MICRONANO

MMC Activities

MicroNano 2007 Report

MicroNano 2007 was held from Wednesday, July 25 through Friday, July 27, 2007, with the Tokyo International Exhibition Center (Tokyo Big Sight) in Ariake, Tokyo as the main venue. The exhibition was a resounding success, and the sponsors would once again like to express their appreciation to all who attended.

Like last year, MicroNano 2007 was a joint event in which the exhibition, conference and other events were held concurrently. This year's events attracted more than 12,000 visitors, the highest attendance yet. One noteworthy change from previous years was that the name of the exhibition was changed from Exhibition Micromachine to Exhibition Micromachine/MEMS and a new MEMS device zone was provided. The conference was centered on the 13th International Micromachine / Nanotech Symposium, held in the "Iris" banquet room at the Tokyo Bay Ariake Washington Hotel. The conference events also included a MEMS Forum, held to encourage the development of MEMS-related industries and the adoption of MEMS international standards, and a seminar to announce the interim achievements of the Fine MEMS Project. Each of these events attracted a, huge audience, leaving standing room only. This response is indicative of the high level of interest in micro-nano fields that continues to increase each year.

18th Exhibition Micromachine/MEMS: A Resounding Success

For three days (July 25 - 27, 2007), the 18th Exhibition Micromachine/MEMS was held in the West Hall No. 3 and 4 at the Tokyo International Exhibition Center (Tokyo Big Sight) in Ariake, Tokyo. Although Japan's hot, muggy summer was nearly at its height, the event was favored by excellent weather, and it was a resounding success.

Up until last year, the event was titled Exhibition Micromachine. This year, the name was changed to Exhibition Micromachine/MEMS to better reflect the content of the products shown by exhibitors. Moreover, this year a special MEMS Device Zone was set up to enable visitors to view the many different devices that employ MEMS in a single location.

With the heightened interest in micromachine/MEMS technologies, the exhibition has grown in scale each year. The exhibitors at this year's event included 14 companies that are supporting members of the Micromachine Center and five companies that are associate members of the MEMS Industry Forum. Other exhibitors included private companies, universities, independent administrative agencies and so on. The total number of exhibitors set a new record: 362 companies, organizations, universities and research institutions in 484 booths. This total included 14 overseas companies.

Attendance during the three days of the exhibition was more than 12,424, also a new record.

19th Exhibition Micromachine/MEMS (tentative)

Date/time : Wednesday, July 30 - Friday, August 1, 2008
Venue : West Hall No. 1 & 2, Tokyo International Exhibition Center (Tokyo Big Sight), Ariake, Tokyo

MEMS Forum

The MEMS Forum was held on July 25, 2007 at a special venue set up within the West No. 3 Hall at Exhibition Micromachine/MEMS. The purpose of the Forum was to achieve an enhanced common recognition of issues involved in the development of MEMS-related industries.

At the MEMS Forum, case studies of activities were presented from three perspectives: MEMS personnel infrastructure, MEMS design infrastructure and MEMS manufacturing infrastructure. All of these are issues that will lead to a strengthening of the MEMS industrial base. In addition, a report on academic activities was also presented from the perspective of industrial-academia collaboration, which will support the growth of MEMS industries. A report on research projects conducted by the Micromachine Center and the MEMS Industry Forum was also presented.

In connection with efforts by the MEMS Industry Forum to build cooperative relationships with related overseas MEMS organizations, this year the special focus was on Asia. An Asia MEMS Forum session was held at which delegates from South Korea, China and Taiwan reported on trends in MEMS industry and technology in their countries.

The sessions, presentations and presenters making up this year's MEMS Forum were as follows.

Session 1 : Strengthening the MEMS Industrial Base

(1) The Opening of the MEMS Industry
Tsuneyuki Miyake (Associate editor for Microdevices, Nikkei Business Publications Inc.)

