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Topic

Micro/Nano 2009

The 20th Exhibition Micromachine / MEMS

The world's largest international exhibition on MEMS, ultraprecision machining and micromachining, nanotechnology, and biotechnology

Date: July 29–31, 2009 (Wed–Fri)

Venue: Tokyo Big Sight (Tokyo International Exhibition Center), East Hall 5

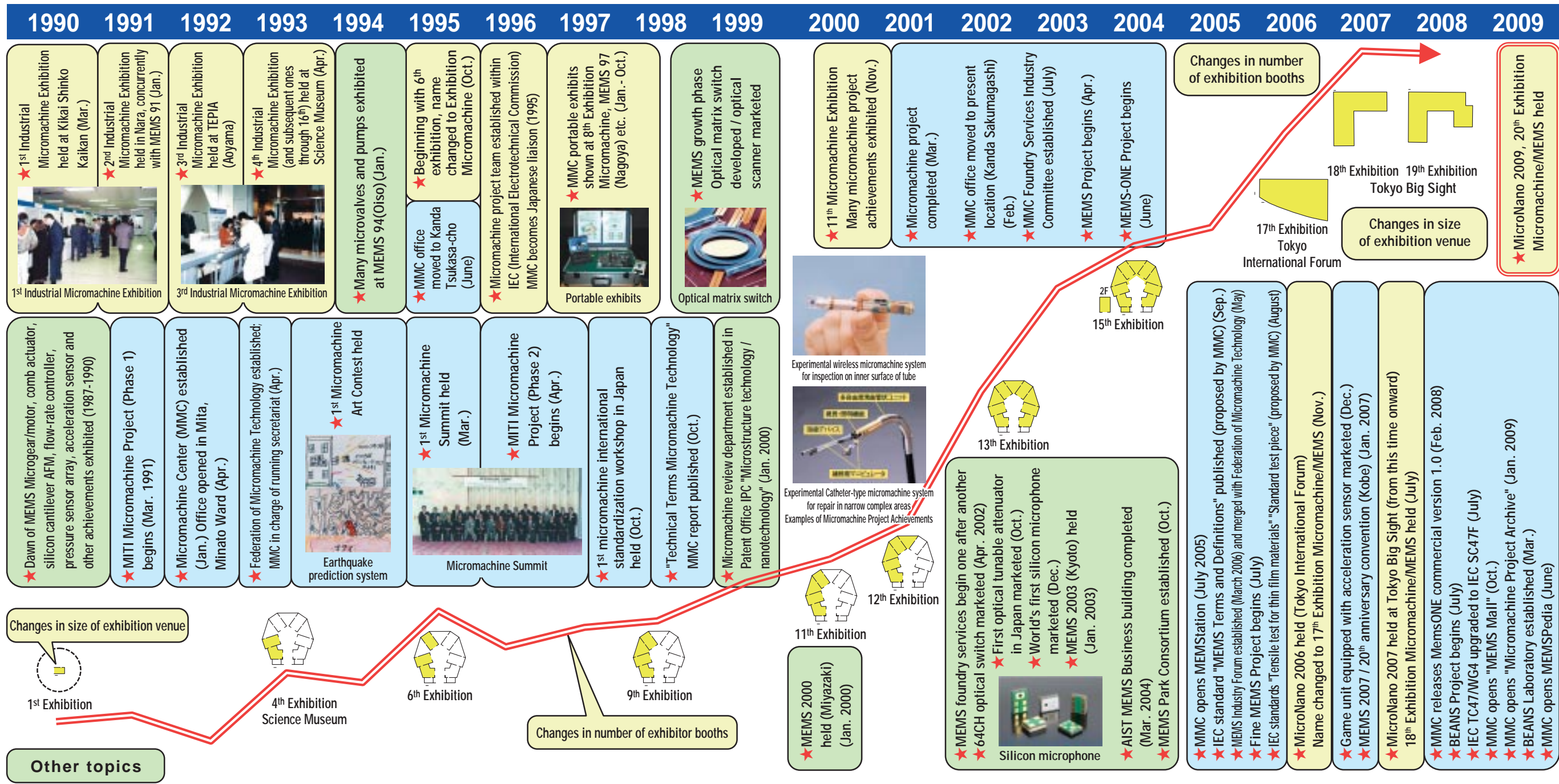
Sponsored by the Micromachine Center, Micro/Nano 2009 is a comprehensive event that brings together all the latest technology and products in the micro/nano and MEMS-related fields at one venue. Micro/Nano 2009 will be held at Tokyo Big Sight for three days on July 29–31, 2009 (Wed–Fri). Since this year marks the 20th holding of the Exhibition Micromachine/ MEMS, we have prepared a special exhibit that visually showcases developments in the micro/nano and MEMS industries, and a diverse schedule of events to be held concurrently in two special conference areas set up at the venue.



Schedule of Concurrent Events (No admission fee)

- 7/29 ■ **The 15th International Micromachine/Nanotech Symposium ~MEMS World~ (Conference area A)**
Breakthroughs in the industrialization of MEMS and nanodevices achieved through integration and convergence: experts from Japan and abroad will present the latest information on an intensification of R&D activities and promising MEMS applications.
- **The Workshop on Industry-Academia Collaboration (Conference area B, morning)**
Academic and public research affiliates of the MEMS industry forum will present their latest research findings on micromachines and MEMS together with exhibits at the 20th Exhibition Micromachine/MEMS.
- **MEMS Packaging Forum (Conference area B, afternoon)**
An event that is new to Micro/Nano 2009, this seminar will focus on MEMS packaging, which is an area being closely watched in the industry today.
- 7/30 ■ **Japanese-German Micro/Nano Business Forum (Conference area A)**
Organized by Germany's IVAM Microtechnology Network in cooperation with the MMC, this forum provides a good opportunity for the mostly Europe-based member companies of IVAM to showcase their products and technologies and to make business contacts with Japanese companies.
- **The Workshop on Industry-Academia Collaboration (Conference area B, morning)**
- **BEANS Project Seminar (Conference area B, afternoon)**
This seminar will provide an overview of Process Integration Project for Hetero-Functional Integrated Devices (the BEANS Project), a five-year project initiated in 2008, and to discuss the prospects of core process technologies required for creating the innovative next-generation devices targeted by the BEANS Project.
- 7/31 ■ **MEMS Industry Forum (Conference area A)**
This forum provides an opportunity for members and guests to exchange ideas and distribute information. The forum presents the latest activities of the MIF and the state of regional efforts by affiliated local clusters and public research institutes to strengthen the infrastructure of the MEMS industry.
- **Presentation of results from the Fine MEMS Project (Conference area B)**
This event summarizes the research findings of the three-year NEDO project entitled the Highly Integrated, Complex MEMS Production Technology Development Project (or the Fine MEMS Project), which concluded in 2008.

