2. Summary of Proposal

(Compile in English within 3 pages.)

Host institution	Tohoku University
Head of host institution	Susumu Satomi, President, Tohoku University
Research center	WPI Advanced Institute for Materials Research
Center director	Motoko Kotani
Chief center-project officer (in October 2007)	Yoshinori Yamamoto, Director, WPI Advanced Institute for Materials Research
Project summary	The aims of the WPI Advanced Institute for Materials Research are (1) to create new materials science and develop new functional materials through deep understanding and control at atomic and molecular level, (2) to construct the processes and devices through those materials, and (3) to construct new systems using those devices and materials leading to social welfare. Cooperation and unification of the existing institutes on individual discipline (materials science, physics, chemistry, and engineering) at Tohoku University, whose activities are already at world-top level, together with incorporating world top-class researchers from abroad and from domestic institutes, must organize a dream team for materials science. Through interdisciplinary fusion and incorporating a mathematical viewpoint, we create entirely new materials with innovative functions, contributing the welfare of mankind.
Mission statement and/or center's identity	Since its establishment, AIMR has continuously pursued the creation of new materials science and revolutionary functional materials by gathering researchers from various fields. The main goal is to promote the common understanding of materials based on the knowledge of different size scales from atoms to materials and different materials such as metals, ceramics, polymers and biomaterials. There is no change in this concept. However, based on the results of discussion and collaborative research carried out during the first five years, we crystallized our mission in a more clear form: to discover common elements and universal principles among various materials and create new materials science which can predict new functions. To accomplish this mission, we inject mathematical viewpoints into materials science and accelerate fusion research toward the goal. We have established the three target projects (1) Non-equilibrium Materials based on Mathematical Dynamical Systems, (2) Topological Functional Materials, and (3) Multi-Scale Hierarchical Materials based on Discrete Geometric Analysis. In AIMR, material scientists and mathematicians join hands in explaining new phenomena measured by AIMR's top class equipment and elucidate the mechanism lying behind the structure-function relationship. This challenge to elucidate the mechanism of function manifestation and link it to the creation of new materials is unprecedented anywhere else in the world. Materials scientists from diverse backgrounds and mathematicians are gathered in a single place and challenge ambitious investigations to create new materials with revolutionary functions, and contribute to society—that is the identity of AIMR.
Research fields	"From Atom and Molecule to Materials", New materials science from interdisciplinary research Integration of the six research fields on Material sciences, Physics, Chemistry, Electronics engineering and information sciences, Precision and mechanical engineering, and Mathematics
Research objectives	The main objective of the Center is to promote the creation of new materials science under a world-leading organization for interdisciplinary

	research through deep understanding and control at atomic and molecular level, departing from the traditional approaches and moving towards the next generation. In addition to basic research, the Center will pursue (1) to create new compounds and materials with innovative functions which exceed existing ones, (2) to construct devices based upon a new fundamental paradigm, and (3) to promote applied research projects on materials and system architecture that will generate direct societal impacts. In addition, the Center will establish innovations in understanding diverse material functions through the creation of new basic materials and compounds which brings significant benefits for the future of humanity.
Outline of management	In the bid for a rapid and flexible decision making process, we maintain a top-down command system governed by our Center Director. The Executive Committee composed of the Director, Administrative Director and five Research Group leaders disseminates the Director's message and intensifies exchange of information. Besides PI meeting and Staff meeting are regularly held. Aimed for the support of a Center Director's top-down decision making system, the "International Advisory Board" which includes Nobel Laureate board members, advises the Center Director. We will also prepare strong staff backup functions for accounting, personnel, research support, liaison and public relations works so that the researchers can devote themselves to research. The International Relation Unit will assist foreign researchers in a unified manner. To secure the independence of the center administration, the host institution will limit its authority to extremely important items such as the appointment and dismissal of the Center Director, and leave all other personnel, budget execution and other items effectively under the discretion of the Center Director. Also, the university will activate environmental improvements concerning flexible approaches, revisions and betterment of the university's system upon the center director's request with help of the Executive Vice President in charge of Research as liaison.
Researchers and other center staffs, satellites, partner institutions	・33 PIs (including 12 People from abroad); the number of total researchers is 146 including 73 foreign people; the number of total people of the Center is 220 at the final goal (at the end of FY2016). ・Major PIs; Tadafumi Adschiri, Mingwei Chen, Masayoshi Esashi, Alan Lindsay Greer, Yasumasa Nishiura, Hideo Ohno, Takashi Takahashi, Paul S. Weiss, Qi-Kun Xue, Alain Reza Yavari ・Satellites; (1) University of Cambridge, (2) Institute of Chemistry, Chinese Academy of Sciences, (3) University of California, Santa Barbara ・15 partner institutions including the three satellites
Administrative director	Masaru Tsukada
Outline of research environment	As to administrative tasks, we will prepare strong staff backup functions for accounting, personnel, research support, liaison and public relations, outreach works so that the researchers can devote themselves to research. Moreover, a Researcher Support Office will be set up where senior mentor will arrange a one-stop-services for the researchers. The performance of center researchers will be strictly evaluated and the researchers' salary assessments will be determined based on the evaluation results. Employment of researchers including PIs will be basically determined by international recruitment. The necessary start-up funds will be provided in cases when the invited researchers require funds to vigorously continue their own research when they are initially transferred to the center. In the recruitment of post-doctoral researchers, we will secure personnel via international recruitment. The researchers will be strictly evaluated at renewal time. We will provide the researchers with research support from senior mentors and otherwise promote the organic development of research. In addition to the existing research space of our university, newly-created WPI main building provides the space for interactions and outreach activities, such as combination room and multi-purpose hall.

<table>
<tr><td></td><td>The International Advisory Board, including Nobel Prize laureates as members, which will report directly to the Center Director to support top-down type decision making by the Center Director.
We also hold international research conferences assembling top-level researchers from over the world on a regular basis.</td></tr>
<tr><td>Outline of indicators for evaluating a center's global standing</td><td>Researcher ID is continuously used for thorough evaluations of research activities. Moreover, to evaluate our global standing in the field in a transparent manner, international and visible criteria such as the number of international prizes, and number of citation of papers and top 1 % paper are also used. ISI Highly Cited Researcher List is also checked. For research projects that take longer to generate outcomes, a comprehensive approach to evaluation will be taken with peer reviews of distinguished researchers inside and out side Japan.</td></tr>
<tr><td>Securing research funding</td><td>Tohoku University supports the fund for research, setting up instruments and equipment necessary for research at the Center. Besides, Principal Investigators annually obtain from subsidies the outside sources totaling US$ 28,500,000 on average. We expect to receive similar (or even higher) amounts of research funding years to come. In addition, the University keeps paying salaries of Principal Investigators who were affiliated with the host institution prior to joining AIMR.</td></tr>
<tr><td>Appropriations plan

(Exchange Rate: JPY/USD=80)</td><td>
<table>
<tr><td>FY</td><td>2012</td><td>2013</td><td>2014</td><td>2015</td><td>2016</td><td>Total</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cost
($ millions)</td><td>16.68</td><td>16.68</td><td>16.68</td><td>16.68</td><td>16.68</td><td>83.40</td><td></td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
<tr><td>Summary of host institution's commitment</td><td>Tohoku University clearly stipulates the strengthening and support for AIMR as a priority in its interim plan. The Tohoku University action plan "Inoue Plan 2007 (Revised for 2011)" released in June 2011 also clearly stipulates that the university will reinforce the organization of AIMR as a measure for playing a leading role as part of a top-class international network. The support for the Center is a shared determination of the university and the policy will be passed to the next president.
The host institution already provided the laboratory for the Mathematics Unit and a library in the WPI-AIMR main building constructed with the subsidies of MEXT. Additionally, the host institution will pay the personnel expenses, other required items as research expenses and other researcher support, the installation of apparatus required for research at the center, the refurbishing of research space.
To secure the independence of the center administration, the host institution will limit its authority to extremely important items such as the appointment and dismissal of the Center Director, and leave all other personnel, budget execution and other items effectively under the discretion of the Center Director.
The host institution will support the In-house Council of AIMR comprising heads of related departments and research institutes and coordinate with the departments by taking their educational activities into consideration.
We have already established the International Advisory Board which advises the Center Director to support top-down type decision making.
Also, so that work at the center can be conducted smoothly in English, we will assign staff with superior English skills, in addition to expertise in such fields as accounting, personnel and research assistance, as administrative staff on a priority basis.
A standing task team will also be established with the Executive Vice President in charge of Research as its lead for rapid examinations and responses in cases when the Center Director requests the flexible administration, revision, improvement or adjustment of the host institution's systems, and the host institution will otherwise prepare an environment for the smooth conduct of top management by the Center Director.
After the completion of the program, the cooperation among the related departments and research institutes achieved by AIMR will serve as a base for developing new integrated organization for materials research.</td></tr>
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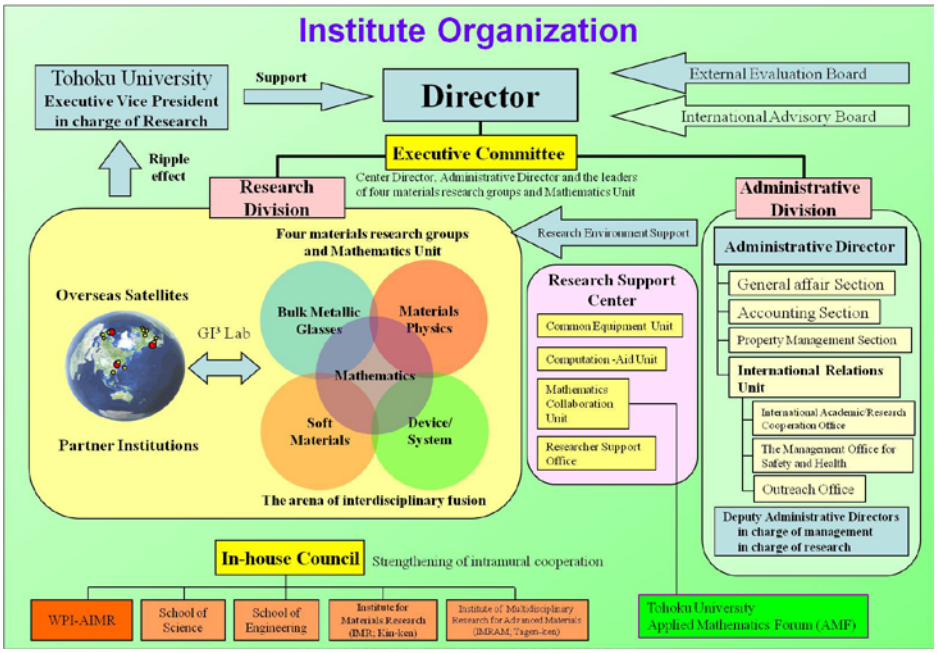
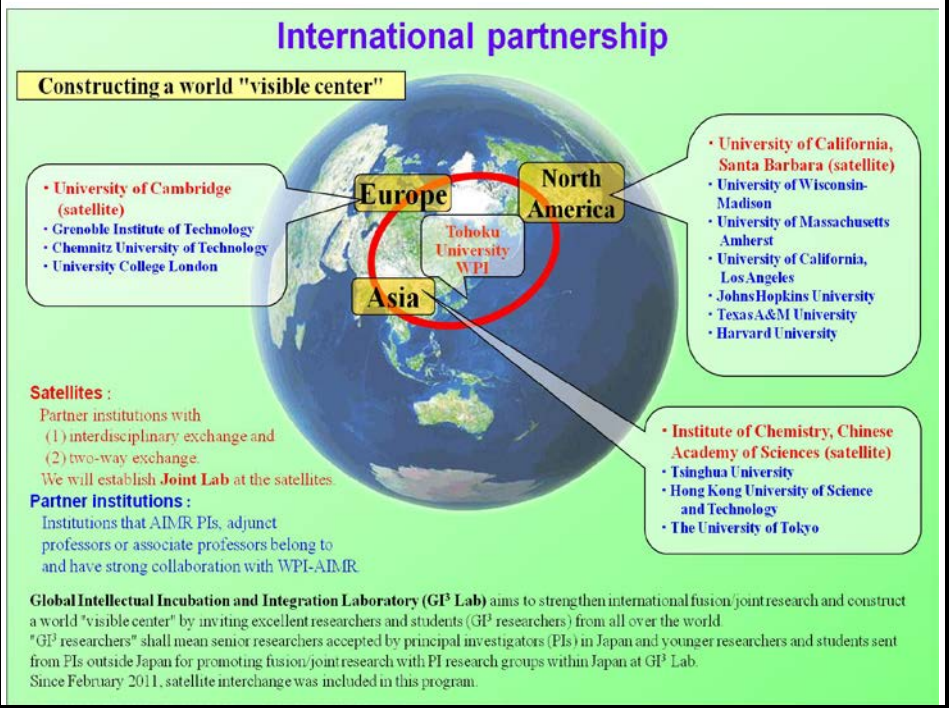
3. Research Center Project (in English)