(2) Case Study: Training of Personnel to Promote Applied MEMS in the MOT Project Research
Kiyoshi Itao (Professor, Tokyo University of Science)

(3) MEMS Personnel Training and Technologies for Commercial Application of MEMS
Ryutaro Maeda (Senior Researcher, Advanced Manufacturing Process Department, National Institute of Advanced Industrial Science and Technology [AIST])

(4) Features of MemsONE (MEMS Design / Analysis Support System) and Case Studies
Hidetoshi Kotera (Professor, Kyoto University)

(5) Overview of Activities to Create a MEMS Foundry Network
Kazushi Tomii, Chair, Foundry Service Industry Committee, MEMS Industry Forum (Matsushita Electric Works Ltd.)

Session 2 : Industry-Academia Collaboration

(1) Use of MEMS and Biochips Produced through Micro/Nano Stereolighography
Shoji Maruo (Professor, Graduate School of Engineering, Yokohama National University)

(2) Workshop on 3D Integration Using Hetero Wafer Bonding
Tadatomo Suga (Professor, Graduate School, The University of Tokyo)

(3) Organizations for Interdisciplinary / New Domain Research Activities: Inauguration of Dedicated Micro/Nano Engineering Forum
Hidetoshi Kotera (Professor, Kyoto University)

Session 3 : Asia MEMS Forum

(1) MEMS in China Mainland
Dong F.Wang (Senshu University, Ishinomaki, Japan)

(2) Micro/Nano Technology in Korea
Young-Ho Cho (KIST, Korea)

(3) MEMS & Nanotechnology in Taiwan
M. S. Lin (Industrial Technology Research Institute [ITRI])

(4) MEMS Industry Forum (MIF) Towards Virtuous Cycle of the MEMS Industry Growth of Asia
Junji Adachi (Micromachine Center, Japan)

Session 4 : Research Results

(1) MEMS Market Research Report
Shunichi Adegawa (General Manager, Industry Department, Micromachine Center)

(2) Report of Outcome Survey, Micromachine Project
Shinichi Tamura (Manager, Survey Research No. 2 Section, Research Department, Japan Technical Information Services Corporation)

(3) BEANS (Toward the Achievement of 3rd Generation MEMS)
Junji Adachi (General Manager, Research Department, Micromachine Center)

Fine MEMS Project Interim Achievements Seminar

As one of the events comprising MicroNano 2007, the Fine MEMS Project Interim Achievements Seminar was held on Friday, July 27 at a special venue set up within the West No. 3 Hall at the Tokyo International Exhibition Center (Tokyo Big Sight). As its name implies, the seminar was held to announce the interim achievements of the Highly Integrated / Complex MEMS Manufacturing Technology Development Project (Fine MEMS Project) commissioned and subsidized by the New Energy and Industrial Technology Development Organization (NEDO). The seminar was sponsored by the Fine MEMS Project Committee and the Micromachine Center, and co-sponsored by NEDO, with assistance provided by the Ministry of Economy, Trade and Industry (METI).

The seminar opened with greetings from two invited guests: Hiroaki Okahashi, Deputy Director of METI, and Masami Takayasu, Director of NEDO. These greetings were followed by a presentation entitled "Overview of Fine MEMS Project" by Isao Shimoyama, Professor and Dean of the Graduate School of Information Science and Technology at the University of Tokyo. Professor Shimoyama provided an overview of the project's achievements including grant activities. This was followed by detailed reports of the latest consignment project achievements in eight areas by the project supervisors, which triggered a lively discussion. Following the conclusion of the seminar, a technical consultation corner was set up at the NEDO Highly Integrated / Complex MEMS booth at Exhibition Micromachine/MEMS, affording visitors the opportunity to talk directly with research and development supervisors with the aim of facilitating the practical application of project achievements.

At the seminar, the 130 seats that had been set up at the special venue filled up just as the seminar was about to begin, so an additional 50 seats were hastily provided. However, these also filled up immediately. Judging from the air of excitement that permeated the venue from beginning to end, the expectations for this project are extremely high. An opinion survey was conducted for the 126 persons who attended the seminar and 219 persons who visited the exhibition booth. The results will be analyzed and will serve to spur efforts aimed at rapidly achieving practical applications for the manufacturing technologies developed in the course of the project.

