well as conducting their own research. In FY2012, AIMR propelled three Target Projects which were discussed and set in late FY2011 in order to promote mathematics – materials science collaboration, and the Interface Unit effectively interacted with these Target Projects. Due to this, the opportunities for exchange between researchers with different background increased and now AIMR is ready to step up to the next stage where we can develop science of higher quality. The role of the interface researchers has gradually changed into leading the interdisciplinary fusion research on their own initiative and some papers have been submitted from the interdisciplinary teams. Although creation of a completely new scientific field takes time, results are beginning to be produced steadily.

The outline of the Target Projects is described below and the organization for mathematics – materials science collaboration at AIMR is shown in Figure 2. In order to share the result of each project in whole institute, a meeting for progress reports is held every 3-4 months.

Three target materials

1) Non-equilibrium Materials based on Mathematical Dynamical Systems

We have found similar structure in different non-equilibrium materials, for example, in metallic glasses and polymer glasses. Making these similar phenomena as a foothold, we aim to discover common structures and common principles in non-equilibrium materials and create new materials producing novel functions. We target, for example, metallic glasses, polymer glasses, block copolymers, bio-inspired materials, super-hybrid materials, and multifunctional devices. So far, we have applied the mathematical analysis tool “computational homology” and succeeded in obtaining quantitative data which characterize the non-equilibrium materials.

2) Topological Functional Materials

We are focusing on functions originating from the “spin” of electrons, and functions related to the “topology of energy bands.” The relationship between “topology” and the activity of nanoporous metal catalysts has been also suggested. We introduce mathematics in the exploration of novel materials and in the principle study of their multi-functions utilizing the robustness of the environment response properties of topological features. Target materials are, for example, spintronics materials, superconductors, and MEMS devices for energy-saving, along with nanoporous metal catalysts and new materials for photo-voltaic solar energy conversion and thermoelectric conversion for energy-harvesting. So far, the electronic structure of topological insulators has been clarified and the structure of nanoporous metals has been characterized from the mathematical point of view by “graph theory” and the relationship with catalytic activities has been investigated.

3) Multi-Scale Hierarchical Materials based on Discrete Geometric Analysis

It has been recognized that there are hierarchical structures from atoms and molecules to macroscopic bulk materials, through short-range ordering (nano-clusters), long-range ordering (nano-crystals), each single crystal and poly-crystals levels in case of inorganic materials. In such hierarchical structures, the importance of functional

manifestation which derives from the relationship between the scales and multi-scale structures has also been understood. In addition, spatial interface (e.g. grain boundaries and solid/liquid interface) is one of the keys. This project targets the identification of mid-range and long-range order in the atomic / molecular / cluster / domain arrangement and functional manifestation, as well as process of various interfaces by creating the hierarchical structures. This project targets, for example, grain boundaries for the improvement of electric conduction in devices, solid-liquid interface control for the improvement of friction problems for energy-saving, nanoporous supercapacitors for energy storage, and bio-inspired materials. We held many meetings discussing this problem and have almost understood the essential relationship between hierarchy and materials.

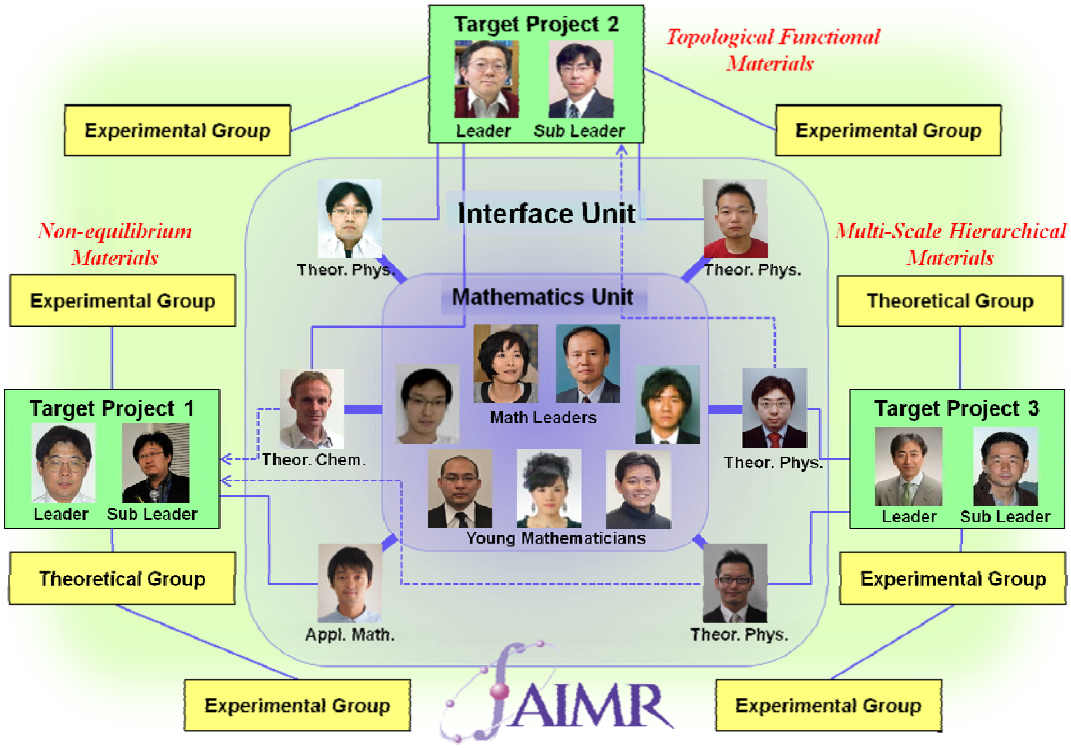

Figure 2 Organization for mathematics – materials science collaboration

Since we confirmed that the Interface Unit can play a crucial role in our mathematics – materials science collaboration at AIMR we plan to employ two more interface researchers early in the next fiscal year.

3. Globalization of the institution

* Describe what's been accomplished or recognized in the efforts to raise the center's international recognition as a genuine top world-level research institute, along with innovative efforts proactively being taken in accordance with the development stage of the center, including the following points, for example:
- Efforts being developed based on the analysis of number and state of world-leading, frontline researchers; number and state of visiting researchers; exchanges with overseas entities
- Proactive efforts to raise the level of the center's international recognition
- 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)

The International Relations Unit supports foreign researchers not only in their research activities at AIMR but also with the daily life of their families. As of March 31, 2013, AIMR has 32 principal investigators (PIs) and 50% of them (16 PIs) are foreign researchers. More than 50% of all researchers are foreigners. In order to position AIMR into the flow of global brain circulation, public advertisements for the positions of associate professor, assistant professor

and research associate (postdoctoral researcher) were carried out for international recruitment and AIMR was able to employ talented researchers from around the world. As a concrete plan to enhance international partnership and collaborations, AIMR promoted the GI^3 (Global Intellectual Incubation and Integration) Laboratory Program and Global Brain Circulation Program. In GI^3 Laboratory Program, young researchers were sent and accepted via foreign PIs and 15 partner institutions. After the GI^3 Laboratory Program was institutionalized in FY2009, the number of researchers exchanged between AIMR and overseas partner institutions increased, though it decreased in FY2011 because of the earthquake (15, 18, 9 and 20 researchers in FY2009, 2010, 2011 and 2012, respectively). In the Global Brain Circulation Program started in FY2012, cooperating with other departments of Tohoku University, one young researcher has been sent to overseas academic institutions and one young researcher has been accepted by each "affiliated professor". In order to create an environment which can attract foreign researchers, AIMR helped non-Japanese researchers to apply for external research funds, submitting successful applications to KAKENHI and CREST. The winning of a CREST grant by an AIMR foreign researcher (M.W. Chen PI) in FY2011 and his continuous world top level research outcomes was one of the big achievements due to the support system.

In order to strengthen the cooperation with overseas satellites, AIMR established Joint Laboratories at the University of Cambridge and the University of California, Santa Barbara in FY2012 and joint research between AIMR and the satellites has greatly progressed. Global collaboration between AIMR and overseas satellites and partner institutions produced 17 papers in FY2012 and consequently the name recognition of AIMR was raised.

The AIMR International Symposium (AMIS2013) was held in February 2013 and 240 participants from 14 countries (regions) attended it. This international symposium has been developed from the annual workshop which had continuously been held at this time every year. Since the first annual workshop held in February 2008, the number of foreign PIs, adjunct professors and adjunct associate professors have increased and the number of participants is increasing year by year as well. In particular, mathematicians joined AMIS2013 this time, allowing us to confirm our mission of mathematics – materials science collaboration through deep discussion. AIMR researchers also attended many other international meetings. They gave 103 invited presentations at international meetings in FY2012, with many being plenary lectures and keynote presentations. AIMR researchers introduce WPI and AIMR briefly at the beginning of every presentation to gain international publicity and established reputation.

The Public Relations & Outreach office was established in the Administrative Division in FY 2012 and started to enhance AIMR's publicity and outreach activities. In order to publicize AIMR further, we set AIMR's new logo whose motif is AIMR's objective of integrating materials science fields by mathematics (using the integral sign ∫) and advertisements for AIMR were printed in *Science* (Vol.336, 13 April 2012) and *Nature Asia-Pacific* (PUBLISHING INDEX 2012), and furthermore, targeting researchers, advertisements for *AIMResearch* was printed in *Nature* (Vol.486, 28 June 2012 and another three times). The banner advertisement on the websites of those scientific magazines was also carried out. The Summer School (ASSM2012) was held for almost one week in July, 2012, partially aiming to promote AIMR's outreach activities and international research collaboration activities. This summer school had 200 applications in total, and 30 undergraduate and graduate students from 13 countries (regions) were selected.

The "Combination Room" in the Main Building of AIMR has become an important place for active exchanges and discussion between researchers. "Tea Time" held on every Friday at the Combination Room provides further opportunities to make and increase collaboration. Sometimes within this Tea Time, a "Tea Time Talk" is held, where foreign PIs and visiting researchers give talks in a relaxed atmosphere, thereby providing opportunities to create new joint research projects. These occasions also encourage exchanges between foreign researchers and Japanese researchers. Fusion research is also enhanced in such an atmosphere.

The research environment for researchers from abroad, including short-stay visiting researchers, was improved by completing the "Research Support Center" which consists of the "Common Equipment Unit", "Computation-Aid Unit," "Mathematics Collaboration Unit," and "Researcher Support Office" in FY2012. Through the support of this

center, researchers are able to start their research quickly after their arrival at AIMR.

4. Implementing organizational reforms

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

AIMR implemented the following organization reforms and ripple effects on the host institution and other departments of the host institution were confirmed.

(1) Construction of new research organization in the host institution based on the achievements of the WPI Program

Based on the world top level research center system which AIMR is organizing, for example, the "Brain Circulation Program", "Research Support Center" and double affiliation researcher employment, the president of Tohoku University has established a "Project Team" to discuss constructing a new research organization of the world's highest standards which can become the hub of global brain circulation in Tohoku University.

(2) Ripple effects of research support system on the host institution

In FY2012, the Research Support Center (Researcher Support Office), which AIMR had started to establish in late FY2011, has been almost completed and began a mentoring service, which provides opportunities for young researchers to increase their research skills in writing papers, making good presentations, and so on. This service at AIMR led to the Paper Writing Workshop held by the host institution.

The logistics expertise accumulated at the International Relations Unit, for example, the expertise in holding international symposia has been utilized for international symposia held by the departments in the host university.

(3) Promotion of international activities of the host institution

The status and treatment of the researchers of AIMR including the overseas institutions (satellites) were reconsidered and personnel issues such as an employment agreement form were standardized. This measure will help the host university to promote the global brain circulation and reinforcement of the partnership with overseas institutions.

(4) Overseas traveling procedure for inviting foreign researchers

In order to increase the invited foreign researchers' convenience and simplify the paperwork, AIMR realized the liquidation denominated in foreign currencies concerning charges forward for overseas traveling expenses. Furthermore, AIMR is developing a new system to send airline tickets directly to foreign researchers. It is expected that, owing to these measures, the host institution can accomplish major laborsaving with respect to the office processing for the overseas traveling expenses. Furthermore, this new system will favorably influence the improvement of the infrastructure to promote the global brain circulation by the whole host institution.

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

* Please address the following items, which are essential to mid- to long-term center development:
  - Future Prospects with regard to the research plan, research organization and PI composition; prospects for the fostering and securing of next-generation researchers
  - 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
  - Measures to sustain the center as a world premier international research center after program funding ends (including measures of support by the host institution)

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

In FY2011, AIMR advertised the strategy of promoting mathematics – materials science collaboration to

establish new materials science which can design new functional materials based on prediction and contribute to society through the creation of new functional materials based on the newly established materials science. In order to realize this strategy, AIMR completed the reform of the organization by, for example, establishing the Interface Unit, in FY2012. Our mid-term goal is to provide a basis for common understanding among the existing four research groups via a mathematical viewpoint, and our long-term goal is to contribute to society through creating revolutionary *Green Materials* for "energy harvesting," "energy saving" and "environmental clean-up." In order to promote our new approach we have carried out the following activities.

AIMR employs interface researchers to promote mathematics – materials science collaboration and links the interface researchers to the Target Projects. In FY2012 AIMR employed six interface researchers and plans to employ two more researchers in FY2013. Under supervision by a mentor, the interface researchers take up the important role of acting as bridges between materials researchers and mathematicians by an effective link with the Target Projects, as well as performing thier own research as independent researchers. These actions assure direct interaction between mathematicians / theorists and interface researchers / experimentalists so that every AIMR researcher can mutually benefit from the collaboration and obtain new skills for interdisciplinary fusion research.

From the comprehensive viewpoint of development of mathematics – materials science collaboration, promotion of Target Projects and acceleration of interdisciplinary fusion, some PIs were replaced in order to enhance our new research direction. In FY2012, Professor Hideo Ohno (magnetic semiconductor), Professor Eiji Saitoh (spin current), Professor Shin-ichi Orimo (hydrogen functional materials), Professor Seiji Samukawa (device process), and Professor Tomasz Dietl (spintronics theory) were appointed as new PIs. On the other hand, Professor Terunobu Miyazaki and Professor Michio Tokuyama have retired from the PI role. Junior Principal Investigators (Junior PIs) and Independent Investigators (IIs), the scintillatingly excellent young researchers at AIMR, have been given an independent environment, almost the same as that of PIs, and can pioneer new research areas. A Research Support Center (Common Equipment Unit, Computation-Aid Unit, Mathematics Collaboration Unit, and Researcher Support Office) was completed and support for a smooth start of research at AIMR has been developed. A new framework for researcher support, through for example training on presentations at the Researcher Support Office, will contribute to fostering next generation researchers.

(2) 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

The promotion of AIMR is clearly positioned in the most important items in the Mid-Term Objectives and Plans of our host institution, Tohoku University. AIMR was established as a department of Tohoku University from the beginning and the university has decided to retain AIMR as a world top level research center for innovative materials science even after the end of the WPI program. The host university has already established a Project Team for implementation of this plan; the Team has evaluated the outcomes of AIMR so far and the advantages for Tohoku University to keep AIMR, and has started to discuss deeply the sustainable organizational framework of AIMR and the number of researchers. Tohoku University has a large stock of researchers in materials science. In order to gather all their power and construct an unshakable world top research center in materials science at Tohoku University, realization of an international community based on the global network with AIMR placed as a core is necessary. To achieve this, Tohoku University is planning to promote international cooperation as well as cooperation inside the university in materials science.

