MICRONANO
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Topic

MicroNano 2010

The World's largest exposition on MEMS and nano- and biotechnologies

21st Exhibition Micromachine/MEMS

<NEW> ROBOTECH Exhibition on Next-Generation Service Robot Manufacturing Technologies

<Concurrent event> SURTECH Exhibition on Surface Technology

July 28–30, 2010 (Wed–Fri)
Tokyo Big Sight (Tokyo International Exhibition Center), East Hall 5/6

The Micromachine Center (MMC) will be holding MicroNano 2010, an exposition that effectively assembles all the latest micro/nano- and MEMS-related technologies and products at one venue. This year's event will be even more attractive with the newly established exhibition ROBOTECH and the exhibition SURTECH organized by the Surface Finishing Society of Japan held concurrently with the Exhibition Micromachine/MEMS, as well as the addition of new concurrent events to the program such as the BEANS Project Seminar, that cover the latest trends in MEMS research and technology, and the inclusion of a new Job Matching Support Plaza. We expect the event to attract a large number of visitors.

MicroNano 2010 is not to be missed!

1. Three exhibitions held concurrently

The exhibition ROBOTECH, held for the first time this year, will focus on service robots, a field having promising applications for MEMS sensors and actuators. The holding of ROBOTECH in concert with SURTECH is expected to produce a substantial synergistic effect.

2. The International Micromachine/Nanotech Symposium (July 28, 13:00–16:15, MicroNano Conference Area A) focusing on sensor networks and their applications

In addition to the keynote speech given by Isao Shimoyama, professor at the University of Tokyo, on "Green Innovation Explored by Ambient Devices," this year's symposium will feature the latest findings on novel MEMS devices and their applications from such international research institutes as Imec-NL of the Netherlands, CEA-LETI of France, BSAC of the U.S., and Fraunhofer ENAS of Germany.

3. The Tsukuba Innovation Arena (TIA) NMEMS Symposium (July 30, MicroNano Conference Area A)

This symposium will feature reports on expectations held by the government, industry, and academia for the implementation of the open innovation center TIA-NMEMS as one of the six core areas in the TIA-Nano framework, and the activities of the MMC's MEMS Industry Forum.

4. The ROBOTECH Seminar (July 30, MicroNano Conference Area B)

The ROBOTECH Seminar will be held in conjunction with the new exhibition ROBOTECH. Speakers at the seminar will talk about approaches for service robots, which have many promising applications for MEMS, in alleviating problems associated with the declining birthrate and the aging population, a grave issue facing not only Japan, but also other advanced nations.

5. The MEMS Concierge Service and the Job Matching Support Plaza

The MMC booth will offer a concierge service to help visitors more easily find exhibitor booths that match their interests by answering such questions as "Who handles sensors that employ piezoelectric elements." Please don't hesitate to drop by with your questions. Next to the MMC booth, there will also be a Job Matching Support Plaza serving as a place for students having an interest in MEMS to meet exhibiting companies looking for outstanding human resources.

Micromachine Center Booths Planned for Exhibition Micromachine/MEMS 2010

MEMS Concierge Corner and Job Matching Support Plaza

A MEMS Concierge Corner will be provided in the Micromachine Center (MMC) booth, to one side of the reception counter. Visitors can consult with the Concierge Corner for directions on where to go, such as when they are interested in something specific but don't know where to find it or when they want to compare a specific device produced by various companies, and the concierge service will guide them to the appropriate booths. Please don't hesitate to drop by with your questions.

This year for the first time, an experimental Job Matching Support Plaza will be set up near the MMC booth. The Plaza is designed to serve as a place for students interested in micro/nano-related industries to learn about companies looking to hire outstanding talent. Company and employment information will be posted in the Job Matching Support Plaza, enabling students (visitors) to directly visit the booths of companies they are interested in, collect information, and get a feel for the company and the type of work available. For companies, the Plaza may simply offer the benefit of employment-related publicity, but we anticipate that it will provide them opportunities to get in contact with potential employees.

MemsONE Booth

MemsONE is a design tool that provides powerful support for MEMS design and manufacturing processes and is an indispensable tool for MEMS experts, but easy enough to use for beginners with little experience in MEMS. This marks the third year since full-fledged MemsONE dissemination activities began. During this period, versions 1.1, 2.0, and 3.0 of the product have been released, giving MemsONE enhanced, more powerful functions and greater stability. Version 3.0 released in January this year has even more improvements in analysis capabilities and user-friendliness. To further promote and disseminate MemsONE, a consultation corner will be provided at the MemsONE booth for use support. In addition, the academic version of MemsONE will be offered for a limited time at no charge, and the product will be promoted through videos and computer demonstrations. Updated information on the MemsONE functions will also be provided at the MEMS Industry Forum Workshop.

MEMS Mall Booth

The MEMS Mall is a Web site that enables MEMS-related companies to introduce their MEMS products and technologies on the Internet. On the MEMS Mall Web site, companies involved in MEMS manufacturing-related fields can provide information on MEMS devices and applications, biomedical-related products, MEMS manufacturing equipment, nanoimprint technology, MEMS design tools, foundry services, evaluation, measurement, and inspection equipment, and materials.

Individual company data on the MEMS Mall Web site may also include a link to the company's home page, with the idea of connecting MEMS users to suppliers over the Internet. The member companies of the MEMS Industry Forum make up the core of registered companies, but participation in the Mall is open to other companies for a fee. The MEMS Mall booth will also feature computer terminals connected to the Internet, allowing visitors to access and explore the Mall.

MEMS Foundry Network Booth

The MMC manages the Web site for a MEMS foundry network. The Web site introduces users to companies that provide foundry services and also offers a service called MEMStation. MEMStation functions as an intermediary service for potential clients who are looking for companies that provide a particular service.