From Industrial Micromachine Exhibition to Exhibition Micromachine/MEMS: Celebrating 20 Years



1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009																				
Reunification of Germany (Oct.)	Mr. Akiyama becomes Japan's first astronaut (Dec.)	Gulf War begins (Jan.)	Carbon nanotubes discovered (June)	Rio Summit held (June)	Astronaut Mohri boards space shuttle (Sep.)	J-League founded (May)	Japan's first Internet service begins (July)	Website for prime minister's office established (Aug.)	Nobel Prize for literature awarded to Mr. Oe (Oct.)	Great Hanshin-Awaji Earthquake (Jan.)	"Windows 95" released (Nov.)	"Dolly", world's first cloned sheep, born (July)	"O157" infection / mass outbreak of food poisoning (July)	"Tamagocchi" and "Pokemon" become popular (Apr.)	COP3 Kyoto Protocol adopted (Dec.)	Winter Olympics held in Nagano (Feb.)	Google, Inc. established (Sep.)	Euro (EU currency integration) (Jan.)	"Aibo" domestic robot marketed (June)	Nobel Prize for Chemistry awarded to Prof. Shirakawa (Oct.)	BS digital broadcasting begins (Dec.)	9/11 attacks in U. S. (Sep.)	Nobel Prize for Physics awarded to Prof. Noyori (Oct.)	World Cup held in Japan and South Korea (May)	Nobel Prize awarded to Prof. Koshida and Mr. Tanaka (Sep.)	Human genome project completed (Apr.)	Terrestrial digital broadcasting begins (Dec.)	Teito Rapid Transit Authority privatized (Apr.)	Chuetsu Earthquake (Niigata Prefecture) (Oct.)	Aichi Expo held (Mar.)	Earthquake-resistant strength deception discovered (Nov.)	One-segment broadcasting begins (Aug.)	Pluto downgraded from planet to dwarf planet (Aug.)	Many occurrences of deceptive food relabeling discovered (Aug.)	Postal services privatized (Oct.)	Worldwide financial crisis (Sep.)	Nobel Prize awarded to Prof. Nambu and two others (Oct.)	Obama J.D. inaugurated as U. S. President (Jan.)	H1N1 Influenza virus pandemic (Apr.)

Overview of the Micromachine Center Booth and BEANS Laboratory Booth

1. Micromachine Center Booth

(1) Special 20th Anniversary Booth

This year, to commemorate the 20th anniversary of Exhibition Micromachine/MEMS, the Micromachine Center will provide a special booth that introduces major topics and reviews the history of the event, showing how it grew from the initial "Industrial Micromachine Exhibition" to become Micro/Nano 2009, one of the world's major integrated events in this field.

(2) MEMSOne Booth

This marks the second year since full-fledged MemsONE dissemination activities began. In February of this year, version 2.0 was released, with improved analysis capabilities, ease of operation and stability.

To encourage dissemination, a special corner will be set up at this exhibition for consultations, and a version with a limited number of licenses will be provided at no charge. Detailed information will also be provided through video screenings, demonstrations and so on.

(3) MEMS Mall Booth

This booth will offer exhibits relating to MEMS Mall, which makes MEMS products and technologies available on the Internet. MEMS Mall opened in October of last year with the participation of the member companies of the MEMS Industry Forum, and starting this April participation was opened to other companies for a fee (with companies exhibiting at Exhibition Micromachine/MEMS given preferential status). The booth features panels showing the products and services offered by MEMS Mall as well as participating companies and methods. There are also computers that visitors can use to visit the mall.

(4) MEMS Foundry Network Booth

This booth provides information about the MEMS Foundry Network that is made up of MEMS Industry Forum member companies. It also features MEMStation, a help desk for submitting items for prototyping. MEMStation makes it easy for even users who do not have manufacturing equipment to conduct MEMS manufacturing.

(5) 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 Micromachine Center has established a roadmap for MEMS standardization, and standardization activities are being conducted in accordance with this roadmap. The booth showcases the MEMS nomenclature and definitions that have been proposed and established, tensile test methods for MEMS thin membrane materials, standard test specimens for tensile tests, and fatigue test methods for MEMS thin film materials, in addition to international draft standards that are currently being reviewed or are under development.

2. BEANS Booth

One year has passed since Process Integration Project for Hetero-Functional Integrated Devices (BEANS Project) was launched in July of last year. This exhibition marks the full-fledged debut of the BEANS Project at a public venue attended by interested parties in the MEMS area from Japan and other

countries. The booth is sponsored jointly by the BEANS Laboratory and the New Energy and Industrial Technology Development Organization (NEDO).

The exhibition will be significant as a venue for unveiling the achievements of BEANS Project activities during the past year. More importantly, it is an opportunity to promote widespread awareness of the BEANS Project itself and give visitors a sense of the dedicated enthusiasm of the participating researchers. The content of the exhibits will reflect both of these objectives.

The green booth will have zone partitions decorated with the "beans" that are the project's symbol. In addition, the booth will be enclosed by five green message stands that present a general overview of the BEANS Project. The side of the message stands that faces the passageway will present an overview of BEANS headquarters, while the other (inner) side will provide personal profiles of the researchers involved in the project and the positioning of the individual research centers in Kyushu, Shiga, Tsukuba and Komaba.

The inner walls of the booth will be dedicated to posters and exhibits with particular emphasis on promoting and outlining the research efforts of the individual centers: Life BEANS, Life BEANS Kyushu, 3D BEANS, 3D BEANS Shiga and Macro BEANS.