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

Tohoku University is planning to establish "the organization for Advanced Studies" (tentative name) including

AIMR as a first member. It depends on the discussed results with respect to the outcomes of AIMR so far and the significance of AIMR in Tohoku University. Furthermore, the new institute aims to permeate the new systems developed by AIMR throughout the whole university and strengthen the research capabilities of Tohoku University. The organization for Advanced Studies (tentative name) also includes a research reception center and an internationalized administrative office, with a complete research environment of world standards. A "visitor research center for theory" also will be established within the organization for Advanced Studies, using the Interface Unit of AIMR as a model. Cooperating with the "visitor research center for theory", AIMR will invite the theoretical scientists and mathematicians of the Nobel Prize and the Fields Medal class, and will further develop and establish the mathematics – materials science collaboration. Consequently AIMR will continue as the world top level research center for materials science without equal in the world. The mathematics – materials science collaboration established as a world-first by AIMR also becomes a model of collaboration of mathematics with fields other than materials science, always attracting attention from the world and will serve as space filled with the energy of researchers who come from around the world to learn about AIMR's new system.

6. Others

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

i) On April 1st, 2012, AIMR Professor Motoko Kotani, a mathematician, was inaugurated as the new Center Director of AIMR and Professor Masaru Tsukada, a theoretical physicist, was appointed as the Administrative Director. They have almost completed a new organization to achieve progress in mathematics – materials science collaboration and carried out system reform to make AIMR an international research center.

ii) The international guest house at Tohoku University – plans for which were based on the requests of AIMR to the University – was completed next to the AIMR main building in March 2013, so that the environment for visiting researchers to stay AIMR has been improved.

iii) In order to increase chances for personal communication among researchers including foreign PIs, AIMR is arranging "Tea Time Talks" and mini concerts during Friday Tea Time. These events contribute to creating a good atmosphere at AIMR.

iv) Recognizing the necessity for starting original action with respect to the safety management in environments where researchers with different backgrounds and cultures gather, AIMR made a regulation that prior inspection by the Management Office for Safety and Health is necessary before introducing new equipment or moving equipment.

v) AIMR started a skill development system to send administrative office staff to foreign satellites or partner institutions for a short period and create opportunities to discuss office work directly with the staff at the institutions.

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

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

A) Response to the requests and recommendations suggested in the follow-up report by the program committee

1) The director introduced a new culture and paradigm to materials science field. Now AIMR became a visible existence and seems on the right track to be a world premier institute. We are looking forward to seeing

emergence of unique scientific accomplishments, although in its nature we must wait for a while.

[Action]

As suggested by the program committee, the mathematical viewpoint was injected into materials science and interface researchers who can bridge the gap between mathematicians and materials scientists joined AIMR; the opportunities for active exchange between researchers with different backgrounds increased, and now we are ready to step up to the next stage where we can develop science of higher quality. The role of the interface researchers has gradually changed from the role of interpreters to the role of leaders who advance the interdisciplinary research independently; some papers have been submitted from the interdisciplinary teams. Although creation of a completely new scientific field takes time, results are beginning to be produced steadily.

2) The next two years will be crucial for the Center for sustainability of the center.

[Action]

As mentioned above (**A-1**), the mathematics – materials science collaboration at AIMR is developing as expected. We believe that we can get over almost all important hurdles that we have to overcome within these two years (FY2012 and next fiscal year 2013).

3) There should be some boundary which could not simply be resolved by the concept of math-mate collaboration, for example, in some synthetic chemistry. Serious discussion is necessary what fields in the materials science could be covered or should be challenged by the AIMR's new concept.

[Action]

As the program committee suggested, research fields can be divided into two groups; one where the collaboration with mathematics is relatively easy and the other where collaboration is very difficult. However, even in the latter case, we think that we can find new prospects for fusion by repeated discussion. For example, even in the field of synthetic chemistry, we can find and discuss the relationship with mathematics through geometric characteristics or associated properties of synthesized products. On April 1, 2013, a young talented organic synthetic chemist, Prof. Hiroyuki Isobe, the professor of the Department of Chemistry, Graduate School of Science, Tohoku University, was appointed as a PI of AIMR. A multitude of organic molecules that his group has synthesized have an aspect of "geometry" and "topology", and now attract much attention.

In addition, the fusion research group of organic synthesis (Asao-Jin group), physics (Tanigaki group) and theory recently found the interesting phenomenon of light emission which can be controlled through the geometric feature of organic molecules and succeeded in publishing two papers, an experimental one and a theoretical one (K. Oniwa et al., Journal of Materials Chemistry C **1**, 4163−4170 (2013) ; H. Tamura et al., Journal of Physical Chemistry C **117**, 8072−8078 (2013)).

4) What are the real benefits to the Lab brought by the 3 satellites and 16 partners and by the large number of oversea PI?

[Action]

As shown in the **list below (*)**, satellites, partner institutions, foreign PIs and adjunct professors have clear roles for the joint research with AIMR and dissemination to increase the international visibility of AIMR. Furthermore, exchange between AIMR and such foreign partners has become more active and substantial. Therefore, we do not plan to reconsider our framework for international partnership.

B) Response to the results of the site visit held in August, 2012

1) Even though there still remains the initial concern about its feasibility, concept of math-mate collaboration

is a bold move and should be pursued. It has potential to create truly new directions in materials science and definitely encouraged as a unique part of this Institute.

[Action]

We sincerely thank the program committee for supporting us. We will surely create new materials science and establish a visible world top level research center on this occasion.

2) For AIMR, it is essential to overcome two gates, the first one is conditional approval for 2 years after the interim evaluation, and when it is cleared, the second gate for 5 year extension beyond 10 years period. For this, it is important for AIMR to hold the current strategy with full confidence. Also short time and medium time strategy should be carefully prepared in parallel.

[Action]

After the interim evaluation, the strategy that AIMR established has worked well and we had clear progress in the mathematics – materials science collaboration. In particular, the interface researchers actively play their roles as a bridge between mathematicians and materials scientists. These three groups have fused together and are frequently holding seminars and study meetings, and they have already submitted some papers of their results. We are sure that this progress in our new strategy is one step ahead of what we initially expected. We believe that we have passed the conditions for the **first gate**, and we are now directing our attention to the **second gate** for the 5 year extension beyond the 10 year period.

3) At the same time, there should be some boundary which could not simply be resolved by the concept of math-mate collaboration, for example, in some synthetic chemistry. Serious discussion is necessary what fields in the materials science could be covered or should be challenged by the AIMR's new concept.

[Action]

The comment is just the same as that of **A-3**. Please refer the action to the comment **A-3**.

*** List of the roles of satellites, partner institutions, foreign PIs and adjunct professors mentioned at above A-4.** (As of March 31, 2013)

a) Satellites

(1) University of Cambridge

AIMR established Joint Laboratories for non-equilibrium materials (at the Department of Materials Science and Metallurgy) and soft materials (at the Department of Chemistry). At the Joint Laboratory for non-equilibrium materials Jiri Orava (Research Associate, AIMR) was employed and joint research between the A. Lindsay Greer group (AIMR foreign PI, Head of the Department of Materials Science and Metallurgy) and Dmitri V. Louzguine (PI, AIMR) started. At the Joint Laboratory for soft materials Katherine Orchard (Research Associate, AIMR) was employed and joint research between the Erwin Reisner (Lecturer at Department of Chemistry) group and the groups of Tadafumi Adschiri (PI, AIMR) and Naoki Asao (Professor, AIMR) started. The above research associates stay at AIMR 2-8 weeks out of every year so that they can effectively advance the joint research. Now, AIMR is preparing to establish a Joint Laboratory of mathematics.

(2) Institute of Chemistry, Chinese Academy of Sciences

Li-Jun Wan (AIMR foreign PI) is the Director of the Institute of Chemistry, Chinese Academy of Sciences, one of the world authorities of surface chemistry, who obtained his doctoral degree at Tohoku University. Zhang Xu (Research Associate) is placed at Wan Laboratory at AIMR and is doing joint research on molecular nanotechnology and devices. AIMR is now preparing to establish a Joint Laboratory at the Institute of Chemistry,

Chinese Academy of Sciences.

(3) University of California, Santa Barbara (UCSB)

AIMR established a Joint Laboratory for organic opto electronics and condensed phase phenomena (at UCSB California Nano systems Institute (CNSi)). At the Joint Laboratory Yonghao Zheng (Research Associate, AIMR) was employed and joint research between the Fred Wudl (AIMR foreign adjunct professor) group and Katsumi Tanigaki (PI, AIMR) group started. The research associate stays at AIMR 2-8 weeks out of every year so that they can effectively advance the joint research.

b) Partner institutions

(1) University of Wisconsin-Madison

John H. Perepezko (Adjunct Professor), professor of University of Wisconsin-Madison, stays at AIMR 1-4 weeks out of every year and is carrying out joint research with the Dmitri V. Louzguine (PI, AIMR) group on metallic glasses. He has a high level of activity for exchange with AIMR young researchers during his stay, for example, by giving Tea Time Talks at the Friday Tea Time.

(2) Grenoble Institute of Technology

Alain Reza Yavari (AIMR foreign PI), professor of Grenoble Institute of Technology, stays at AIMR 1-3 months out of every year and is carrying out joint research with the Mingwei Chen (PI, AIMR) and Dmitri V. Louzguine (PI, AIMR) groups on bulk metallic glasses. He has a high level of activity for exchange with AIMR young researchers during his stay, for example by giving Tea Time Talks at the Friday Tea Time. Konstantinos Georgarakis (Assistant Professor) is placed at Yavari's laboratory at AIMR and they have arranged a joint research structure.

(3) University of Massachusetts Amherst

Thomas P. Russell (AIMR foreign PI), professor of University of Massachusetts Amherst, stays at AIMR 2-5 weeks out of every year and is carrying out joint research with the Ken Nakajima (Associate Professor, AIMR) group on polymers and soft materials. He has a high level of activity for exchange with AIMR young researchers during his stay, for example by giving Tea Time Talks at the Friday Tea Time. He places young researchers including PhD students of his laboratory of the University of Massachusetts at AIMR as visiting scientists.

(4) Chemnitz University of Technology

Thomas Gessner (AIMR foreign PI), professor of Chemnitz University of Technology, is the Director of the Fraunhofer Research Institution for Electronic Nano Systems (ENAS) in Germany. He is conducting joint research on micro electro mechanical systems (MEMS) with Masayoshi Esashi (PI, AIMR) based on their long collaboration. Yu-Ching Lin (assistant professor) and Yao-Chuan Tsai (Research Associate) are placed at Gessner's laboratory at AIMR and they have arranged a joint research structure. He also places young researchers including PhD students of his laboratory of Chemnitz University of Technology at AIMR as visiting scientists. Due to such strong cooperation, AIMR - Fraunhofer Project Center has been established and further joint research is carried out. We are planning to extend our contract to more comprehensive one.

(5) University College London

Alexander Shluger (AIMR foreign PI), professor of University College London, stays at AIMR 2-5 weeks out of every year and is carrying out joint research with the Kazuto Akagi (Associate Professor, AIMR) group, Kazue Kurihara (PI, AIMR) group and Dmitri Louzguine (PI, AIMR) group on theoretical calculation, surface and interface chemistry and metallic glasses, respectively. Filippo Federici Canova (Research Associate) is placed at Shluger's laboratory at AIMR and they have arranged a joint research structure. He also places young researchers including PhD students of his laboratory of University College London at AIMR as visiting scientists.

(6) University of Cambridge

Refer to **satellites** listed above

(7) Institute of Chemistry, Chinese Academy of Sciences

Refer to **satellites** listed above

(8) University of California, Santa Barbara (UCSB)

Refer to **satellites** listed above

(9) University of California, Los Angeles (UCLA)

Paul S. Weiss (AIMR foreign PI), professor of UCLA, is the Director of California Nanosystems Institute (CNSi) UCLA. He is carrying out joint research with the Taro Hitosugi (Associate Professor, AIMR) group on atom/molecule control of surface and interface. He has his laboratory at AIMR and places Patrick Han (Assistant Professor) at the AIMR laboratory, and has arranged a joint research structure with AIMR.

(10) Johns Hopkins University

Kevin J. Hemker (AIMR foreign PI), professor of Johns Hopkins University, is carrying out joint research with Mingwei Chen (PI, AIMR) on metals and alloys.

(11) Tsinghua University

Qi Kun Xue (AIMR foreign PI), professor of Tsinghua University, is carrying out joint research with the Materials Physics group on surface physics. Zhang Ling (Assistant Professor) is placed at Xue's laboratory at AIMR and they have arranged a joint research structure.

(12) Texas A&M University

Winfried Teizer (AIMR Junior PI), the associate professor of Texas A&M University, stays at AIMR 3-5 months out of every year and is carrying out joint research with the Tadafumi Adschiri (PI, AIMR) group and Taro Hitosugi (Associate Professor, AIMR) group on nanocrystals and molecular magnets. He has a high level of activity for exchange with AIMR young researchers during his stay, for example by giving Tea Time Talks at the Friday Tea Time. He has his laboratory at AIMR and places Aurelien Sikora and Kyongwan Kim (Research Associates) at the AIMR laboratory. He also places young researchers including PhD students of his laboratory of Texas A&M University at AIMR as visiting scientists.

(13) Harvard University

Ali Khademhosseini (AIMR Junior PI), the associate professor of Harvard University, stays at AIMR 2-6 weeks out of every year and is carrying out joint research with the Tomokazu Matsue (PI, AIMR) group and Hongkai Wu (AIMR Junior PI) group on biomaterials and bio-devices. He has his laboratory at AIMR and places Serge Ostrovidov (Assistant Professor) and Samad Ahadian, Selvakumar Prakash and Toshinori Fujie (Research Associates) at the AIMR laboratory. Collaboration with Natsuhiko Yoshinaga (Assistant Professor) from the Mathematical Unit has been started.

(14) Hong Kong University of Science and Technology

Hongkai Wu (AIMR Junior PI), the associate professor of Hong Kong University of Science and Technology, stays at AIMR 1-4 weeks out of every year and is carrying out joint research with the Tomokazu Matsue (PI, AIMR) group and Ali Khademhosseini (AIMR Junior PI) group on biomaterials and bio-devices. He has his laboratory at AIMR and places Haixin Chang (Assistant Professor) and Xuetao Shi and Haijun Yu (Research Associates) at the AIMR laboratory and they have arranged a joint research structure.

(15) The University of Tokyo

Yuichi Ikuhara (PI, AIMR), the professor of the University of Tokyo, stays at AIMR every month and is carrying out interdisciplinary research with many AIMR laboratories using their special technique of scanning transmission electron microscopy. He has his laboratory at AIMR and places Susumu Tsukimoto (Lecturer), Mitsuhiro Saito (Assistant Professor), Zhongchang Wang (Assistant Professor), and Chunlin Chen (Research Associate) at the AIMR laboratory and they have arranged a joint research structure.