Host institution	Tohoku University
Head of host institution	・Name, position title Susumu Satomi, President, Tohoku University
Research center	WPI Advanced Institute for Materials Research
Center director	Motoko Kotani
Chief center-project officer(in October 2007)	・Name, affiliation, position title (in October 2007) Yoshinori Yamamoto, Director, WPI Advanced Institute for Materials Research
Project summary	・Briefly describe the general plan of the project. Our world faces the global challenges concerning the energy and environment for the future generation. WPI Advanced Institute for Materials Research (WPI-AIMR) will play an important role in addressing them with scientific basis. For this purpose, AIMR will carry out world-class research by gathering excellent researchers in materials science, physics, chemistry, and engineering – fields in which Tohoku University has traditionally held a leading position in its research. Building on this excellence as a leading research organization, AIMR aims to contribute to society by creating innovative functional materials, which have a great impact on building the foundation for the safe and enriched life of people. We will conduct collaborative and interdisciplinary researches beyond conventional ideas along with the following objectives: 1) To elucidate fundamental principles lying behind functional manifestation common to different kinds of materials 2) To build a basis for “predicting” new functions and new materials based on the newly-established principles 3) To create Green Materials to contribute to “Energy Harvesting”, “Energy Saving” and “Environmental Clean-up” In order to achieve these objectives through top-level scientific activities, we will make an ideal research environment in AIMR to attract excellent and competent researchers from around the world. Researchers at AIMR should be able to concentrate on their studies by being provided world top level research facilities and equipment. For researchers from overseas, we also provide housing, assistance for the daily life of their family members, and information on Japanese culture and Japanese language learning. For swift and flexible decision making, the center will be administered and governed by the top-down decision making by the Center Director. The Center Director obtains advice from the International Advisory Board, consisting of highly reputed personalities including Nobel Prize laureates, and exchanges opinions with the In-house Council in order that the Director can grasp global trends in research and carry out a system reform to make AIMR a top level research center in the world. Human resource development for the next generation is also an important mission of the WPI centers, thus we will provide sufficient support for young researchers in their career building at AIMR so that they can grow to be research leaders in the next generation by providing an ideal research environment for them. In addition, we will streamline

research activities within the organization, and establish a system for researchers, including newly employed researchers, to carry out their research promptly and smoothly by making the Research Support Center consisting of (1) Common Equipment Unit, (2) Computation-Aid Unit, (3) Mathematics Collaboration Unit, and (4) Researcher Support Office.



In order to strengthen ties with overseas partner institutions and construct a “visible center”, AIMR has established 15 partner institutions in the world, including three satellites (the University of Cambridge; the University of California, Santa Barbara; and the Institute of Chemistry, Chinese Academy of Sciences) to enhance its global linkage, collaboration, and joint research. AIMR promotes research exchange, especially with these satellites, by establishing joint laboratories. Under the GI^3 (Global Intellectual Incubation and Integration) Laboratory Program (institutionalized in 2009), excellent researchers from all over the world gather at AIMR, and carry out joint research in collaboration with AIMR’s principal investigators.



	In the future, the cooperation among the related departments and research institutes, which will be achieved by AIMR as locomotive, will serve as a base for developing new integrated organization for materials research as a “World-leading center of intellect” at Tohoku University.
	Major changes from initial project plan: There is no major change in our plan to contribute to the human society by establishing a new materials science, and creating innovative functional materials based on it, by bringing together various materials science-related fields. However, it has become clear that we need to introduce mathematical viewpoints into our research in order to achieve our goal in five years by advancing interdisciplinary research. Thus, we will establish Mathematics Unit. It will serve as a catalyst to find common factors and functions of different kinds of materials. AIMR, together with materials scientists and mathematicians, aims to create a basis for new materials science which can predict new functions.
Mission statement and/or center’s identity	・ Briefly and clearly describe the mission statement and/or the project’s identity as WPI center. Since its establishment, AIMR has maintained a consistent viewpoint in aiming to cultivate new materials science fields and revolutionary functional materials by gathering researchers: (1) who work in different layers of materials, including atoms, molecules, materials, and devices to bridge the layers from microscopic to macroscopic scales; (2) who treat various materials such as bulk metallic glasses (BMG), ceramics, polymers, and biomaterials to promote common understanding of different materials from theory to application. With the mission of utilizing this success to contribute to society, AIMR has achieved several notable research results. There is no change in this concept. However, during the first five years researchers from different fields engaged in discussion and collaborative research, and we crystallized our mission in a more clear form: <u>to discover common elements and universal principles among different material fields and create new materials science which can predict new functions.</u> 1) We try to elucidate fundamental principles lying behind functional manifestation common to different kinds of materials. 2) We will build a basis for “predicting” new functions and new materials based on the newly-established principles. 3) We will create Green Materials to contribute to “Energy Harvesting”, “Energy Saving” and “Environmental Clean-up”. We also proposed to take a new approach <u>employing mathematical viewpoints</u> to accomplish the mission. Since mathematics simplifies phenomena and abstracts principles behind them, it will accelerate fusion research toward the goal. In line with this mission the following three projects were established as the targets to be tackled in 2012. **(1) Non-equilibrium Materials based on Mathematical Dynamical Systems** **(2) Topological Functional Materials** **(3) Multi-Scale Hierarchical Materials based on Discrete Geometric Analysis** These projects were selected by the new Center Director, a mathematician, based on proposals from materials scientists. The interface researchers who connect the materials science and mathematics are important. We will place these researchers (theoretical researchers in physics or chemistry, or researchers having a mathematical background) into each project.

	In AIMR, material scientists and mathematicians join hands in explaining new phenomena measured by AIMR's top class equipment and elucidate the mechanism lying behind the structure-function relationship. This challenge to elucidate the mechanism of function manifestation and link it to the creation of new materials is unprecedented anywhere else in the world. As pointed out by the program committee, this challenge will not be easy. It is a tremendously arduous path; however, the researchers in AIMR (both materials scientists and mathematicians) feel strong attraction to the adventure based on the new strategy developed through their repeated discussions. Materials scientists from diverse backgrounds and mathematicians are gathered in a single place and challenge ambitious investigations to create new materials with revolutionary functions, and contribute to society—that is the identity of AIMR.

(1) Research fields

- Describe in simple words and phrases within one line the research field of the project.
- Choose relevant fields from among ①－⑦ below, specifying the interdisciplinary field(s) that the project addresses.
  ①Biosciences, ②Chemistry, ③Material sciences, ④Electronics engineering and information sciences, ⑤Precision and mechanical engineering, ⑥Physics, ⑦Mathematics
- Describe the importance of the proposed research, including domestic and international R&D trends in the field and Japan's advantages.
- If centers in similar fields already exist in Japan or overseas, please list them.