At the Exhibition Micromachine/MEMS, we have plans for an exhibit that will introduce the types of services offered by companies participating in the MEMS foundry network, as well as information on how MEMStation works and how to get the most out of it. We have also expanded the services available through MEMStation. This year we have introduced follow-up counseling whereby, if companies registered with the MEMS foundry network are unable to meet a client's needs, the MMC in cooperation with the National Institute of Advanced industrial Science and Technology (AIST) will investigate and recommend companies capable of filling this need. In addition, the booth will include panel exhibits and information on the MEMS foundry network.

Standardization Booth

This booth presents the current status of standardization in the MEMS industry. To promote international standardization activities in the MEMS industry in a more strategic manner, the MMC has established a roadmap for MEMS standardization, and standardization activities are being conducted in accordance with this roadmap. The booth showcases the international standards that Japan has proposed and established to date, including a tensile testing method of thin film materials, a thin film standard test piece for tensile testing, and axial fatigue testing methods of thin film materials, in addition to drafts that are currently being reviewed by the International Electrotechnical Commission (IEC), such as a method for fatigue testing thin film materials using the resonant vibration of a MEMS structure, wafer-to-wafer bonding strength measurement for MEMS, and bonding strength tests for thin film materials and standard test pieces for calibration. The booth will also introduce the current status of drafts currently under development for micro-gyroscopes, electronic compasses, and methods of measuring microscale structures, and will display the actual publications that have already been issued for MEMS-related international standards and JIS standards.

MEMSPedia Booth

The Highly Integrated, Complex MEMS (Fine MEMS) Production Technology Development Project produced a database storing knowledge data (1500 entries) sorted by keywords used in the Fine MEMS Project and patent data (4500 entries) sorted by R&D topics, and a MEMS equivalent circuit generator for generating models that are capable of simulating MEMS operations with a circuit simulator. In June 2009, these data and tools were made available to the general public on the Internet as an encyclopedia called MEMSpedia, which includes knowledge data, design tools, and a variety of open content. During the approximate one-year period since MEMSPedia was made public, the database has been accessed more than 670,000 times, and the number of users is expected to continue to grow. The MEMSPedia booth provides descriptions of the knowledge database and the MEMS equivalent circuit generator and instructions on using these tools through panel exhibits and computer terminals that are available for the visitors' convenience.

BEANS Project Booth

This year will be the second that the BEANS Project participates in the Exhibition Micromachine/MEMS, the first being in July of last year. The BEANS Project booth will be expanded from last year's five exhibit spaces (one space is 3x3 meters) to twelve exhibit spaces. The booth is being sponsored jointly by the New Energy and Industrial Technology Development Organization (NEDO) and the BEANS Laboratory. The BEANS Project booth is located in a corner of the exhibition hall far from the entrance, but is adjacent to both the Micromachine Center booth and Conference Areas A and B at which various seminars will be held during the exhibition.

Since the level of recognition for the BEANS Project itself was low last year, our exhibits were focused on raising awareness of the BEANS Project. It will be important this year as well to increase awareness of BEANS among industry insiders, but the primary objective will be to publicize achievements of the project, as this is the interim evaluation period. Thus, in coordination with a report of achievements given at the BEANS Project Seminar, which is to be held on the afternoon of July 29 during the exhibition, we hope to take this opportunity to illustrate what important achievements the BEANS Project has produced over a mere two years since its inception and how the level of achievement has exceeded expectations.

The booth itself is an "island" surrounded on all four sides by passageways. An emblem of the bright green sprouting bean plant that has been the symbol of BEANS will adorn the entrance to this island, and the interior of the booth will be furnished with carpeting and other elements in a matching green. We have no intention of putting up walls or other barriers between the booth and the passageways, so as to give the booth a fairly open feel, but we are considering how to control traffic flow within the booth in order that visitors will see everything on display. The entrance to the booth is the main exhibit zone, which connects to various inner zones devoted to 1) Macro BEANS, 2) 3D BEANS Tokyo, 3) Life BEANS Kyushu, and 4) Life BEANS Tokyo, for example.

The display items provided for each center are essentially posters, mock-ups or the actual articles, and display monitors showing animated or live-action video. Highlights planned for the exhibition are (1) new lifestyles created by BEANS (in the main zone); (2) photographs depicting low-damage, neutral beam etching, models for elucidating the mechanism of supercritical films, trench capacitors, patterning using peptides, and true 3D machining; (3) large panel displays and an exhibit of actual glowing microbeads related to a hybrid cell doll created from hydrogel beads and a glowing ear that reflects changes in blood sugar level; and (4) animation simulating weaving experiments and non-vacuum deposition for a study on fiber substrates with nanostructures and a meter-size fabric touch sensor.

In coordination with the booth exhibits, the 4th BEANS Project Seminar will be held in Conference Area B on the afternoon of July 29. Please don't miss the seminar, as all interim results of the BEANS Project will be presented.

G-device Project Booth

The G-device Project was added to the NEDO-sponsored "Hetero-functional Integrated Device Technology Development Project (BEANS Project)" and launched in April this year. The challenges taken up in this project are to develop an advanced sensor network system and environmentally friendly processes.

In order to develop an advanced sensor network system, an experimental system will be installed in a clean room for fabricating large-diameter (8-inch) MEMS in order to monitor energy consumption, temperature, pressure, air volume, foreign particles, gas, and other factors in the clean room and to analyze their effects on energy savings and the reduction of carbon content. The G-device booth will provide demonstrations on controlling an air conditioning system and the like, while sensing temperature, humidity, and foreign particles at various points in order to illustrate the concept of the project. Another goal of the project is to verify the effects of a sensor network system installed in a plant factory for detecting temperature, light, humidity, and other conditions in the factory on energy savings and productivity in crop cultivation. A miniature plant factory will be exhibited at the booth to demonstrate this process.