13th International Micromachine / Nanotech Symposium

- Introducing BEANS as the 3rd Generation of MEMS -

The 13th International Micromachine / Nanotech Symposium was held Thursday, July 26, 2007 as one of the events of MicroNano 2007. The symposium was held in the “Iris” banquet room at the Tokyo Bay Ariake Washington Hotel. The subtitle of this year's symposium was “MEMS Frontier: Innovative Devices by Micro and Nano-Bio Fusion Create New Lifestyles.” Thirteen invited guests – three from the United States, one from Belgium, one from Italy and eight from Japan – gave presentations on the latest research and development trends in the fields of MEMS and nano-bio fusion (environment / energy, comfort / security / safety and health care / welfare). The symposium was attended by 255 people who also participated in the spirited discussion.

One of the two keynote lectures, entitled “BEANS: Hetero-Functional Integrated Device Impacting the Society over the Next 20 Years,” was given by Professor Hiroyuki Fujita of the Institute of Industrial Science at The University of Tokyo. Professor Fujita discussed Bio Electromechanical Autonomous Nano Systems (BEANS), devices that represent a fusion of different fields and are expected to have a revolutionary impact on society twenty years from now. Third generation MEMS are defined as MEMS that fuse microtechnology with bio- and nanotechnologies to create devices and systems that will function in an autonomous and decentralized manner. In Japan, it is said that semiconductors are the “rice” (in other words, the core) of Japanese industry. In contrast, MEMS will be the “beans” of industry, providing it with protein as well as muscle in the form of sensors and actuators to serve as eyes and ears and the like. It is for this reason that the acronym BEANS was adopted.

BEANS will focus market expansion efforts on those fields that are presently the main markets for MEMS: automobile, IT, health care, biotechnology, environment, energy, security, safety and so on.

In order to make BEANS a reality, three processes will be essential:

1) Three-dimensional nanostructure formation
2) Biotechnology-fusing processing
3) Large-area continuous processing

A FY 2008 budget request for BEANS has been submitted by the Ministry of Economy, Trade and Industry. The budget focuses on the development of manufacturing technologies for next-generation devices that fuse different fields.

The other keynote lecture, entitled “Bio POETS for Innovative Healthcare,” was presented by Professor Luke Lee of the Berkeley Sensor & Actuator Center (BSAC) at the University of California at Berkeley. BSAC is the center for MEMS research and development at UC Berkeley. Professor Lee spoke about the following research and development efforts aimed at achieving bio-related applications for MEMS:

- Cellular Biologic Application Specific Integrated Circuits (BioASICs)
  (devices in which microfluidic elements, sensors, control circuits etc. are integrated)
- Biologically-inspired Polymeric Opto-Electro Mechanical Systems (BioPOEMs)
  (photoregulation, automation and imaging in bio-reactive element arrays)
- Quantum Nanoplasmonics for In-vivo Molecular Imaging
  (molecular imaging by means of Surface Enhanced Raman Scattering [SERS] using nanocrescents)

The 14th Symposium will be held next year, once again as part of MicroNano 2008.