Research Field

"From Atom and Molecule to Materials", New materials science through interdisciplinary research

Interdisciplinary Fields

Material sciences, Physics, Chemistry, Electronics engineering and information sciences, Precision and mechanical engineering, Mathematics

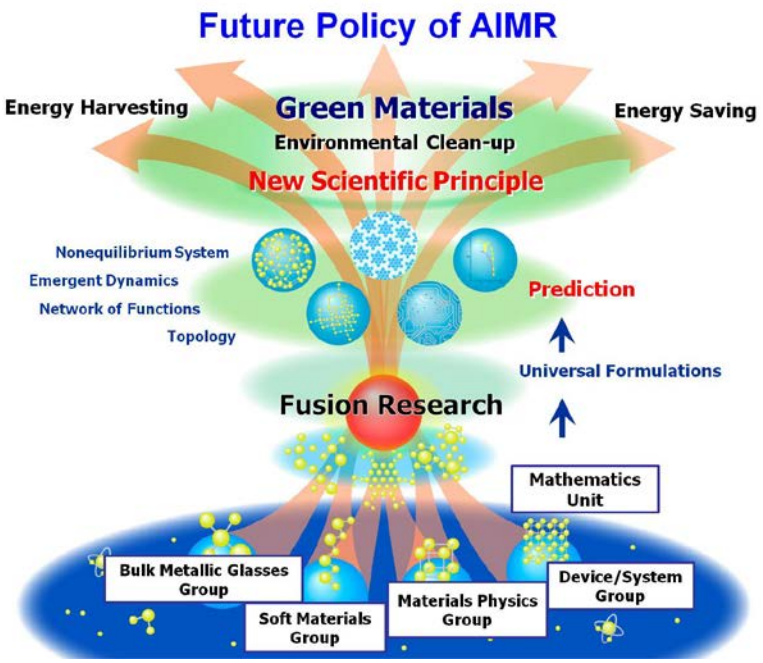
Mathematics functions as a catalyst for the fusion of different fields related to materials science, and in the process, discoveries of new methodologies in mathematics are also expected.

Importance

Materials science is one of the most important fields of science in order for Japan to lead the world through science and technology. The most important foundation for all production activities in modern society is materials. As such, we should keep promoting materials science as a core technology of Japan and maintain the current high level of technology.

Tohoku University's research activities in materials science rank among the best in the world. In order to maintain the current level of research, which surpasses other universities and institutes in the world, and pass down its proud history to the next generations, we have introduced viewpoints of physics, chemistry, and engineering - the fields in which Tohoku University has always excelled - into materials science. We have also added mathematics' viewpoints. Through such inter-disciplinary efforts, AIMR aims to contribute to the sustainable development of human society, by creating materials which contribute to the safety and enriched lives of humans, by creating comprehensive materials science that exceeds its conventional boundaries.

This type of challenge to create new materials science is necessary for the future of mankind. AIMR aims to lead the world by integrating the research activities of four materials science groups (Bulk Metallic Glasses, Materials Physics, Soft Materials, and Device/System) and of Mathematics Unit.



(2) Research objectives

・ Describe in a clear and easy-to-understand manner the research objectives that the project seeks to achieve by the end of the grant period. In describing the objectives, the following should be articulated in an easily understandable manner: What new domains are expected to be pioneered by fusing the target fields. In the process, what world-level scientific issues are sought to be resolved. What is the expected impact of the scientific advances to be achieved on society in the future.

・ Describe concretely the research plan to achieve these objectives.

Research Goals and Fields to be Explored

Under the center's motto "From Atom and Molecule to Materials," researchers of materials science in various fields gather at AIMR and carry out cutting-edge research in the field.

It is recognized that materials take various forms ranging from a microscopic atom or molecule to an industrial material with 8-to-10 digit differences in size, and that there are multilayered materials hierarchies, in which each layer is controlled by different physical laws. Finding how these layers are connected in the structure of a material, and controlling macro-level physical properties of a material by controlling its micro-level layers is the ultimate achievement and the most difficult challenge for materials scientists. To study and understand a material at its atomic or molecular level, and apply this knowledge in understanding its physical properties has become more realistic, thanks to the invention and development of high-resolution electron microscopy, scanning tunneling microscopy, and atomic force microscopy with atomic and molecular resolution, and research in various fields have actively pursued this endeavor. However, no one has yet to achieve results that could give a unified solution to the challenge of creating a new material by controlling its atoms and molecules. This has prompted AIMR to take up this new challenge. In doing so, AIMR has upgraded its organization greatly, far better than conventional research organizations, by implementing the following measures:

1) Gathering researchers who work in different layers of materials, including atoms, molecules, materials, and devices to bridge the layers from microscopic to macroscopic scales.
2) Gathering researchers who treat various materials such as bulk metallic glasses (BMG), ceramics, polymers, and biomaterials to promote common understanding of different materials from theory to application.
3) In order to accelerate the fusion of knowledge in different fields, mathematicians also participate in the research of materials science.

AIMR is now making an organization that can find a solution for the problem of the multilayer hierarchy where researchers of various specialization share knowledge and technologies and help

each other. By implementing the above mentioned measures, we will be able to elucidate hierarchical structures common to different kinds of materials and bring about a new materials science that can help create a new material. In addition to these efforts, AIMR will also financially support various joint and inter-disciplinary research projects among different fields including mathematics, through the 'Fusion Research Proposal Program'.

Expected Scientific Progress and its Impact on Society

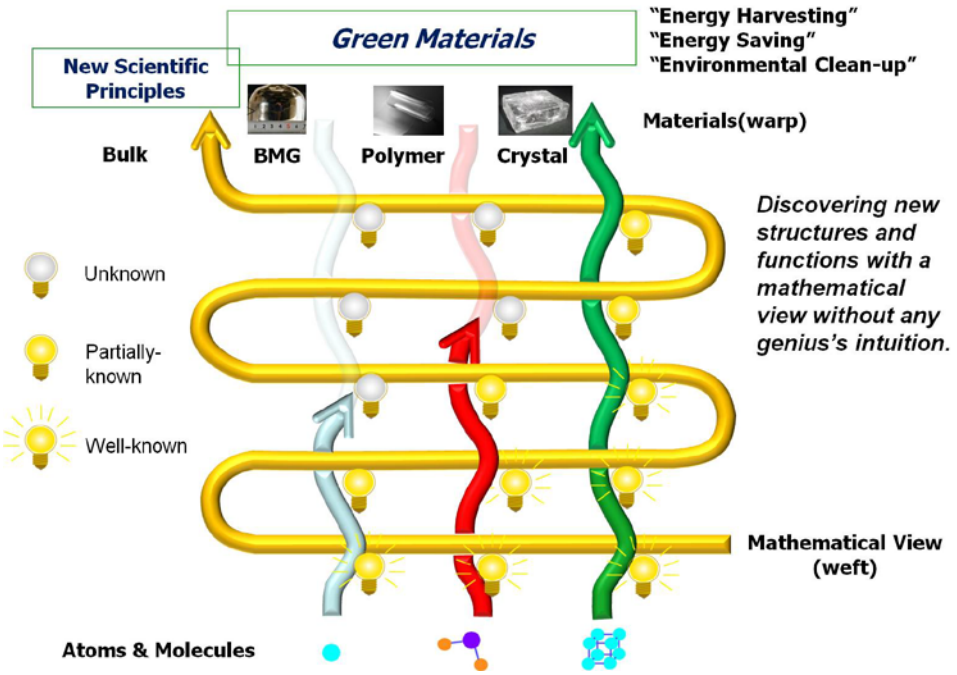
By the fusion of mathematics and different materials science fields, the following scientific progress and subsequent impacts on society are expected.

1) We try to elucidate fundamental principles lying behind functional manifestation common to different kinds of materials.
2) We will build a basis for "predicting" new functions and new materials based on the newly-established principles.
3) We will create Green Materials to contribute to "Energy Harvesting", "Energy Saving" and "Environmental Clean-up".

Based on these progresses AIMR creates innovative materials with a great impact which provide the base of safe and enriched life and contributes to the society.

The Role of Mathematics

The role of mathematics is visually described in the diagram below. AIMR is trying to elucidate and systematize the structure and functional manifestation not only in each material system but also in whole materials systems in the complicated hierarchy by introducing mathematical methods of simplification and abstraction, then find common factors among material-structure-function relationships in order to predict undiscovered functions and, based on these predictions, come up with clues which could lead to the development of a new material.



The following three materials systems include elements for which materials scientists of various specializations share the same understanding and mathematical approaches can be applied. Therefore, AIMR has decided to carry out research on these three materials, and search for the possibility of creating a new material using unconventional methods.

1) Non-equilibrium Materials based on Mathematical Dynamical Systems
2) Topological Functional Materials
3) Multi-Scale Hierarchical Materials based on Discrete Geometric Analysis

(3) Management

i) Center director

・ Provide the name of the center director, his/her age (as of 1 April 2012), , specialties, and brief career profile(within 5 lines).

・ If there is a plan to change the center director, how does the new center director intend to construct the center and what is his/her vision of objectives to be achieved? Provide a synopsis written by the new center director (free format).

Motoko Kotani, 52 years old

Prof. Kotani has specialized in mathematics, and has made distinguished achievements in her research activities. For example, she was awarded the 25th Saruhashi Award in 2005 for her work in “Discrete Geometric Analysis on Crystal Lattices.” Lately, she has been actively promoting collaboration between mathematics and materials science fields as the leading researcher of “A Mathematical Challenge to a New Phase of Material Science, Based on Discrete Geometric Analysis”, a project of Core Research for Evolutional Science and Technology (CREST) under the Japan Science and Technology Agency (JST). She has a lot of experience in both short-term and long-term overseas research, and has acquired an international mindset. She is also well equipped for management and participates in the operation of Tohoku University as a Special Advisor to the President of Tohoku University. She is an Associate Member of the Science Council of Japan (Committee on Mathematical Sciences), Member of the Board of Trustees of Mathematical Society of Japan, and a councilor of the Geometry Section of Mathematical Society of Japan, and has contributed to the promotion of mathematics throughout the country.

At AIMR, she is vigorously promoting materials science research by making a full use of her research experiences, and plays a bridging role between mathematics and materials science while leading the administration and management of the institute.

ii) Administrative director

・ Provide the name of the administrative director, his/her age (as of 1 April 2012), and his/her brief career profile(within 5 lines).