In the task for developing environmentally friendly processes, our research entails developing an efficient etching process with low-environmental impact, integrating hybrid devices at the wafer level, using MEMS to reduce the environmental impact of processes and devices, and sharing eco-friendly information at the design stage. The details of these processes will be introduced at the exhibition.

We are looking forward to telling you about the G-devices that will drive green innovation, so please do visit our booth at the exhibition.

Activities of the Micromachine Center in FY 2009

Overview

The Micromachine Center (MMC) carries out various activities aimed at establishing fundamental technologies in micromachines, micro electro mechanical systems (MEMS), and other micro/nano fields. These activities include research studies, data collection and provision, and projects to encourage information exchange and cooperation among businesses in MEMS and other industries carried out through the MEMS Industry Forum (MIF) in order to improve the environment for MEMS industrialization, such as policy recommendations and industrial vitalization, as well as activities to promote standardization and improve public awareness of MEMS.

In FY 2009 the MMC worked to implement various projects in a manner deemed most effective and efficient. These projects are designed to contribute to the growth of Japan's industrial fields having ties with micromachines, MEMS, and other micro/nano technologies by exploiting unique features of the non-profit sector in order to supply an extensive and flexible array of services necessary for meeting numerous demands in micromachines and MEMS fields that cannot be met by the private sector alone. The projects are also aimed at creating a safe and secure society with little impact on the environment through technological innovation in these fields in order to contribute not only to Japan, but also to the international community as a whole. The following is an overview of each project.

1. Research Studies

The MMC has conducted research studies aimed at gaining a clearer picture of the technological and industrial trends in micromachine and MEMS technologies, which are emerging as key technologies in the manufacturing industry. These research studies entailed the investigation of new issues facing micro/nano technologies that arise when merging nanotechnology with technologies in other fields and included surveys of technological and industrial trends at home and abroad.

2. Data Collection and Provision

In order to strengthen Japan's industrial competitiveness in micromachines and other technologies, the MMC has implemented a data collection and provision project for the purposes of clearly identifying technological and industrial trends and for contributing to surveys, studies, and information distribution. A portion of the collected information has been made available over the Internet, and all data is available to the general public year-round in the MMC archives.

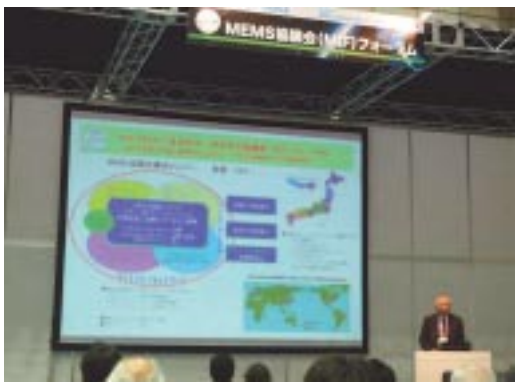
3. MEMS Industry Forum Projects (promoting information exchange and cooperation among businesses in MEMS and other industries)

The MMC has conducted the following activities in FY 2009 within the MIF in collaboration with affiliated academies, regional centers, and overseas institutions.

1) Policy recommendations

The MIF Promotion Committee comprising MIF member companies held an informal gathering on MEMS to encourage the exchange of ideas with government and related agencies. The MIF also held the MEMS Industry Forum Workshop as one of the concurrent events at MicroNano 2009 and actively promotes government policies related to MEMS.

The 2009 informal gathering on MEMS



The 2009 MIF Workshop

2) Industry-academia collaboration

The MIF continued its study group activities, which bring together member companies interested in specific research themes. The MIF also gave extensive consideration to R&D projects needed for accelerating the BEANS Project and for realizing a low-carbon economy. In addition, the MEMS Advanced Technology Forum was held three times during the year.

3) MEMS infrastructure improvements

The MIF implemented the following five projects aimed at improving the infrastructure for MEMS development.

a. Expansion and upgrading of the MEMS foundry network system
b. Compilation and upgrading of MEMSPedia
c. Dissemination of the MEMS equivalent circuit generator
d. Strengthening of collaboration among regional public foundries and local clusters
e. Implementation of personnel training projects

4) Information exchange among businesses

The MIF also implemented the following seven projects for encouraging information exchange among businesses in MEMS and other industries.

a. Promotion of the MEMS Mall
b. Holding of the exposition MicroNano 2009
c. Holding of Exhibition Micromachine/MEMS
d. Expansion of the international affiliate network
e. Participation in the 15th World Micromachines Summit
f. Participation as an exhibitor at Hannover Messe
g. Dispatch of overseas fact-finding missions and exchange of researchers

MicroNano 2009 (including the Exhibition Micromachine/MEMS)

4. Activities to Promote Standardization

In the fields of micromachines and MEMS, the MMC has promoted standardization while demonstrating its initiative on the international stage.

1) Joint research for the purpose of proposing international standards

a. Standardization for methods of evaluating the performance of micro-gyroscopes

b. Standardization for measuring methods and notation for MEMS shapes

2) Follow-up to a proposal of standards for testing MEMS wafer-to-wafer bonding strength

We conducted a follow-up on methods for a 3-point bending test and a die shear test that Japan proposed in FY 2008 as methods for testing wafer-to-wafer bonding strength, with the aim of realizing their adoption as international standards in FY 2009.

