

# Chapter 1: Mission and Future Visions

## 1. Introduction

In 1987 the Institute for Materials Research (IMR) was reorganized into the present form of a national collaborative research institute. Since then it has aimed at both “basic and applied materials science.” As our English name indicates, we are dealing not only with metals but also with materials in general. (The original Japanese name, a literal translation of which would be “Institute for Metallic Materials Research,” has not been changed.) Speaking of technical terms, in Japanese we can use different words to mean “materials” (e.g. *zairyo*, *busshitsu*, and *sozai*). Such a rich collection of terms is one demonstration that Japan is leading the research activities in materials science in the world and we are proud of this fact. In 1987, we established the Laboratory for Advanced Materials to create a framework for research on future applications of a variety of promising materials already developed by us. In 2002, we opened the International Frontier Center for Advanced Materials, which emphasizes fundamental research on materials science from an international viewpoint. As we have mentioned above, our mission is to contribute to the cultural development and people’s welfare by carrying out both basic and applied research in a wide range of materials such as metals, semiconductors, ceramics, organic materials, and composite materials, and to develop new materials that will be of great use in the highly-advanced technological society of the 21st century. To accomplish this mission, we have shifted our research policy from being mostly committed to the development with the greatest efficiency, to giving consideration to energy conservation, environmental protection, and the future aged society of Japan. Since Tohoku University was privatized in April 2004, the Institute has been converted into an affiliated institute of the University in the new system, and we are working towards further development of the Institute in order to incorporate the purposes and the vision of the privatization. Based on these circumstances, we have set out a number of basic objectives for the mid-term project in the first term (six years from 2004 to 2009) following the privatization.

Since its establishment, as a COE (Center of Excellence) of materials research, the Institute has been one of the leading materials research centers in the world and has invented many new materials. Our inventions have made a significant contribution to developing the infrastructure for the advanced industrial society of the 20th century. As an international COE of the science of various materials, mostly metallic ones, we have extensively made research in materials science and its applications. The basic objective of our institute for the 21st century is to contribute to the continuous development of society and the prosperity of humankind by developing new materials, incubating excellent materials researchers, and promoting materials science which will serve as

the infrastructure for the front line of science and engineering, including environmental protection, energy saving, bionics, information and communications, and advanced safe space technology.

Currently the Institute has a total floor area of 34,320m<sup>2</sup>, with about 600 people, including staff members, guest researchers and graduate students. It is the largest institute affiliated to a university in Japan. The number of research papers published is about 700 annually. Tohoku University was ranked as the first one in the number of citations in materials science papers published between 1991 and 2001 according to the classification of the research institutes throughout the world (Science Watch, vol.12, No.4, 2001). The analysis of the citations tells that the Institute has made the most contribution to materials science. We are very open to foreign countries; about 65 researchers from abroad are working with us. There are also a number of short- and long-term visitors. Every month many lectures are given by researchers from Japan and abroad. The Institute also serves as a hub for international cross-disciplinary exchanges and joint research.

The following sections provide a summary of our activities, define our research objectives and future visions, and describe our effort for improving the research environment.

## 2. Future Visions

The Institute was started by the chief researcher, Professor Kotaro Honda, in 1916. The Institute has always been the center of materials research in Japan, having accomplished a great number of achievements and trained excellent researchers. It was initially established on a request from the government to serve as a foundation for the steel industry. However, we have been always shouldering responsibilities to meet the needs of the times because materials research provides the foundation of science and technology. For Japan to remain on the front line of science and technology in the 21st century, a constant leap in materials science and rapid progress from fundamental research to applications are required. Taking advantage of the rich collection of intellectual properties on materials science based on our history and achievements, we are determined to serve as the center of fundamental materials research in the 21st century.

Since its foundation, the Institute has always been ahead of the times in its belief that materials research is the foundation of science and technology. Steel was the fundamental material of domestic industry in the time of Professor Kotaro Honda. Now semiconductors, especially silicon, which is now often referred to as the chief material of all industries, are indispensable to current advanced electronics. There is an urgent need for the development of

fundamental materials for the next generation of semiconductors. For development in such a new field, new research environment and systems are required. As the center of materials science, our mission is to contribute to the development of human culture by carrying out fundamental and applied research on a wide variety of materials and creating new useful materials. With this mission in mind, we are performing close collaboration of research using unique experimental equipment and corresponding theories and simulations, which befits our policy as an advanced comprehensive research institute for the development of new materials from the atomic level, exploration of useful characteristics and phenomena, and resulting applications.

As we stated earlier, materials science forms the foundation of science and technology. It requires cross-disciplinary research without being bound by traditional differences among academic research fields. The reason that we converted ourselves into a national collaborative research institution and changed our name to the “Institute for Materials Research” was to enable our research activities from a wider variety of these perspectives.