List of Center's Research Results and Main Awards

A. Refereed Papers

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

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

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

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

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

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

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

(2) Method of listing paper

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

(3) Submission of electronic data

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

(4) Use in assessments

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

(5) Additional documents

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

Order of Listing

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

5. Articles written in other than English

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

C. Previously published WPI-related papers

A. WPI papers【Original article】

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A. WPI papers【Review articles】

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281. Jin, T.N., M. Yan, and Y. Yamamoto, "Click Chemistry of Alkyne-Azide Cycloaddition using Nanostructured Copper Catalysts", *ChemCatChem*, **4**, 9, 1217-1229, (2012)
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A. WPI papers【Proceedings】

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A. WPI papers【Articles written in other than English】

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B. WPI-related papers【Original article】

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8. Liu, C., T. Lei, Ino Kosuke, Tomokazu Matsue, Nongjian Tao and Chen-Zhong Li, "Real-time Q1 Q2 monitoring biomarker expression of carcinoma cells by surface plasmon resonance biosensors.", *Chemical Communications*, **48**, 84, 10389-10391, (2012)
9. Marko, D., T. Devolder, K. Miura, K. Ito, J. V. Kim, C. Chappert, S. Ikeda, and H. Ohno, "Material parameters and thermal stability of synthetic ferrimagnet free layers in magnetic tunnel junction nanopillars", *Journal of Applied Physics*, **112**, 5, 053922 (4 pages), (2012)
10. McLeod, J.A., A. Buling, E.Z. Kurmaev, P.V. Sushko, M. Neumann, L.D. Finkelstein, S.W. Kim, H. Hosono, and A. Moewes, "Spectroscopic characterization of a multiband complex oxide: Insulating and conducting cement 12CaO center dot $7Al_2O_3$", *Physical Review B*, **85**, 4, 045204 (8 pages), (2012)
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12. Michimura, S., T. Inami, E. Matsuoka, M. Watahiki, K. Tanigaki, H. Onodera, "Resonant X-Ray Diffraction Study of Multipole Ordering in the Ferromagnetic Compound $CePd_3S_4$", *Journal of the Physical Society of Japan*, **81**, 044711 (5 pages), (2012)
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16. Yabu, H., S. Sato, T. Higuchi, H. Jinnai, and M. Shimomura, "Creating suprapolymer assemblies: nanowires, nanorings, and nanospheres prepared from symmetric block-copolymers confined in spherical particles", *J. Mater. Chem.*, **22**, 16, 7672-7675, (2012)
17. Yamamoto, H., J. Hayakawa, K. Miura, K. Ito, H. Matsuoka, S. Ikeda, and H. Ohno, "Dependence of magnetic anisotropy in $Co_{20}Fe_{60}B_{20}$ free layers on capping layers in MgO-based magnetic tunnel junctions with in-plane easy axis", *Applied Physics Express*, **5**, 5, 053002 (3 pages), (2012)
18. Yamamoto, K., N. Oyamada, M. Mizutani, ZJ. An, N. Saito, M. Yamaguchi, M. Kasuya and K. Kurihara, "Two Types of Two-Component Gels Formed from Pseudoenantiomeric Ethynylhelicene Oligomers", *Langmuir*, **28**, 32, 11939-11947, (2012)
19. Yamamoto, M., T. Yasukawa, M. Suzuki, S. Kosuge, H.Shiku, T. Matsue, F. Mizutani, "Patterning with particles using three-dimensional interdigitated array electrodes with negative dielectrophoresis and its application to simple immunosensing.", *Electrochimica Acta*, **82**, SI, 35-42, (2012)
20. Yasukawa, T., J. Yamada, H. Shiku, F. Mizutani, T, "Negative dielectrophoretic particle positioning in a fluidic flow", *Inteligent Automation and Soft Computing*, **18**, 2, 201-211, (2012)
21. Yoshimura, Y., T. Koyama, D. Chiba, Y. Nakatani, S. Fukami, M. Yamanouchi, H. Ohno, and T. Ono, "Current-induced domain wall motion in perpendicularly magnetized Co/Ni nanowire under in-plane magnetic fields", *Applied Physics Express*, **5**, 6, 063001 (3 pages), (2012)

B. WPI-related papers【Review articles】

22. Brataas, A., A.D. Kent, and H. Ohno, "Current-induced torques in magnetic materials", *Nature Materials (Revies Articles)*, **11**, 5, 372-381, (2012)
23. Seidi, A., and M. Ramalingam, "Impact of Gradient Biomaterials on Interface Tissue Engineering", *Journal of Biomaterials and Tissue Engineering*, **2**, 2, 89-99, (2012)

B. WPI-related papers【Proceedings】

24. Enobio, E.C.I ., H. Sato, K. Ohtani, Y. Ohno, and H. Ohno, "Photocurrent measurements on a quantum cascade laser device by fourier transform infrared microscope", *Japanese Journal of Applied Physics*, **51**, 6, 06FE15 (3 pages), (2012)
25. Ghali, M., K. Ohtani, Y. Ohno, and H. Ohno, "Vertical-electrical-field-induced control of the exciton fine structure splitting in GaAs island quantum dots for the generation of polarization-entangled photons", *Japanese Journal of Applied Physics*, **51**, 6, 06FE14 (3 pages), (2012)
26. Kinoshita, K, T. Yamamoto, H. Honjo, N. Kasai, S. Ikeda, and H. Ohno, "Damage recovery by reductive chemistry after methanol-based plasma etch to fabricate magnetic tunnel junctions", *Japanese Journal of Applied Physics*, **51**, 8, 08HA01 (8 pages), (2012)
27. Suzuki, D., M. Natsi, T. Endoh, H. Ohno, and T. Hanyu, "Design of a compact nonvolatile four-input logic element using a magnetic tunnel junction and metal-oxide-semiconductor hybrid structure", *Japanese Journal of Applied Physics*, **51**, 4, 04DM02 (5 pages), (2012)
28. Teramoto, T., A. Satake, A.Ooga, Y.Nishiura and M.Iima, "Density gradient of florigen signals mediates diversity of inflorescence architectures : Phloem transport model based on source-sink balance", *Progress in Photonics: Materials, Nano-and Bio-Imaging and Communications*, 101-104, (2012)

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

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

No.	Lecturer/presenter names and details
1	Yasumasa Nishiura, "Pulse generators in dissipative systems", International Conference on Dynamics of Differential Equations, Georgia Institute of Technology, Atlanta, GA, USA, March 16, 2013
2	Kazue Kurihara, "Overview of "Interfacial Fundamentals" research area", Emerging Leadership Workshop Australia–Japan Colloid Materials Partnership, Melbourne, Australia, December 2–4, 2012
3	Taro Hitosugi, "Atomic-scale investigation of $LaAlO_3/SrTiO_3$ interface" International Conference on Emerging Advanced Nanomaterials (ICEAN), Brisbane, Australia, October 22, 2012
4	Katsumi Tanigaki, "Intercalation of Polyacenes and Their Physical Properties: Present status and future possibility", LEMSUPER Workshop, Max-Planck Institute, Dresden, Germany, October 12–14, 2012 (Keynote Lecture)
5	Eiji Saitoh, "Dynamical generation of spin currents", Joint European Magnetic Symposia 2012 (JEMS2012), Palma, Italia, September 12, 2012 (Semi Plenary)
6	Ken Nakajima, "AFM-based modulus measurement for polymeric materials" , 244th American Chemical Society National Meeting & Exposition, Philadelphia, USA, Aug. 19–23, 2012
7	Hideo Ohno, "Bridging Semiconductor and Magnetism", 31st International Conference on the Physics of Semiconductors (ICPS 2012), Zurich, Switzerland, July 29 – August 3, 2012 (Plenary)
8	Masatsugu Shimomura, "Biomimetic Self-organized Functional Surface Materials", 4th International Conference on Smart Materials, Structures and Systems, Montecatini Terme, Italy, June 10–14, 2012
9	Tadafumi Adschiri, "Supercritical Route for Super Hybrid Materials", ISSF 10^{th} International Symposium on Supercritical Fluids, San Francisco, CA, USA, May 13–16, 2012 (Keynote Lecture)
10	Tomokazu Matsue, "Bioelectrochemical Imaging with SECM-SICM Hybrid System", 2012 Asia-Pacific Conference on Analytical Sciences (APCAS) and the 3rd Regional Electrochemistry Meeting of South-East Asia (REMSEA), Philippines, April 12, 2012 (Keynote Lecture)

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

No.	Recipient names and details
1	Tadafumi Adschiri, 2013 The SCEJ (The Society of Chemical Engineers, Japan) Award, 2012
2	Akari Takayama (Graduate Student of Takahashi Laboratory at AIMR), Third (FY2012) JSPS IKUSHI Prize, 2012
3	Hideo Ohno, Fellow of American Physical Society, 2012
4	Ali Khademhosseini, The 2012 Young Investigator Award, Biochemical Engineering Journal, 2012
5	Eiji Saitoh, DoCoMo Mobile Science Awards 2012, Fundamental science, Excellence award, 2012
6	Junqiang Wang, Young Scientist Award in 19th International Symposium on Metastable, Amorphous and Nanostructured Materials (ISMANAM), 2012
7	Tadafumi Adschiri, The11th GSC (Green and Sustainable Chemistry) Award awarded by the Minister of Education, Culture, Sports, Science and Technology, 2012
8	Akihiko Hirata, The Japanese Society of Microscopy, Encouraging Prize, 2012
9	Hideo Ohno, IEEE David Sarnoff Award, 2012
10	Yasumasa Nishiura, Prizes for Science and Technology (Research Category), The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, 2012

FY 2012 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 the latest report, attach "Biographical Sketch of a New Principal Investigator".

<Results at the end of FY2012>

Principal Investigators Total: 32

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			
Center director Motoko Kotani* (53)	Professor, AIMR, Tohoku University	Dr of Science, Mathematics (Geometry)	40%	50%	10%	0%	Director: From April 2012 Deputy Director: From May 2011 PI: From March 2011	Usually stays at the center	
Tadafumi Adschiri* (55)	Professor, AIMR, Tohoku University	Dr of Engineering, Hybrid materials, Super-critical Fluid Technology	80%	0%	0%	20%	From start	Usually stays at the center	
Mingwei Chen* (47)	Professor, AIMR, Tohoku University	Dr of Engineering, Materials Science	100%	0%	0%	0%	From start	Usually stays at the center	

Masayoshi Esashi* (64)	Professor, AIMR, Tohoku University	Dr of Engineering Sensors, Micro Electro Mechanical Systems	80%	0%	0%	20%	From start	Usually stays at the center	
Kazue Kurihara * (62)	Professor, AIMR, Tohoku University	Dr of Physical Chemistry, Colloid and Interface Science	80%	0%	0%	20%	From Apr. 2010	Usually stays at the center	
Dmitri V. Louzguine * (45)	Professor, AIMR, Tohoku University	Dr of Engineering, Materials Science	100%	0%	0%	0%	Professor: From Dec. 2007 PI: From 2009	Usually stays at the center	
Tomokazu Matsue*(59)	Professor, AIMR, Tohoku University	Dr of Pharmacy, Biosensing Engineering	80%	0%	0%	20%	From Nov. 2010	Usually stays at the center	
Terunobu Miyazaki* (69)	Professor, AIMR, Tohoku University	Dr of Engineering, Magnetic Properties	100%	0%	0%	0%	From start	Usually stays at the center	

Yasumasa Nishiura* (62)	Professor, AIMR, Tohoku University	Dr of Science, Applied Mathematics (Nonliner Dynamics)	100%	0%	0%	0%	From Feb. 2012	Usually stays at the center	
Shin-ichi Orimo * (47)	Professor, AIMR, Tohoku University	Ph.D., Materials Engineering and Chemistry	80%	0%	0%	20%	From Jan. 2013	Usually stays at the center	
Eiji Saitoh*（41）	Professor, AIMR, Tohoku University	Dr of Engineering, Spintronics	80%	0%	0%	20%	From Apr. 2012	Usually stays at the center	
Masatsugu Shimomura* (59)	Professor, AIMR, Tohoku University	Dr of Engineering, Polymer Science	80%	0%	0%	20%	From start	Usually stays at the center	
Takashi Takahashi* (61)	Professor, AIMR, Tohoku University	Dr of Science, Solid-State Physics	80%	0%	0%	20%	From start	Usually stays at the center	

Katsumi Tanigaki* (58)	Professor, AIMR, Tohoku University	Dr of Engineering, Nano Materials Science	80%	0%	0%	20%	From start	Usually stays at the center	
Michio Tokuyama* (64)	Professor, AIMR, Tohoku University	Dr of Science, Statistical Physics	80%	0%	0%	20%	From start	Usually stays at the center	
Hideo Ohno* (58)	Professor, Research Institute of Electrical Communication, Tohoku University	Dr of Engineering, Semiconductor Physics and Engineering, Spintronics	40%	0%	40%	20%	From Apr. 2012	Usually stays at the Institute of Research Institute of Electrical Communication, close to the center, and participate in the center's activities	
Seiji Samukawa* (54)	Professor, Institute of Fluid Science, Tohoku University	Dr of Nanoprocess Engineering	40%	0%	40%	20%	From Apr. 2012	Usually stays at the Institute of Fluid Science, close to the center, and participate in the center's activities	
Yuichi Ikuhara* (54)	Professor, School of Engineering, University of Tokyo	Dr of Engineering, Physical Metallurgy	40%	0%	40%	20%	From start	Stays at the center every two weeks	

Kazuyoshi Yamada* (63)	Director, Neutron Science Laboratory, High-Energy Accelerator Research Organization (KEK)	Dr of Science, Solid-State Physics	40%	0%	40%	20%	From start	Stays at the center three times a year	
Tomasz Dietl* (62)	Professor, Head of Laboratory of Cryogenic and Spintronic Research, Institute of Physics, Polish Academy of Sciences	Dr. Hab., physics of semiconductors and magnetic materials, low-temperature physics	20%	0%	45%	35%	From Apr. 2012	Stays at the center twice a year Attends the conference	
Thomas Gessner* (58)	Professor, Center for Micro-technologies, Chemnitz University of Technology	PhD in Device Science/ Technology	30%	0%	50%	20%	From start	Stays at the center twice a year Attends the conference Sends young scientists to the center	send young scientists to the WPI center (1/4.5 years since 2008) (1/3 months since 2012) (1/7 months) (2/6 months each) (1/4 months) (3/3 months each) (1/1 month)
Alain Lindsay Greer* (57)	Professor, Department of Materials Science & Metallurgy, University of Cambridge	PhD in Metallurgy & Materials Science	20%	0%	45%	35%	From start	Stays at the center twice a year Attends the conference Sends a young scientist to the center	send young scientist to the WPI center (1/5 months since 2012)
Kevin J. Hemker* (51)	Professor, Department of Mechanical Engineering, Johns Hopkins	PhD in Physical Metallurgy	20%	0%	45%	35%	From start		