3) Research study on overseas standards

4) Adoption of a thin film material tensile testing method as a JIS

5. Dissemination and Publicity Projects (dissemination, publicity, and information services)

The MMC has continued to publish and distribute newsletters, hold exhibitions, and otherwise expand public awareness of micromachines and MEMS. The MMC also continues to collect reference materials and documentation related to micro/nanotechnologies from universities, industrial circles, public organizations, and other sources in Japan and overseas. This documentation is consolidated with reference materials for surveys conducted at the MMC and is available in the MMC's archives for browsing and searching. Information is also being provided internally and externally through MMC's Web site.

6. Other Projects

1) A follow-up to previous national/NEDO-commissioned projects (activities related to MEMS R&D projects)

In an effort to establish fundamental technologies for micromachines and MEMS, the MMC has been a central figure in actively promoting MEMS R&D projects while harnessing the combined capabilities of government, industry, and academia. In FY 2009 we engaged in the activities below to follow up on these projects.

The MMC continued its activities of the previous year to aggressively promote and disseminate the MemsONE software, which was the product of R&D in the MEMS Open Network Engineering System of Design Tools project (commonly referred to as the MemsONE Project), a national/NEDO project that was completed in March 2007. We have also continued our aggressive promotion and dissemination of the fine MEMS knowledge database and the new MEMS equivalent circuit generator developed in the Highly Integrated, Complex MEMS Production Technology Development Project (commonly referred to as the Fine MEMS Project), a three-year project carried out between 2006 and 2008. We also worked to develop an outline for firmly establishing fine MEMS in Japan's industry and to write up drafts and proposals for plans related to relevant R&D projects. Specifically, we drew up plans for effectively establishing the role of a support organization for outfitting the Tsukuba Nanotech Innovation Arena and for effectively considering R&D on an advanced network sensor system and environmentally friendly processes.

Standardization Activities

While the Micromachine Center (MMC) promotes standardization related to MEMS technology, this article will detail our current R&D projects.

Developing Standards for Micro-gyroscopes and Electronic Compasses

Gyroscopes are indispensable for controlling the attitude of a device in a space by detecting fluctuations in attitude. Recent developments for reducing the size and cost of devices while improving performance through MEMS and other technologies have led to a more active role for micro-gyroscopes in various contexts of daily life.

Gyroscopes incorporated in controllers for game consoles detect movement in the controller and adjust the image accordingly. An image stabilizer has become a standard feature of digital cameras and is even provided in the cameras of cell phones. This function is achieved with a gyroscope that detects attitude changes in the camera and moves the lens and image-detecting unit accordingly. Gyroscopes having greater precision and resistance to impacts are the key components of safety systems installed in vehicles to control the engine and brakes when detecting impacts and changes in attitude. Even higher precision gyroscopes have appeared in aircraft and space applications. Now efforts are being made to replace the conventional gyroscopes, which have good precision but are heavy and bulky.

Compasses are age-old instruments that have been central to navigation for ships and aircraft. A compass detects the Earth's magnetic field and displays the directions north, south, east, and west. However, since geomagnetism itself is very faint, various compensations are needed to boost the precision of the compass, resulting in a large and heavy instrument. Recent years have seen the appearance of an electronic compass that combines a sensor element for detecting geomagnetism with a system for analyzing and processing the sensor signal. With their decreasing size and cost, electronic compasses are being provided in cell phones to configure a navigation system for pedestrians that can detect the user's position with the Global Positioning System (GPS) and directions with the electronic compass.

Consequently, the number of practical applications for micro-gyroscopes and electronic compasses continues to grow. The objective of our project is to standardize the specifications and methods of measurement needed to define the performance of these devices as sensors. This is expected to lead to more efficient communication between device manufacturers and users.

For micro-gyroscopes, we have established an absolute maximum rating, recommended operating conditions, and various characteristics, including sensitivity, cross-axis sensitivity, bias, output noise, frequency response, and resolution. We are also investigating methods for measuring these properties.

Similarly, we have established an absolute maximum rating, recommended operating conditions, and characteristics for electronic compasses, and are studying methods of measuring the analog circuit characteristics and DC characteristics of these devices. Further, although it is generally assumed that conventional compasses are installed in a more or less level orientation, cell phones obviously have a high degree of flexibility in how they are oriented. Therefore, we are suggesting new ways of conceptualizing the coordinate system of these compasses.

This project is being implemented under a three-year plan that began in FY 2008, and the findings of the project will be submitted to the Subcommittee on MEMS (SC 47F) of the Technical Committee on Semiconductor Devices (TC 47) under the International Electrotechnical Commission (IEC). Initially we intend to submit a new proposal on electronic compasses within the current fiscal year.

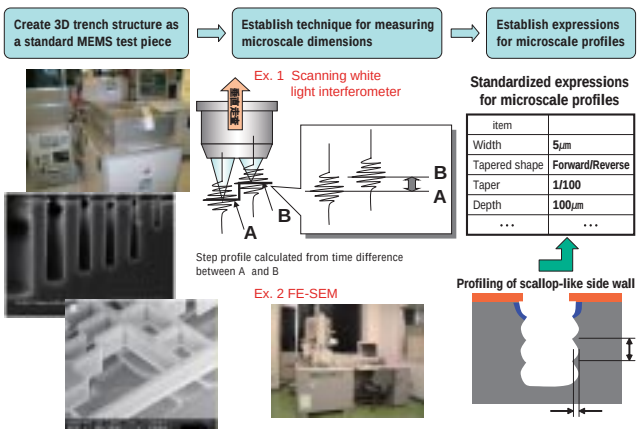
Developing Standards for Measuring Microscale Dimensions

MEMS applies techniques used in semiconductor fabrication to produce three-dimensional structures. While dimensions and other aspects of the 3D profile are important elements of structures, a method of measuring such profiles has not been established. Accordingly, the goal of our project is to standardize a suitable method of measuring dimensions and shapes of microscale structures.