Masaru Tsukada, 69 years old

Dr. Tsukada is a theoretical physicist (Professor Emeritus of the University of Tokyo) specialized in condensed-matter physics and the theory of surface science. After being Professor of the University of Tokyo and Invited Professor of Waseda University, he has participated as Principal Investigator in AIMR since its establishment, where he has driven the front-line research and promoted the fusion research through planning and management of the Annual Workshop and Joint Seminars as well as redaction of the Institute’s scientific magazine ”WPI-AIMR News”. His administrative skills enriched by his specialty knowledge demonstrated through these works have obtained him a great confidence both inside and outside of AIMR. Moreover, he has abundant experience of organization and management from assuming key positions of important academic societies such as the President of the Surface Science Society of Japan, and he has an internationalized personality gained through several stays in foreign research institutes. It is no doubt that with his viewpoint of a theoretician deeply involved in materials science, he can support the Director, with a view to realizing the Research Center Project through reinforcement of the support system for research and administrative organization which contribute to promotion of mathematics-materials science collaboration.

iii) Composition of administrative staff

・ Concretely describe how the administrative staff is organized.

The Administrative Division is composed of the Administrative Director and the Deputy Administrative Directors (two persons: one in charge of management, and another person in charge of research) who assist the Administrative Director, the General Affairs Section, the Property Management Section, the Accounting Section, and the International Relations Unit (the International Academic Research Cooperation Office, the Management Office for Safety and

Health, and the Outreach Office). They employ the eligible experts who can provide logistics support which allows researchers to conduct their studies flawlessly and carry out the expansion of research results and planning, and can enhance proactive research development together with the researchers. Consequently, this formation can significantly contribute to the Center's research goal activities.

Specifically, for the daily routines such as in accounting, human resources, and research support, highly experienced staff who can accomplish their duties without difficulties will be selected mainly from intramural administrative staff under the Deputy Administrative Director in charge of management. To satisfy the means of the Center's official language, which is English, staff who have supportive abilities in the English language will be preferentially assigned, and external staff with a good command of English are also recruited. The international Relations Unit manages a work in a unified manner a range of tasks from daily care of foreign researchers, assistance to the application to the research funds to the secretarial work of the organization of the symposium.

Excellent and experienced personnel from various fields including researcher evaluation, international research coordination, activating expansion, and public relation of research results, planning, and support of research workshops will be allocated under the Deputy Administrative Director in charge of research. We will proactively hire diverse professionals; not only experienced at the University, but also from the private sector or non-Japanese with international experience or former researchers, etc. utilizing an annual salary system.

iv) Decision-making system

・ Concretely describe the center's decision-making system.

In order to enable a rapid and flexible decision making process, the management of the Center is determined by a top-down command system governed by the Center Director, and we will not specifically launch a council system as a decision making organization within the Center. However, we arrange the Executive Committee composed of the Center Director, Administrative Director, and five Research Group Leaders in order to disseminate the message from the Center Director and intensify exchange of information throughout the organization. Also, we will launch a Principal Investigators (hereinafter called PIs) meeting and a monthly staff meeting by assistant professors and higher to get the decisions reflected immediately throughout the whole center.

Aimed for the support of a Center Director's top-down decision making, the "International Advisory Board", which includes Nobel Prize laureates as board members, has been established directly under the Center Director position. We develop a proper environment utilizing Internet technology so that the Center Director and board members can effectively exchange and share their views together on implementation of system reform and other issues for creation of a world premier international research center.

Also, the University will permanently implement a task force team established with a lead of the Executive Vice President in charge of Research and will activate environmental improvements for a smooth execution of the Center Director's top-down management in order to promptly review and respond to the Center Director's requests concerning flexible operation, revision, and betterment of the University's system.

v) Allocation of authority between the center director and the host institution's side

・ Concretely describe how authority is allocated between the center director and the host institution's side.

To secure the independence of the center administration, Tohoku University will take only limited authority of important items such as the appointment and dismissal of the Center Director, and leave all other personnel, budget execution, and other items effectively under the discretion of the Center Director.

For personnel matters, the University will only retain authority over the appointment and dismissal of the Center Director and have all other personnel items within the center including the employment of Principal Investigators determined by the Center Director.

The budget allotted to the center (personnel expenses and non-personnel expenses) will be a lump-sum payout for free execution at the judgment of the Center Director, and it will be possible to carry over funds allocated for budget items that are not implemented by the end of the fiscal year to the subsequent fiscal year.

(4) Researchers and other center staffs, satellites, partner institutions

i) The “core” to be established within the host institution

a) Principal Investigators (full professors, associate professors or other researchers of comparable standing)

	numbers		
	At beginning	At end of FY 2011	Final goal (March, 2017)
Researchers from within the host institution	15	16	17
Foreign researchers invited from abroad	11	12	12
Researchers invited from other Japanese institutions	4	4	4
Total principal investigators	30	32	33

・ Describe the concrete plan to achieve final staffing goal, including steps and timetables.

・ Attach a list of principal investigators using the Appendix. Place an asterisk (*) by names of the investigators considered to be ranked among the world’s top researchers. Describe the policy and strategy for inviting the PIs who are to be included after 1 April 2012.

b) Total members

	Numbers		
	At beginning	At end of FY 2011	Final goal (March, 2017)
Researchers	60 < 19, 31%> [, %]	132 < 63, 48%> [11, 8%]	146 < 73, 50%> [22, 15%]
Principal investigators	30 < 12, 40%> [, %]	32 < 12, 38%> [2, 6%]	33 < 12, 36%> [2, 6%]
Other researchers	30 < 7, 23%> [, %]	100 < 49, 49%> [9, 9%]	113 < 59, 52%> [20, 18%]
Research support staffs	44	43	50
Administrative staffs	35	23	24
Total number of people who form the “core” of the research center	139	198	220

・ Enter the total number of people in the columns above. 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.

・ Enter matters warranting special mention, such as concrete plans for achieving the Center’s goals, established schedules for employing the main researchers, particularly principal investigators.

ii) Collaboration with other institutions

・ If the “core” forms linkages with other institutions, domestic and/or foreign, by establishing satellite functions, Provide the name of the partner institution(s), and describe the role of the satellite functions, personnel composition and structure, and collaborative framework between the host institution and the said partner institutions (e.g., contracts to be concluded, scheme for resource transfer).
・ If some of the principal investigators will be stationed at satellites, attach a list of these principal investigators and the name of their satellite organizations using the Appendix.
・ If the “core” forms organic linkages with other institutions, domestic and/or foreign, without establishing satellite functions, provide the names of the partner institutions and describe their roles and linkages within the center project.

a) Satellites

Institution (1) **University of Cambridge**
-Role
Joint research will be conducted continuously through the promotion of two-way exchanges of researchers, with the main theme of non-equilibrium materials and soft materials.
- Personnel composition and structure
Alan Lindsay Greer (PI), Bill Jones (Adjunct Professor)
- Framework of collaboration
Upon the conclusion of the Agreement with the Department of Chemistry, Dr. E. Reisner, a fellow of the University Lecturer & EPSRC Career Acceleration, and Dr. M. Kato (post-doc) of the same university were to have been invited to the Center in April 2011. However, it has been postponed due to the major earthquake that struck eastern Japan.
A joint symposium on materials physics and soft materials was held at the University of Cambridge in June 2011.
As part of the joint research framework, AIMR will accept young researchers including PhD students as visiting scientists.

Institution (2) **Institute of Chemistry, Chinese Academy of Sciences**
-Role
Joint research will be conducted continuously through the promotion of two-way exchanges of researchers, with the main themes of the research on molecular nanotechnology and devices.
- Personnel composition and structure
Li-Jun Wan (PI), Zhang Xu (post-doc)
- Framework of collaboration
As part of the joint research framework, AIMR will accept young researchers including PhD students as visiting scientists.

Institution (3) **University of California, Santa Barbara (UCSB)**
-Role
Joint research will be conducted continuously through the promotion of two-way exchanges of researchers, with the main theme of organic electronics and condensed phase phenomena.
- Composition of personnel, structure
Fred Wudl (Adjunct Professor)
- Framework of collaboration
Professor Yamamoto, the Center Director, visited UCSB in May 2011 and discussed on more concrete research prospects in the future. A joint symposium together with AIMR was held at UCSB in January 2012.
As part of the joint research framework, AIMR will accept young researchers including PhD students as visiting scientists.

b) Partner institutions

Institution (1) **University of Wisconsin-Madison**
-Role
Joint research on materials physics

-Personnel composition and structure
John H. Perepezko (Adjunct Professor)
-Collaborative framework
As part of joint research framework, AIMR will accept young researchers including PhD students as visiting scientists.

Institution (2) **Grenoble Institute of Technology**
-Role
Joint research on bulk metallic glasses
-Personnel composition and structure
Alain Reza Yavari (PI), Konstantinos Georgarakis (assistant professor)
-Collaborative framework
Joint research on bulk metallic glasses will be conducted continuously. Yavari has frequently visited AIMR, promoting the BMG group's joint research project. The Grenoble Institute of Technology has served as a collaborative institution which is working with the European satellite set up at the University of Cambridge in 2008. Consequently, an added emphasis is put on researcher exchange with the Grenoble Institute of Technology.
As a way of promoting research collaboration, Georgarakis has been posted in Sendai as an assistant professor.
As part of the joint research framework, AIMR will accept young researchers including PhD students at the Yavari research group at the Grenoble Institute of Technology as visiting scientists.

Institution (3) **University of Massachusetts Amherst**
-Role
Joint research on high polymer chemistry and soft materials
-Personnel composition and structure
Thomas P. Russell (PI)
-Collaborative framework
Joint research on high polymer chemistry and soft materials will be conducted continuously.
As part of the joint research framework, AIMR will accept young researchers including PhD students at the Russell research group at the University of Massachusetts Amherst as visiting scientists.

Institution (4) **Chemnitz University of Technology**
-Role
Joint research on MEMS
-Personnel composition and structure
Thomas Gessner (PI) , Yu-Ching Lin (assistant professor), Yao-Chua Tsai (post-doc)
-Collaborative framework
Joint research on MEMS will be conducted continuously. To strengthen the collaborative relationship, Lin (assistant professor) and Tsai (post-doc) will be posted in Sendai. As part of the joint research framework, AIMR will accept young researchers including PhD students at the Gessner research group at the Chemnitz University of Technology as visiting scientists.