	University								
Thomas P. Russell* (59)	Professor, Department of Polymer Science and Technology, University of Masachu-Setts Amherst	PhD in Nano-Science Technology	20%	0%	45%	35%	From start	Attends the conference Sends a young scientist to the center	send young scientist to the WPI center (1/3 months)
Alexander Shluger* (58)	Professor, Department of Physics and Astronomy, University College London	PhD in Compu-tational Materials Science, Condensed Matter Physics	35%	0%	40%	25%	From start	Stays at the center three times (one month in total) a year Attends the conference Sends young scientists to the center	send young scientists to the WPI center (1/6 months since 2012) (1/1 month)
Li-Jun Wan* (55)	Professor, Institute of Chemistry, Chinese Academy of Science	PhD in SPM, Physical Chemistry, Nano-science and technology	20%	0%	45%	35%	From start	Attends the conference Sends a young scientist to the center	send young scientist to the WPI center (1/1year and 9 months since 2011)
Paul S. Weiss* (53)	Professor, Department of Chemistry and Biochemistry, University of California, Los Angeles	PhD in Surface Science	20%	0%	45%	35%	From start	Sends a young scientist to the center	send young scientist to the WPI center (1/9 months since 2012)
Qi-kun Xue* (49)	Professor, Department of Physics, Tsinghua University	PhD in Surface Science	20%	0%	45%	35%	From start	Attends the conference Sends a young scientist to the center	send young scientist to the WPI center (1/1 year since 2012)
Alain Reza Yavari* (62)	Professor, Grenoble Institute of Technology	PhD in Physical Metallurgry	30%	0%	45%	25%	From start	Stays at the center several times Attends the conference Sends young scientists to the center	send young scientists to the WPI center (1/4 year and 9 months since 2008) (2/2months each)

Ali Khademhosseini (37)	Associate Professor, Medical School, Harvard University	PhD in Bio-engineering	35%	0%	45%	20%	From Nov. 2009	Stays at the center several times Joins a videoconference regularly from the home institution (Harvard Univ.)	send young scientists to the WPI center (1/2 years and 9 months since 2010) (1/ 2 years since 2011) (2/1 year each since 2012)
Winfried Teizer (41)	Associate Professor, Department of Physics, Texas A&M University	PhD in Physics	35%	0%	40%	25%	From Nov. 2009	Stays at the center several times (over six months in total) a year Joins a videoconference regularly from the home institution (Texas A&M Univ.)	send young scientists to the WPI center (1/2 years and 4 months) (1/2 years and 3 months) (1/1year) (1/3 months)
Hongkai Wu (34)	Associate Professor, Department of Chemistry, Hong Kong University of Science and Technology	PhD in Chemistry	35%	0%	45%	20%	From Nov. 2009	Stays at the center for a month Joins a videoconference regularly from the home institution (Hong Kong Univ.)	send young scientists to the WPI center (1/2 years and 5 months since 2010) (1/2years and 1 month since 2011) (1/1year and 4 months)

Researchers unable to participate in project in FY 2012

Name	Affiliation (Position title, department, organization)	Starting date of project participation	Reasons	Measures taken
Kingo Itaya	Professor, Graduate School of Engineering, Tohoku University	From start	To concentrate on the research at the Graduate School of Engineering, Tohoku University	
Masahiko Yamaguchi	Professor, Graduate School of Pharmaceutical Sciences, Tohoku University	From start	To concentrate on the research at the Graduate School of Pharmaceutical Sciences, Tohoku University	
Yoshinori Yamamoto	Executive Research Coordinator, AIMR, Tohoku University	Director: From start PI: From 2009	Step down as PI because of the rule on age limitation of Tohoku University	
Masaru Tsukada	Administrative Director, AIMR, Tohoku University	From start	To concentrate on the administration at the center	
Toshio Nishi		From start	Step down as PI because of the rule on age limitation of Tohoku University	

Records of FY2012 Center Activities

1. Researchers and center staffs, satellites, partner institutions

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

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

	Goal set in the "Post-interim evaluation revised center project"	Results at end of FY 2012	Final goal (March, 2017)
Researchers	146 < 73, 50%> [22, 15%]	165 < 91, 55%> [15, 9%]	146 < 73, 50%> [22, 15%]
Principal investigators	33 < 12, 36%> [2, 6%]	32 < 15, 47%> [2, 6%]	33 < 12, 36%> [2, 6%]
Other researchers	113 < 59, 52%> [20, 18%]	133 < 76, 57%> [13, 10%]	113 < 59, 52%> [20, 18%]
Research support staffs	50	67	50
Administrative staffs	24	27 (24, 89%)	24 (22, 92%)
Total	220	259	220

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.

"GI^3 (Global Intellectual Incubation and Integration) Laboratory" was inaugurated in FY2009 to motivate prominent researchers (including graduate students) to converge on AIMR from all over the world. The laboratory is designed to become a center of the brain circulation where researchers specializing in materials science can undertake internationally collaborative and fusion research activities. The GI^3 system has led to active exchange with researchers from countries all over the world.

The number of researchers who visited AIMR in FY2012 within the framework of GI^3 was 6 senior researchers (professors and associate professors) and 14 young researchers (assistant professors, post-docs, and graduate students).

The following are examples of prominent researchers studying on a full-time basis who are part of the global brain circulation of researchers.

No.	Position at AIMR	Length at AIMR	Former affiliation	Affiliation after AIMR
1	Postdoc	1 year	PhD. Student, Inst. of Physics Chinese Academy of Sciences (CHN)	(remain at AIMR)
2	Postdoc	1 year	Researcher, Hokkaido Univ. (JPN)	(remain at AIMR)
3	Postdoc	1 year	PhD. Student, Chuo Univ. (JPN)	(remain at AIMR)
4	Postdoc	1 year	PhD. Student, Nagoya Univ. (JPN)	(remain at AIMR)
5	Postdoc	1 year	Researcher, Tohoku Univ. (JPN)	Assist. Prof., AIMR
6	Assist. Prof.	5 months	Postdoc, AIMR	Assist. Prof., Graduate School of Science, Tohoku Univ. (JPN)
7	Assist. Prof.	1 year	Postdoc, AIMR	(remain at AIMR)
8	Assist. Prof.	1 year	Postdoc, AIMR	(remain at AIMR)
9	Assist. Prof.	1 year	PhD. Student, Kyoto Univ. (JPN)	(remain at AIMR)
10	Assist. Prof.	1 year	Researcher, Tohoku Univ. (JPN)	(remain at AIMR)
11	Assist. Prof.	1 year	PhD. Student, The Univ. of Tokyo (JPN)	Assist. Prof., Inst. for Materials Research, Tohoku Univ. (JPN)
12	Assist. Prof.	1 year	Assist. Prof., Graduate School of Science, Tohoku Univ. (JPN)	(remain at AIMR)
13	Postdoc	4 months	Researcher, Tohoku Univ. (JPN)	Assist. Prof., Graduate School of Engineering, Tohoku Univ. (JPN)
14	Postdoc	1 year	Researcher, Italian Inst. of Technology (ITA)	(remain at AIMR)
15	Postdoc	11 months	Researcher, Pusan National Univ. (KOR)	Researcher, Inst. of Multidisciplinary Research for Advanced Materials, Tohoku Univ. (JPN)
16	Postdoc	11 months	PhD. Student, The Univ. of Tokyo (JPN)	(remain at AIMR)
17	Postdoc	11 months	Researcher, Osaka Univ. (JPN)	(remain at AIMR)
18	Postdoc	11 months	Researcher, The Univ. of Tokyo (JPN)	(remain at AIMR)
19	Postdoc	10 months	Researcher, National Chiao Tung Univ., (TAIWAN)	(remain at AIMR)
20	Assist. Prof.	10 months	JSPS Postdoctoral Fellowship for Foreign Researchers (JPN)	(remain at AIMR)
21	Assist. Prof.	10 months	Researcher, Japan Science and Technology Agency (JST) (JPN)	(remain at AIMR)

22	Assoc. Prof.	9 months	Researcher, WPI-MANA (JPN)	(remain at AIMR)
23	Assist. Prof.	9 months	Researcher, Forschungszentrum Juelich (FRG)	(remain at AIMR)
24	Assist. Prof.	9 months	Researcher, Univ. of California, LA (USA)	(remain at AIMR)
25	Postdoc	8 months	PhD. Student, Beijing Univ. of Technology (CHN)	(remain at AIMR)
26	Assist. Prof.	8 months	Project Assist. Prof., The Univ. of Tokyo (JPN)	(remain at AIMR)
27	Postdoc	7 months	JSPS Postdoctoral Fellowship for Foreign Researchers (JPN)	(remain at AIMR)
28	Postdoc	7 months	PhD. Student, Nankai Univ. (CHN)	(remain at AIMR)
29	Postdoc	7 months	PhD. Student, Donghua Univ. (CHN)	(remain at AIMR)
30	Assist. Prof.	7 months	Postdoc, AIMR	(remain at AIMR)
31	Postdoc	7 months	PhD. Student, Pisa Univ. (ITA)	(remain at AIMR)
32	Postdoc	6 months	PhD. Student, Tampere Univ. of Technology (FIN)	(remain at AIMR)
33	Postdoc	5 months	Researcher, Univ. of Cambridge (GBR)	(remain at AIMR)
34	Postdoc	4 months	PhD. Student, Technische Universität Berlin (FRG)	(remain at AIMR)
35	Postdoc	4 months	Researcher, Nanoco Technologies Ltd., (GBR)	(remain at AIMR)
36	PI	3 months	Prof., Inst. for Materials Research, Tohoku Univ. (JPN)	(remain at AIMR)
37	Assist. Prof.	3 months	Researcher, Kyoto Univ. (JPN)	(remain at AIMR)
38	Assist. Prof.	3 months	Researcher, Max Planck Inst. for Polymer Research (FRG)	(remain at AIMR)
39	Postdoc	3 months	JSPS Postdoctoral Fellowship for Foreign Researchers (JPN)	(remain at AIMR)
40	Assist. Prof.	2 months	Researcher, Hokkaido Univ. (JPN)	(remain at AIMR)
41	Assist. Prof.	2 months	Research Fellowships for Young Scientists, JSPS (JPN)	(remain at AIMR)
42	Postdoc	1 month	PhD. Student, Fudan Univ. (CHN)	(remain at AIMR)
43	Postdoc	1 month	Researcher, Univ. of California, Santa Barbara (USA)	(remain at AIMR)
44	Postdoc	1 year and 4 months	Researcher, Univ. of Texas (USA)	Returned to home country

45	Postdoc	1 year and 3 months	PhD. Student, Graduate School of Science, Tohoku Univ. (JPN)	Staff, Hitachi Global storage Technologies
46	PI	5 years and 6 months	Prof., Inst. of Fluid Science, Tohoku Univ. (JPN)	Researcher, Inst. of Multidisciplinary Research for Advanced Materials, Tohoku Univ. (JPN)
47	PI	5 years and 5 months	Prof., Graduate School of Engineering, Tohoku Univ. (JPN)	Research Adviser, AIMR
48	Assist. Prof.	4 years and 6 months	Researcher, Univ. of London (GBR)	Senior researcher, RIKEN (JPN)
49	Assist. Prof.	4 years and 1 month	Researcher, Osaka Univ. (JPN)	MANA Scientist, WPI-MANA (JPN)
50	Assist. Prof.	4 years	Researcher, Pacific Northwest National Laboratory (USA)	Senior Researcher, National Institute for Materials Science (NIMS) (JPN)
51	Assist. Prof.	3 years	Postdoc, AIMR	Assoc. Prof., AIMR
52	Postdoc	3 years	Researcher, Kyushu Univ. (JPN)	Assist. Prof., AIMR
53	Postdoc	3 years	PhD. Student, Graduate School of Engineering, Tohoku Univ. (JPN)	Assist. Prof., Inst. for Materials Research, Tohoku Univ. (JPN)
54	Postdoc	2 years and 8 months	Assist. Prof., Tianjin Polytechnic Univ. (CHN)	Assist. Prof., Tianjin Polytechnic Univ. (CHN)
55	Postdoc	2 years	Researcher, Univ. of Hyogo (JPN)	Assist. Prof., AIMR
56	Postdoc	2 years	Researcher, WPI-MANA (JPN)	Researcher, Graduate School of Environmental Studies, Tohoku Univ. (JPN)S
57	Postdoc	1 year and 6 months	Postdoctoral Fellowships for research abroad	Assist. Prof., AIMR
58	Assist. Prof.	4 years and 5 months	Researcher, Fraunhofer (FRG)	Assoc. Prof., AIMR
59	Postdoc	3 years and 7 months	PhD. Student, Univ. of Science and Technology of China (CHN)	Assoc. Prof., Chinese Academy of Sciences (CHN)
60	Postdoc	2 years and 5 months	PhD. Student, Chinese Academy of Sciences (CHN)	Assist. Prof., Univ. of Wisconsin (USA)
61	Postdoc	2 years and 4 months	Senior Researcher, National Univ. of Science and Technology (MISIS) (RF)	Returned to home country

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 Cambridge	Alan Lindsay Greer Bill Jones	Principal Investigator Adjunct professor
Institute of Chemistry, Chinese Academy of Sciences	Li-Jun Wan	Principal Investigator
University of California, Santa Barbara	Fred Wudl	Adjunct professor

< Partner institutions>

Institution name	Principal Investigator(s), if any	Notes
University of Wisconsin-Madison	John H. Perepezko	Adjunct professor
Grenoble Institute of Technology	Alain Reza Yavari	Principal Investigator
Johns Hopkins University	Kevin J. Hemker	Principal Investigator
Polish Academy of Sciences	Tomasz Dietl	Principal Investigator
University College London	Alexander Shluger Peter Sushko	Principal Investigator Adjunct professor
Texas A&M University	Winfried Teizer	Principal Investigator
University of California, Los Angeles	Paul S. Weiss	Principal Investigator
Tsinghua University	Qi-Kun Xue	Principal Investigator
University of Massachusetts Amherst	Thomas P. Russell	Principal Investigator
Chemnitz University of Technology	Thomas Gessner	Principal Investigator
Harvard University	Ali Khademhosseini	Principal Investigator
Hong Kong University of Science & Technology	Hongkai Wu	Principal Investigator
The University of Tokyo	Yuichi Ikuhara	Principal Investigator

2. Securing competitive research funding

- Competitive and other research funding secured in FY2012:

Total: 2,420,000,000 yen

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

Name of Project	Chief Researcher	Total Amount (JPY)	Project Period
Creation of Innovation Center for Advanced Interdisciplinary Research Areas	Professor Esashi Masayoshi	550,007,991	April 1, 2007 to March 31, 2016
Fund for World-Leading Innovative R&D on Science and Technology (FIRST Program) (JSPS)	Professor Esashi Masayoshi	360,334,049	March 10, 2010 to March 31, 2014
Fund for World-Leading Innovative R&D on Science and Technology (FIRST Program) (JSPS)	Professor Hideo Ohno	242,456,847	March 10, 2010 to March 31, 2014
Green Tribology Innovation Network (GRENE) (MEXT)	Professor Kazue Kurihara	167,196,000	December 6, 2011 to March 31, 2016
Core Research for Evolutional Science and Technology (CREST)	Professor Mingwei Chen	86,234,200	April 1, 2012 to March 31, 2015
Scientific Research (S)	Professor Takashi Takahashi	69,290,000	May 31, 2012 to March 31, 2014
Research and Development for building next generation IT foundation (MEXT)	Professor Hideo Ohno	57,508,800	September 21, 2012 to March 31, 2016
Core Research for Evolutional Science and Technology (CREST)	Professor Kazue Kurihara	50,797,500	October 1, 2008 to March 31, 2014
Sponsored Research with Toshiba co., Ltd.	Professor Terunobu Miyazaki	46,000,000	September 1, 2011 to March 31, 2014
Funding Program for Next Generation World-Leading Researchers (NEXT Program) (JSPS)	Professor Shin-ichi Orimo	45,030,000	February 10, 2011 to May 30, 2013
Core Research for Evolutional Science and Technology (CREST)	Professor Motoko Kotani	34,907,100	October 1, 2008 to March 31, 2014
Core Research for Evolutional Science and Technology (CREST)	Professor Eiji Saitoh	33,053,800	April 1, 2012 to March 31, 2015