MEMS devices are fabricated using the time-consuming techniques of wet etching and deep dry etching. However, MEMS structures inherently have a microscale profile, and techniques have not yet been established for measuring the angle of a forward tapered or reverse tapered side wall, the depth and width of high-aspect-ratio trench structures, and the surface roughness resulting from etching. We are measuring microscale structures according to a variety of techniques with the goal of standardizing techniques for evaluating suitable methods of measuring the dimensions and shapes of such structures and of expressing such dimensions and shapes. Using the standard, it is likely that designers, manufacturers, and others involved in the various stages of MEMS fabrication can better communicate with one another. This is a three-year project that began in FY 2009, and we will be submitting our findings to the SC 47F of the IEC TC 47.

Our study involves creating specimen for use as a reference for measuring MEMS profiles, measuring these specimen according to a variety of techniques, and comparing and evaluating the results. Specimen are produced by creating structures having different aspect ratios (ratio of depth to width) and spacing their gauge marks at varying distances. Specimen are measured using an optical microscope, a laser scanning microscope, a scanning white light interferometer, an optical standing wave scale displacement sensor, a stylus-type contact profilometer, and other apparatus, and the results are analyzed through comparisons with reference measurements obtained using a high-resolution field emission scanning electron microscope (FE SEM). We have also included 3D microprotrusion structures as specimen.

As we enter the second year of the project, we are continuing to collect and organize data obtained through repeated measurements in order to develop standards for comparing and evaluating methods of measurement and for expressing dimensions and shapes of the microscale structures.



Activities of the MEMS Industry Forum

The MEMS Industry Forum (MIF) was established with the goal of contributing to the international competitiveness of Japan's MEMS industry. Membership in the MIF is composed primarily of companies in MEMS-related industries. The MIF conducts various activities in collaboration with affiliated academies, regional centers, and overseas institutions.

1. Planning for FY 2010

The Industrial Exchange Committee, Foundry Service Industry Committee, and International Exchange Committee have been established to work out the detailed project activities of the MIF under the guidance of the MIF Promotion Committee. During May and June this year, the MIF Promotion Committee and the three other committees held their first committee meetings and finalized the schedules for this fiscal year.

At the MIF Promotion Committee meeting held on June 9, the committee decided on the overall schedule of activities for the current fiscal year. In addition to improving and intensifying the traditional activities of the MIF, this year plan calls for implementing strategic activities aimed at the establishment of a future micro/nano R&D center. The following are three distinct aspects of the current plan.

(1) Establish a new Promotion Committee of Micro/Nano Education and Training aimed at developing self-reliant personnel training programs nationwide.

(2) Establish an investigative committee composed primarily of MIF member companies to discuss suitable strategies for a future micro/nano R&D center and an appropriate administrative structure and implementation plan required to realize this center.

(3) Consider how equipment installed for the G-device project of the BEANS Laboratory at the National Institute of Advanced Industrial Science and Technology (AIST) can best be utilized in the future to enhance collaboration with the MEMS Foundry Service.

The activity schedules for each of the above committees was finalized in accordance with this overall activity schedule, and implementation of the projects for this fiscal year has begun.

2. Preparations for MicroNano 2010

The micromachine exposition MicroNano 2010 will be held at Tokyo Big Sight on July 28–30, 2010. Below is a description of some of the features in this year's event and the current state of preparations.

a. The International Micromachine/Nanotech Symposium

The 16th International Micromachine/Nanotech Symposium is held to collect all the latest findings from overseas research institutes under the theme "Green Innovation Explored by Ambient Devices," as indirect support for the G-device project. As part of its duties, the International Exchange Committee is studying the program while consulting with Toshihiro Ito, co-director of the AIST's Research Center for Ubiquitous MEMS and Micro Engineering. By establishing a theme that overlaps the research theme of the G-device project, we hope to gain insight into the trends of research both in Japan and overseas.

b. Addition of the TIA-NMEMS Symposium

The TIA-NMEMS Symposium will be divided into two parts held in the morning and afternoon, respectively. Part I will serve to hear all expectations of government, industry, and academia toward NMEMS, which is one of the core research domains of the Tsukuba Innovation Arena (TIA)-Nano, while Part II will introduce the preparatory activities of the MEMS Industry Forum Workshop to date for implementing the concept of TIA-NMEMS. Part I will be hosted jointly with the AIST and will encourage closer collaboration among government, industry, and academia.

c. Establishment of the Job Matching Support Plaza

As a new experiment for MicroNano 2010, a Job Matching Support Plaza will be added to provide a place for students with an interest in the MEMS industry to meet companies looking for outstanding personnel who are currently engaged in MEMS research. As we have asked for cooperation from exhibiting companies, announced the Job Matching Support Plaza through the Industrial Exchange Committee, and notified university research labs of the exhibition program, we anticipate the participation of a large number of companies and students.

3. International Exchange Activities (Hannover Messe, Micromachine Summit)

As part of its international exchange activities, the MIF encourages international business and academic exchange by holding the International Micromachine/Nanotech Symposium and dispatching overseas fact-finding missions, for example.

So far during the current fiscal year, the MIF has exhibited products and presented papers at Hannover Messe 2010 held in Hannover, Germany on April 19–23 and has participated in the 16th Micromachine Summit held in Dortmund, Germany on April 27–30. While both events took place during the difficult circumstances of the volcanic eruption in Iceland, which resulted in a chaotic flight schedule, we were able to attend the event in part due to the support of MIF member companies.

The theme of this year's Micromachine Summit was "Ambient Assisted Living" on how micro/nano technology can be used to improve lifestyles in an aging society. We left the Summit feeling that, while the problem of an aging population is a major issue for Japan, it is actually a universal issue. As a result, nations around the world have accelerated research efforts in a race to find a solution to the problem.

