MMC
2006 8
MICRONANO

MMC Activities

Activities of the Micromachine Center in Fiscal 2005

OVERVIEW

The Micromachine Center undertook the following activities regarding research and studies into micromachines (MEMS and other nanoscale machines and systems), the collection and provision of micromachine information, and exchange and cooperation with domestic and worldwide organizations. The aim of these activities was to establish basic micromachine technologies and promote their industrialization, thus contributing to the further development of Japan's industrial economy and to international society.

1. Research and Investigation of Micromachines

We carried out activities aimed at gaining a clear understanding of the technological and industrial trends in micromachines and MEMS as they become key manufacturing technologies. At the same time, we pursued research into new technological issues regarding the fusion of micro - and nanotechnologies. We also made proposals for national government and NEDO projects in fields where new technology development is required.

(Governmental/NEDO project related activities)

(1) In FY2005 the MEMS-ONE: MEMS Open Network Engineering System of Design Tools Project (NEDO-commissioned project) carried out research and development into the production and verification of software based on the research findings from the specification design carried out as part of the system development completed the previous year. Part of this research also involved obtaining related knowledge and data. In addition, thermal and optical nanoimprint analysis functions were introduced as a development issue, and from October we carried out intensive research and development on this theme. The various committees oversaw the progress of development, making changes as necessary following testing of the developed functions. Progress went largely according to the initial plan.

(2) Investigation of methods of promoting MEMS-ONE (NEDO-commissioned project)

Following on from FY2005, we carried out research with Mizuho Information & Research Institute and Nihon Unisys Excelutions into efficient business models for improving the reach of MEMS-ONE, and assembling a consistent body of specialized terminology relevant to the field. To further these ends, we held Exhibition MICROMACHINE to publicize and demonstrate the interim findings of the MEMS-ONE Project, and to survey the attitudes of users.

(3) Committee to investigate next generation projects

Based on a proposal from 2004, we undertook deliberations concerning the research system and development centers from a policy viewpoint, considering refinement of the technological issues pursued and their results, and refinement of the common elements of integration, with a view to initiating a national project from 2006.

(4) As part of the research activities of the micro analysis and production system project, centered on the Association of Microscience Chip DB Systems (Microscience Research Association Contract), we created a database of literature useful for research and development of microchip devices and systems. To this end, we gathered information, provided data and other similar activities.

(Survey, Research and Development of Micromachines)

(5) Study of R&D trends in micromachine technology in Japan and abroad

We examined and analyzed the latest situation regarding micromachine technologies and research trends that are making notable progress in Japan and overseas, and maintained a library of basic technological data that can contribute to advances in micromachine technology.

(6) Joint survey research activities concerning the industrialization of MEMS

In order to facilitate further industrialization of MEMS which in recent years have rapidly been finding new application fields, we have been tackling general issues such as accelerating foundry services, and establishing cooperation with the MEMS equipment and materials fields. At the same time, we continued joint research with businesses that provide foundry services from the previous year, investigating specific issues such as fact-finding at overseas foundries, standardization of processes, establishing materials databases, and cooperation between foundries.

(7) Research regarding standardization strategies for MEMS (JMF-commissioned project)

In order to strengthen and maintain the productive capacity of MEMS and promote strategic international standardization and regulation required as the foundation for international development of MEMS, we carried out research into the technical needs of the MEMS industry. We analyzed Japan's current position in the world, identifying the technological factors crucial to future standardization and regulation, and developed a proposal for a standardization roadmap.

2. Collection and Provision of Micromachine Information

We collected information and documents on micromachines from universities, industry, and public organizations both in Japan and overseas, along with the results of surveys carried out by MMC. These materials are freely available in the MMC library, and have been disseminated widely, both domestically and internationally.

(1) Improved dissemination and exchange of information through the MMC website

We have actively sought to disseminate and exchange information through the MMC website. We have also improved the contents provided to our supporting members.

(2) Publication of a micromachine periodical

We publish a micromachine periodical entitled *Micromachine Index* which gathers together abstracts of important documents for distribution to supporting members and related agencies.

(3) Publication of a newsletter

We distributed a monthly newsletter *MMC Newsletter* with information concerning research and governmental trends related to micromachines to supporting members.

(4) Maintaining and upgrading the MMC library

We upgraded the library by gathering further technical documentation and materials, and added this and other information to our database.

3. Exchange and Cooperation with Micromachine-Related Organizations Worldwide

In order to promote exchange with related organizations in and outside Japan, we participated in the Micromachine Summit, held an international symposium, employed and dispatched researchers and experts, and undertook cooperation with domestic and external agencies aimed at establishing a micromachine foundry network.