The main attraction of the booth will be the various exhibits placed in the very center of the space so as to enable many visitors to gather around them for viewing. These exhibits will present the technical details of microfabrication processes that are difficult to explain using only posters and the like. They will also include biotech exhibits that are expected to attract many visitors as a result of TV and newspaper coverage in January and June of this year, and exhibits relating to large-area film deposition and fibrous nanostructures that were covered in the July edition of Nikkei Microdevices. The loom for laboratory use that is also scheduled to be exhibited is sure to be seen as a breath of fresh air by those in the MEMS industry.

The essential mission of the BEANS Project is to develop the manufacturing process technologies that will lead to the achievement of next-generation devices, and so the actual work that researchers are engaged in day and night is fundamental process development that is by no means glamorous. For this reason, it is not the essential purpose of the project to introduce exciting futuristic devices, and unavoidably the content tends to consist of unglamorous posters explaining technical processes. However, nothing will be gained if visitors do not come to see the exhibition, so we focused our efforts on presenting in visible form those process development efforts that are extremely important but essentially difficult to view. Visitors are invited to come and see for themselves whether our efforts were in vain or (hopefully) we succeeded beyond our wildest dreams.

In conjunction with the exhibit content, the 3rd BEANS Project Seminar will also be held during the afternoon of July 30 at a special venue set up next to the booth. As this will be first seminar to give a full picture of the BEANS Project, we hope that all interested parties will attend.

Activities of the Micromachine Center in FY 2008

Overview

The Micromachine Center (MMC) is actively engaged in technical development projects commissioned by the government and the New Energy and Industrial Technology Development Organization (NEDO) in an effort to establish core technologies for micromachines, Micro Electro Mechanical Systems (MEMS), and other micro/nano-related fields. At the same time, in order to promote widespread use and industrialization of these core technologies, the MMC aggressively pursues activities to improve the environment for micro/nano technologies. These activities include policy recommendations, industrial exchange and vitalization, investigative research, activities to promote standardization and to encourage dissemination and publicity projects designed to promote industrial development in micro/nano fields and to contribute to the international community.

The following is an outline of the projects that the MMC conducted in 2008.

1. National / NEDO Projects

(1) Highly Integrated and Complex MEMS Manufacturing Technology Development Project (The Fine MEMS Project)

2008 marked the final year of the Highly Integrated, Complex MEMS Production Technology Development Project, more commonly referred to as the Fine MEMS Project, which was a three-year undertaking initiated in 2006. This project concluded after having achieved its original goals satisfactorily.

The Fine MEMS Project ultimately succeeded in compiling a knowledge database with more than 1,500 items of content, which will be made available on the Internet in a Wiki format. Research findings for the fine MEMS integrated design platform were stored in a Web-based system dubbed an equivalent circuit generator, which has built-in functions for linking equivalent circuit models for MEMS and the like and for outputting the electrical and mechanical properties of the models.

(2) The Project to Develop Next-generation Device Manufacturing Technologies that Fuse Different Fields (The BEANS Project) (Commissioned by METI)

The BEANS Laboratory was newly established as a centralized research framework for the Project to Develop Next-Generation Device Manufacturing Technologies that Use Different Fields (commonly referred to as the BEANS Project) initiated on July 1, 2008. The BEANS Laboratory has worked to introduce project management driven by the private sector, to coordinate R&D activities for the inaugural year, and to install research equipment. In 2008, seventeen companies, eleven universities, and two research centers participated in the BEANS project.

(3) Promotion and Dissemination of MemsONE

In an independent project, the MMC has been working with the MEMS Industry Forum to aggressively promote and disseminate the MemsONE software, which was the product of research and development in the MEMS Open Network Engineering System of Design Tools project. We also worked with the software vendor to update the software, which is the basis of our dissemination activities. Hence, Version 1.1 produced at the end of the project was improved and enhanced and released as the more complete Version 2.0, which has more powerful functions and greater stability.

2. MEMS Industry Forum Projects (for Policy Recommendations and Industrial Exchange and Vitalization)

The MEMS Industry Forum (MIF) was established in April 2006 as a special project committee with the goal of supporting the further development of MEMS industries. Membership in the MIF increases each year, spurring more and more activity. In 2008 the MIF continued to promote activities centered on its MEMS-related member companies in collaboration with affiliated academies, regional centers, and overseas institutions, including various activities for proposing policies to the government and related agencies (e.g. encouraging the exchange of ideas between MIF members and the government and related agencies at MIF promotion committees),

encouraging industrial exchange and vitalization (e.g., informal gatherings on advanced micro/nano technologies), implementing MEMS training programs to develop personnel knowledgeable in MEMS development, and encouraging information exchange among businesses in MEMS and other industries (e.g., the MEMS Mall launched October 1, 2008).

3. Investigative Research and Data Collection and Provision

We also investigated new issues on micro/nano technologies that arise when merging nanotechnology with technologies in other fields.

The MMC is also collecting information and documents related to micro/nano technologies from universities, industrial circles, public organizations, and other sources in Japan and overseas, which documentation will be consolidated with documentation from surveys conducted at the MMC. We periodically issue the *Micro/Nano* Index, an informational publication including abstracts of technical documents and materials. The collection of technical documents and materials has been organized and stored in the MMC archives, where they have been made available for browsing and searching.

4. Standardization Activities

In 2008 we demonstrated initiative on the international stage by promoting standardization in the micromachines and MEMS fields. These activities included examining standard certification criteria for proposing international standards, following up on a proposal of standards for fatigue testing of thin film materials, conducting an investigative study on overseas standards, and pursuing the adoption of a tensile test method for thin film material as a JIS.

5. Dissemination and Publicity Activities

In 2008 the MMC continued to provide information internally and externally through its Web site, publish and distribute newsletters, hold exhibitions, and otherwise disseminate information on micromachines and MEMS to educate the public and publicize the MMC's activities. This year also featured the 19th Exhibition Micromachine/MEMS, a three-day event held at Tokyo Big Sight from July 30 to August 1, 2008 as part of Micro/Nano 2008. Over these three days, the exhibition received a total of 14,075 visitors, which was nearly a 12% increase over the previous year (12,424) and a record high for the event.