Institution (5) **University College London**
-Role
Joint research on surface physics and theoretical research
-Personnel composition and structure
Alexander Shluger (PI), Sanliang Ling (post-doc), Peter Sushko (Adjunct Associate Professor)
-Collaborative framework
Joint research on surface physics and theoretical research will be conducted continuously.
To strengthen the collaborative relationship, Ling will continue to be posted as a post-doc in Sendai. As part of the joint research framework, AIMR will accept young researchers including PhD students at the Shluger research group at University College London as visiting scientists.

Institution (6) **University of Cambridge**

Refer to satellite institutions listed above

Institution (7) **Institute of Chemistry, Chinese Academy of Sciences**

Refer to satellite institutions listed above

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

Refer to satellite institutions listed above

Institution (9) **University of California, Los Angeles (UCLA)**
-Role
Joint research on materials physics
-Personnel composition and structure
Paul S. Weiss (PI)
-Collaborative framework
Joint research on materials physics will be conducted continuously. As part of the joint research framework, AIMR will accept young researchers including PhD students at the Weiss research group at the University of California, Los Angeles as visiting scientists.

Institution (10) **Johns Hopkins University**
-Role
Joint research on bulk metallic glasses
-Personnel composition and structure
Kevin J. Hemker (PI)
-Collaborative framework
Joint research on bulk metallic glasses will be conducted continuously.
As part of the joint research framework, AIMR will accept young researchers including PhD students at the Hemker research group at Johns Hopkins University as visiting scientists.

Institution (11) **Tsinghua University**
-Role
Joint research on materials physics
-Personnel composition and structure
Qi Kun Xue (PI)
-Collaborative framework
Joint research on materials physics will be conducted continuously.
As part of the joint research framework, AIMR will accept young researchers including PhD students at the Xue research group at Tsinghua University as visiting scientists.

Institution (12) **Texas A&M University**
-Role
Joint research on biophysics
-Personnel composition and structure
Winfried Teizer (PI), Daniel Oliveira (post-doc), Aurelien Sikora (post-doc), Kyongwan Kim (post-doc)
-Collaborative framework
Joint research on biophysics will be conducted continuously.
To strengthen the collaborative relationship, Oliveira, Sikora and Kim are posted in Sendai. As part of the joint research framework, AIMR will accept young researchers including PhD students at the Teizer research group at Texas A&M University as visiting scientists.

Institution (13) **Harvard University**
-Role
Joint research on bio-devices
-Personnel composition and structure
Ali Khademhosseini (PI), Serge Ostrovidow (post-doc), Samad Ahadian (post-doc)
-Collaborative framework
Joint research on bio-devices will be conducted continuously.
To strengthen the collaborative relationship, Ostrovidow (post-doc) and Ahadian (post-doc) are posted in Sendai. As part of our joint research framework, AIMR will accept young researchers including PhD students at the Khademhosseini research group at Harvard University as visiting scientists.

Institution (14) **Hong Kong University of Science and Technology**
-Role

Joint research on bio-devices

-Personnel composition and structure

Hongkai Wu (PI), Xuetao Shi (post-doc), Haijun Yu (post-doc), Haixin Chang (post-doc), Jianhia Zhou (post-doc)

-Collaborative framework

Joint research on bio-devices will be conducted continuously.

To strengthen the collaborative relationship, Shi, Yu, Chang and Zhou are posted in Sendai.

Institution (15) **The University of Tokyo**

-Role

Joint research on crystal interfaces and theory

-Personnel composition and structure

Yuichi Ikuhara (PI), Susumu Tsukimoto (lecturer), Mitsuhiro Saito (assistant professor), Zhongchang Wang (assistant professor), Chunlin Chen (post-doc)

-Collaborative framework

Joint research will be conducted on crystal interfaces and theory.

To strengthen the collaborative relationship, Tsukimoto, Saito, Wang and Chen will continue to be posted in Sendai.

(5) Research Environment

・ Concretely describe measures to be taken to satisfy each of the requirements outlined below, including steps and timetables.

○ Provide an environment in which researchers can devote themselves exclusively to their research, by exempting them from other duties and providing them with adequate staff support to handle paperwork and other administrative functions.

We will continue to arrange the environment to the greatest possible extent so that the researchers participating at this Center can devote themselves exclusively to research. The environment provided by the Center to PIs is similar to that for Distinguished Professors in the US.

We will make arrangements so that the researchers themselves will not be involved in the managerial work of not only the University but that of the Center. We provide thorough time management (effort management) for the researchers and otherwise secure ample time for the researchers to engage in research at this Center as much as possible.

To be more concrete, we will reinforce staff backup functions for accounting, personnel, research support, liaison, and public relations work as well as outreach tasks to take care of various paperwork on behalf of the researchers so that the researchers can devote themselves to research. In addition to these staff functions to perform day-to-day administrative tasks, we will assign individuals with outstanding experience in planning and support fields such as researcher evaluation, international research coordination, the ordered development of research findings, the publication of research findings, and the research conferences. We will also assign technical staff as required to support research activities from a technical point of view, in order to progress the use or development of the leading-edge research equipment smoothly and rapidly.

Moreover, we will set up a researcher support office and allocate senior mentors to arrange a one-stop-service system that can handle all kinds of administrative procedures from research work of the researchers to issues related to their family's life.

○ Provide startup research funding as necessary to ensure that top-caliber researchers invited to the center do not upon arrival lose momentum in vigorously pursuing their work out of concern over the need to apply immediately for competitive grants.

The necessary start-up funds will continue to be provided in cases when the invited researchers require funds to vigorously continue their own research when they are initially transferred to the Center.

We will provide the invited researchers with opportunities for research and information exchange and brainstorming with researchers inside and outside the Center to examine the potential for joint research. Also, we will continue to support their access to common experimental and other facilities within the University, and encourage them for the vertical start-up of the research.

○ As a rule, fill postdoctoral positions through open international solicitations.

(Open Recruitment Method)

In the recruitment of post-doctoral researchers, we will secure superior international personnel via international recruitment using Tohoku University's website (English and Japanese), international scientific journals, and Tohoku University's overseas bases, specifically as follows.

1) International recruitment via the contents of the Center continuously posted on Tohoku University's website (English and Japanese).
2) International recruitment through recruitment advertisements in *Nature*, *Science*, and other international scientific journals, and in the publications of academic societies in which Principal Investigators are members.
3) International recruitment via the website of the JREC-IN (Japan Research Career Information Network) personnel database (English and Japanese) administered by the Japan Science and Technology Agency.
4) International recruitment using Tohoku University's US office, China office, and other overseas offices and bases, and by asking renowned universities worldwide to post the recruitment information on their websites including global universities which have academic exchange agreements with Tohoku University (155 institutions), and members of university consortia (The Association of East Asian Research Universities [AEARU], etc.).
5) Other international recruitment utilizing the international networks that PIs have developed in each academic field.

(Employment Screening Method)

Post-doctoral researcher employment screening committees comprising several members will be organized for each PI, with the PI serving as the committee chairperson. The post-doctoral candidates will be determined through an initial selection by examination of documents and a secondary selection by interviews. The final employment decisions will be made by the Center Director. This process will employ post-doctoral researchers with superior results in their field of specialization, and also positively employ post-doctoral researchers in "interdisciplinary research fields" in order to promote cross-sectional interdisciplinary research efforts. The Center Director will directly make the employment decisions to secure promising post-doctoral researchers in accordance with the center concept.

(Employment of Female Researchers)

Consideration will be needed for employment so that the number of female candidate reaches at least 15% of the total number of researchers including post-doctoral.

○ Establish English as the primary language for work-related communication, and appoint administrative personnel who can facilitate the use of English in the work process.

We will continue to arrange an environment whereby the communication between researchers and administrative staff can always be conducted all in English by assigning staff members who can perform their work duties in English.

To these ends, for administrative staff in the Center promoted from the University, we will assign staff with English skills on a priority basis, in addition to expertise in each field such as accounting, personnel, and research assistance. Additionally, to supplement the English abilities of those staff, we will also secure staff that are proficient in English by utilizing dispatched workers system or the employment by annual salary system and allocate them in the administrative division.

Furthermore, we will arrange systematic opportunities for administrative staff in the Center to participate in English training and constantly improve their English ability (including English in areas of expertise).

All application documents for internal use that must be filled out personally by the researchers will be prepared in English so that the foreign researchers will be able to submit all relevant documents in English.

We will also incrementally boost the ability to use English in the performance of duties at the Center, and progressively shift to a system whereby "English will become the official language for all meetings inside the Center" and "English will be used for all documents drafted inside the Center".

In principle, all research papers by Center researchers will be written in English.

○ Adopt a rigorous system for evaluating research and a system of merit-based compensation. (For example, institute a merit-based annual salary system primarily for researchers from outside the host institution. As a basic rule, the salaries of researchers who were already employed at the host institution prior to the centers' establishment are to be paid by the host institution.)

As for the evaluation of researchers, Tohoku University has already stipulated a university-wide method for the assessment of individual faculty, with a researcher evaluation scheme at each department. The performance of researchers in the Center will also be strictly evaluated in accordance with this scheme, and the researchers' salary assessments (pay-raise system and diligence allowance), reappointment and rise in rank, and incentives such as priority allocation of research funds will be determined based on the evaluation results. For salaries in particular, in addition to the active adoption of the annual salary system, special allowances will be granted to researchers who make outstanding contributions.

We establish the International Advisory Board, including Nobel laureates as members, and an external evaluation board. They help to evaluate not only the research of individual PIs but also the system and organization of the Center.

Tohoku University's "University Professor System" will be actively used for the invitation of prominent researchers.

○ Provide equipment and facilities, including laboratory space, appropriate to a top world-level research center.

To prepare an environment with facilities and equipment suitable for a global top-level center, Tohoku University has installed a facility and equipment as a core for the Center's activities since its establishment in October 2007. This facility is equipped with flexible water supply and drainage equipment, air conditioning equipment, and power sources in a room arrangement of large space configuration so that the researchers of various branches of materials science can use it as a research space that meets the usage demands of the respective theme and the status of their research areas. With the intentions to encourage collaboration and frank exchange of opinion among the researchers, the WPI main building, which was completed in late July 2011, has combination room and a multi-purpose hall to be used actively. Also, based on the experience of the greatest earthquake on record, we will arrange the facilities and equipment to be upgraded for a more secure and safe environment that is suitable for a "global top-level center".