(1) Participation in the 11th Micromachine Summit

We participated in the 11th Micromachine Summit held in Dallas, where we discussed wide-ranging issues regarding micromachine technology and worldwide trends in the fields of micromachine applications.

(2) Hosting the 11th International Micromachine/Nanotech Symposium (partially sponsored by the Japan Motorcycle Racing Organization)

We hosted the 11th International Micromachine/Nanotech Symposium which focused on technological issues involved in the merger of micromachines/MEMS technology and nanotechnology, and on the outlook for this field.

(3) International exchange and dispatch of researchers

We promoted exchanges with overseas universities and other micromachine-related research agencies, sending researchers on missions overseas. They also participated in international symposia and academic conferences held overseas. Furthermore we promoted exchanges by inviting experts from Europe and America and dispatching Japanese experts and researchers overseas.

(4) Building a MEMS foundry network system

In order to establish the foundries essential for industrialization of MEMS, we promoted the establishment of a system aimed at improving services through networking with businesses providing foundry services and the Foundry Service Industry Committee formed by related companies.

(5) Establishing a forum for the exchange of cutting-edge micro/nano technology

In order to promote the development of cutting-edge micro/nano technology, a basic technology that is expected to find applications in many fields, we continued holding meetings of cutting-edge micro/nano technology exchange forums from the previous year as a forum for information exchange and the development of joint research.

4. Promotion of Standardization of Micromachines

In the technological field of micromachine/MEMS, standardization is being promoted as international initiatives get underway.

(1) Standardization of fatigue testing methods for micro-nano materials (NEDO-commissioned project)

Continuing on from the previous year, we carried out research into standard methods for fatigue testing to enable measurement and evaluation of the mechanical characteristics of various thin film materials with widths of 10 μm and lengths of 100 μm or less, with a view to international standardization. Therefore we carried out fatigue testing with specimens about 1/1,000 the dimensions of earlier specimens in order to establish the limits of application of fatigue testing methods used for currently standardized millimeter-order specimens. Fiscal 2005 was the last year of this 3-year project, and we incorporated the results of the project in the draft standard “Fatigue Testing Methods for Thin Film Materials”.

(2) Standardization of tensile testing methods for thin film materials

Based on the results of “Standardization of Measurement and Evaluation Methods for the Characteristics of Micromachine Materials” carried out as a NEDO-commissioned project from FY1999 to 2001, we proposed it to IEC as an international standard in 2003. In 2004 a Committee Draft of the standard was recognized, and in 2005 we proposed a Committee Draft for Vote and continued our activities towards international standardization.

(3) Standardization of micromachine specialist terminology

The international standardization proposal for micromachine specialist terminology that we made to the IEC in 2002 was recognized by Committee Draft for Vote in 2004 via the New Project stage. In 2005 it was prepared as a Final Draft for International Standard as the final stage, and we continued our activities towards international standardization.

(4) Research and investigation of micromachine standardization

In order to continue to develop new strategic international standards proposals, we prepared a roadmap for international standardization and identified standardization proposal issues in concert with the MEMS-ONE Project, the Reliability Evaluation Committee and so on.

5. Dissemination of information and education concerning micromachines

We issued publications, held expositions, and conducted a wide range of PR and educational activities regarding micromachines.

(1) Besides publishing a regular public relations magazine, we are disseminating information on the MMC website.

(2) We exhibited leading-edge products and manufacturing materials related to the micromachine/MEMS industry, and hosted the 16th Exhibition MICROMACHINE as a forum for announcing the latest research findings.

(3) As the organizer of the Federation of Micromachine Technology, we worked to consolidate and strengthen micromachine-related organizations.

Establishment and Activities of the MEMS Industry Forum

Micro/nano/MEMS technologies are growing more and more essential for the strengthening of Japan's industrial competitiveness. Against this background, the MEMS Industry Forum (MIF) was established in April this year as a special council of the Micromachine Center.

A party to commemorate the inauguration of the MEMS Industry Forum was held on May 19 at the Shoko Kaikan Hall in Kasumigaseki, Tokyo. The approximately 70 participants included representatives of industry (full) members, associate members, affiliated organizations, MEMS fellows (individuals), and Forum advisers, and an enjoyable evening was had by all.

MEMS technology enables the creation of small, high-precision, high energy efficiency, high-performance devices; because these can be used as key devices in the expansion of various industrial fields, and because government-industry-university cooperation can be an effective means of developing MEMS technologies, party participants expressed high expectations for the future endeavors of the Forum as a core body promoting such development activities.