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

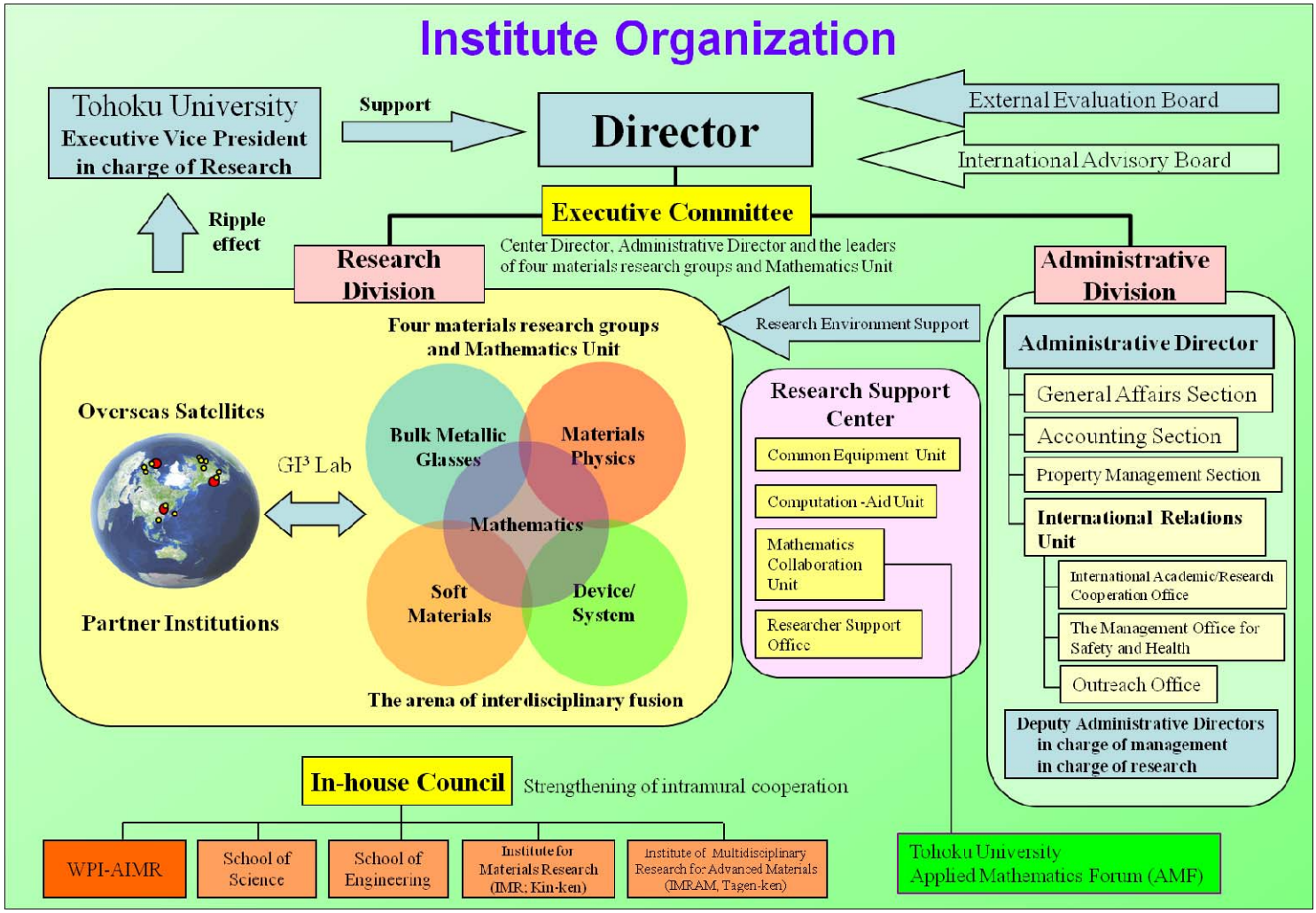
- Indicate the number of international research conferences or symposiums held in FY2012 and give up to three examples of the most representative ones using the table below.

FY 2012: 6 meetings

Major examples (meeting title and place held)	Number of participants
The AIMR International Symposium 2013 (AMIS2013) (Sendai, Miyagi, Japan)	From domestic institutions: 178 From overseas institutions: 62
International Association of Colloid and Interface Scientist, Conference (IACIS2012) (Sendai, Miyagi, Japan)	From domestic institutions: 600 From overseas institutions: 400
The 2nd AIMR-CNSI workshop (Sendai, Miyagi, Japan)	From domestic institutions: 47 From overseas institutions: 5

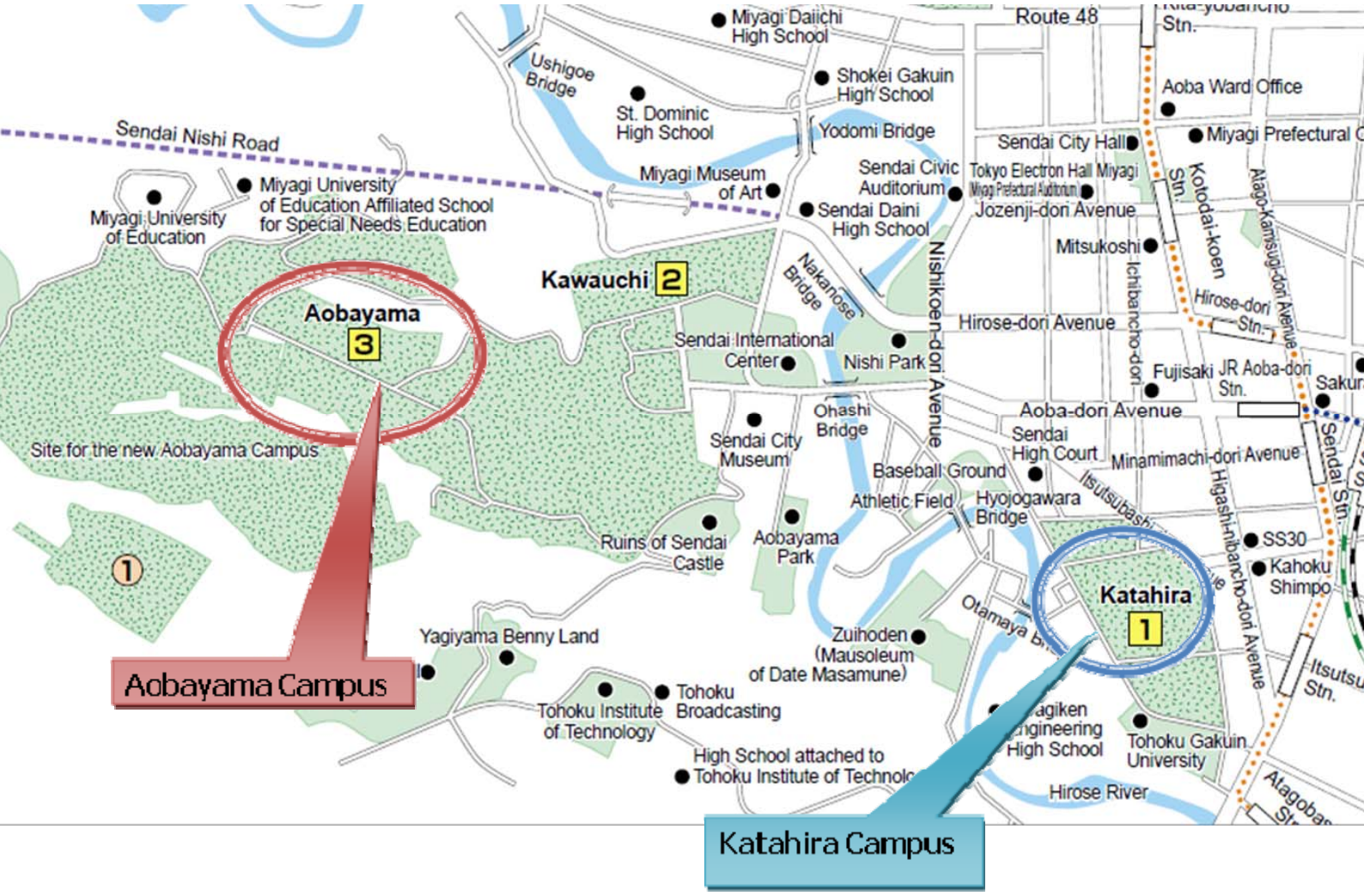
4. Center's management system

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



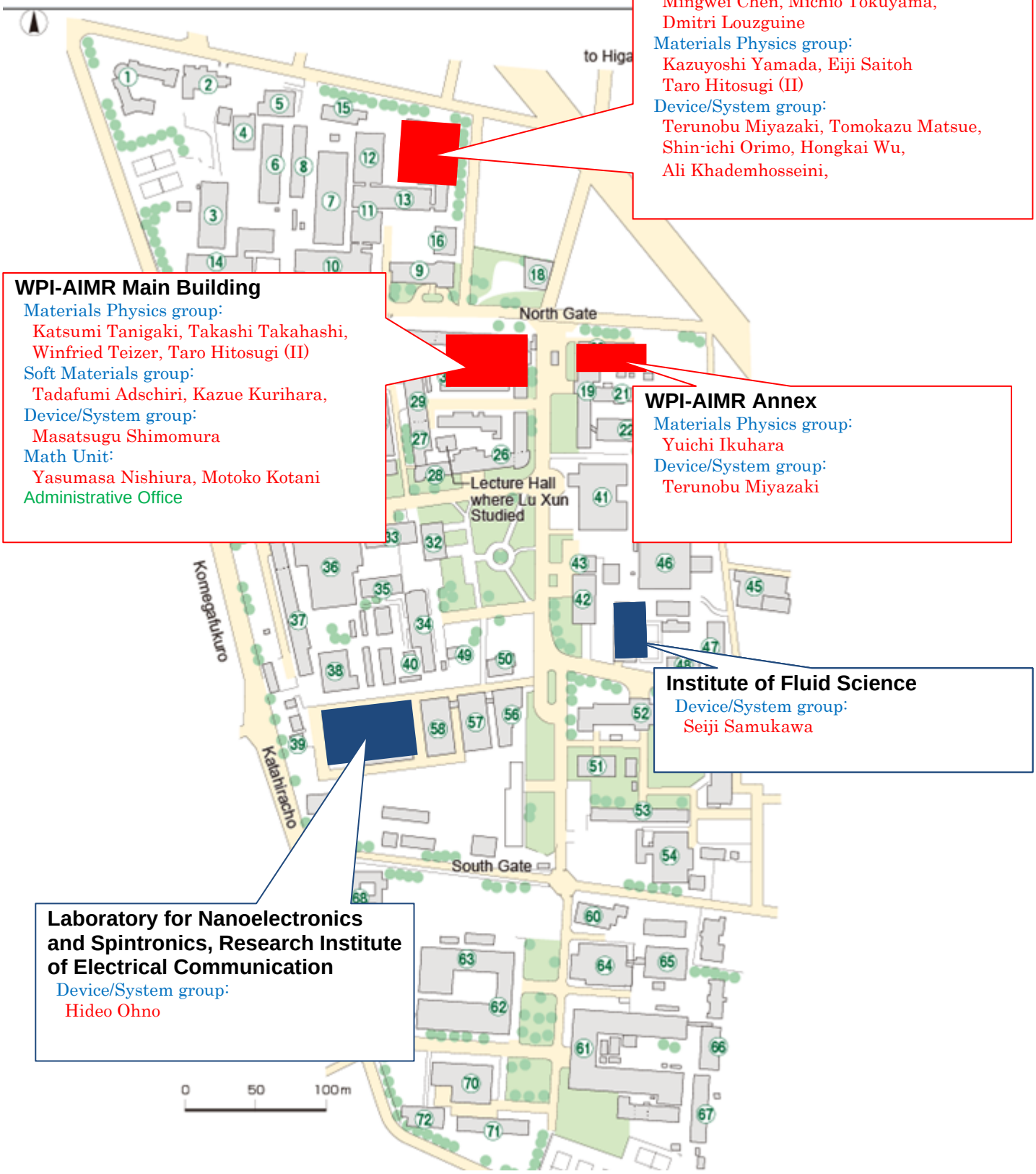
5. Campus Map

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



Note: It takes about 15 minutes from Katahira to Aobayama by car.