19th Exhibition Micromachine/MEMS



MEMS Industry Forum (May 2008)

Research and Standardization Activities

MEMS international standardization was reviewed at an IEC/SC47F meeting held June 17 and 18 at Jeju in Korea, where three of the Unesco World Heritage sites are located. In coordination with this meeting, the 5th Japan-Korea-China MEMS Standardization Workshop was held on June 19. This workshop is held to promote cooperation and the exchange of information relating to MEMS standardization on the part of Japan, Korea and China. The first workshop was held in 2005 in Tokyo, and each year the venue alternates among the three countries. The following is an overview of this year's workshop.

1. IEC SC47F / WG1 meeting

Following email review and agreement by specialists regarding some of the technical issues, it was agreed that the "RF-MEMS Switch" "FBAR Filter" "Tensile Properties Test Method by Means of Bending" and "Wafer-to-wafer Bonding Strength Test Method" proposed by Korea would be promoted from the Committee Draft (CD) stage to the Committee Draft for Vote (CDV) stage. The response to comments from the other countries regarding the "Fatigue Test Method Using Resonant Vibration" that had been proposed by Japan and approved as a New Work Item Proposal (NP) was accepted, and a CD will be prepared in accordance with this response. The "Micropillar Compression Test Method" and "Coefficient of Thermal Expansion Test Method" proposed by Korea did not attract sufficient project participant countries and were not approved as NPs. Although the proposals were rejected this time, they will be resubmitted, and China is expected to become a project participant next time, resulting in project approval.



2. 5th Japan-Korea-China MEMS Standardization Workshop

The first half of this workshop was devoted to presentations by representatives from Japan, Korea and China on the latest news and roadmaps relating to MEMS standardization in each country. The second half of the workshop was devoted to the following MEMS research presentations.

(1) Professor Ohwada of Teikyo University gave a presentation on an electronic compass that is currently under development. This electronic compass is made up of biaxial and triaxial magnetic sensors and an acceleration sensor that detects the inclination of the compass. The use of MEMS technology

in its manufacture enabled miniaturization of the device. Issues to be considered with regard to compass performance include the inclination of the device and correction of the disturbances caused by external magnetic fields.



(2) Professor Isono of Kobe University gave a presentation entitled "Scanning Probe??? Parallel Nanolithography for NEMS Fabrication Using MEMS Cantilever Array," relating to nanoscale patterning and processing using a cantilever array. Applying bias voltage with an AFM cantilever during scanning makes it possible to process 50 nm linewidths during anodic oxidation, self-assembled monolayer patterning and EB resist processing.



(3) Professor Ya-pu Zhao of the Chinese Academy of Science gave a presentation entitled "Electrowetting on a Lotus Leaf (EWOL)." Electrowetting is the process of changing the angle of contact by applying voltage. This process is expected to find applications in fluid variable-focus lenses (Philips) and monitors (e-ink) (Liquavista).

(4) Yong-Hak Huh of the Korea Research Institute of Standards and Science (KRISS) gave a presentation on a bulge test method using application of hydraulic pressure, measurement of displacement using a laser interferometer (electronic speckle pattern interferometry or ESPI), application of gas pressure, and detection of displacement using capacitance. He also discussed parameters that will be important for standardization.

(5) Dr. Hojun Ryu of the Electronics and Telecommunications Research Institute (ETRI) gave a presentation on an uncooled infrared sensor (bolometer) and said that standardization of this infrared sensor would also be pursued.

At this workshop, China also announced that it had established a domestic organization for MEMS standardization, and specifically that it will propose, as an NP, a draft standard for defining and measuring geometrical shapes. There is great anticipation with regard to the start of concrete action by China. While the vibrant activity in MEMS standardization is a welcome development, duplication and competition have occurred in the draft standards proposed by the individual countries, making cooperation and coordination by Japan, Korea and China all the more essential.

Activities of the MEMS System Development Center

Initial Release of MEMSPedia Developed in the Fine MEMS Project

The Highly Integrated, Complex MEMS Production Technology Development Project (2006–2008) commissioned and subsidized by NEDO produced significant achievements before coming to a conclusion last year. In this project, commonly referred to as the Fine MEMS Project, the Micromachine Center (MMC) compiled a knowledge database on fine MEMS and developed a fine MEMS integrated design platform aimed at increasing the support and expanding the base of researchers and engineers involved in the development and manufacturing of advanced MEMS. Both the fine MEMS knowledge database and the MEMS equivalent circuit generator developed in this project were made available on the MMC's Web site on June 8 of this year as MEMSPedia.

By the end of March 2009, the MEMS System Development Center had compiled more than 1,500 items of data in the fine MEMS knowledge database from such sources as R&D findings (research data, scientific knowledge, and documentation) of participants (commissioned and grant-funded) in the fine MEMS project, R&D findings from re-commissioned university studies, and presented papers and technical literature collected by the MMC at academic conferences in Japan and overseas.

The Center also reviewed Japanese unexamined patent applications, patents registered in the U.S., and PCT applications as far back as the year 2000 and entered patent information related to this project in the database.

The MEMS equivalent circuit generator is a design tool capable of presenting MEMS devices and electronic circuits in the form of equivalent circuit models. There has been an increase in R&D activity on the integration of MEMS and electric circuits and on integration through combinations of different types of MEMS. As more successful products emerge through this research, the MEMS equivalent circuit generator will provide a new design tool capable of assisting MEMS and electronics engineers in designing devices.

Research and development on the fine MEMS integrated design platform conducted between 2007 and 2008 produced a Web library of MEMS equivalent circuits that stores integrated circuit models for various devices studied in the project, and netlists that can be used in a circuit simulator.

We have made these tools available on the Internet as an encyclopedia that includes knowledge data, design support tools, and a variety of open content in the hope of effectively disseminating this knowledge while encouraging others to expand the information. We hope you will use MEMSPedia.



MEMSPedia: fine MEMS knowledge database



MEMSPedia: MEMS equivalent circuit generator

MEMS Industry Forum Activities

The MEMS Industry Forum (MIF) was established to help strengthen the international competitiveness of the MEMS industry in Japan. Members are primarily companies in areas related to the MEMS industry. The MIF promotes various activities in cooperation with affiliated academies, regional centers, overseas institutions and so on.