1. MEMS Industry Forum Activities

The MEMS Industry Forum comprises MEMS-related organizations at its core. In continuing cooperation with affiliated academies, regional bases, and overseas organizations, the Forum undertakes various activities – such as making MEMS policy recommendations to government bodies and other related organizations, industry-university cooperation, and industrial exchange/invigoration – through which it aims to support the further development of the MEMS industry and thereby to the strengthening of Japan's industrial competitiveness on the international stage.

The Main Activities of the MEMS Industry Forum are as follows.

(1) Policy recommendations: The Forum will make recommendations to government bodies and other related organizations concerning basic issues affecting MEMS industrial expansion, such as basic technological development, foundry networks, industry-university cooperation, personnel training, formulation of regulation, standardization, and overseas expansion.

(2) Industry-University Cooperation: The Forum will undertake to strengthen (through information exchange, etc.) communication and cooperation between study group activities related to cutting-edge technology status and second-generation technology issues; activities of cutting-edge technology exchange forums aimed at furthering industry-university exchange in the micro-nano field; and MEMS-related research organizations, societies, and university research laboratories within Japan.

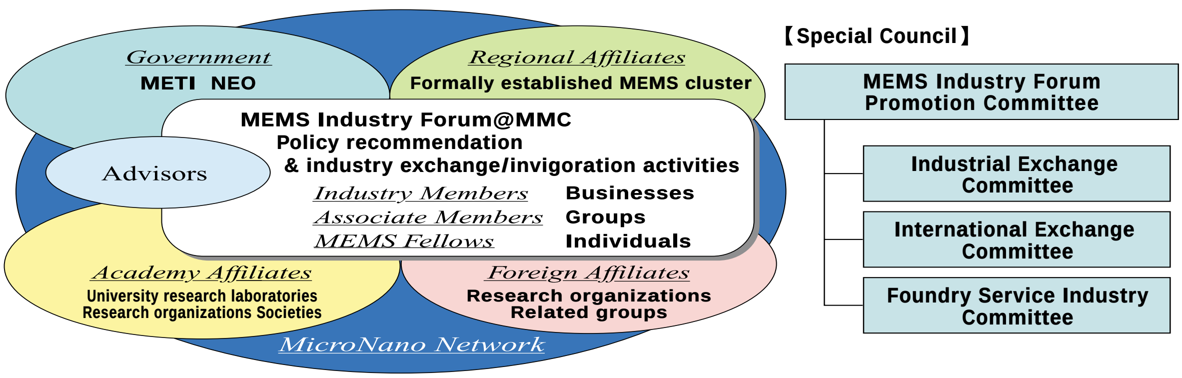
(3) Activities to Enhance the MEMS R&D Infrastructure: The Forum will promote personnel training activities through expansion and strengthening of the foundry network, diffusion and promotion of MEMS-ONE, implementation of MEMS lecture activities, and internship support.

(4) MEMS Business Domestic/International Exchange Activities: The Forum will host "Micro/Nano 2006," a general event to promote business exchange at the Tokyo Forum according to the following schedule.

Nov. 6	The 2nd Workshop on Characterization of Materials for MEMS/MST Devices (Venue: Mitsubishi Building Conference Square)
Nov. 7-9	17th Micromachine Exhibition
Nov. 7	MEMS Forum
Nov. 8	12th International Micromachine Nanotechnology Symposium
Nov. 9	MEMS-ONE Research Debriefing

The Forum will also establish an "MEMS Mall" that introduces catalogues of new products – such as MEMS devices, foundries, and manufacturing equipment – and new technologies in order to support the operation of the "MicroNano Net" as a forum for many government-industry-university people involved in the micro/nano field to come together on the Internet, as well as the invigoration of MEMS business. Furthermore, as the permanent secretariat for the Micromachine Summit – a forum for the free discussion of the current status and future expectations for education, technological trends, policies, and other micromachine/MEMS-related topics in various countries – the Forum will undertake a variety of activities to promote business exchange between companies, both within Japan and overseas, through participation in the Micromachine Summit and other micro/nano-related events both in Japan and abroad.

Organization and implementation of MEMS Industry Forum activities will be performed by three soon-to-be established committees – the Industrial Exchange Committee, International Exchange Committee, and Foundry Service Industry Committee – under the guidance of the MEMS Industry Forum Promotion Committee.