In order for a smooth use and development of the leading edge research facilities, a Common Equipment Unit and a Computation-Aid Unit will be newly established.

Arrangements will be made to provide the researchers with priority access to the leading edge equipment through close coordination with the Technology Center for Research and Education Activities and other related Tohoku University organizations.

○ Hold international research conferences or symposiums regularly (at least once a year) to bring the world's leading researchers together at the center.

By positively utilizing Tohoku University's US office, China office, Russia office, and 9 liaison offices and other overseas offices and bases, and also by working together with global universities which have academic exchange agreements with Tohoku University (155 institutions), member universities of international consortia (Association of Pacific Rim Universities [APRU], The Association of East Asian Research Universities [AEARU], and Top Industrial Managers for Europe [T.I.M.E.]) will provide researcher and other personnel exchanges and institutional relations for international joint research and will progress to an international development.

Specifically, we will first organize an international consortium among leading global universities to advance research on the topic "new substances and materials from atomic and molecular control, and functional innovation" and establish a structure to advance research and development under international institutional cooperation.

Then, using this international consortium along with Tohoku University's existing global network described above, we will arrange periodic opportunities for mutual exchange including the short-term overseas dispatch of the center researchers and the invitation of global researchers to Japan. We also hold pacesetting cutting-edge international research conferences assembling top-level global researchers on a regular basis (twice a year or so). By making these efforts, we are continuously preparing an environment in which the Center's researchers can engage in international research exchange, information exchange, and brainstorming with the world's leading researchers.

○ Other measures to ensure that top-caliber researchers from around the world can comfortably devote themselves to their research in a competitive international environment, if any.

We will advance the following approaches to build a center that compiles the latest global information and drives research forward, and attracts the top minds initiating dramatic developments of academic fields.

1) We established the "International Advisory Board", including Nobel Prize laureates as members, which reports directly to the Center Director to support top-down type decision making by the Center Director. The members of the International Advisory Board are: Prof. Herbert Gleiter (Director of Institute of Nanotechnology, Karlsruhe, Germany), Prof. J. Georg Bednorz (Fellow in IBM Zurich Research Laboratory, Switzerland. Awarded the Nobel Prize in Physics in 1987), Prof. Venkatesh Narayanamurti (Harvard University), Prof. Ei-ichi Negishi (Purdue University, USA. Awarded the Nobel Prize in Chemistry in 2010), and Akihisa Inoue (President of Tohoku University). The Center Director and the International Advisory Board will organically cooperate and exchange opinions, and positively implement system reforms to build a global top-level research center and promote globalization. The achievement evaluations of researchers every year and the employment of post-doctoral researchers will be conducted based on peer review by domestic and international specialists.
2) We will arrange a flat research organizational structure with as few hierarchical relations as possible to create an environment where even young researchers can get and develop their own ideas.
3) We will set up a Researcher Support Office to provide young researchers with research support from senior mentors and promote the organic development of research.

Also, we will prepare a system to support the daily life in Japan of foreign researchers at the Center and their families

(6) Indicators for evaluating a center's global standing

・ Describe concretely the following points.

i) Criteria and methods to be used for evaluating the center's global standing in the subject field
ii) Results of current assessment made using said criteria and methods
iii) Goals to be achieved through the project (at time of final evaluation)

i) Criteria and methods to be used for evaluating the center's global standing in the subject field

AIMR continues to use Researcher ID to conduct thorough evaluations of our research activities. We will also upgrade our website so that people can search the information from outside. Moreover, we will evaluate our global standing in the field in a transparent manner, harnessing the international and visible criteria such as the number of international prizes awarded to our researchers, the number of times our papers are cited, and the number of papers which made it to the top 1%, and by checking the ISI Highly Cited Researcher List. For research projects that are considered to be particularly challenging and take longer to generate outcomes, we will take a comprehensive approach to evaluation using peer reviews of distinguished researchers inside and outside Japan.

ii) Results of current assessment made using said criteria and methods

The number of papers written by senior principle investigators solely employed by AIMR and published during the past 10 years (2000-2010) is 3,255. 85 of these (2.61%) were ranked in the top 1% in terms of the numbers of citations received, which is much higher than that of comparable institutions in Japan; JST (2.56%), RIKEN (2.49%), Tohoku University (1.21%), and NIMS (1.15%). AIMR's ratio is still quite high when compared with overseas leading organizations such as Max Planck (3.25%), NASA (2.59%), and CNRS (1.57%), indicating that it ranks among the world's leading institutions in the field.

In addition, after the establishment of AIMR, our researchers have received the following international academic awards:

(1) Arthur C. Cope Scholar Award of the American Chemical Society (ACS) (2007, Yamamoto, Center Director)
(2) Membership of the National Academy of Engineering (NAE) (2008, Russell, PI; Inoue, PI)
(3) James C. McGroddy Prize for New Materials of the American Physical Society (APS) (2009, Inoue, PI)
(4) Oliver E. Buckley Condensed Matter Prize of the American Physical Society (APS) (2009, Miyazaki, PI)

(5) The International Rubber Conference Organization (IRCO) Medal (2009, Nishi, PI)
(6) Royal Society of Chemistry (RSC) Centenary Prize (2009, Yamamoto, Center Director)
(7) Unilever Award of the American Chemical Society (ACS) (2010, Khademhosseini, PI)
(8) A. E. Alexander Lecture Award of the Colloid and Surface Chemistry Division of the Royal Australian Chemical Institute (2011, Kurihara, PI)
(9) Humboldt Research Award (2011, Ikuhara, PI)
(10) Esashi (PI)'s research project was selected in the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST) Program of the Japan Society for the Promotion of Science.

iii) Goals to be achieved through the project (at time of interim and final evaluations)

As one of the outcomes, in the basic research fields, we strongly expect the world premier award in science, or at the very least a world top-class international award to be given to a researcher in our institute. Also, it is expected that the ISI citation ranking of Tohoku University will be elevated dramatically. In the applied research fields, we are sure that many new systems will be developed on the basis of the newly created materials, and their innovative functions will become commercially realizable to contribute very much to society's wellbeing.

(7) Securing research funding

Future prospects
- Describe the concrete prospects for securing resources that match or exceed the project grant.
- Calculate the total amount of research funding (e.g., competitive funding) based on the percentage of time the researchers devote to research activities at the center vis-à-vis the total time they spend conducting research activities. Be sure the prospects are realistically based on the past record.

i) Past record

(the exchange rate used: JPY/USD=80)
FY2007 20,743,750
FY2008 30,342,308
FY2009 29,670,180
FY2010 28,889,669
FY2011 25,000,000(estimated)

Total 134,645,907(estimated)

ii) Prospects after establishment of the center

In the four years since the inception of AIMR in October 2007, Tohoku University has extended funds to construct the institute's facilities over a total space of 9,000 m^2, including the main building. In addition, Tohoku University has kept paying salaries of Principal Investigators who were members of Tohoku University and joined AIMR. Further, the fund for research, setting up instruments and equipment necessary for research, arrangement of research space and laboratories at the Center has been supported by Tohoku University.

Besides the above mentioned support from Tohoku University, AIMR's Principal Investigators annually obtain subsidies from outside sources totaling US$28,500,000 on average. We expect to receive similar (or even higher) amounts of research funding in years to come.

Others
- Describe activities and initiatives to be taken after project funding ends.
- Describe expected ripple effects（e.g., how the research center project will have trailblazing components that can be referred to by other departments in the host institution and/or other research institutions when attempting to build their own top world-level research centers）.
- Describe other important measures to be taken in creating a world premier international research center, if any.

After the completion of this program, the cooperation among the related departments and research institutes, which will be achieved by AIMR as locomotive, will serve as a base for developing new integrated organization for materials research as a "World-leading center of intellect" at Tohoku University.

While this program is still being implemented, we will actively work to persuade other

departments and research centers of Tohoku University to adapt the know-how of treatment of competent researchers and the researchers' evaluation methods developed by AIMR. In order to construct a world-class research center, contributions not only to research but also to the development of human resources are strongly required, thus we plan to improve our post-doctoral system, and organize its international summer school on a regular basis for qualified graduate students from abroad.

Vision of the Director

Motoko KOTANI
Center Director,
WPI-AIMR
Tohoku University

1. Scope

The history of the development of materials is that of progress of mankind itself. Whenever mankind has discovered new materials, such as stone implements, earthenware, ironware, metals, ceramics, or polymeric materials, our society has changed drastically, and along with changes in our society, new values have been created. It is not an overstatement that the ultimate goal of materials science is realization of the dreams of mankind.

The Advanced Institute for Materials Research (AIMR) was established in 2007, aiming to contribute to society through the creation of new and innovative materials by gathering researchers from all over the world in the fields of materials science, physics, chemistry, and engineering – fields in which Tohoku University holds a leading position in the world in its research. Since its foundation, while AIMR has consistently pursued top-level research in individual research areas, it has also put much effort to create new materials science by interdisciplinary research. Through those activities, we have identified the objectives of the AIMR as follows:

(1) To elucidate fundamental principles lying behind functional manifestation common to different kinds of materials.
(2) To build a basis for “predicting” new functions and new materials based on the newly-established principles.
(3) To create Green Materials to contribute to "Energy Harvesting", "Energy Saving" and "Environmental Clean-up".

Now we have introduced a mathematical viewpoint to deepen common understanding of materials and accelerate our research activities towards the goal, which is our new characteristic. We shall establish a seamless and comprehensive materials research base where top level researchers with various backgrounds are gathered, and inspired each other daily. We believe this is the way to introduce new values for the next generation through development of materials science.

2. Management

In order to achieve the above goals, we manage the operation of the institute as follows:

1) Research Environment and the Support System for Researchers

As a center established under the WPI Program, it is essential to attract and gather top-level researchers from all over the world, and provide for them an ideal research environment. Researchers at AIMR should be able to concentrate on their studies like distinguished professors in the U.S. by being provided world top-level research facilities and equipment. For researchers from overseas, we also provide housing, assistance for the daily life of their family members, and information on Japanese culture and Japanese language learning.