1. Planning of Fiscal Year 2009

Under control of the MIF Executive Committee, three special committees (Industrial Networking Committee, Foundry Service Industry Committee and International Networking Committee) have been established to implement specific project activities. From May through June, the MIF Executive Committee and the three special committees held their first committee meetings and finalized their activity schedules for the fiscal year.

At the MIF Executive Committee meeting held on June 12, the overall schedule of activities for the current fiscal year was approved. The main components of this fiscal year's activities include the following:

1. Continue the ongoing survey of industry trends with increased depth of focus
2. Study how the Nanotech Arena concept (being promoted primarily by the Ministry of Economy, Trade and Industry) could be employed by the MIF
3. Support personnel training activities being implemented in regional areas and begin the process of organizing these activities as an ongoing effort
4. Intensify efforts to disseminate the achievements of past projects such as MemsONE
5. Prioritize international networking activities in the midst of the tight budgetary environment

The three special committee activity schedules were finalized in accordance with this overall activity schedule and implementation of the projects for the fiscal year has begun.



1st MIF Executive Committee Meeting

2. MMC Survey of MEMS Industry Trends

A report was compiled that added a relevant study conducted by the MMC Industrial Trends Research Committee to the "Survey of Domestic and International Technology Trends for the Formulation of Strategies in the MEMS Field" compiled last year at the request of the New Energy and

Industrial Technology Development Organization (NEDO).

This study was conducted to study and analyze MEMS industry trends and to determine how devices, application equipment etc. using MEMS technologies should be deployed, as well as ways to achieve market expansion.

The main content of the study includes the following:

- Industry trends as seen by the papers presented at international conferences and the patent applications that have been filed
- Analysis of individual application fields in order to determine application trends
- Analysis of the current status of players in the MEMS field in order to determine trends at MEMS-related companies

The study provides basic data on the overall industry as well as information on strategy formulation by individual companies. In the near future, the study will be made available on the MIF Supporting Member page.

3. International Networking Activities (Hanover Messe, Micromachine Summit, LETI Workshop)

As international Networking activities, the MIF engages in business-related and academic international interchanges that include sponsoring international symposiums and dispatching overseas study missions.

So far during this fiscal year, the MIF has exhibited products and presented papers at the Hanover Messe (in Hanover, Germany) held April 21 - 25, and presented papers and participated in interchange activities at the MMC/LETI Workshop held June 11 - 12 in Grenoble, France. Attendance by Japan at the Micromachine Summit held May 5 - 8 in Edmonton, Canada was canceled due to the H1N1 influenza outbreak.

The MMC/LETI Workshop was held to provide a venue for the presentation of MEMS-related papers and to study ways to enhance cooperation with LETI/MINATEC, an MIF overseas affiliate and one of the centers for device research in Europe. Japanese universities and companies participated in the workshop in addition to representatives from the Ministry of Economy, Trade and Industry and NEDO. The workshop and related facility visits provided valuable stimulation with regard to future projects, research activities and policy research.



Workshop participants from Japan in front of LETI/MINATEC (Grenoble, France)

Dissemination and Publicity Projects

This session focused on the latest dissemination and publicity activities conducted by the Micromachine Center and the Beans Laboratory.

1. Meeting of the Dissemination and Publicity Committee

The first meeting of the Dissemination and Publicity Committee for FY 2009 was held on June 3. The committee reviewed the dissemination and publicity activities of the Micromachine Center for the current fiscal year and approved the schedule of activities.

The Center's Commercialization and Public Relations Department also makes information available on its Web site to in an effort to publicize the achievements of national projects and stimulate MEMS industries.

2. Information-providing Activities

(1) Publication of Quarterly Magazine "MICRONANO"

Beginning this fiscal year, MICRONANO is being published jointly under the name of both the Micromachine Center and the BEANS Laboratory. Each issue covers the status and achievements of project activities as well as upcoming projects and events.

- Japanese edition (MICRONANO)

Published quarterly and distributed in print form as well as in electronic form on the Center's Web site

- English edition (MICRONANO) (English translation of Japanese magazine)

Published quarterly in electronic form on the Center's Web site

(2) MMC-MIF-BEANS Monthly

Starting this fiscal year, MMC-MIF-BEANS Monthly is being published jointly by the Micromachine Center and the BEANS Laboratory. The monthly newsletter covers the status of activities, policy trends, information on upcoming events and so on.

(3) MicroNano Net

This occasional bulletin is published via mailing list and sent to supporting members of the Micromachine Center, MEMS Industry Forum members and so on. It provides information on MicroNano-related industry-academic joint activities and upcoming events.

(4) MEMS Mall

Since April 2009, not only MEMS Industry Forum members but also general companies have been able to list products and technologies on the MEMS Mall. Access has been expanded in this manner in order to invite participation from more MEMS-

related companies and make the MEMS Mall a portal site for MEMS business.

(5) News Blog

A Blog entitled "MEMS Wave @ Micromachine Center" has been started on the Micromachine Center Web site to provide quick updates on the latest activities of the Micromachine Center. Please feel free to visit to the Blog.

URL : <http://beanspj.cocolog-nifty.com/mems/>

3. Dissemination of Domestic Project Achievements

(1) MEMS-ONE Project

The MemsONE Support Center has taken the lead in holding training sessions and technology exchange seminars and so on to promote dissemination of the design tool "MemsONE[®]" achieved by the MEMS Open Network Engineering System of Design Tools (MEMS-ONE) Development Project (FY 2004 - 2006).

(2) Fine MEMS Project

(MEMS System Development Center)

The Fine MEMS knowledge database and the MEMS equivalent circuit generator achieved as a result of the Highly Integrated Complex MEMS (Fine MEMS) Production Technology Development Project (FY 2006 - 2008) have been made available in the form of the "MEMSPedia" Web content on the Micromachine Center's Web site.

(3) BEANS Project (BEANS Laboratory)

Starting in FY 2009, the BEANS Laboratory became the implementing entity for the BEANS Project (FY 2008 - 2012). Accordingly, the Micromachine Center is participating in the BEANS Project as a member, providing appropriate personnel and financial support to ensure the success of the project.

(4) Other Activities

① Micromachine Technology Project

The MMPJ Archive has been made available on the Micromachine Center's Web site. The MMPJ Archive organizes the achievements of the Micromachine Technology Research and Development Project (FY 1991 - 2000) in Web contents, enabling information to be retrieved as needed.