【Katahira Campus】



WPI-AIMR Laboratory Building
Bulk Metallic Glasses group:
Mingwei Chen, Michio Tokuyama, Dmitri Louzguine
Materials Physics group:
Kazuyoshi Yamada, Eiji Saitoh, Taro Hitosugi (II)
Device/System group:
Terunobu Miyazaki, Tomokazu Matsue, Shin-ichi Orimo, Hongkai Wu, Ali Khademhosseini,

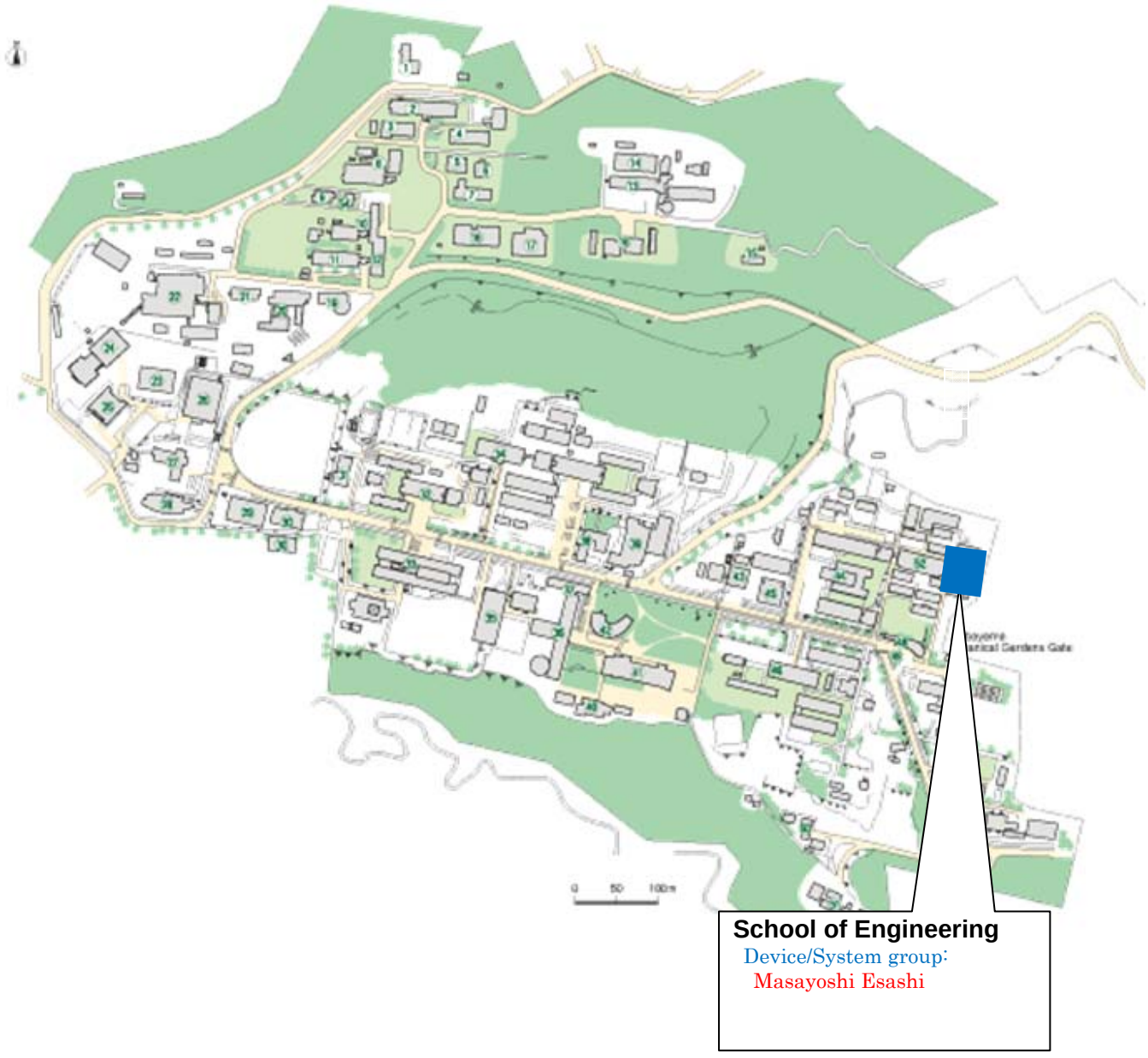
WPI-AIMR Main Building
Materials Physics group:
Katsumi Tanigaki, Takashi Takahashi, Winfried Teizer, Taro Hitosugi (II)
Soft Materials group:
Tadafumi Adschiri, Kazue Kurihara,
Device/System group:
Masatsugu Shimomura
Math Unit:
Yasumasa Nishiura, Motoko Kotani
Administrative Office

WPI-AIMR Annex
Materials Physics group:
Yuichi Ikuhara
Device/System group:
Terunobu Miyazaki

Institute of Fluid Science
Device/System group:
Seiji Samukawa

Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication
Device/System group:
Hideo Ohno

【Aobayama Campus】



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

i) Overall project funding

Cost Items	Details	Costs (10,000 dollars)
Personnel	Center director and Administrative director	25
	Principal investigators (no. of persons):18	209
	Other researchers (no. of persons):99	528
	Research support staffs (no. of persons):28	45
	Administrative staffs (no. of persons):31	141
	Total	948
Project activities	Gratuities and honoraria paid to invited principal investigators (no. of persons):11	15
	Cost of dispatching scientists (no. of persons):0	0
	Research startup cost (no. of persons):27	132
	Cost of satellite organizations (no. of satellite organizations):0	0
	Cost of international symposiums (no. of symposiums):1	21
	Rental fees for facilities	0
	Cost of consumables	59
	Cost of utilities	57
	Other costs	150
	Total	434
Travel	Domestic travel costs	7
	Overseas travel costs	26
	Travel and accommodations cost for invited scientists (no. of domestic scientists):7 (no. of overseas scientists):12	13
	Travel cost for scientists on secondment (no. of domestic scientists):10 (no. of overseas scientists):3	3
	Total	49
Equipment	Depreciation of buildings	140
	Depreciation of equipment	857
	Total	997
Other research projects	Projects supported by other government subsidies, etc.	0
	Commissioned research projects, etc.	974
	Grants-in-Aid for Scientific Research, etc.	187
	Total	1161
Total		3589

Ten thousand dollars

WPI grant 1304

Costs of establishing and maintaining facilities 0

Establishing new facilities
(Number of facilities: , m²) Costs paid:

Repairing facilities
(Number of facilities: , m²) Costs paid:

Others 0

Cost of equipment procured 0

Reflectron type three dimensional atom probe system
Number of units: 1 Costs paid:
Field emission scanning electron microscope
Number of units: 1 Costs paid:
Yb-doped fiber laser system
Number of units: 1 Costs paid:
No damage TEM specimen preparation system
Number of units: 1 Costs paid:
Liquid chromatography / time-of-flight mass spectrometer
Number of units: 1 Costs paid:
Analytical equipment FT-NMR apparatus
Number of units: 1 Costs paid:

Thermally decomposed gas-modified particle analyzer
Number of units: 1 Costs paid:

Energy dispersive X-ray micro-analyzer
Number of units: 1 Costs paid:

High field electromagnetic apparatus
Number of units: 1 Costs paid:
Panel type clean booth
Number of units: 1 Costs paid:
Others

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):15	
	Research support staffs (no. of persons):0	
	Administrative staffs (no. of persons):0	
	Total	74
Project activities		15
Travel		16
Equipment		0
Other research projects		0
Total		105

Status of Collaboration with Overseas Satellites

1. Coauthored Papers

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

Overseas Satellite 1: University of Cambridge (Total: 1 paper)

No.	Author names and details
1-131	S.V. Madge, D.V. Louzguine-Luzgin, J.J. Lewandowski and *A.L. Greer*, "Toughness, Extrinsic Effects and Poisson's Ratio of Bulk Metallic Glasses", Acta Mater., 60, 4800-4809, (2012)

Overseas Satellite 2: Institute of Chemistry, Chinese Academy of Sciences (Total: 1 paper)

No.	Author names and details
2-235	Wang, Y.Q., L. Guo, Y.G. Guo, H. Li, X.Q. He, S. Tsukimoto, Y. Ikuhara, and L.J. Wan, "Rutile-TiO_2 Nanocoating for a High-Rate $Li_4Ti_5O_{12}$ Anode of a Lithium-Ion Battery", *Journal of the American Chemical Society*, **134**, 18, 7874-7879, (2012)

2. Status of Researcher Exchanges

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

Overseas Satellite 1: University of Cambridge

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	2				2
	9				9

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	1	1			2
		2	1	1	4

Overseas Satellite 2: Institute of Chemistry, Chinese Academy of Sciences

<To satellite>

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

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2012	1				1
	1	2		1	4

Overseas Satellite 3: University of California, Santa Barbara

<To satellite>

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

<From satellite>

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

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

Researchers Total: 88

Name	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)
Alexander Shluger	Professor, University College London	Ph.D., Computational Materials Science		Mar 25 - Apr 4, 2012 Oct 7-20, 2012 Feb 11-22, 2013	Participation as Principle Investigator Invited talk at AIMR International Symposium 2013 (AMIS2013)
Richard D. Tilley	Associate Professor, Victoria University of Wellington	Ph.D., Chemistry	Principal Investigator, MacDiarmid Institute for Advanced Materials and Nanotechnology Easterfield medal by the New Zealand Institute of Chemistry and Royal Society of Chemistry, UK	Mar 16 – May 16, 2012	Stay for joint research
Jacob Sagiv	Professor, Department of Materials and Interfaces, Weizmann Institute of Science	Ph.D., Supramolecular Architecture at Interfaces	The Kolthoff Prize in Chemistry (2010) The Israel Chemical Society Prize (2005)	May 10-19, 2012	Participation in IACIS2012 Conference (cosponsored by AIMR) and discussion
Steave Pennycook	Group Leader, Oak Ridge National Laboratory	Ph.D., HRTEM		May 13, 2012	Visit to Lab.
Manfred Ruehle	Group Leader, Max Planck Institute for Materials Science	Ph.D., HRTEM	Habilitation	May 13, 2012	Visit to Lab.
Pietro Tundo	Professor, Department of Science of Ca' Foscari University of Venice, President of the Interuniversity Consortium "Chemistry for the Environment" (INCA)	Ph.D., Green Chemistry	Chairman of the IGN Founder of INCA	May 13-19, 2012	Participation in IACIS2012 Conference (cosponsored by AIMR) and discussion

Thomas Healy	Professor Emeritus, The University of Melbourne	Ph.D., Colloid Chemistry	Member of the Australian Academy of Science Member of US National Academy of Engineering Sir Eric Rideal Medalist, Royal Society of Chemistry UK and the Society of Chemical Industry UK (2010)	May 13-20, 2012	Participation in IACIS2012 Conference (cosponsored by AIMR) and Emerging Leadership Australia-Japan Collaboration Workshop (sponsored by AIMR) and discussion
George Franks	Professor, Department of Chemical and Biomolecular Engineering, The University of Melbourne	Ph.D., Colloid Chemistry, Chemical Engineering	R & D 100 Award (1991) H. Kent Bowen Extra Mile Award (1991)	May 13-22, 2012	Participation in IACIS2012 Conference (cosponsored by AIMR) and Emerging Leadership Australia-Japan Collaboration Workshop (sponsored by AIMR) and discussion
Gerhard Findenegg	Professor, Technical University Berlin	Ph.D., Surface Science		May 14-20, 2012	Participation in IACIS2012 Conference (cosponsored by AIMR) and Emerging Leadership Australia-Japan Collaboration Workshop (sponsored by AIMR) and discussion
Ila Hiriyakkanavar	Senior Scientist / Honorary Professor, INSA	Ph.D.	Fellow of Indian Academy of Sciences, Bangalore (FASc.) Fellow of Indian National Science Academy (INSA), New Delhi (FNA)	May 14 – Jun 22, 2012	stay for joint research
Neil Furlong	Professor, RMIT University	Ph.D., Colloid and Surface Chemistry	Editor (Asia and Australasia) - Colloids and Surfaces A	May 19-21, 2012	Participation in Emerging Leadership Australia-Japan Collaboration Workshop (sponsored by AIMR) and discussion
Thomas P. Russell	Professor, University of Massachusetts Amherst	Ph.D., Polymer Science and Engineering	Editorial Board Member, Current Opinion in Chemical Engineering (2011-present) Honorary Distinguished Professor, Chinese Academy of Science, Changchun Institute of Applied Chemistry (2011-present) International Advisory Board, Chinese Journal of Polymer Science (2011-present)	May 23-30, 2012 Jul 27 – Aug 13, 2012 Feb 10 – Mar 3, 2013	Participation as Principle Investigator Attendance to the AIMR International Symposium 2013 (AMIS2013)
Winfried Teizer	Associate Professor, Texas A&M University	Ph.D., Physics Biophysics	Montague/Center for Teaching Excellence Scholar, Texas A&M University (2004)	May 28 – Aug 30, 2012 Oct 5-21, 2012 Nov 12 – Dec 2, 2012 Jan 7-20, 2013 Feb 12-23, 2013	Participation as Principle Investigator Attendance to the AIMR International Symposium 2013 (AMIS2013)

Ali Khademhosseini	Associate Professor, Harvard Medical University	Ph.D.	Presidential Early Career Award for Scientists and Engineers (PECASE) (2011) Biochemical Engineering Journal Young Investigator Award (2012) AIMBE´s College of Fellows by The American Institute for Medical and Biological Engineering (2012)	May 28 – Jun 16, 2012 Jul 16-28, 2012 Jan 17-30, 2013 Feb 16-22, 2013	Participation as Principle Investigator Attendance to the AIMR International Symposium 2013 (AMIS2013)
Subra Suresh	Director, National Science foundation (NSF)	Ph.D., Science	Acta Materialia Gold Medal (2006) European Materials Medal (2007) Eringen Medal of the Society of Engineering Science (2008) General President's Gold Medal from the Indian National Science Congress (2011) Padma Shri Award from the president of India (one of the highest civilian honors from the Republic of India) (2011) Nadai Medal (2011) Timoshenko Medal from the American Society of Mechanical Engineers (2012) R.F. Mehl Award from the Minerals, Metals & Materials Society (2012)	Jun 6, 2012	Discussion with Center Director and Laboratory tour
Takeshi Egami	Distinguished Scientist, Professor, University of Tennessee – Oak Ridge National Laboratory Director, Joint – Institute for Neutron Sciences	Ph.D., Materials Science	Senior Researcher Prize, International Symposium on Metastable and Nano Materials (2006)	Jun 20-30, 2012 Feb 13-22, 2013	Participate in WPI-AIMR Workshop "Structure and Dynamics of Glass" Attendance to the AIMR International Symposium 2013 (AMIS2013)
Jaromir Pastorek	President, Slovak Academy of Sciences	Ph.D., DSc.	Scientist of the year of the Slovak Republic (2001) Elected member of European Academy of Sciences and Arts (2008)	Jun 26, 2012	Discussion with Center Director
Srikanth Sastry	Professor, Jawahar Lal Nehru Centre for Advanced Scientific Research (JNCASR)	Ph.D.		Jun 26-30, 2012	Participate in WPI-AIMR Workshop "Structure and Dynamics of Glass"

Wei Hua Wang	Professor, Institute of Physics, Chinese Academy of Sciences	Ph.D.		Jun 26-30, 2012	Participate in WPI-AIMR Workshop "Structure and Dynamics of Glass"
Burkard Hillebrands	Professor and Vice President of University ofKaiserslautern	Ph.D., Spin dynamics	IEEE Magnetic Society Distinguished Lecture (2005) Member of the Academy of Sciences and Literature Mainz IEEE Fellow, APS Fellow and Fellow of the Institute of Physics	Jul 4-6, 2012	Short-term stay for joint-research
Claudia Felser	Professor, Max Plank Institute, Dresden	Ph.D., Electric structure calculation	IEEE Magnetics Society, Distinguished Lecturer Award (2010)	Jul 4-6, 2012 Feb 20- 21, 2013	Short-term stay for joint-research Invited talk at AIMR International Symposium 2013 (AMIS2013)
Albert P. Pisano (59)	Professor, University of California Berkeley	Ph.D., Mechanical Engineering	Micro Systems, MEMS (Fellow, American Society of Mechanical Engineers, 2004 et.al.)	Jul 5-7, 2012 Jan 29, 2013 Mar 13-16, 2013	Collaborative research on harsh environment sensor with Tohoku University
Alain Reza Yavari	Professor, Grenoble Institute of Technology	Ph.D., Metallic Glasses	Assigned as a researcher of the highest rank at CNRS (2012) ISMANAM Senior Scientist Award	Jul 24–Aug 25, 2012 Nov 9–Dec 12, 2012 Feb 14–Mar 6, 2013	Participation as Principle Investigator Attendance to the AIMR International Symposium 2013 (AMIS2013)
Alan Lindsay Greer	Professor, Department of Materials Science and Metallurgy, University of Cambridge	Ph.D., Metallurgy & Materials Science	Hume Rothery Prize Griffith Medal	Jul 24 –Aug 18, 2012 Feb 16 –22, 2013	Participation as Principle Investigator Attendance to the AIMR International Symposium 2013 (AMIS2013)
Nieh Taigang	Professor, The University of Tennessee	Ph.D., Materials Science and Engineering	Fellow of TMS (2004) Fellow of ASM International (1992)	Jul 24 –Aug 10, 2012	Stay for joint research and discussion
Hongkai Wu	Associate Professor, Hong Kong University of Science and Technology	Ph.D., Chemistry	DuPont Young Professor Award (2007-2010)	Jul 29 – Aug 22, 2012	Participation as Principle Investigator
Ming Bao	Professor, State Key Laboratory of Fine Chemicals, Dalian University of Technology, China	Ph.D., Chemistry	Member of Homogeneous catalysis committee, China	Aug 1 – Oct 31, 2012	Stay for joint research
Yu Xiao Qiang	Associate Professor, Dalian University of Technology	Ph.D.		Aug 21-28, 2012	Stay for joint research