Human resource development for the next generation is an important mission of the WPI research center, thus we provide sufficient support in their research environment for Junior PIs, independent investigators (young excellent researchers who can carry out their research activities on their own independently), associate professors, lecturers, assistant professors, and post-doctoral young researchers, so that they build their careers at AIMR, grow to be research leaders in the next generation in the flow of a global brain-circulation.

In addition, we need to streamline research activities within the organization, and establish a system for researchers, including newly employed researchers, to start and carry out their research without delay by making the Research Support Center with (1) Common Equipment Unit, (2) Computation-Aid Unit (3) Mathematics Collaboration Unit, (4) Researcher Support Office.

2) Internationalization

Internationalization is the most important agenda for the WPI research center. In order to construct a “visible center,” AIMR will establish satellites and partner institutions in the world, and promote fusion and joint research on a worldwide scale. Out of 15 partner institutions in total, the following three institutions – the University of Cambridge; the University of California, Santa Barbara; and the Institute of Chemistry, Chinese Academy of Sciences – are designated as satellite institutions to carry out active research exchange by establishing a joint laboratory. The University of Cambridge has the Department of Materials Science and Metallurgy and that of

Chemistry, both famous for their strong basic study and the Isaac Newton Institute for Mathematical Science, a national and international visitor research institute, which is a globally well-known institute where Dr. Andrew Wiles proved the Fermat conjecture. The University of California, Santa Barbara, is famous for nanotechnology and conductive polymer material, and there is a strong tie between materials science and mathematics because the University is promoting the application of the fruits of their research for practical use. AIMR conducts allied research focused on soft materials and leverage its applied research with the Institute of Chemistry, the Chinese Academy of Sciences. The satellite function with these pioneering institutions is one of motives which make excellent researchers attracted to AIMR.

As a specific measures to promote global research alliances further, WPI operates its own exchange program called the GI^3 (Global Intellectual Incubation and Integration) Laboratory Program (which was institutionalized in 2009). As a result, while AIMR accepts excellent researchers and students who are active at the forefront of research, AIMR also actively sends researchers and students overseas to promote forcefully global fusion and tie-up research, and aims to establish a base of brain circulation in materials science.

3) Organization

In order to promote system reform, which cannot be accomplished by traditional old universities, the Center Director makes top-down decisions with my clear visions. In order to support the Center Director, the Center regularly holds the Executive Committee, consisting of the Director, the Administrative Director and group leaders, and the In-house Council, consisting of heads of related departments and research institutes, and the International Advisory Board gives advice to the Director from a global perspective.

AIMR consists of not only researchers but also Administrative Division officers. They aim to create a world top-level research center on their own initiative and to promote “visible administration.” In line with the vision of the Center Director, the Administrative Director, who is also a materials scientist, the Deputy Administrative Director in charge of research and the Deputy Administrative Director in charge of management will make an effort for the realization of an ideal research environment. Following the principle of WPI Program, the official language at AIMR is English. For

further smooth operation, the International Relations Unit has been established. The Administrative Division shall reform the host institution by taking pioneering measures which are free from conventional practices.

3. New approach: Materials science with the participation of Mathematics

AIMR has focused its efforts on creating new materials science using innovative atomic and molecular control methods through “fusion research” and other interdisciplinary approaches, resulting in some outstanding results. Through successful research outcomes achieved by each research group, we have recognized the importance of focusing on functions of a wide range of materials. Innovative functional materials that give a future vision to human society can be created only by recognizing the process from atoms and molecules through to materials, devices and systems as a complex layered system and by elucidating the mechanism of the manifestation of functions in layers and between layers with a function as an indicator. During the course of these studies, we have recognized the importance of accelerating fusion and interdisciplinary research more actively and effectively.

In order to accelerate fusion research across those different disciplines in a more substantial way and to achieve a new scientific and technological breakthrough, AIMR has realized the necessity of the power of mathematics, which has a long tradition of providing a common language to all the fields of science and technology. Moreover, mathematics simplifies complicated and diverse phenomena and abstracts principles from them. Based on these principles, it may be possible to predict and create new functional materials. After intensive discussions, all the PIs and researchers of AIMR have now recognized the importance of the injection of mathematics at AIMR. We are convinced that mathematics will play a role of a catalyst to stimulate fusion research more extensively, thus creating a new materials science. This concept is in line with the initial concept of AIMR, which is the establishment of a new materials science through fusion research.

4. Concrete research plans

In order to promote our new approach, AIMR has set target projects. The concept of setting target projects was generated as the fruit of our efforts to concretize math-materials science collaborations through the Joint Seminars and Math-Mate

Seminars that have been held since March 2011.

Each project will be carried out by an interdisciplinary team. This year, seventeen proposals were submitted by materials scientists, and after elaborating on them from the point of view of injecting mathematics, they were categorized into the following three projects based on intensified discussions at several PI meetings.

1) Non-equilibrium Materials based on Mathematical Dynamical Systems

One of the major challenges in materials science is to synthesize multifunctional materials, in which multi-functions emerge based on non-equilibrium states, hybrid structures consisting of different types of materials, or the inhomogeneity of systems. Based on Mathematical Dynamical System, we focus on understanding mechanisms of dynamical structural formulation in non-equilibrium systems. This enables us to accurately control non-equilibrium and inhomogeneous materials and to achieve prescribed multi-functions under a given environment.

This project targets, for example, metallic glasses, polymer glasses, block copolymers, bio-inspired materials, and super-hybrid multifunctional devices for green society.

2) Topological Functional Materials

Topology is a mathematical concept for describing a shape up to continuous deformation. It is also a tool to abstract essential properties from a complex shape and to make it into a simpler shape. One challenge in materials science using “topology” is to synthesize functional materials that are robust under environmental change but achieve highly sensitive properties at the same time.

This project targets, 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.

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

Innovative functional materials can be created only by recognizing the

complex multi-scale hierarchical structure in materials systems from the atom/molecule scale to the macroscopic scale of materials and devices. Therefore, the understanding and the use of the multi-scale hierarchy are the fundamental research processes of AIMR. At AIMR, precise structure analysis and control at each level of hierarchy from the atom/molecule scale will be carried out using top-level equipment and new technology.

In addition to experimental technology, AIMR will apply a mathematical method, namely Discrete Geometric Analysis to this hierarchical problem. Discrete Geometric Analysis can make a bridge between scales and take account of detailed geometric data. By employing these advanced tools, we are attempting to produce functional multi-scale hierarchical materials.

This project targets the identification of mid-range and long-range order in the atomic arrangement of bulk metallic glasses and interfacial processes from the atom/molecule level to macroscopic properties, such as grain boundaries for the improvement of electric conduction in devices and solid-liquid interface control for the improvement of friction problems for energy-saving.

Through the whole process of the target projects, direct interaction between mathematicians / theorists / experimentalists is assured so that each stakeholder can mutually benefit from the research.

These are very ambitious projects, and we have to take an arduous way to accomplish them. However, we would have never encountered this great opportunity without AIMR, thus in order to make the best of the opportunity, we dare to challenge these projects.

The relationship between materials scientists and mathematics exists on a diverse range of levels. The first stage of our cooperation is the daily consultation regarding the operation of mathematics and the introduction to cutting-edge mathematics. The final stage is to develop mathematical models and discover new principles. The world top-level cutting-edge instruments in AIMR can produce new data and discover new phenomena that nobody has found, and this will inspire the mathematicians / theorists to make new mathematical models. Having opportunities to deepen and develop mathematics makes a great impact on mathematicians and theorists in the world.

5. Contribution of mathematics to materials science and global trends:

There is a world trend of science and technology cooperating with mathematics. As described above, in AIMR the contribution of mathematics to materials sciences has been started. This is the first attempt in the world to promote math-materials science collaboration at an institutional level. Consequently, our approach is just ahead of its time. We will lead global trends by initiating direct interaction between mathematics and materials science.

5. Host Institution's Commitment (in English)

Date 2/8/2012

To MEXT

Name of host institution Tohoku university
Name and title of head of host institution
Akihisa Inoue, President
Signature

I confirm that the measures listed below will be taken faithfully regarding "Advanced Institute for Materials Research" adopted under the World Premier International Research Center Initiative.

＜Provision in host institution's mid-to-long-term plan＞

・ Describe clearly the host institution's mid-to-long-term strategy plan and how the center is positioned within that strategy.

National University Corporation, Tohoku University states in the second interim plan (from April 1st, 2010 to March 31st, 2016), under Article 2 "Measures to Achieve Research Goals (1) Measures to Achieve Goals Concerning Research Levels and Research Results, section ①-3 Development of World-Class Scientific Research on Priority Areas," that in order to make Advanced Institute for Materials Research (AIMR), selected and established by the World Premier International Research Center Initiative (WPI), the top international research network center, Tohoku University will strengthen and support its research and operation. Section ②-1 "Drive Innovative Research through International Advanced Research and Education Organization" states "The host institution will promote innovative research by making use of International Advanced Research and Education Organization, WPI-AIMR, the Graduate School of Biomedical Engineering." In addition, taking account of the importance of human resource development, under Article 1 "Measures to Achieve Educational Goals," section ② -4 "Fostering of the Highly-Qualified Researchers in the Multidisciplinary Area" states "The host institution will carry out education programs to train human resources of high-level multidisciplinary research under the collaboration of International Advanced Research and Education Organization, AIMR, and Global COE Program."

The Tohoku University Action Plan "Inoue Plan 2007 (Revised for 2011)" introduced in June 2011 clearly states that Tohoku University takes steps, including reinforcing the organization of the WPI, in order to play a leading role as part of a top-class international research network. The support for the center is a shared determination of the university and the policy obtained the understanding of the entire members of the university. This policy will be passed down to the next president.

＜Concrete Measures＞

・ Describe the concrete measures that the host institution will take to satisfy the following requirements.

(1) How it will support the center's need to secure resources that match or exceed the project grant through such means as competitive grants obtained by researchers participating in the project,

in-kind contributions and other forms of assistance by the host institution (including partial payment of salaries, provision of research space), and/or external donations.