Introduction to the High Integration Composite MEMS Fabrication Technology (Fine MEMS) Development Project

1. Development aims

In recent years, MEMS (Micro Electro Mechanical Systems) technology has contributed significantly to miniaturizing and increasing the performance of electronic equipment and components, and they are expected to become key devices in a range of fields such as telecoms, medicine, biotechnology, and automobiles among others. In the new industrial strategy produced by the Ministry of Economy, Trade and Industry in FY05, and in the strategy for new economic growth issued in FY06, MEMS are positioned as one of the high-level component industries on which to concentrate. Due to the necessity of reinforcing Japan's competitiveness in MEMS, which are expected to see growth internationally too, the strategy aims to achieve greater miniaturization, power saving, higher performance, and higher reliability through further improvements in MEMS fabrication technology. The High Integration Composite MEMS Fabrication Technology Project was planned to address the important technical issues of combining MEMS with nano-functions, integration with semiconductors, and bonding between MEMS.

2. Project overview

The research and development issues are;

1) MEMS/nano-function composite technology, 2) MEMS/semiconductor integrated fabrication technology, 3) MEMS/MEMS high integration composite technology, 4) Establishment of a database of high integration composite MEMS knowledge

In particular, issues 1) to 3) each consist basically of four technology themes as shown in **Table 1**. Each theme comprises technologically difficult aspects, and factors linking them to industrial production. Technologically sophisticated aspects will be mandated to universities and national research institutions, while development of applications will be conducted by corporations under subsidies. Theme 4) involves gathering technical knowledge and internal and external approaches to high integration composite MEMS gained through this research and development, and establishing a knowledge database to make it widely available to Japanese industry.

3. Period and scale of the Project

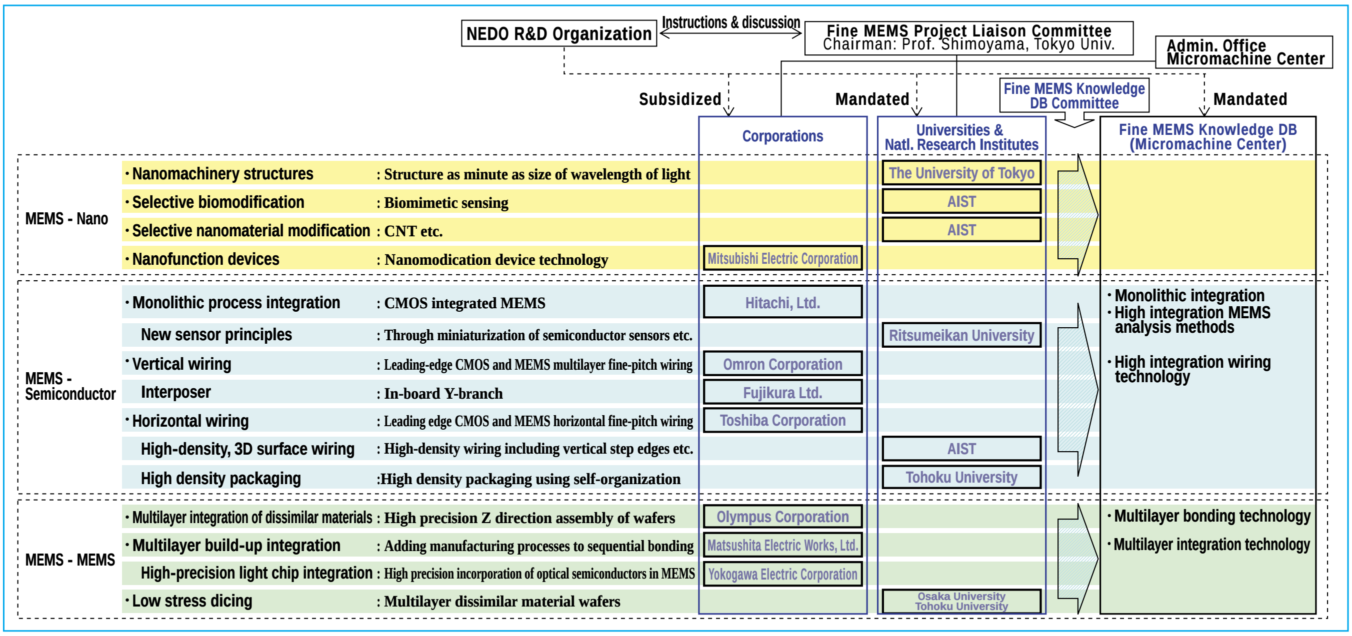
The Project will run for three years from FY2006 to FY2008, and yen 1.1 billion is budgeted for FY2006.

4. Development organizations and the approach of the Micromachine Center

Eight corporations have been selected for subsidized projects and eight organizations (universities and national research institutions) have been selected for mandated projects. The Micromachine Center has been entrusted with 4) Establishment of a database of high integration composite MEMS knowledge.