John H. Perepezko	Professor, Department of Materials Science and Engineering, University of Wisconsin - Madison	Ph.D., Phase transformations	William Hume-Rothery Award, TMS (2009)	Aug 25– Sep 21, 2012 Feb 16–22, 2013	Stay for joint research and discussion with BMG members Attendance to the AIMR International Symposium 2013 (AMIS2013)
Chao-Sung Lai	Professor, College of Engineering, Chang Gung University	Ph.D., Integrated Circuit Processing	Lam Award 1997	Aug 2012	Stay for joint research
Qi-kun Xue	Professor, Tsinghua University	Ph.D.	Member, Chinese Academy of Sciences (CAS) Member, the Editorial Board, Surface Science, Journal of Physics D(Applied Physics) and Nanotechnology Fellow, the Chinese Physical Society	Sep 2-4, 2012 Mar 3-6, 2013	Short-term stay for participation in WPI-AIMR Mini Workshop Stay for joint research and discussion
Jianhua Jiang	Associate Professor, Shanghai Jiao Tong University	Ph.D.		Sep 27 – Dec 26, 2012	stay for joint research
Murugan Ramalingam	Associate Professor, Centre for Stem Cell Research	Ph.D.		Sep 30 – Oct 16, 2012 Dec 22-31, 2012 Feb 15-22, 2013	Stay for joint research Attendance to the AIMR International Symposium 2013 (AMIS2013)
Meiling Wang	Professor, University of Science and Technology Beijing	Ph.D.		Sep 30 – Oct 2, 2012	Discussion on joint research
Qiang Feng	Professor, University of Science and Technology Beijing	Ph.D.		Sep 30 – Oct 2, 2012	Discussion on joint research
Peter Ventzek	Principal Simulation Engineer, Technology Development Center, Tokyo Electron	Ph.D., plasma simulation	NOGLSTP GLBT Engineer Award (2006)	Sep 2012	Stay for joint research
Lee Chen	Technical Staff, Tokyo Electron America	Ph.D.		Sep 2012	Stay for joint research

Arnold van Zyl	Rector, Chemnitz University of Technology	Ph.D., Engineering		Nov 19, 2012	Discussion with Center Director
Bernard Chenevier	CNRS Director of Research Director of LMGP	Ph.D., Physics		Nov 19, 2012	Discussion with Center Director
Philip Hofmann	Professor, Department of Physics, Aarhus University	Dr. rer. nat, surface science	Gaede Award of the German Vacuum Society (2011) Visiting Professorship of the Leverhulme Trust (2007)	Nov 30-Dec 1, 2012	Participation in symposium
Hartmut Buhmann	Professor, Physics Institute, University Wurtzburg	Dr. rer. Nat, quantum transport	Europhysics prize(2010)	Nov 30-Dec 1, 2012	Participation in symposium
Igor Protsenko	Vice-rector for science and innovations, Far Eastern Federal University (Russia)	Ph.D., Physics and Mathematics		Dec 19, 2012	Discussion with Center Director
Katherine Aidala	Associate Professor, Mount Holyoke College	Ph.D.	Presidential Early Career Award for Scientists and Engineers (PECASE), (2010) NSF Faculty Early CAREER Development Award (2010)	Jan 5-16, 2013	Participation in Tohoku – Harvard Joint Workshop "New Directions in Materials for Nanoelectronics, Spintronics and Photonics"
Yacoby Amir	Professor, Harvard University	Ph.D.		Jan 7-17, 2013	Participation in Tohoku – Harvard Joint Workshop "New Directions in Materials for Nanoelectronics, Spintronics and Photonics"
Robert Berg	Professor, Wellesley College	Ph.D., Physics		Jan 11-18, 2013	Participation in Tohoku – Harvard Joint Workshop "New Directions in Materials for Nanoelectronics, Spintronics and Photonics"
Robert Westervelt	Professor, Harvard University	Ph.D.		Jan 12-21, 2013	Participation in Tohoku – Harvard Joint Workshop "New Directions in Materials for Nanoelectronics, Spintronics and Photonics"
Tomasz Dietl	Professor, Institute of Physics, Polish Academy of Sciences	Ph.D. Low-temperature Physics Semiconductor Spintronics	Fellow, Institute of Physics (IOP) (2004) Maria Skłodowska-Curie Award in Poland (1997) Alexander von Humboldt Research Award in Germany (2003) Agilent Technologies Europhysics Prize (2005)	Jan 1-26, 2013 Feb 14-26, 2013	Research as principal investigation (theoretical description of spin related phenomena and functionalities in semiconductors) Participation for WPI-AIMR Symposium
Yet Ming Chiang	Professor, Department of Materials Science of MIT	Ph.D., Materials Science		Jan 11, 2013	Visit to Lab., Lecture

Alexey E Romanov	Professor, Russian Science Academy	Ph.D., Dislocation		Jan 11, 2013	Visit to Lab., Lecture
Ingrid de Wolf	Professor, IMEC (Belgium)	Ph.D., Semiconductor	Micro Systems, MEMS	Jan 29, 2013	Invited talk in the 3rd International Symposium on Integrated Microsystems
Shanhong Xia	Professor, Institute of Electronics, Chinese Academy of Sciences	Ph.D., Semiconductor	Micro Systems, MEMS	Jan 29, 2013	Invited talk in the 3rd International Symposium on Integrated Microsystems
Aaron Partridge	CTO, SiTime (USA)	Ph.D., Semiconductor	Micro Systems, MEMS	Jan 29, 2013	Invited talk in the 3rd International Symposium on Integrated Microsystems
Dim-Lee Kwong	Director, Institute of Micro Electronics (IME), (Singapore)	Ph.D., Semiconductor	Micro Systems, MEMS	Jan 29, 2013	Invited talk in the 3rd International Symposium on Integrated Microsystems
Bernhard Boser	Professor, University of California Berkeley	Ph.D., Semiconductor	Micro Systems, MEMS	Jan 29-Feb 2, 2013	Invited talk in the 3rd International Symposium on Integrated Microsystems, Discussion in Tohoku Univ,
Peter Grünberg	Professor, The Institute for Solid State Physics at Forschungszentrum Jülich	Ph.D., Physics	Nobel Prize in Physics (2007)	Feb 14–23, 2013	Speaking at IMR
Konstantin Mischaikow	Professor, Department Mathematics and BioMaPS Institute Rutgers University	Ph.D., Computational Topology and Dynamics	AMS Invited Address, AMS Sectional Meeting, Newark, NJ, (2010) Best Paper Award: Trans. Japanese SIAM (2003)	Feb 15–23, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013), Collaboration research: Application of computational homology to materials science
Ngai Kialing	Professor, University of Pisa	Ph.D.		Feb 15–19, 2013	Invited talk at WPI-AIMR Workshop "Structure and Dynamics of Glass"
Yue Wu	Professor, The University of North Carolina at Chapel Hill	Ph.D.	Member of APS, MRS, and AAAS Fellow of the American Physical Society	Feb 15–19, 2013	Invited talk at WPI-AIMR Workshop "Structure and Dynamics of Glass"
Gianluigi G Botton	Professor, HREM Center of Mac Master University	Ph.D., Materials Science and Engineering	Discovery Accelerator Award (2012) Canada Research Chair, Tier 1 (2009) M. Brian Ives Lectureship Award, ASM (2009)	Feb 16-23, 2013	Discussion on joint research And Invited talk at AIMR International Symposium 2013 (AMIS2013)
Carlos Javier Garcia Cervera	Professor, University of California, Santa Barbara	Ph.D., Mathematics	Faculty Early Career Development Award (CAREER) from the National Science Foundation (2007-2012) Alfred P. Sloan Dissertation Fellowship (1997)	Feb 16-23, 2013	Participate in The 2nd AIMR-CNSI workshop

Khomyakov Petr	Research Staff Member, IBM Research – Zürich	Ph.D., Physics		Feb 16-21, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Tomas Jungwirth	Head, Academy of Sciences of the Czech Republic	Ph.D., Physics	ERC Advanced Grant (2011) Praemium Academiae of the Academy of Sciences of the Czech Republic (2008)	Feb 17-21, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Arun Bansil	Professor, Director, Advanced Scientific Computation Center of Northeastern University	Ph.D. Physics, condensed matter theory	Affiliated Faculty, Lawrence Berkeley National Lab, USA (2003-present); Honorary Professor in Solid State Theory, Tampere Univ. of Technology, Finland (1989-present)	Feb 17-21, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Christian Elsaesser	Professor, Fraunhofer Institute for Mechanics of Materials IWM	Ph.D., Theoretical Calculation	Otto-Hahn Medal of the Max-Planck Society (1991)	Feb 17-22, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Rolf Allenspach	Manager, Physics of Nanoscale Systems of IBM Research – Zürich	Dr. Sc. Nat.	Member of Swiss Academy of Technical Sciences (2012) APS Fellow (2009)	Feb 17-23, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Johannes Georg Bednorz	Fellow Emeritus IBM Research – Zürich	Dr. sc. Nat., Dr. h. c. mult.	Nobel Prize in Physics (1987)	Feb 17-25, 2013	Participate in AIMR International Symposium 2013 (AMIS2013) Attend AIMR International Board Meeting Participate in The 2nd AIMR-CNSI Workshop Give a talk at special science cafe
Barry W. Ninham	Emeritus Professor and Foundation Professor (1970-2000), Australian National University	Ph.D. Colloid and Surface Chemistry, Applied chemistry	Honorary Doctorate of Science, U. Western Australia (2010) Craig Medal, Australian Academy of Sciences (2006)	Feb 17-25, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013), Seminar and discussion
Ei-ichi Negishi	H. C. Brown Distinguished Professor of Chemistry, Purdue University	Ph.D., Organic Chemistry	Nobel Prize in Chemistry (2010)	Feb 18-21, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Markus Münzenberg	Professor, Göettingen University	Ph.D., Spintronics	Member of the German Physical Society, American Physical Society, Institute of Electrical and Electronics Engineers (IEEE)	Feb 18- 21, 2013	Discussion for joint-research and invited talk at AIMR International Symposium 2013 (AMIS2013)

Christian Ratsch	Associate Director, Institute for Pure and Applied Mathematics (IPAM) of UCLA	Ph.D., Physics		Feb 18-21, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Motomu Tanaka	Professor and Chair, University of Heidelberg	Habilitation in Experimental Physics	Bronze Medal, Fonds der Chemischen Industrie (2007) Emmy Noether Fellow, German Science foundation (2001)	Feb 18-21, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
DR. Fecht Hans-Joerg	Professor, Dean of Institute of Micro and Nanomaterials, Ulm University	Ph.D., Materials Science	Co-Chairman Science Council EML / ESA (2007)	Feb 18-21, 2013	Participate in AIMR International Symposium 2013 (AMIS2013)
Meyya Meyyappan	Chief Scientist for Exploration Technology, Center for Nanotechnology, NASA	Ph.D., Nanotechnology	Presidential Meritorious Award; Arthur Flemming Award given by the Arthur Flemming Foundation and the George Washington University; IEEE-USA Harry Diamond Award	Feb 18-21, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Ali Yazdani	Professor, Princeton University	Ph.D.	Fellow of APS, AAAS	Feb 18-21, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013)
Yiming Li	Professor, Department of Communications Engineering, National Chiao Tung University	Ph.D., Parallel and Scientific Computing	International Symposium on Nano Science and Technology (ISNST) Outstanding verbal Paper Award (2012) The 3rd IEEE Asia Symposium on Quality Electronic Design (ASQED 2011) Best Paper Award	Feb 18 - May 17, 2013	Stay for joint research
David Awschalom	Professor, Department of Physics, University of California, Santa Barbara Director, California Nanosystems Institute, Professor, Institute for Molecular Engineering, University of Chicago	Ph.D., Semiconductor Spintronics	International Magnetism and Néel Metal (IUPAP, 2003) Oliver E Buckley Prize (APS, 2005) Agilent Europhys Prize (EPS, 2005) Newcomb clevelang prize (AAAS, 2006) David Turnbull Award (MRS, 2010) Fellow, APS and AAAS	Feb 19-23, 2013	Invited talk at AIMR International Symposium 2013 (AMIS2013) and The 2nd AIMR-CNSI Workshop
Fred Wudl	Professor, Director of University of California, Santa Barbara	Ph.D.	Stephanie Kwolek Award for Polymer Science from the Royal Society of Chemistry (2010)	Feb 20-22, 2013	Participate in The 2nd AIMR-CNSI Workshop

Michael Chabinyc	Professor, University of California, Santa Barbara	Ph.D., Chemistry	Emerging Leader Lectureship Materials Department U.C. Santa Barbara (2007)	Feb 20-23, 2013	Participate in The 2nd AIMR-CNSI Workshop
Chris J. Palmstrom	Professor, University of California, Santa Barbara	Ph.D., Electrical and Electronic Engineering		Feb 21-23, 2013	Participate in The 2nd AIMR-CNSI Workshop
Klaus-Jürgen Friedland	Principle Investigator, Paul-Drude-Institut für Festkörperelektronik	Dr. rer.nat		Feb 26 – Apr 12, 2013	Stay for joint research
Johann – Dietrich Woerner	Chairman of Executive Board, German Aerospace Center (DLR)	Ph.D.	Prize of the Organisation of Friends of theTechnische Universitaet Darmstadt for outstanding scientific performance	Mar 1, 2013	Discussion with Center Director
Srinivasa Ranganathan	Professor Emeritus, Department of Material Engineering, Indian Institute of Sciences	Ph.D., Nanostructured Materials, Metallic Glasses and Quasicrystals	Platinum Medal, Indian Institute of Metals (2005) Professor Jai Krishna Memorial Award (2006) Distinguished Alumnus Award, IISc (2006)	Mar 11, 2013	Special Lecture and Discussion of BMG members
Kurt Petersen	President, KP-MEMS (USA)	Ph.D., Semiconductor	Micro Systems, MEMS	Mar 13-16, 2013	Invited talk in MEMS Engineer Forum 2013, Discussion in Sendai
Weileun Fang	Professor, Power Mechanical Engineering, National Tsing Hua University (Taiwan)	Ph.D., Semiconductor	Micro Systems, MEMS	Mar 13-16, 2013	Invited talk in MEMS Engineer Forum 2013, Discussion in Sendai
Thomas Kenny	Professor, Mechanical Engineering, Stanford University	Ph.D., Semiconductor	Micro Systems, MEMS	Mar 13-16, 2013	Invited talk in MEMS Engineer Forum 2013, Discussion in Sendai
Jo de Boeck	Senior Vice President and CTO., IMEC (Belgium)	Ph.D., Semiconductor	Micro Systems, MEMS	Mar 13-16, 2013	Invited talk in MEMS Engineer Forum 2013, Discussion in Sendai
Cleopatra Cabuz	CTO, Honeywell	Ph.D., Semiconductor	Micro Systems, MEMS	Mar 13-16, 2013	Discussion in Sendai
Quentin Ramesse	EPSRC National Facility for STEM、Scientist	Ph.D., HRTEM		Mar 14, 2013	Visit to Lab., Lecture

State of Outreach Activities

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

Activities	FY2012(number of activities, times held)
PR brochure, pamphlet	5
Lectures, seminars for general public	4
Teaching, experiments, training for elementary and secondary school students	7
Science cafe	3
Open houses	2
Participating, exhibiting in events	6
Press releases	26

Special Achievements

Personnel increase in the Public Relations & Outreach Office and a review of Public Relations & Outreach strategies

In FY2012, Dr. Yasufumi Nakamichi joined the office as a Public Relations & Outreach manager with the aim of stimulating activities. Dr. Ikeda, who had been a former manager until the previous fiscal year, kept offering assistance with the total coordination of activities while devoting himself to the operational work as a deputy administrative director. To start a new five-year term, Public Relations & Outreach strategies were reviewed with the consideration of a new Mathematics Unit established in the previous fiscal year and an appointment of a new director in the same year. The outreach activities were categorized into four groups: (1) Brochure, (2) Event, (3) Website, and (4) Media, and previous activities were drastically revised and new projects were launched so that proper approaches can be provided for anticipated stakeholders. As for the "Event" activities in particular, cooperation with other departments and offices in Tohoku University as well as neighboring organizations was gained and efficient approaches were able to be delivered extensively. Examples of specific activities are summarized as follows.