MEMS Standardization Roadmaps

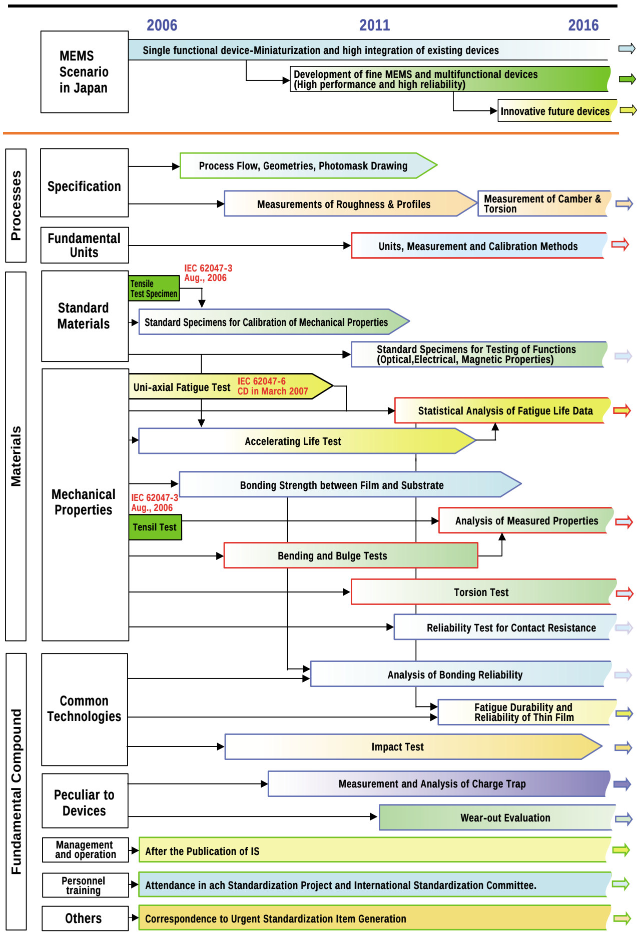
Recognizing the need for a mechanism to promote international standardization activities in MEMS fields in a strategic manner, the Micromachine Center has established roadmaps to serve as a guide for future international standardization activities. Specifically, as the technologies and products in MEMS fields are diverse, these have been divided into two main categories – fundamental technologies and MEMS devices – and for each category a roadmap for the next 10 years has been prepared.

With regard to the fundamental technologies for MEMS, technical fields were divided into three categories: processing and process technologies, material technologies and fundamental compound technologies. For each of these categories, a technology map for standardization was prepared, based on a study of technological and standardization trends, and each standardization item was ranked in terms of priority to create the roadmap.

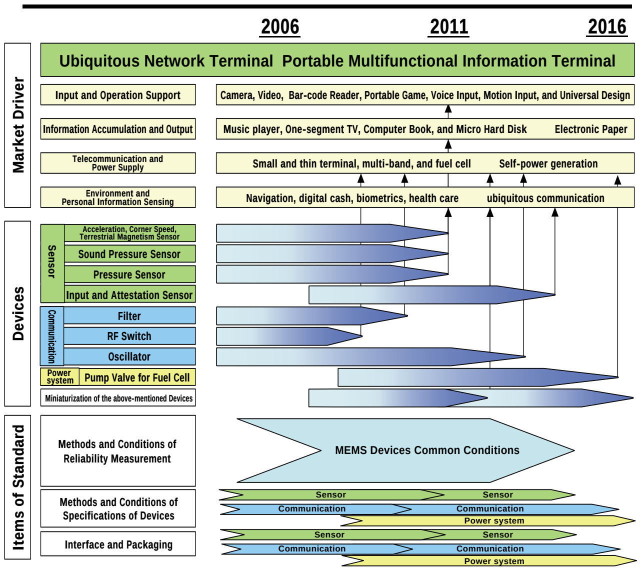
With regard to MEMS devices, the focus was on the two major application fields of automobiles and information & communications (mobile devices). For each field, future market trends and needs, standardization trends, and the items needed for standardization were identified, and each item was ranked in terms of priority to create the roadmap.

In the future, based on these MEMS standardization roadmaps, the creation of international standards will be promoted in a strategic manner, strengthening international competitiveness in MEMS fields.

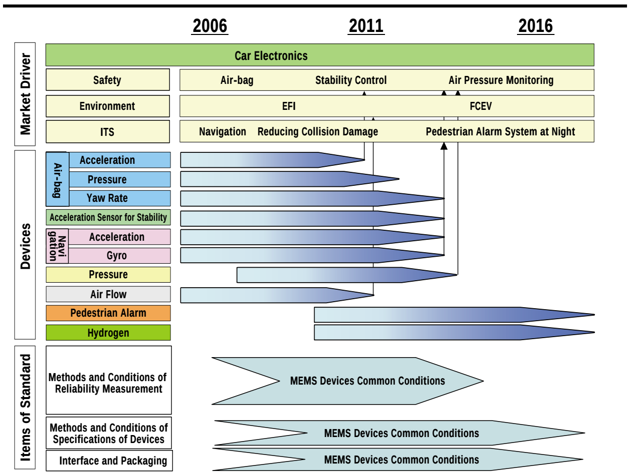
MEMS Standardization Roadmap for Fundamental Technologies