The knowledge database must cover all the issues involved in high integration composite MEMS fabrication technologies, and therefore a fine MEMS knowledge database committee will be organized to strengthen cooperation within the Project to enable the research data from all the corporations and bodies participating in the Project to be collected. Besides considering effective means of allowing each researcher to enter knowledge easily, the Project will invite university researchers with superior knowledge of the relevant issue to supplement the knowledge data relating to the subsidized project themes in particular.

In addition, the Micromachine Center will provide management support for the Project overall. As described above, the Project is a composite project comprising a number of issues and themes, involving mandated and subsidized programs, therefore it will be necessary to carry out efficient management of progress and of the necessary liaison within and between the disciplines, and to provide a suitable environment for industrialization at the latter stage. With this objective, a project liaison committee will be established for organizing periodic consultations and coordination. The Micromachine Center will be responsible for this role and, under the guidance of the Project Leader, the Center will take an active approach with the aim of maximizing the results of the Project.



High Integration Composite MEMS Fabrication Technology Development Project: Development Issues and Organization

Expectations for MemsONE

Yusuke Ichinose, Project Manager, New Energy and Industrial Technology Development Organization

MEMS (Micro Electro Mechanical Systems) is defined as a technology for creating fine, movable three-dimensional structures using semiconductor processing and other technologies, or the components manufactured in this way. In Japan they are called micromachines while in Europe they are known as MST (Micro System Technology), and broadly speaking, the terms have been used to mean nearly the same thing. MEMS differ from LSI circuits in that a wide range of inputs and outputs are possible, such as electrical signals, energy, mechanical displacement, physical quantities, optical signals, chemical quantities and so on. If machinery or systems are compared to humans, circuits correspond to the brain, while MEMS correspond to important parts such as the five senses and muscles. Since a wide variety of inputs and outputs are possible, MEMS can be applied in a range of fields whether in telecoms, medicine and biotechnology, automotive and so on, and since they use semiconductor process technologies, it is possible to manufacture high value-added products that are small, high performance, and have superior energy saving characteristics.

The New Energy and Industrial Technology Development Organization (hereafter, "NEDO") recognizes MEMS as an important field, and since FY1991 NEDO has carried out the Micromachine Project resulting in improvements in MEMS basic technology, and commercialization of some developments. However, since MEMS requires expensive and large scale equipment, NEDO has overseen the MEMS Project for the last 3 years since FY2003 in order to reduce risk from the viewpoint of capital investment, and to provide facilities and infrastructure. This project has carried out foundry improvements and has led to the development of high-level, three-dimensional process technologies.

Consequent to these circumstances, the Project for Development of a Design and Analysis Support System for MEMS (hereafter, "Mems-ONE Project" has been underway since FY2004 based on a 3-year plan. This project is focusing on development of a design and analysis support system for MEMS. One of the reasons why MEMS has not met its latent potential is that only limited numbers of researchers and engineers have been involved in the development of MEMS. By using this system, researchers and engineers from many other fields will more easily be able to participate in MEMS, and it will be possible to reduce the cost and time involved for MEMS development by using simulations.

One of the features of this system is a built-in database of knowledge such as MEMS terminology, explanations of representative processes and devices, and examples of analysis so that engineers who do not have much experience of MEMS can use it. At the same time, providing the system with a full materials database improves the accuracy of analysis, making it a worthwhile system for engineers who are already currently involved in MEMS development too.

When NEDO established this project, we designed the system so that it could be used both by beginners and experienced engineers. However, since MEMS is a technology in a growth field where the environment is changing significantly, we carried out a survey regarding activities to promote the Design and Analysis Support System for MEMS and its repercussion effects. This survey was conducted in parallel with the FY2004 project. When we surveyed the technology trends and the needs of society, we found that nanoimprint technology was considered a promising MEMS manufacturing technology, although in its startup phase it was still thought to be a future technology. Therefore using the NEDO system, we obtained a new budget and from FY2005 we started development of a Nanoimprint Process and Analysis System. Furthermore, from FY2006, we are starting the new High Integration Composite MEMS Fabrication Technology Development Project based on a 3-year plan. This project is scheduled to cover, (1) Development of MEMS/nano-function composite technology, (2) Development of MEMS/semiconductor integrated fabrication technology, and (3) MEMS/MEMS high integration composite technology. In future MEMS support systems, analysis of MEMS technology and semiconductor technology at the same time will likely be required, therefore from FY2006, we have been working on development of a circuit integration MEMS simulator.