The Institute is located in Sendai City, in the northern part of Honshu (the central island of Japan). It is surrounded by research institutes in various fields including life sciences, information and communication technology, scientific instrumentation and measurement, hybrid (organic and inorganic) materials science, and fluid science in Tohoku University. We expect that close collaboration with these institutes will create an ideal environment for carrying out materials research, developing the science and technology of the 21st century, and educating promising researchers. We are also leading programs for cooperation among the research institutes in the university.

A new material often creates a new industrial foundation. Therefore it is very necessary to set up a system for rapidly turning the fruits of fundamental research into industrial applications. Some independent administrative institutions in Japan such as the National Institute of Materials Science (NIMS) and the National Institute of Advanced Industrial Science and Technology (AIST) have experience in project research in industrial applications of new materials. Developing a system in cooperation with these institutions for bringing fundamental research to the industry-academia

-government collaborative research projects at the national level will enable a faster response to social needs. Furthermore, exchanges of researchers and students at NIMS are breaking down the traditional walls between universities and research institutions and will make a meaningful contribution to the development of true cross-disciplinary research and education.

### 3. System and Method of Operation

The Institute comprises of 27 research laboratories, 3 laboratories of visiting professors and 4 attached research centers which directly promote research and education, together with various support organizations such as technical service division and administrative office, which enable smooth and effective research and educational activities. There were also various committees, including the executive committee, for managing discussions at faculty meetings and for supporting the director. However, the excessive number of committees and resulting inefficiencies posed a serious squeeze on research activities. To resolve this problem, we implemented a variety of reforms towards a more efficient and simplified operation of management.

Following the privatization of the national universities in April 2004, we declared the following mid-term objectives and programs for executing a ground-up reform of the management system:

- Clarifying the leadership roles and responsibility of the director.
- Establishing a transparent decision-making organization.
- Efficient operations for enabling faculty members to concentrate on their research as much as possible.

We took the following steps to improve the management operations stated above:

- Appointing the leader of the Institute, the director, and assigning two deputy directors (one for research and education, and the other for management and operations).
- Setting up an executive committee comprising the director, deputy directors, research-planning office manager, information and public relations office manager, strategy office manager, industrial relations office manager, two faculty meeting members (professors), and the head of administrative office manager.
- Holding faculty meetings with professors and associate professors for discussing research and education, and faculty staffing.
- Setting up an external evaluation committee for evaluating the overall activities of the Institute.
- Setting up an external advisory board of materials science specialists from home and abroad (more than half of the members are overseas researchers) to provide advice on our 10- and 20-year visions, and the directions of research.

In addition:

- Setting up a committee (under the direct supervision of the director) and an office for controlling and ensuring safety and health.

Under the executive committee:

- Setting up an office for research planning to discuss research plans, mid-term objectives, and projects. This office determines the number of faculty members, selects visiting faculty members,

overseas researchers, part-time researchers, plans the work rules, handles budget requests and distribution, and investigates tasks concerning the land and buildings.

- Setting up an office of information and public relations for announcing the results of research and for gathering information on researchers. This office also helps the director with his inspection and evaluation of various activities including the operations of the library and computer network, public relations for the Institute as a whole, research and education of the Institute and its faculty members. It also reviews and discusses summer seminars and lectures.
  - Setting up an office of industrial relations to promote the industrialization of the outcome of the research carried out in the Institute. This office encourages the researchers to obtain patents for useful materials. The office also supports collaborative research with private companies and activities for reinforcing industry-academia-government cooperation.
  - As the front runner in materials science research, setting up an office of strategy for discussing the promotion of advanced research and researcher training, and the management and operations of the Institute in the short and the long terms.
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- Maintaining the conventional small laboratory system to encourage the birth of new research from bottom-up efforts in each laboratory, help the research to bloom and bear fruit. In general, each laboratory consists of a professor, an associate professor, and research associates. However, the configuration and numbers are not fixed in order to enable responsive and flexible staffing. The director manages the vacant posts that arise due to personnel changes and retirements, following the decisions of the executive committee to allow flexibility in personnel distribution.
  - The professor of each laboratory is selected from candidates by the laboratory research characterization committee and the selection committee organized in the faculty meeting based on the mid-term objectives and projects planned by the executive committee, and finally adopted at the faculty meeting.
  - Exploring new research fields by adopting a visiting professor system to overcome the limitations on the research fields already covered by the current members of the institute.
  - Making efforts to prepare and enrich the facilities for shared use, and to upgrade equipment in order to further promote collaboration with internal and external researchers. The general principles on the collaborative research programs are discussed by the users committee, which comprises of directors from the three graduate schools for science and engineering, three research institutes and one research center at Tohoku University which are closely related to our Institute, and further internal and external specialists appointed by the director of the Institute. The Committee members include those from industry circles as well as academia to obtain advices and suggestions from them. The specifics of the collaborative research are discussed by the research laboratory divisions in each department and the committee in each

attached center. The advisory committee for the collaborative research is set up to discuss the basics of the shared use of the entire Institute and to undertake the coordination between the committees.