MEMS Standardization Road Map in Cellular Phone



MEMS Standardization Road Map in Automotive Application



MEMS - Semiconductor Process Integration Monolithic Manufacturing Technology

(The Search for a New MEMS Sensing Principle)

Susumu Sugiyama, Professor, COE Promotion Organization, Ritsumeikan University
Toshiyuki Toriyama, Professor, Department of Micromachine Systems Engineering, College of Science and Engineering, Ritsumeikan University
Yoshimasa Isono, Professor, Department of Micromachine Systems Engineering, College of Science and Engineering, Ritsumeikan University

Forming components comprising semiconductor ICs and sensors, actuators, or other MEMS devices in an integrated manner will make it possible to create more compact, more highly functional and more reliable devices. The need for improvement is particularly keen in areas such as automobile components and medical sensors, in which advancement is a must.

In the case of MEMS semiconductor integration, the technical complexity increases along with the level of integration, due to the complexity of conducting the design using different processes, the duplication of manufacturing equipment and so on. Moreover, whereas the size of the transistors making up the IC is in the sub-μm domain, the size of the elements making up the sensor are in the μm domain. As a result, a size of several mm is needed to accommodate the entire sensor, and this increases the size of the chip with which the IC is integrated. In this way, the complexity of the technologies used in the manufacturing process and the resulting lowered yield and increased chip size reduce the yield constant, making it impossible to maintain profitability in cost terms.

The purpose of this development project was to resolve this problem by developing a manufacturing technology for creating MEMS and semiconductors in an integrated manner, thereby providing higher added value and more advanced functions. The ultimate goal was to increase the international competitiveness of Japan's unique leading-edge technologies.

In particular, we aimed to create the advantages that would be obtained from higher added value and more advanced functions. We focused on the piezoelectric element that is one of the basic sensor elements, working to determine its properties at the sub-μm level and to find a sensing principle that would lead to higher sensitivity.

Achieving a nanomechanical structure and determining nanoelastic properties

It is not yet clear whether the same mechanical properties are maintained or different mechanical properties are exhibited when a mechanical sensor mechanism is reduced to the sub-μm scale or smaller. The purpose of this study was to measure this experimentally in the hope that the results would serve as useful data for the design of highly integrated MEMS. **Fig. 1** shows an autonomous silicon nanomechanical structure manufactured by means of Scanning Probe Nano Lithography (SPNL). **Fig. 2** shows the structure of a nanoelectromechanical system (NEMS) resonant device. From these resonance properties, the mechanical properties were measured and their application in sensors was studied. The planned width of the nanowire and the gap between electrodes is less than 100 nm.

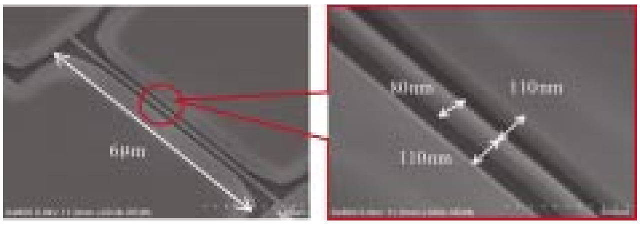


Fig. 1 Stand-alone Si nanowire manufactured using Scanning Probe Nano Lithography (SPNL)