The Mems-ONE Project will finish this fiscal year. However, the system developed as a result of the NEDO project will still be promoted after the end of the project, and we anticipate that the software will be improved and the database updated on a self-sustaining basis. As part of the High Integration Composite MEMS Fabrication Technology Development Project, NEDO will establish a database of high integration composite MEMS knowledge and will provide support so that the results are provided to the Mems-ONE Project. In addition, we are planning a standardization project to promote international standardization of technology developed by the Mems-ONE Project, and we expect that by going through these stages, improvement of the software and updates of the database will ultimately become self-sustaining, the results will be disseminated continuously, and the MEMS industry will continue to grow.

Column

Material failure at the MEMS scale

- Size effects on fracture behavior -

Kazuki Takashima, Professor, Kumamoto University Graduate School of Science and Technology, Materials Science and Engineering

Since beginning research several years ago regarding evaluation of mechanical properties of the micromaterials used in MEMS, I have begun to dip a toe into the world of MEMS. Whenever I make a presentation about evaluating the mechanical properties of micro scale materials, I am always asked, “What about the size effect?”. Size effect is generally used to mean the changes in material properties compared with bulk materials when the dimensions of a material are made smaller. But for those of us who have been involved mainly in mechanical characteristics, the question of how the mechanical characteristics change is what seems to interest us.

Generally it is said that brittle materials (such as glass and ceramic) increase in strength as their size gets smaller. This phenomenon is explained as being linked to the existing probability of defects being present in the material. In other words, as the dimensions of the material get smaller, so the number of defects included in the material becomes fewer, meaning that the starting points for failure are reduced, thereby raising the strength. However, with MEMS materials, the dimensions are in the order of microns, so that various other size effects come into play.

These size effects can be divided into intrinsic effects and extrinsic effects. Intrinsic effects are those where, as the dimensions become smaller, the deformation mechanisms of the materials change, with the result that the mechanical properties change. Extrinsic effects are those where the mechanical properties change due to exogenous elements such as the defects mentioned above. With MEMS materials especially, even nanosize defects may be located in stress concentration zones, causing the mechanical properties of the material to change significantly. With the materials used for MEMS, the changes in the mechanical properties caused in the manufacturing process can be said to be extrinsic size effects since the form of defects and their existing percentage depends on that process. However, because both types of effect are typically present together, size effects on mechanical properties are extremely complicated.

Incidentally, the dimension at which size effects begin to appear irrespective of mechanical characteristics is called the “characteristic length”. When electromagnetic properties or quantum effects are involved, characteristic lengths in the nanometer order are typical. However, among mechanical characteristics there are some with a characteristic length in the micron order which is the size of MEMS. For example, tension tests of ductile materials (materials that show significant plastic deformation until they break, like many metal materials) indicate that material strength largely does not depend on the dimensions of the material down to the micron size. However, if a stress gradient or strain gradient occurs such as with bending or twisting, a size effect becomes apparent in which the strength increases as the dimensions of the material decreases, as demonstrated experimentally and theoretically. There are differences between the types of material, particularly with metal materials. However when the characteristic length is in the micron order, in MEMS devices where metal is used for parts in which bending (as seen in cantilevers and hinges), and twisting stress is applied, this size effect becomes important.

Incidentally, for the design and development of MEMS devices with superior reliability and durability, it is very important to evaluate the rupture characteristics of microdimensional materials with high precision. Here I will present a relevant example of a size effect. When uniform force is applied to the material, stress is concentrated at the ends of any scratches or cracks. However, if the stress at the end of a crack exceeds the yield stress, plastic deformation will occur. If the size of the area where this plastic deformation occurs (in the case of failure, the parameter related to characteristic length) is very small compared to the ligament length (the length from the end of the crack to the free surface beyond it) brittle fracture will occur. However, if the size of the area is large, a size effect appears in which the fracture morphology of the material transitions from brittle fracture to ductile fracture. In ductile materials, the characteristic length in this case is in the order of millimeters or higher, so even if the size is reduced to micron order, the material still tends towards ductile fracture. However, in brittle materials, the fracture morphology may make a transition according to the size. In our group, we researched the fracture behavior from micro to macro sizes using single crystals of Fe-3%Si alloy (a material in which cleavage (brittle) fracture occurs at macro sizes, but with a characteristic length in the order of 10 μm or more). From our tests we discovered that although cleavage fracture occurs at the macro size, the behavior changes to ductile fracture at the micro size (**Fig. 1**).