As a core facility of research activities, the WPI-AIMR main building was built in July 2011 by a subsidy from the Ministry of Education, Culture, Sports, Science and Technology and the matching fund of the host institution. The main building holds research space for approximately 10 PIs, a combination room for interactive activities, and a multi-purpose hall especially for outreach activities. As a host institution, Tohoku University constructed laboratories for Mathematics Unit and a library in the same building. AIMR plans to use existing facilities in Katahira campus for WPI-AIMR and promote research activities under one roof. Additionally, the host institution will basically pay the personnel expenses of all researchers who are also affiliated with the host institution prior to the formation of the center. Beyond that, the host institution will expend enough money each year on such items as research expenses and other researcher support, the installation of apparatus required for research at the center, the refurbishing of research space, and management, administration and other items required for the smooth execution of the center's research. Aside from that, the host institution will provide the researchers with priority access to the Technology Center for Research and Education Activities' high-performance electron microscopes and other research equipment and assistance so that the center can implement global top-level research.

In addition to this support from the host institution, the researchers who will participate in the center obtained funds totaling approximately US $ 29,000,000 from outside organizations, based on the actual achievement of FY 2010. The amount of the total funds is projected to remain at the same level or more in the future, too. Thus overall, the host institution fully expects to secure an amount of resources for the center that is equal or greater than the amount of support provided by this program.

(2) How it will institute a system under which the center's director is able to make substantive personnel and budget allocation decisions necessary to implementing the center project—a system, which in practice, allows the center director autonomy in making decisions regarding the center's operation.

To secure the independence of the Center administration, the host institution will only retain its authority of extremely important items such as the appointment and dismissal of the Center Director. The other items such as personnel affairs, budget execution and other items effectively will be determined by the Center Director.

In other words, with regard to personnel affairs, the host institution will only retain authority over the appointment and dismissal of the Center Director. The other personnel affairs within the center including the employment of PIs will be determined by the Center Director.

The budget allotted to the center (personnel expenses and non-personnel expenses) will be turned over in its entirety for free execution at the judgement of the Center Director, and it will be possible to carry over funds, allocated for budget items that are not implemented by the end of the fiscal year to the subsequent fiscal year.

(3) The support it will provide to the center director in coordinating with other departments within the host institution when recruiting researchers for the center, while giving reasonable regard to the educational and research activities of those departments.

The host institution will support the In-house Council of AIMR, comprising heads of related departments and research institutes, and coordinate with other departments by taking their educational activities into consideration.

(4) Its flexibility in applying, revising, or supplementing the host institution's internal systems as needed for the center to effectively implement new management methods (e.g., English-language environment, merit-based pay, top-down decision making) unfettered by conventional modes of operation.

We established the International Advisory Board, including Nobel Prize laureates as members, which advises the Center Director to support top-down decision making by the Center Director. An environment will be established, including the use of Internet technologies, to facilitate swift consensus building and organic linkages between the Center Director and the International Advisory Board. Also, so that work at the Center can be conducted smoothly in English, we will continue to assign staff with superior English skills, in addition to expertise in such fields as accounting, personnel and research assistance, as administrative staff on a priority basis.

Tohoku University's "University Professor System" will also be actively used to invite the world's cutting-edge researchers to the center.

A standing task team will also be established with the Executive Vice President in charge of Research as its lead for rapid examinations and responses in cases when the Center Director requests the flexible administration, revision, improvement or adjustment of the host institution's systems, and the host institution will otherwise prepare an environment for the smooth conduct of top management by the Center Director.

(5) Its accommodation of the center's infrastructural requirements (for facilities, e.g., laboratory space; equipment; land, etc.).

As a core facility of research activities, the WPI-AIMR main building was built in July 2011 by a subsidy from the Ministry of Education, Culture, Sports, Science and Technology and the matching fund of the host institution. The main building holds research space for approximately 10 PIs, a combination room for interactive activities, and a multi-purpose hall especially for outreach activities. As a host institution, Tohoku University constructed laboratories for Mathematics Unit and a library in the same building. They plan to use existing facilities in Katahira campus for WPI-AIMR and promote research activities under one roof.

In addition, an accommodation facility for researchers from overseas is planned to be built near the WPI-AIMR main building in the spring of 2013, and about 30 rooms will be allocated for the researchers invited by WPI-AIMR. To secure research space in accordance with the advance of the research and the expansion of the center's research organization, the center will be given priority use of joint-use space at the university or campus level, and the Facilities Preparation and Administration Committee will deliberate all items of concern regarding the use of research space and other facilities and accommodate the center's needs.

(6) Other types of assistance it will provide to give maximum support to the center in achieving its concepts and objectives and becoming a world premier international research center in both name and deed.

As mentioned above, National University Corporation, Tohoku University's interim plan and the "Inoue Plan 2007 (Revised for 2011)" clearly state their support for WPI-AIMR.

Tohoku University intends to provide its maximum continued support to the center as a special research zone within the host institution, arrange organic relations with the International Advanced Research and Education Organization and other plans of internationalization, making them into vehicles for education and research and help us contribute, as one of the world's leading universities,

to the development of our society.

As an outlook for the future, after the completion of this program, the cooperation among the related departments and research institutes, which will be achieved by AIMR as locomotive, will serve as a base for developing new integrated organization for materials research as a “World-leading center of intellect” at Tohoku University.

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(in English)

List of Principal Investigators

・If the number of principal investigators exceeds 10, add columns as appropriate.
・Place an asterisk(*) by the name of the investigators who are considered to be ranked among the world's top researchers.
・Give age as of 1 April 2012.
・For investigators who cannot participate in the center project from 1 April 2012, indicate the time that their participation will start in the "Notes" column.

Name	Age	Current affiliation (organization, department) and specialties	Academic degree	Notes
① Tadafumi Adschiri*	54	Tohoku University, Advanced Institute for Materials Research / Hybrid materials, Supercritical Fluid Technology	Dr.of Engineering	
② Mingwei Chen *	46	Tohoku University, Advanced Institute for Materials Research / Materials Science	Dr.of Engineering	
③ Masayoshi Esashi*	63	Tohoku University, Advanced Institute for Materials Research / Micro Electro Mechanical Systems	Dr.of Engineering	
④ Motoko Kotani*	52	Tohoku University, Advanced Institute for Materials Research /Mathematics (Geometry)	Dr. of Science	
⑤ Kazue Kurihara*	61	Tohoku University, Advanced Institute for Materials Research / Colloid and Interface Science	Dr.of Engineering	
⑥ Dmitri Valentinovich Louzguine*	44	Tohoku University, Advanced Institute for Materials Research / Materials Science	Dr.of Engineering	
⑦ Tomokazu Matsue*	58	Tohoku University, Advanced Institute for Materials Research / Biosensing Engineering	Dr. of Pharmacy	
⑧ Terunobu Miyazaki*	68	Tohoku University, Advanced Institute for Materials / Magnetic Properties of Materials	Dr.of Engineering	

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⑨	Yasumasa Nishiura*	61	Tohoku University, Advanced Institute for Materials Research /Applied Mathematics (Nonliner Dynamics)	Dr. of Science	
⑩	Hideo Ohno*	57	Tohoku University, Research Institute of Electrical Communication / Nanoelectronics	Dr. of Engineering	
⑪	Eiji Saitoh*	40	Tohoku University, Advanced Institute for Materials Research / Quantum Nano Science	Dr.of Engineering	
⑫	Seiji Samukawa*	53	Tohoku University, Institute for Fluid Science / Nano-Process Engineering	Dr. of Engineering	
⑬	Masatsugu Shimomura*	58	Tohoku University, Advanced Institute for Materials Research / Polymer Science	Dr.of Engineering	
⑭	Takashi Takahashi*	60	Tohoku University, Advanced Institute for Materials Research/Solid-State Physics	Dr.of Science	
⑮	Katsumi Tanigaki*	57	Tohoku University, Advanced Institute for Materials Research / Nano Materials Science	Dr.of Engineering	
⑯	Michio Tokuyama*	63	Tohoku University, Advanced Institute for Materials Research / Statistical Physics	Dr.of Science	
⑰	Kazuyoshi Yamada*	62	High Energy Accelerator Research Organization (KEK) , Institute of Materials Structure Science / Solid-State Physics	Dr.of Science	
⑱	Yuichi Ikuhara*	53	The University of Tokyo, School of Engineering, Institute of Engineering Innovation /	Dr.of Engineering	
⑲	Tomasz Dietl*	61	Polish Academy of Sciences, Institute of Physics / Condensed Matter Physics (Theory)	Ph.D	
⑳	Tomas Gessner*	57	Chemnitz University of Technology, Center for Microtechnologies / Device Science/Technology	Ph.D	

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㉑	Alan Lindsay Greer*	56	University of Cambridge, Department of Materials Science & Metallurgy / Metallurgy & Materials Science	Ph.D	
㉒	Kevin J. Hemker*	50	Johns Hopkins University,Department of Mechanical Engineering / Physical Metallurgy	Ph.D	
㉓	Ali Khademhosseini*	36	Harvard-MIT Division of Health Sciences and Technology, Brigham and Women's Hospital, Harvard Medical School /Bioanalysis, Microfluidics & Biomaterials	Bioengineering / Ph. D	
㉔	Thomas P. Russell*	59	University of Masachusetts,Polymer Science and Engineering Department /Polymer Science and Engineering	Ph.D	
㉕	Alexander Shluger*	57	University College London,Department of Physics and Astronomy /Computational Materials Science,Condensed Matter Physics (Theory)	Ph.D	
㉖	Winfried Teizer*	40	Texas A&M University , Department of Physics and Director of Center for Nanoscale Science and Technology / Nano-Physics	Ph.D	
㉗	Li-Jun Wan*	54	Chinese Academy of Sciences,Institute of Chemistry /SPM,Physical Chemistry,Nanoscience and technology	Ph.D	
㉘	Paul S. Weiss*	52	University of California, Los Angels, California NanoYsstems Institute / Surface Science	Ph.D	
㉙	Hongkai Wu*	33	Hong Kong University of Science and Technology, Department of Chemistry / Bioanalysis, Microfluidics & Biomaterials	Ph. D in Chemistry	
㉚	Qi kun Xue*	48	Tsinghua University,Department of Pysics / Surface Science	Ph.D	

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㉛	Alain Reza Yavari*	62	Grenoble Institute of Technology /Physical Metallurgy	Ph.D	