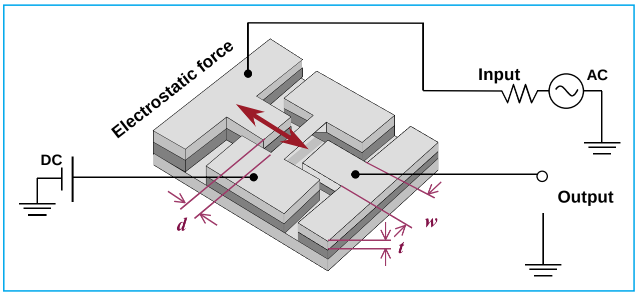


Fig. 2 Structure of Nanoelectromechanical system (NEMS) resonant device

Determining the piezoresistance effect of nanoscale silicon

The piezoresistant elements used as sensing elements in mechanical sensors are simple in terms of structure and detection path. For this reason, they have been widely used in pressure sensors and acceleration sensors and so on. As shown in **Fig. 3**, when the width of the silicon piezoresistant element is reduced to the sub-μm level or below, the coefficient of piezoresistance, which affects sensor sensitivity, increases greatly. We focused on this phenomenon in our efforts to increase sensor sensitivity. First, we reduced the width of the silicon piezoresistant element to 100 nm or below and conducted a theoretical analysis of piezoresistance based on the low-dimensional band structure. Based on these analytical predictions, we plan to manufacture a silicon piezoresistant element and determine the actual coefficient of piezoresistance. It is thought that, if the prediction is correct, sensor sensitivity will be increased anywhere from several times to nearly an order of magnitude greater.

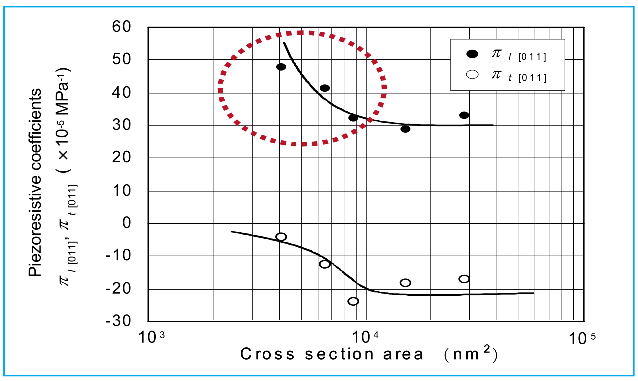


Fig. 3 Relationship between Si piezoresistance effect and section area

Column

MEMS Frontier Devices

"Blue Devices" That Provide Comfort, Safety and Security

Yoshiro Mita, Associate Professor of Electrical Engineering, Graduate School of Engineering, The University of Tokyo

On a recent business trip to France, I wrote an essay about the fact that, up until around 20 years ago, the United States and Europe had seemed very far away. At that time, one of my former teachers was living in the United States on a long-term basis. He told me that, hungry for things written in the Japanese language, he had read and reread all of the books that he had brought with him, even those that he would not ordinarily read. The physical distance of around 10,000 kilometers between the United States and Japan has not changed. But now, even when we go to the other side of the world, we do not feel that we are very far away. The reason, of course, is the dramatic progress in cellular telephones and the means of transmitting information typified by the Internet. Now, wherever you are in the world, there is an infrastructure in place that allows you to "connect."We have entered an age in which, using the same cell phone you use at home, you can easily communicate with friends and family wherever you are.

Even while I was writing these words, however, I was excited and fidgety and unable to calm myself. The reason was simple. During the summer I had been in France away from my family in Japan, and I knew that tonight I would be reunited with my wife and eight-month-old son for the first time in 40 days. (I know that in Japan it is forbidden to bring up one's family in speeches of this kind, so I would ask you to apply the European standard and forgive me.) Naturally my wife and I called one another on the phone frequently, and in the background I could hear my son's voice. But telephones do not transmit the feel of the skin and the warmth of the body, so it is different from actually being there. When you think about it, the information and telecommunications technologies of the 20th century were successful at transmitting information over long distances for only two of the five senses: seeing and hearing. Even though we are now in our seventh year of the 21st century, the transmission of information for the other three senses – smell, taste and touch – has not yet become viable. If we were successful in transmitting these three senses, it would enable communication with a greater sense of actually being there. Things would change from "home is so far away" to "home is always nearby," and it would undoubtedly have a revolutionary impact on society.

In order for "blue devices" to enable people to have more comfortable, more human lives, they must aim to create not only sensors and actuators capable of transmitting information for all five senses (not merely video and audio) but also "sixth sense"devices – devices that offer not second sight or the "six senses" of Buddhism (the five senses + innermost feelings or "heart") but that sense physical and chemical quantities that cannot be detected with the five senses available to human beings, such as imaging by means of infrared rays and terahertz waves.