In MEMS, in order to aim for higher performance it is considered necessary to use many materials such as metals, ceramics, polymers and so on, and as well as silicon materials. Furthermore, because there are many types of silicon and ceramic that undergo brittle fracture at macro sizes, I believe that our results showing the effects of dimension on fracture behavior will prove very important in designing MEMS devices that are reliable and durable.

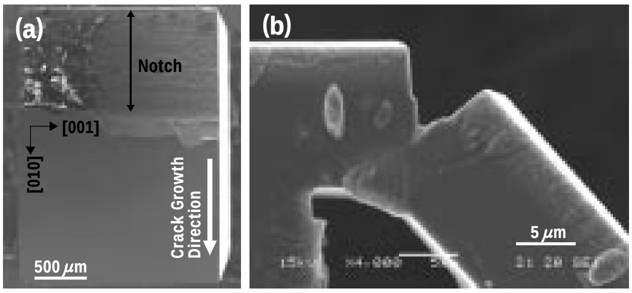


Fig.1 Changes in fracture behavior in (a) a macro size specimen, and (b) a micro size specimen of Fe-3%Si single crystal. At macro sizes, cleavage (brittle) fracture occurs, but at micro sizes, ductile fracture occurs. As this demonstrates, the fracture behavior and morphology of a single material differs when the dimensions of the material change to a micro order.

Overseas Trends

Report on the 12th Micromachine Summit

The 12th Micromachine Summit was held over 3 days, from April 27 to 29, 2006, at the yellow-sand hazed Jiu Hua Spa & Resort on the outskirts of Beijing, China.

The summit was hosted by Tsinghua University and was attended by 88 delegates and observers from 17 countries and regions: Australia, Canada, China, France, Germany, India, Japan, the Republic of Korea, Singapore, Switzerland, Taiwan, the United Kingdom, the United States, the Benelux countries (Belgium, the Netherlands, Luxembourg), the EU, the Mediterranean region (Italy, Spain, Portugal, Greece), and the Nordic countries (Denmark, Norway, Sweden, and Finland). Japan was represented by a delegation of 16 – the largest ever for a summit held overseas – led by Professor Isao Shimoyama of the University of Tokyo as Chief Delegate.

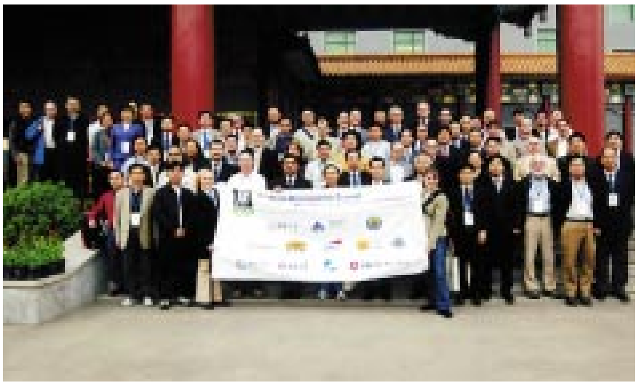
Held over two days, April 27 and 28, the summit conference was chaired by Prof. Zhaoying Zhou of Tsinghua University. Altogether, an impressive 54 presentations were made in the 6 sessions: (1) Country/Region Review; (2) Strategy & Cooperation; (3) Infrastructures & Education; (4) Market, Industrialization & Standardization; (5) To Nano-Technology; and (6) Innovative Technology.

Japan made five presentations. The content of each and every one of these was excellent and received high praise from delegates of other countries; having acted as secretariat for the summit for a long time now, I am sure that there was renewed awareness among participating countries of Japan's position. In Session 1, Professor Shimoyama gave an outline of the Integrated MEMS Technology Development Project, which began this year, in his presentation entitled "Fine MEMS – upcoming MEMS project". In Session 4, Micromachine Center Executive Director Keiichi Aoyagi described the activities of the MEMS Industry Forum, which was established in April this year, in a presentation entitled "Towards advancement of MEMS industry in Japan". In Session 5, various businesses representatives described their companies' activities regarding MEMS and nanotechnology: Mr. Masaaki Terada, Director and Senior Executive Managing Officer of Olympus Corporation, spoke on "Nano-Bio MEMS technology for Medical Application"; Koichi Imanaka, Managing Officer and Senior General Manager of Research & Development H.Q. of Omron Corporation, spoke on "Micro and nano technology in Japan - example of OMRON Corporation–"; and Kazuhiko Tsutsumi, Manager of Imaging Technology, Mitsubishi Electric Corporation Advanced Technology Research and Development Center, spoke about "Micro/nano technologies at Mitsubishi Electric Corporation".