16th Micromachine Summit (Dortmund, Germany)

FY 2009 Reports on Research Studies

The Micromachine Center (MMC) conducts surveys on trends in MEMS-related industries and technologies, compiles the data in its annual reports, and distributes these reports to all member companies in the MEMS Industry Forum (MIF) and others involved in the MEMS industry. The Report on Industrial Trends and the report on field-specific "Survey of Technological Trends at Home and Abroad" for FY 2009 have been completed, and a summary of each is given below.

FY 2009 Report on Industrial Trends (by the MEMS Industrial Trends Study Committee)

The Industrial Trends Study Committee is continuing its research study begun last fiscal year on the types of tools employing MEMS technology (MEMS-Inside) and the uses for these tools (MEMS applications), as well as the state of affairs for MEMS-related businesses. The committee compiled this information into its FY 2009 report on challenges and strategies for the expansion of Japan's MEMS industry.

1. Trends in MEMS Applications

MEMS has already been incorporated as a practical technology in numerous products, including such recognizable devices as airbag sensors for automobiles, controllers for game consoles, and image stabilizers for digital cameras. It is anticipated that applications for various devices in diverse fields will continue to emerge as we see further advances in MEMS/nano-function composite technology, MEMS/semiconductor integrated fabrication technology, and MEMS/MEMS high-integration technology. Through recent trends in MEMS sensors, microfluidic systems, and bioMEMS used in medical and welfare fields, we expect to see an increase in the number of applications of MEMS for medical diagnostics, examinations, and treatment.

2. Trends in MEMS-Related Businesses

Companies that make up the MEMS industry are continually expanding into diverse sectors of business. An increasing number of companies involved in electronic, mechanical, precision, and chemical businesses are beginning to file Japanese patent applications related to MEMS and micromachine fields. The number of companies engaged in MEMS devices has also increased since the previous year's survey, with more and more companies pursuing fields expected to have future MEMS applications, such as MEMS sensors, optical MEMS, and bioMEMS.

3. Challenges for the Expansion of Japan's MEMS Industry

Japan's MEMS industry is configured of a group of dominant companies that follow a vertical integration model, as opposed to the horizontal division of labor employed in overseas groups, such as STMicroelectronics and foundries for analog devices and MEMS. Japan's model is less efficient because its technology, expertise, and facilities are scattered, and Japan does not conduct sufficient activities aimed at market penetration and growth for MEMS devices. Thus, in terms of cost competitiveness, which will be an important factor in the future of industrial competitiveness, Japan's model may be inferior to that used overseas. To strengthen the MEMS industry in Japan, it will be necessary to implement aggressive activities choreographed by industry and public institutions, such as promoting standardization through collaboration with public institutions and businesses, in order to facilitate Japan in changing its focus from technological and applied development to market growth and mass production.

FY 2009 Survey of Technological Trends at Home and Abroad (by the MEMS Technological Trends Study Committee)

The object of this survey is to monitor technological trends from the fixed perspective of Transducers (held in Denver, Colorado in 2009), the largest MEMS-related conference worldwide.

1. Oral Presentations by Region

Since the Transducers conference was held in the U.S. in 2009, North America accounted for 43% of the oral presentations, a large increase from its 25% share in the previous year. On the other hand, Europe, which accounted for 39% of the oral presentations in the previous year, dropped by more than half to 19% in 2009. Japan had a slight decrease in such presentations from the previous year, but oral presentations for other Asian countries increased from 14% to 19% in 2009.

2. Numbers of Presentations by Specific Field

Among the basic technologies, actuators were the most popular, followed by packaging technologies, whose number increased dramatically over the previous conference. Under applied technologies, mechanical sensors occupied the top spot with a considerable increase in number over the previous conference. This topic was followed in popularity by fluidic and biomedical systems, while the number of presentations on chemical/bio sensors was half that of the previous conference.

When looking at the number of presentations by region for specific applied technologies, North America had a large number of presentations on RF-MEMS, power-MEMS, fluidics, and chemical/bio sensors, reflecting a focus on sensor networks, health care, and medical treatment. Europe, on the other hand, gave numerous presentations on image sensors and chemical/bio sensors, reflecting a focus on bio-related fields. Japan had numerous presentations on mechanical sensors and chemical/bio sensors, indicating an emphasis on sensors used in automobiles and consumer electronics. In contrast, Japan's small number of presentations on power-MEMS suggests that Japan may be lagging behind in the area of energy harvesting.

3. Numbers of Presentations for Basic and Applied Fields

At the Transducers conference held the year before last, the proportion of presentations on basic technologies was down, while presentations on applied technologies were on the rise, but this year saw a slight increase in presentations on basic technologies. In general, the proportion of interest in basic technologies is high in European countries, but on the decline in Asia. While Japan and Asia invest relatively heavily in short-term projects, it appears that European countries are conducting longer-term studies with a focus on basic technologies.

Dream Devices from BEANS

Devices that BEANS Researchers Would Like to See Ten Years from Now

The BEANS Project was not established to develop any specific device. We simply cannot designate any specific target device because devices so innovative as to change the way we live are beyond our imagination today. Thus, trying to develop innovative processes is much like feeling our way in the dark, but we expect that such processes will eventually lead us to produce innovative devices. By the same token, you cannot take a journey without knowing your destination, and we cannot develop manufacturing processes without giving any thought to a target device. Therefore, we decided to dream up some innovative devices for the future by thinking about what we truly wanted to achieve and, when our entire research staff gathered for the Annual Meeting of the BEANS Project on June 16, we held a brainstorming session.