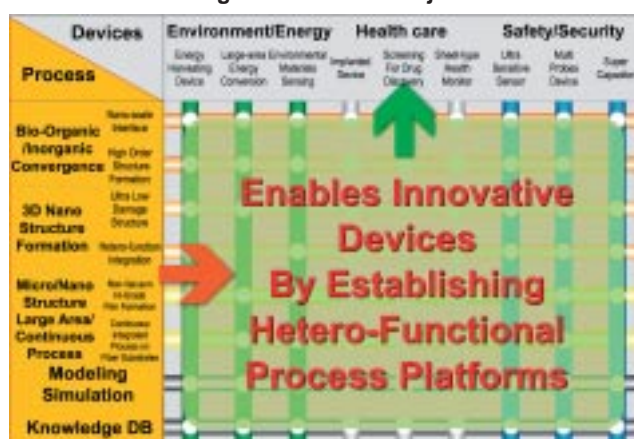
② Study Report Data Service (Research and Standardization Department)

The Information Service Activities page of the Micromachine Center's Web site contains a list of research reports published in 1997 and thereafter, and also provides these reports at cost.

Goals of the BEANS Project

One goal of the BEANS Project is to establish integrated micro/nano manufacturing technologies that combine the top-down approach of micromachining with the bottom-up approach of nano/bio processes, the objective being to produce innovative devices that will revolutionize our lives in such areas as the environment and energy, medical care and welfare, and safety and security. Specifically, we are attempting to merge science and engineering while fusing dissimilar fields such as MEMS and nano/bioengineering. Another goal of the project is to develop a set of new core process technologies (BEANS processes) required to create innovative next-generation devices (BEANS) and to establish these core process technologies as the BEANS platform.

Target of BEANS Project



Below is a description of the goals we hope to achieve upon completion of the project based on the R&D tasks set forth in the basic project plan, and the rippling effect these achievements will have on industry.

1. Bio Integration Processes

- To conduct R&D on processes for forming biomaterials, such as hydrogels and artificial lipid bilayers, having long-term stability. The purpose of this R&D is to establish processes for forming artificial lipid bilayers that are capable of performing biomolecular measurements with great sensitivity and can remain stable for at least one day in biocompatible materials, such as hydrogel and microfluidic devices capable of functioning continuously in the body for at least three months.
- To produce advanced functions by constructing artificial cells and artificial tissues. This will be achieved by establishing process technologies for producing bead capsules using a microbead technique, synthesizing peptides for cell adhesion, and assembling 3D structures of micro-organs and cells for expressing and preserving biofunctions.

2. Organic Material Integration Processes

- To conduct R&D on producing high-performance organic photovoltaic devices. Through this R&D, we hope to establish processes for forming self-assembled nanostructures, such as organic molecular nanopillars spaced at the sub-200-nm carrier diffusion length of the organic semiconductor, organic molecular nanoporous structures with uniform sub-100 nm pores, and mesh or linear structures having a sub-100 nm line-and-space (L/S) pattern. Basic functions such as the conversion rate will be verified based on the envisioned design.

3. 3D Nanostructure Formation Processes

- To produce damage-free 3D nanostructures (nanosize holes with an aspect ratio of 100 or greater) in the etching surface with atomic layer control by developing ultra-low-damage neutral beam etching for use on glass, compound semiconductors, and organic semiconductor material in addition to silicon. Combining this technology with femtosecond laser modification will give us a processing technology for forming complex 3D nanostructures with a precisely controlled isotropic/anisotropic nature to suit the device structure.
- To establish coating and deposition techniques for preventing microstructures from sticking to one another due to interfacial tension, using supercritical carbon dioxide fluid to transport raw material deep into the 3D nanostructure. This technique will also be expanded to embed metal, oxide film, block polymers, and other materials in microtrenches and microholes of 3D nanostructures (nanosize holes with an aspect ratio of 100 or greater) with no gaps. The feasibility of these 3D nanostructure processes will be verified based on envisioned devices.

4. Micro/Nanostructure Large-Area Continuous Manufacturing Processes

- To develop process technologies capable of forming functional films with electronic functions having an electron mobility of 1 cm²/V-sec or greater and thin films with mechanical functions constructing micro/nano structures while achieving a practical deposition rate using non-vacuum deposition processes such as coating or self-assembly processes.
- To establish a process technology capable of forming the above high-level functional film over a meter-scale large-area substrate by scanning the substrate to deposit a uniform film thickness within ± 10%, with a patterning resolution no greater than 200 μm and a processing time no greater than that of current vacuum devices.
- To develop processes for forming 3D nanostructures on a fibrous substrate coated with a nanofunctional film at a processing speed of 20 m/min or better, and to develop weaving integration process technologies to create sheet-like devices that function even when deformed three-dimensionally and to verify the functions of flexible sheet-like devices.

In order to apply the achievements acquired above extensively to BEANS manufacturing methods as a platform for processes that fuse different fields, future core processing technologies will be modeled to simulate the processes. We will also create a database with related processing knowledge and expertise to build a design infrastructure for BEANS processes, and will provide licensing for intellectual property rights essential for commercializing BEANS manufacturing techniques in order to remove all obstacles in the patenting process.

In the event that the BEANS Project achieves all of the goals set forth above, BEANS processes will be recognized as a platform for producing innovative devices that can revolutionize the way we live. It is our hope that this platform will contribute extensively to business development and the cultivation of new industries when adopted by companies in diverse industrial fields.

BEANS Project Seminar Report

The BEANS Project Seminar was held for two days on May 19 - 20, 2009 at X Wave Fuchu in Fuchu City, Tokyo Prefecture. The seminar featured invited guests from the Ministry of Economy, Trade and Industry (METI) and the New Energy and Industrial Technology Development Organization (NEDO) and was attended by a total of members. The purpose of the seminar was to report on research and development efforts during the previous fiscal year by researchers in each research area, and to discuss the creation of new technologies through technology fusion between individual centers and the future that will be created by BEANS. Organizers also hoped the seminar would help to improve intra-project cooperation and competitiveness.

The May 19 session featured opening remarks from BEANS Project leader Atsushi Yusa and the presentation of research achievements during the previous fiscal year in poster format, followed by individual discussions in preparation for the group discussions to be held on the following day.