#### 4. Recruiting and Faculty Staffing

As of April 1, 2004, the Institute staff comprises of 25 professors, 33 associate professors, 2 assistant professors, and 70 research associates. In the attached centers, ( i ) five associate professors and three associates work for the International Research Center for Nuclear Materials Science, ( ii ) one professor, four associate professors, and four research associates for the Laboratory for Advanced Materials ( renamed as the Advanced Research Center of Metallic Glasses in April, 2005), ( iii ) one professor, two associate professors, and two research associates for the High Field Laboratory for Superconducting Materials, and ( iv ) two professors and one research associate for the International Frontier Center for Advanced Materials.

We also have several visiting researchers. Three Japanese researchers are located in the Research Department, one Japanese and one foreign researcher in the Advanced Research Center of Metallic Glasses and three foreign researchers in the International Frontier Center for Advanced Materials.

The number of research laboratories other than visiting researcher sections is 27. In general, each laboratory comprises of one professor, one associate professor, and two research associates. However, different configurations are also possible.

Professors are recruited from applications open to the public. If a vacant position arises or is scheduled to arise, a faculty meeting decides the characteristics of the laboratory concerned, and then sets up a selection committee consisting of four professors. The result of the selection is reported to the faculty meeting to obtain its approval. In many cases, before this, an extended selection committee is held in order to have comments and suggestion from other professors before a final decision is made. Associate professors, assistant professors, and research associates are also recruited from applications open to the public as a general rule. However, in some cases the professor of each laboratory can recruit his/her research staff without the open-application procedure when it is not necessary. To select associate professors and lecturers, the faculty meeting sets up a selection committee of three professors and one associate professor. The result of the selection is reported to the faculty meeting. Recruiting research associates does not require a selection committee. The professor of each laboratory directly suggests candidates. In either case, the faculty meeting makes the final decision by taking a vote.

The current research staff configuration has the advantage that the number of faculty members

in each laboratory is larger than that in other departments and universities. If all members of each laboratory concentrate their research on a single research area, they can execute a fairly large project. However, if the professor retires or leaves his/her laboratory without releasing all members, his/ her successor is required to work with the associate professors and research associates assigned by the former professor. However, it may happen that the new professor cannot have joint work on the research project with the remaining staff, in which case the advantages of a large-scale division cannot be fully exploited. To prevent such stagnation or decline in research activities due to the change of professors, all of the professors are required to make efforts to transfer their staff in advance of leaving or being retired. In general, a professor cannot recruit new staff if he/she is scheduled to retire or leave in less than three years. However, to maintain research activities, it is possible to hire research associates for a limited period until the new professor takes up his/her position.

## 5. Future Planning

As we have stated above, with the privatization of the national universities in April 2004, our Institute restarted as an institute affiliated to Tohoku University. Society is expecting universities to have competitiveness on an international scale with individuality, independence and autonomy. Our mission is to show a definite direction as a world-wide leading center of materials science in the 21st century.

With those demands in mind, we issued a questionnaire to all staff regarding the future visions of the Institute. The results are summarized as follows:

- 1) An institute that executes the materials research from the fundamentals to the applications.
- 2) Promoting cross-disciplinary research by breaking down the barriers between science and engineering.
- 3) Maintaining a balance between “uniqueness” and “diversity” in research activities.
- 4) Recognizing the importance of research for solving “social issues,” such as energy, environment, and the future aged society.
- 5) Developing as a center of materials research in the world.
- 6) Discovering new research fields
- 7) Reinforcing incubation of young researchers.

Since we work for an institute with the principal objective of “creating new materials” with the awareness that “materials offer the basis for all science and technology”, we should continue our research activities with a sense of balance, without any bias towards certain materials. We wish to develop core researchers who will stand at the front line of the Institute while maintaining a flexible environment which inspires researchers. We will also support research that makes full

use of our facilities and encourage scientific and engineering to researchers to work together.

Since its establishment, the Institute has always worked on materials which are closely related to people's daily lives. We will continue exploring metallic and related materials and maintain a realistic attitude to materials research studies. Our mid-term objectives and projects define the following research fields:

- 1) Nano-structured/special structured metallic materials
- 2) Materials for environmental protection and energy saving
- 3) Materials for use in electronics
- 4) Materials for use in nuclear energy

Our mid-term projects are expected to yield great results which will take the lead in society and academia in each field. We will select a number of these and define a top-down long-term strategy for the future.