Format of the Discussions

The BEANS Project is currently composed of four major research centers: Center A involved in the biomedical field, Center B involved in organic materials and nanostructures, Center C involved in 3D micromachining and low-damage etching, and Center D involved in non-vacuum large-area deposition and nanofabrication of fiber substrates. Since R&D conducted by integrating dissimilar fields (heterogeneous integration) is a defining feature of the BEANS Project, discussion was performed among groups intentionally composed of members specializing in different fields. Members were divided into four groups, and three thirty-minute sessions were held while shuffling the group members between each session. In Session One, the groups were asked to identify from various perspectives the difficulties, inconveniences, or frustrations that they as individuals or society as a whole deals with in today's world. In Session Two, the groups were asked to discuss what type of device could be used to solve the issues identified in Session One. In Session Three, the final session, groups were asked to devise a road map needed to link the attainment of the target device clarified in Session Two with research currently being performed at the BEANS research centers.

Dream Devices Conceived by Our Young Research Staff

While the composition of the groups arranged to come up with dream devices through heterogeneous integration may have had some influence, the proposals showed a particular bias toward devices that integrate bio-related fields developed by Center A with micromachining by Center C, with very few proposals linking organic materials developed by Center B and large-area deposition processes or fiber substrates developed by Center D with other technological fields. Below are some representative examples of their proposals.

(1) Brain wave response device: While the group referred to their device as a "psychokinesis (telekinesis) remote controller" in their discussions, this device is not designed to use psychic abilities like psychokinesis or telekinesis but rather detects faint brain waves with great sensitivity and uses the detected data to communicate or to control an external device. Hence, by using this device, a person could manipulate a tool by thought, or two people could communicate with each other without speaking. In the case of an implanted device, a biocompatible membrane could be used to cover the device, and a mechanism could be devised to generate power from heat or glucose in the body to drive the device without a battery, thereby involving bio-related fields. The brain wave sensing function could be configured of either a) a very sensitive magnetometer such as a superconducting quantum interference device (SQUID), requiring a technology for forming a room-temperature superconducting wire into a micro-coil, or b) a biosensor capable of detecting hormones and neurotransmitters.

(2) Hayabusa drug delivery: Much like the unmanned spacecraft Hayabusa, which was controlled to land on an asteroid far away from Earth, the proposed system would deliver a drug directly to a very small affected area within the inner "space" of the body with pinpoint accuracy. As in the film *Fantastic Voyage*, a drug capsule 4–400 nm in size would be injected into the blood vessel, and the capsule could be configured of means for navigating through the bloodstream and for releasing the drug once the capsule reached a desired target. Here, the drug capsule must be manufactured with high precision of nano order. It is apparent that a capsule too large or too small could not navigate safely or with stability in the bloodstream.

(3) Flexible device: A great advantage of using organic materials in electronics is their flexibility. The domain of wearable devices similar to clothing stimulates the imagination. There is no limit to the vast number of applications for devices that can be fibrous one minute and membranous the next, such as an organic EL display, thin-film solar cells, and polymer batteries. Organic semiconductors may also be used to configure the drive circuit. Thus, this device is likely the exclusive domain of Center B, which is investigating nanostructures of organic materials and nanofabrication. However, the technologies being developed by Center D for the nanofabrication of fiber substrate surfaces inspired proposals for designing ambient clothing formed of fibers whereby the color of the fibrous surface could be changed at will, and a simple method to nanoimprint hair, enabling people to change their hair color easily.

(4) Portable thin-film spray: Based on the non-vacuum thin-film deposition technology developed by Center D, one group proposed a portable device that could be carried anywhere to apply thin films in much the same way as a spray gun is used to paint a wall. Such a device is significant in that it would allow us to coat walls and roofs with solar cells and to apply a solar cell coating on cars. One day we might even see campgrounds offering a service to spray your tent with solar cells.

At any rate, for one day we were allowed to wonder whether devices such as those mentioned above would be taken for granted ten years from now.

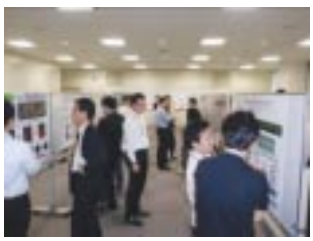
Report on the FY 2010 Annual Meeting of the BEANS Project

The Annual Meeting of the BEANS Project was held for two days on June 15 and 16, 2010 at X Wave Fuchu in Fuchu, Tokyo. The meeting featured invited guests from the Ministry of Economy, Trade and Industry (METI) and the New Energy and Industrial Technology Development Organization (NEDO) for a total of 89 attendees. The purpose of the meeting was to report on R&D efforts during the previous fiscal year by researchers in each research area and to discuss the creation of new technologies through the integration of technologies being pursued at each research center and the future that will be created by BEANS, with the hope of enhancing intra-project cooperation and competitiveness.

The first day's session on June 15 featured speeches by the invited guests and opening remarks from BEANS Project Leader Atsushi Yusa. Next, individual researchers involved in this year's poster presentations gave brief descriptions of their presentations, after which presentations for the previous fiscal year were presented in poster format.

In his opening remarks, Project Leader Yusa reaffirmed the significance of the Annual Meeting's purpose and objectives. He also pointed out that it would be important to intensify efforts to keep up with the project schedule in order to achieve tangible results, since this year is the interim evaluation year for the project. He said that it would be essential for all members as a whole to focus on meeting their objectives.

Project Leader Atsushi Yusa



Poster presentations

There were 44 reports given on the previous fiscal year's R&D achievements in poster format. For poster presentations on achievements in the current fiscal year, individual researchers were allotted one minute each to promote their own presentations. The summaries of achievements were well received and had great bearing on the subsequent announcement of presentation results. Individual researchers used their allotted time to give presentations with their posters, hoping to receive the Best Poster Award, and the session included many valuable discussions. After all poster presentations were given, Sub Project Leader Hiroyuki Fujita gave feedback on the presentations. Following a break for dinner, discussions on the individual research topics were held, continuing until late in the night.