In his opening remarks, BEANS Project Leader Yusa spoke about the purpose, objectives and significance of the seminar, as well as the mission of the BEANS Project members. He also noted the importance of efforts to embody the research vision and scenario in practical form.

Next, 44 research and development achievements for the previous fiscal year were presented in poster form. Individual researchers used their allotted time to give presentations on their posters, hoping to receive the Best Poster Award, and the session included many valuable discussions.



**Opening Remarks
from Project Leader**



Poster Presentation

Following the poster presentations and a break for lunch, discussions to prepare for the group discussions on the following day were held, continuing until late into the night.

The session on the 20th featured the group discussions and a report on their results, an overview of the previous fiscal year's research achievements, oral research presentations and the Best Poster Award and Outstanding Research Award ceremony.

In the group discussions, the attendees were divided into groups containing a mix of researchers from the individual BEANS research centers and from industry, government and academia. Two of these groups debated each of the three discussion topics: Future Development of BEANS Processes, Objectives of the BEANS Project and Integration of BEANS Research Areas. The results of the group discussions were presented in a panel discussion format, with participants presenting the most important and unique views and approaches that came out of the group discussions on the topic. Many members of the audience expressed their views as well.

Summaries of the previous fiscal year's research achievements were also presented by the directors of each of the individual BEANS research centers: Professor Shoji Takeuchi of Life BEANS Center, Professor Chihaya Adachi of Life BEANS Kyushu Center, Professor Masakazu Sugiyama of 3D Beans Center, Professor Masafumi Kimata of 3D BEANS Shiga Center and Mr. Toshihiro Ito of Macro BEANS Center.

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

Life BEANS Center	Yukiko Tsuda
Life BEANS Kyushu Center	Masaya Hirade
3D BEANS Center	Tomohiro Kubota
3D BEANS Shiga Center	Shimpei Ogawa
Macro BEANS Center	Sohei Matsumoto

The awards ceremony acknowledged the achievements of these researchers. In addition, the following persons were awarded the prizes for outstanding poster. The award certificates were presented by Sub-Project Leader Masafumi Kimata.

Best Poster Award	Hideaki Shibata
Outstanding Poster Award	Takeshi Momose, Yoshihiko Watanabe, Makoto Kashiwagi, Shozo Hirata

The conference concluded with an overall summary and review by Sub-Project Leader, Prof. Hiroyuki Fujita.