Tours of the beautifully illuminated Great Wall and Tiananmen Square were arranged for the evenings after the sessions concluded on both days, providing opportunities for participants to deepen friendships and rounding out two highly productive days.

A technology tour was held on April 29. The tour visited Tsinghua University and a bioventure business supported by Tsinghua University, Capital Biochip Corporation, ending the summit on a successful note.

The 13th Micromachine Summit is to be held from April 26 to 28 next year in Venice, Italy and Korea, Canada, the United Kingdom, and India have all expressed a desire to host summits in the future. High expectations are held for the summit as a place for international exchange regarding MEMS and nanotechnology, and I believe we should fully utilize it as such.



Summit Participants: in front of the summit venue, the Jiu Hua Spa & Resort

Japan's Chief Delegate: Presentation by Professor Isao Shimoyama of the University of Tokyo

http://www.mmc.or.jp/kokusai/summit/summit.html

Members' Profiles

Yamatake Corporation

Microsystems Group Leader, Research and Development Division
Shuichi Tanaka

1. Microfabrication technology activities

With our measurement and control technology fostered over many years, Yamatake Corporation is contributing to society in the fields of building automation, advanced automation (manufacturing industry automation), and the life automation that surrounds us (automation that supports our environment and amenities). The company became involved in microfabrication technology in the early 1980s. Measurement of temperatures, humidity, pressure, and flow rates is extremely important to Yamatake, and we have given it a high priority in our research. Technologies that we developed for commercial applications from among the research themes at that time are currently the subject of further research at the Microdevice Center with the goal of expanding the application within our business. Leading edge technology domains that cannot be managed by the Microdevice Center are handled by the Research and Development Division Microsystems Group.

2. Micronano technology activities

(1) Nanocrystal silicon ultrasonic elements

ULSI technology using silicon substrates is crucial to the development of today's industry. At quantum size, the silicon expresses new optical, electronic, thermal, and chemical properties that do not appear in larger sizes. Together with the Koshida Laboratory of the Tokyo University of Agriculture and Technology, Yamatake developed a nanocrystal silicon ultrasonic element using these thermal properties. This new ultrasound source achieves flat frequency characteristics that are difficult to obtain with existing technology, and we are pursuing development to apply this characteristic to new ultrasonic speakers, high-precision range sensors, and compact actuators. Nanosilicon technology holds wide potential, and we plan to deploy this basic technology in many products.

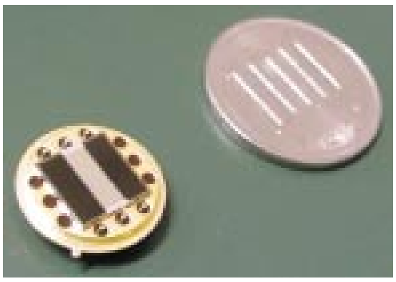


Fig. 1 A nanocrystal silicon ultrasonic element

(2) Spherical SAW gas sensor

The spherical SAW gas sensor uses the phenomenon in which surface acoustic waves (SAW) go around a sphere a number of times (discovered in 1999 by Professor Yamanaka of Tohoku University). This is a sensor for measuring changes in the concentration of gas on the surface of the sphere using the characteristic whereby a crystal sphere with as small as 1 mm diameter exhibits longer propagation lengths (1 m or more). This phenomenon is not seen in flat SAW devices. Since it provides high sensitivity, the sensitive membrane can be thinner allowing a high speed response. The hydrogen sensor that we are currently developing has succeeded in detecting in a wide range from extremely low concentrations (10 ppm) to high concentrations (100%). We are aiming to create a product that will offer safety and peace of mind in the coming hydrogen society. The sensor can also be made to detect other gases by changing the sensitive membrane.

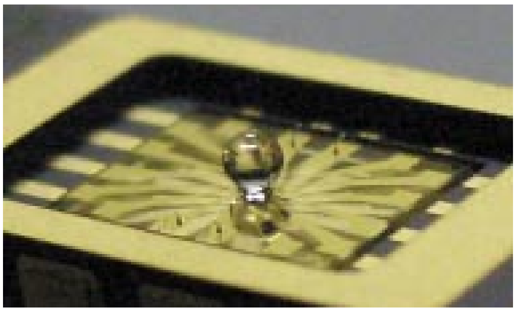


Fig. 2 Spherical SAW gas sensor

3. Future activities

Nanotechnology products are the focus of attention as sensing materials. We plan to probe deeper in this area. We expect to find business possibilities in the life automation field at the end of our research. Although life automation has a different flavor from our existing business domain, we aim to expand our business in the life automation field, and make bold new advances in that area.

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