The second day's session on June 16 featured group discussions, a technical committee meeting, reports on the results of the group discussions, oral presentations, and a ceremony to present the Best Poster Award and the Outstanding Poster Awards.

The Annual Meeting

Sub Project Leader Hiroyuki Fujita

In the group discussions, the researchers from each BEANS research center were divided into four groups containing a mixture of attendees from industry, government, and academia. Groups were asked how the R&D currently engaged by the BEANS Project would contribute to our lifestyles ten years from now and how this R&D could be tied to the development of innovative devices.

The technical committee meeting was held concurrently with the group discussions. The committee meeting featured an exchange of information with representatives of member companies participating in the project, reports on the FY 2009 achievements presented by the directors of each BEANS research center, and two technical speeches given by Professor Yasuyuki Sakai of the University of Tokyo and Professor Nobuyuki Moronuki of Tokyo Metropolitan University.

Thereafter, the results of the group discussions were presented to all participants, with many members of the audience also offering their views on our lifestyles ten years from now.

The oral presentations featured outstanding research presentations by the following researchers recommended by the center directors. Each presentation was followed by a spirited question-and-answer session.

Life BEANS Center	Hideaki Shibata
Life BEANS Center Kyushu	Kentaro Harada
3D BEANS Center	Osamu Nukaga
Macro BEANS Center	Takaaki Murakami

In addition to the above researchers, the following individuals were awarded prizes for outstanding poster at the awards ceremony. The award certificates were presented by Project Leader Yusa.

Best Poster Award	Nobuhiko Kojima
Outstanding Poster Awards	Yukiko Tsuda, Takeshi Kobayashi, Yuichiro Shimada, and Yongfang Li

The Annual Meeting concluded with an overall summary and review by Keiichi Aoyagi, Director for R&D Coordination of the BEANS Laboratory.

Technical committee meeting

Group discussions

Activities of the G-device Project

Owing to a supplementary budget in FY 2009, a new research task entitled "Advanced sensor network system and environmentally friendly fabrication processes" was newly added to the New Energy and Industrial Technology Development Organization (NEDO)-sponsored "Hetero-functional Integrated Device Technology Development Project (BEANS Project)." Nicknamed the "G-device Project," this research task is a short, one-year intensive project that was officially launched in April this year.

An advanced 8-inch MEMS production line is to be installed at the Tsukuba Innovation Arena (TIA) in the Tsukuba Center of the National Institute of Advanced Science and Technology as a testing ground, and a sophisticated network system configured of MEMS sensors will be used to resolve pressing issues that must be overcome to achieve green innovation. Here, green innovation is an approach for reducing energy consumption in clean rooms used in semiconductor and MEMS processes, improving energy efficiency in the processes themselves, and preserving the environment. This approach includes studying the feasibility of sensor devices as means for verifying various achievements in the BEANS Project and assessing the characteristics and configuration of the 8-inch production line. Hence, six new businesses, making a total of fifteen, the National Institute of Advanced Science and Technology (AIST) serving as the core of the development centers, and Ritsumeikan University serving as the Kansai base have been newly added to the BEANS Laboratory, bringing the total number of organizations in the project to eighteen when the Micromachine Center (MMC) is included.

The G-device Project was officially launched at the MMC's Techno Salon in Akihabara on April 8 at 2 p.m., where participating members and researchers gathered with guests from the Ministry of Economy, Trade and Industry (METI) and NEDO. Following greetings and words of encouragement from Tomosaburo Yano, Director for R&D Coordination at METI, and Katsuya Okano, Senior Official at NEDO, BEANS Project Leader Atsushi Yusa presented the objectives of the G-device Project within the overall framework of the BEANS Project. Ryutaro Maeda, President of the G-device Cooperative, enthusiastically laid out the approach and ambitions of the project and vowed that all members would attain their research goals.

While the construction of an advanced 8-inch MEMS production line is an important item for tackling the R&D in this project, it is also a major investment. In order to ensure that equipment was selected prudently, a public meeting was held on May 14 to provide information on the required equipment. More than sixty representatives of companies in Japan that handle MEMS manufacturing equipment were present at the meeting. The attendees were given a summary of the more-than-forty types of equipment needed and a description of the bidding process and responded with numerous questions.

After receiving a good number of bids, an impartial selection committee meeting was held, and most of the sources for our equipment orders have been determined as of today. Company names are listed on the BEANS Laboratory Web site. We are currently ordering the equipment as needed and intend to begin installing the equipment according to the original plans (around the end of October).

We are also making steady progress on our R&D efforts. The president of the G-device Cooperative and the respective directors of the G-device Center based at AIST Tsukuba and the G-device Center Kansai based at Ritsumeikan University are participating in monthly meetings to discuss the progress and challenges of R&D projects at the respective centers. The meetings have produced lively discussions on various problematic points and necessary changes in approach. To date, we have held two meetings, both of which have been attended by NEDO representatives.

Although the G-device Project has just gotten underway, it is our intention to continue with these lively discussions and to proceed with an aggressive approach in order to ensure that the president and center directors can perform timely and appropriate development management for producing the targeted results within the allotted one-year period.

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Keiichi Aoyagi, Executive Director, Micromachine Center (MMC)
MBR99 Bldg., 6F., 67 Kanda Sakumagashi, Chiyoda-ku, Tokyo 101-0026, Japan
Tel : +81-3-5835-1870, Fax : +81-3-5835-1873
Internet Home Page http://www.mmc.or.jp/
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