Group Discussion



Oral Presentation

MicroNano 2009 Concurrent Programs

		15 th International Micromachine Nanotech Symposium ~MEMS World~ Program "MEMS/NEMS evolved by integration and convergence" - Breakthrough for industrialization, Concentration of R&D activities into several major international institutes and Promising applications -	
		Sponsor: Micromachine Center / MEMS Industry Forum Chair: Ryutaro Maeda, Prime Senior Researcher, National Institute of Advanced Industrial Science and Technology	
		Opening	
7/29 (Wednesday)	Special Venue A	10:30—10:35	Opening Remarks Tamotsu Nomakuchi, Micromachine Center
		10:35—10:40	Guest Speech Takeshi Yonemura, Manufacturing Industries Bureau, METI
		Keynote session Concentration of R&D into Major International Institutes	
		10:40—11:10	MEMS in France: the R&D model and vision at LETI / MINATEC Andre Rouzaud, Silicon Heterogeneous Integration Dept. CEA-LETI, MINATEC
		11:10—11:40	Towards micro and nano technologies for integrated systems Thomas Gessner, Prof. Head of Fraunhofer ENAS (Research Institution for Electronic Nano Systems)
		11:40—12:10	Worldwide Growth Opportunities for MEMS: MIG's Perspective on MEMS Activities in the US and Emerging Technologies Karen Lightman, Managing Director, MEMS Industry Group
		Session 1 New World Explored by MEMS	
		13:10—13:40	Animal Watch Sensor System for Human Health and Food Safety Toshihiro Ito, Group Leader, Networked MEMS Technology Group, Advanced Manufacturing Research Institute, National Institute of Advanced Industrial Science and Technology
		13:40—14:10	Silicon Light Modulators: An Enabling Technology Thilo Sandner, Fraunhofer Institute for Photonic Microsystems
		14:10—14:40	Wearable Sensor Technologies for Realizing Safe, Secure and Healthy Societies Kiyoshi Ito, Prof., Tokyo University of Science
14:40—15:10	Harsh Environment Wireless MEMS Sensors for Energy & Power Albert P. Pisano, Prof. and Chair, Department of Mechanical Engineering, UC Berkeley, BSAC		
Session 2 Latest Fabrication Process and Material Corresponding to Development Frontline			
15:20—15:45	Can SOI break the MEMS law? A material supplier's view Markku Tili, Senior Vice President, Research, Okmetic Oyj		
15:45—16:10	Chip to Wafer bonding: The latest technology and future prospective Sunil Wickramanayaka, Director of Technology, Technology Div., EVGroup		
16:10—16:35	Hermetic packaging designs of MEMS: past and future prospective Marco Moraja, Business Manager, Getter for MEMS, SAES Getters S.p.A.		
Closing			
16:35—16:45	Closing Remarks Keiichi Aoyagi, Micromachine Center		
		MEMS Mounting & Packaging Forum	
		Sponsor: Micromachine Center / MEMS Industry Forum Japan Welding Society / Microbonding Study Group	
Special Venue B		13:00—13:10	Opening Remarks Keiichi Aoyagi, Micromachine Center
		13:10—13:50	Progress in MEMS Integration and Hopes for the Creation of New Industries Susumu Sugiyama, Ritsumeikan University
		13:50—14:30	Advances in Electronic Device Mounting and New Trends Kozo Fujimoto, Osaka University
		14:30—14:50	Creation of Functionally Integrated MEMS Through Wafer-level Packaging Masao Kubo, Panasonic Electric Works Co., Ltd.
		14:50—15:10	Development of Heterogeneous Material Multilayer MEMS Integration Technologies Ryo Ota, Olympus Corporation
		15:10—15:30	Development of Low-cost RF-MEMS Variable Capacitors using In-Line WLP (Wafer Level Package) Technology Susumu Obata, Toshiba Corporation
		15:30—15:50	Patterning Technology for Three-dimensional Substrates using Non-linear Lithography Hiroaki Nishiyama, Osaka University
		Sponsor: IVAM Microtechnology Network Cosponsor: Micromachine Center / MEMS Industry Forum	
		Time: 10:30 a.m. — 2:15 p.m.	
		Program: This forum is sponsored by the IVAM Microtechnology Network based in the North Rhine-Westphalia (NRW) province of Germany. It introduces the technologies and products of IVAM member companies (located mainly in Europe) and also provides opportunities for business tie-ups between IVAM member companies and Japanese companies.	
		BEANS Project Seminar	
		Sponsor: New Energy and Industrial Technology Development Organization (NEDO) / BEANS Laboratory Moderator: Yutaka Takei, BEANS Laboratory	
7/30 (Thursday)	Special Venue B	13:10—13:15	Opening Remarks from Sponsor Akira Uehara, New Energy and Industrial Technology Development Organization (NEDO)
		13:15—13:25	Opening Remarks from Project Leader Atsushi Yusa, BEANS Laboratory
		13:25—13:55	Prospects for MEMS and Expectations for BEANS Project Masayoshi Esashi, Tohoku University
		13:55—14:25	The MEMS Market and Recent Technical Trends Tsuneyuki Miyake, Nikkei Microdevices
		14:35—14:55	The Structure and Significance of the BEANS Project Hiroyuki Fujita, Tokyo University
		14:55—15:15	Use of Hydrogel Beads for Enclosure, Embedding and Assembly Shoji Takeuchi, Tokyo University
		15:15—15:35	Manufacture of Organic Nanostructures to Achieve Dramatic Improvement in Organic Semiconductor Performance Chihaya Adachi, Kyushu University
		15:35—15:55	Supercritical Film Formation Technologies for Filling In Nanogaps Masakazu Sugiyama, Tokyo University
		15:55—16:15	Ultra-low Damage Neutral Particle Beam Etching Technologies Seiji Samukawa, Tohoku University
		16:15—16:35	Application of MicroNano Processing Technologies to Infrared Sensors for Use in Outer Space Masaki Kimata, Ritsumeikan University
16:35—16:55	Macro-BEANS Strategies for Achieving Meter-class Large-area Advanced Devices Toshihiro Ito, National Institute of Advanced Industrial Science and Technology (AIST)		
16:55—17:00	Closing Remarks Keiichi Aoyagi, Micromachine Center		
		MicroNano 2009 MEMS Industry Forum — Achieving Growth and Broadening the Base of the MEMS Industry: New Ideas from the MEMS Industry Forum —	
		Sponsor: Micromachine Center / MEMS Industry Forum Moderator: Masahiro Katashiro Micromachine Center / MEMS Industry Forum	
		Opening	
7/31 (Friday)	Special Venue A	10:30—10:35	Opening Remarks Koichi Imanaka Omron Corporation (Vice Chairman, MEMS Industry Forum)
		10:35—10:50	Introductory Talk: What is Needed for MEMS Industry Development? — The Role and Activities of the MEMS Industry Forum — Keiichi Aoyagi Micromachine Center
		Session 1 Data Evidence for MEMS Industry Growth	
		10:50—11:10	Current Trends in MEMS Technology and Future Prospects as Seen in International Conferences Shuichi Shoji Waseda University
		11:10—11:30	The Main Players in the MEMS Industry (Survey of Industry Trends in the MEMS Field) Shun'ichi Adegawa Micromachine Center
		11:30—11:50	Latest Trends in MEMS International Standardization — Growth in Demand and Business Activity — Kuniki Ohwada Teikyo University
		11:50—12:10	How to Use International Standards to Evaluate MEMS Materials Kazuki Takashima Kumamoto University
		Session 2 Prevaling in International Competition Through Research and Development & Improvement of Manufacturing Infrastructure	
		13:05—13:25	Creating a MEMS "Integrated Center of Knowledge and Experience" in the Nanotech Arena Masahiro Katashiro Micromachine Center / MEMS Industry Forum
		13:25—13:45	Improving the MEMS Foundry Network System — Incorporation into Standard Processes — Fumihiko Sato, Omron Corporation
		13:45—14:05	MemsONE: A Verification Tool for Issues in the MEMS Design and Manufacturing Process Yoshiharu Suizu Micromachine Center
		14:05—14:25	MEMSPedia: An Encyclopedia for the MEMS Field Tomoyuki Koike Micromachine Center
		14:25—14:45	Personnel Training in New Project Development & Innovation in the Area of MicroNano Mass Production Technologies and Applied Device Manufacturing Masaharu Takahashi National Institute of Advanced Industrial Science and Technology (AIST)
		14:45—15:15	Research & Development for Establishing a MEMS Industry in Korea Korea Institute of Industrial Technology (KITECH), Senior Researcher, Sung Ho Lee, Ph.D
		Session 3 Expectations for the Establishment of R & D Centers for the MEMS Industry	
15:15—15:35	MEMS Industry Efforts in Tohoku Yutaka Takei General Coordinator, Tohoku Industrial Cluster & MEMS PARK CONSORTIUM		
15:35—15:55	Microfabrication Technology Efforts in Kyushu Nagao Miyashita Industry-Academia Cooperation Center, Kita-Kyushu Foundation for the Advancement of Industry, Science and Technology		
15:55—16:15	Establishing MicroNano Technology Centers Through Transcription — Deployment in the Sustainable Energy Field — Tadashi Hattori Hyogo Prefectural University		
Closing			
16:15—16:20	Closing Remarks Keiichi Aoyagi Micromachine Center		
		Fine MEMS Project Achievements Seminar	
		Sponsor: New Energy and Industrial Technology Development Organization (NEDO)	
		This seminar will present the total research and development achievements of the Highly Integrated and Complex MEMS Manufacturing Technology Development Project (Fine MEMS Project) (FY 2006-2008) that ended in FY 2008, in the Project's four development categories (MEMS/nano-function composite technology, MEMS/semiconductor integrated fabrication technology, MEMS/MEMS high integration composite technology, and establishment of a database of high integration composite MEMS knowledge) as well as in terms of the development of a fine MEMS system design platform.	
		Note: The details of the program have not yet been finalized.	

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