PR brochure, pamphlets

- Creation of Japanese-written pamphlets
  Target: Nonprofessionals in Japan (high school / undergraduate / graduate students, researchers in areas other than materials science, and the general public)
  Objective: To diffuse knowledge about AIMR principles, specifically efforts to fuse mathematics and materials science

- New publication of PR brochure "AIMR Magazine"
  Target: Nonprofessionals in and outside of Japan (high school / undergraduate / graduate students, researchers in areas other than materials science, and the general public)
  Objective: To diffuse knowledge about international research activities at AIMR and the latest research achievements

As for other activities, English written pamphlets and booklets “AIMResearch” to present research results for professionals were issued in the same way as the previous year.

Teaching, experiments, and training for elementary and secondary school students

- AIMR-SSH International Exchange Program (two sessions in total)
  - Target: Students attending SSH (Super Science High school) in and around Sendai
  - Date: Oct. 20 and Nov. 17, 2012
  - Description: A lecture titled “Molecules and Probability” was given in English by Assistant Prof. D. Packwood (given only in the first session). Students were divided into small groups to have an interview in English with foreign researchers about their studies.
  - Objective: To let students know that English is the standard language in the research world and that the international research institute is situated closer to them.
  - Achievement: Although the lecture was given without an interpreter, one student said “it’s interesting to know how a theoretical scientist carries out his research” while another confessed that his English proficiency had yet to be developed.

As for other activities, the idea contest and school visits by researchers were scheduled in the same way as the previous year.

Science cafe

- “Talk with Dr. J. G. Bednorz”
  - Target: Elementary / junior-high / senior-high school students, undergraduate students and the general public
  - Date: Feb. 23, 2013
  - Lecturer: Dr. Bednorz (a member of AIMR International Advisory Board and winner of Nobel Prize in Physics 1987)
  - Facilitators: Susumu Ikeda and Yasufumi Nakamichi
  - Description: The first half of the lecture was given about the discovery of high temperature superconductors based on ceramics and the Nobel Prize, and the second half was set aside for a question-and-answer session. The lecture and Q&A session were interpreted by the facilitators.
  - Achievement: Comments such as “I was excited to know the scientific process until he discovered high temperature superconductors” and “I was impressed by his attitude toward research”.

As for other activities, Prof. Ohno gave a lecture at the Science Café hosted by Tohoku University and an event associating the Higgs boson with the tea ceremony was held jointly with the Faculty of Science.

Open house

AIMR research activities was introduced to the guests of Tohoku University Open Campus, and the MEMS showroom has been opened.

Participating, exhibiting in events

- Development of a simple experiment program “Wonders of Rubber” to familiarize participants with materials science
  - Target: Elementary / junior-high / senior-high school students
  - Description: The wondrous properties of rubber as indicated below were confirmed in the experiment
    - Motion energy converted to heat → a rubber balloon is stretched suddenly to bring about thermal change
    - Heat converted to motion energy → a stretched rubber balloon shrinks when exposed to hot water. Rubber engine.
    - Observation of rubber properties → property change of a bouncy ball immersed in cold (-80ºC) fluid was observed.
  - Exhibition: "Science Day" (Miyagi) and “Science and Technology Festa” (Kyoto).
  - Achievement: Comments such as “I was surprised to know that the ubiquitous rubber had many unknown properties” and “I found materials science interesting”.

As for other activities, a booth was set up at the WPI joint symposium (Tsukuba) and the AAAS annual meeting (Boston).

Other activities worth mentioning

- 2012 AIMR Summer School
  Target: Graduate students studying materials science in and outside of Japan
  Period: Jul. 23-29, 2012
  Description: Lectures and exercises given by AIMR researchers and presentations of achievements demonstrated by participants
  Achievement: Comments such as “My knowledge on materials science has been deepened” and “I was inspired by interaction with other students studying the same subject throughout the world”

< A list of all the activities>

PR brochure, pamphlets

・AIMR outline	Revised in Apr. 2012
・AIRM pamphlet in Japanese	Issued in Aug. 2012
・AIMResearch 2011（Japanese version）	Issued in Oct. 2012
・AIMResearch 2012	Issued in Feb. 2013
・AIMR Magazine vol.1	Issued in Mar. 2013

Lectures, seminars for general public

2012/8/2	Workshop “from microscope to satellite”	@ National Museum of Emerging Science and Innovation
2012/11/5	The 2nd Kao “Eco Together” Forum 2012	@ Daiwa Roynet Hotel Wakayama
2012/11/26	Science Council of Japan Open Symposium	@ Science Council of Japan Lecture Hall
2013/3/16	Innovation brought about by biomimetics and the role of museums	@ National Museum of Emerging Science and Innovation

Teaching, experiments, training for elementary and secondary school students

2012/5/14-16	Workshop: “Fascinating World of Colloids in Daily Life” @Sendai International Center	
2012/8/16-18	Super Nanomechanics Program	@ Tohoku University
2012/10/13	The 4th “EGGS Science” Program 2012	@ AIMR main building
2012/10/20	The 1st AIMR-SSH International Exchange Program	@ AIMR main building, lab building
2012/11/27	Tohoku University Visiting Lecture	@ Sendai Seiryo Junior High School
2012/11/17	The 2nd AIMR-SSH International Exchange Program	@ Sendai Daisan High School
2013/3/23	Idea Contest “Challengers for the Future”	@ National Museum of Nature and Science

Science cafe

2012/5/25	The 80th Tohoku University Science Café	@ Sendai Médiathèque
2012/11/22	Tohoku University Science Café SP (co-hosted by AIMR)	@ AIMR main building
2013/2/23	Tohoku University Science Café SP hosted by AIMR	@ AIMR main building

Open houses

2012/7/30-31	Tohoku University Open Campus	@ Tohoku University Kawauchi Campus
Permanent exhibition	Sendai MEMS Showroom & Historical Museum of Technology @ Junichi Nishizawa Memorial Research Center	

Participating, exhibiting in events

2012/5/17	iCAN’12	@ Tohoku University Katahira Sakura Hall
2012/7/15	Science Day	@ Tohoku University Kawauchi Campus
2012/11/23	WPI 6 Institutes Joint Symposium	@ Tsukuba International Congress Center
2013/1/22	Exhibition on Nature technology and lifestyle	@ Hokkaido University Museum
2013/2/15-17	AAAS Annual Meeting	@ The Hynes Convention Center, Boston
2013/3/16-17	Science and Technology Festa	@ Kyoto Pulse Plaza

Press Releases

2013/03/29 Atomic scale one-dimensional magnet
2013/03/13 A research group led by Prof. Orimo clarified the formation mechanism of perovskite-type hydride for the first time
2013/03/02 New thermoelectric power generation technology
2013/01/30 Development of New Atomisation Process using High-Velocity Air Fuel Flame
2013/01/08 Discovery of a periodic array of quasi-one-dimensional electron tunnel in an oxide

2012/11/07 Microscopic Sandwich
2012/11/07 Associate Prof. Yokoyama -- Development of a compact automatic arc melting furnace --
2012/10/12 Professor T. Takahashi -- Discovery of a new topological material --
2012/09/27 A research group led by Prof. Chen Mingwei --Success in enhancing mechanical properties of nanocrystalline boron carbide ceramics --
2012/09/19 Professor S. Samukawa --Production of high quality germanium metal oxide semiconductor (Ge MOS) transistor structure exceeding specifications of 12-nanometer generation technology with the use of ultra-low damage neutral beam oxidation process
2012/09/19 Researcher A. Kumatani and Associate Professor T. Hitosugi -- World record achieved in superconducting transition temperature of transparent superconductor --
2012/08/27 Professor S. Samukawa -- Defect-free quantum dots with 10 times higher density fabricated by bio-template and neutral beam etching succeeds in light emission --
2012/08/27 Associate Professor T. Fujita -- New active metal catalyst design with apertures of nanosize, catalysis at the atom level clarified –
2012/07/17 AIMR 2012 Summer School
2012/06/20 A research group led by Prof. Tomokazu Matsue and Prof. Masayoshi Esashi --Development of Bio-LSI realized through the fusion of LSI and Bio-MEMS --
2012/06/19 NEC and Tohoku University develop a new device for generating electricity from easily accessible heat sources.
2012/06/11 Professor M. Adschiri won the 11th GSC Award awarded by Minister of Education, Culture, Sports, Science and Technology.
2012/06/11 Professor H. Ohno -- First demonstration of highly reliable spintronics devices --
2012/06/11 Professor H. Ohno -- The World's Smallest Cell Implementation for a High-Density Standby-Power-Free TCAM in Combination with Silicon/Magnetic Devices --
2012/06/08 A research group led by Prof. Seiji Samukawa --Production of highly efficient quantum dot solar cells based on a structure of uniform and high-density quantum nanodisk array --
2012/06/08 Professor T. Matsue -- Development of a microchip which allows for the comprehensive monitoring of cell activity -
2012/06/08 Professor T. Matsue -- Nanoscale imaging of structure and chemical concentration of living cells
2012/05/25 2012 Professor M. Tsukada -- Practical application of simulation software for Scanning Probe Microscopy images --
2012/04/23 Professor K. Tanigaki -- Visualization of the relation between the atom motion "rattling" in the cage structure and thermal conductivity --
2012/04/19 Associate Professor K. Nakayama -- The development in the mass production of amorphous alloy nanowires --
2012/04/06 Professor T. Takahashi -- Discovery of giant Rashba effect at the semiconductor-metal interface -A significant progress for next-generation energy-saving devices --

FY 2012 List of Project's Media Coverage

- Please attach press coverage

No.	Date	Type media (e.g., newspaper, television)	Description
1	2013/3/12	Nikkan Kogyo Shimbun Nikkei Sangyo Shimbun	Research group at Tohoku University clarified the formation mechanism of perovskite-type hydride for the first time. (Orimo)
2	2013/2/25	[Magazine] Nikkei Science	Quantum entanglement and bending time and space (Ishihara)
3	2013/2/21 2013/2/23	Kahoku Shimpo	"Never lose the curiosity" lecture by a Nobel Prize winning German scientist
4	2013/1/17	Nikkei	Advanced Institute for Materials Research
5	2013/1/10 2013/1/11	Nikkan Kogyo Shimbun Nikkei Sangyo Shimbun	Oxide heterointerfaces trigger 1 dimensional conduction channel (Ikuhara)
6	2012/11/25	[Magazine] Nikkei Science	Front Runner (Kotani)
7	2012/11/23 2012/11/25	[TV] Nikkei CNBC / BS Japan	Use the wisdom of 3.8 billion years (Shimomura)
8	2012/11/6	Nikkei Nikkan Kogyo Shimbun Nikkei Sangyo Shimbun	Fabrication of intercalated bilayer graphene (Takahashi, Hitosugi)
9	2012/10/24	Nikkei	Bridgestone succeeded in the technical development of rubber for high performance energy-saving tires (Nakajima)
10	2012/9/21 2012/9/24	Nikkan Kogyo Shimbun Nikkei Sangyo Shimbun	World record achieved in superconducting transition temperature of transparent superconductor (Hitosugi)
11	2012/9/18	Nikkan Kogyo Shimbun Nikkei Sangyo Shimbun	Oxide film with thickness less than 2 nm, Tohoku University, germanium semiconductor (Samukawa)

12	2012/8/31 2012/9/14 2012/9/28 2012/10/12 2012/10/26 2012/11/9	Kagaku Shimbun	Advanced Institute for Materials Research (6 featured articles)
13	2012/8/30	Physics World	Recovering from the quake, in “Special Report Japan”
14	2012/6/25 2012/6/27	Nikkan Kogyo Shimbun Nikkei Sangyo Shimbun	Atomic scale electric field observation (Ikuhara)
15	2012/6/21	Yomiuri Shimbun	A partnership agreement between the Belgian Research Institute and Tohoku University (Esashi, Ohno)
16	2012/6/18 2012/6/25	[TV] NHK Educational	“Test no hanamichi” (Takahashi, Hitosugi)
17	2012/6/18	Asahi Shimbun	Electric generation for engine (Saitoh)
18	2012/6/11 2012/6/12	Yomiuri Shimbun Nikkan Kogyo Shimbun Kahoku Shimpo	Development of low power consumption memory (Ohno)
19	2012/6/10	BS FUJI	Galileo X “Biomimetics” (Shimomura)
20	2012/6/4	Nikkan Kogyo Shimbun Nikkei Sangyo Shimbun Kahoku Shimpo	Silicon quantum dot solar cell, conversion efficiency 12.6% (Samukawa)
21	2012/5/29	Kahoku Shimpo	Giant Rashba effect at metal-semiconductor interface (Takahashi)
22	2012/5/24	Yomiuri Shimbun	Development of spintronics (Ohno)
23	2012/4/23 2012/5/14	Nikkan Kogyo Shimbun Nikkei Sangyo Shimbun	Visualization of the relation between the atom motion "rattling" in the cage structure and thermal conductivity (Tanigaki)
24	2012/4/20	[TV] Sendai Television	Development of mass production technology of nanowires from amorphous alloys (Nakayama)