Naturally, the applications for these devices would not be limited only to the transmission of information. They could also serve as "food security" devices: through the use of sheet-like tags that record changes in temperature and humidity, they could be used to ensure that the environment for gourmet food items has been properly controlled, and guarantee the quality of food not by means of mechanical "sell-by" dates but by monitoring the food itself for changes and determining the date by when it should be consumed. Or they could be used as "caregiver" devices for in-home care use, detecting changes in vital signs and out-of-the-ordinary behavior and other abnormalities and issuing alerts on the network. The expected development of these and other devices in the future will help to ensure both safety and peace of mind. (Fig. 1)

As shown in Fig. 2, there will be three mounting modes for blue devices: tag type, mobile device type and large-area sheet type. Each type will be used where its features are most appropriate.

- Tag type: Supermarket price tags or smaller configurations. As in the example of the food security device, these will be attached to an object and will keep records over a long period of time.
- Mobile device: Similar to present-day cellular telephones. The components in cellular telephones will continue to become smaller and smaller with each new generation. However, from the standpoint of usability, the terminal itself cannot get any smaller. Accordingly, "blue devices" will be integrated into the vacant space to function as "five sense" transmission devices.
- Large-area sheet type: Devices will be integrated into posters or other display objects, or the poster itself will be an electronic device. These devices will be used to create moving life-sized posters or signs that offer simultaneous interpretation services.

The technical issues common to all of these devices are twofold: how to achieve the necessary degree of miniaturization, and how to create large-area screens. More specifically, the following are thought to be essential:

- Commodification of high-end devices, reducing costs, achieving ease of assembly
- Achieving large-area sheets, thinness and flexibility
- Chemical applications for three-dimensional nanostructures

The following research and development topics will be particularly important from this point on:

- Technologies to integrate microcomponents over a large poster-sized area
- Technologies that simplify assembly by completing a circuit simply by using a sealing procedure to align and attach modules (Technology that simplifies assembly processes (for example, configuring circuits by sticking modules together in the same manner as using adhesive tape to attach things to one another)
- Chemical applications for three-dimensional nanostructures that use the principle that the ratio of surface area to volume increases when an object is made three-dimensional

In any age, what is most important is to create a world in which communication between people is smoother, and in which people can live with one another in peace and harmony. This is why I eagerly await the day that "blue devices" can play an important role in creating comfortable lifestyles and a peaceful and safe society thanks to communications utilizing all five senses.

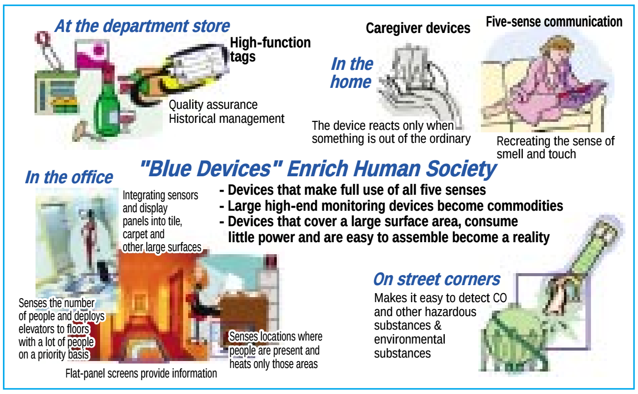


Fig. 1 "Blue devices" have many different applications, from information transmission to historical monitoring to information-provision.

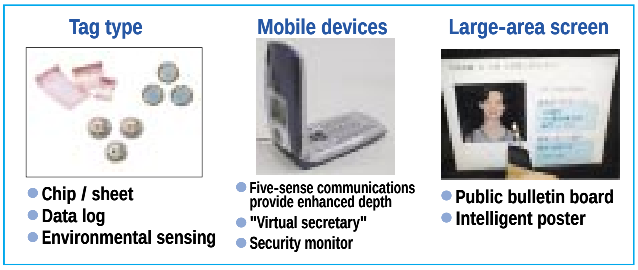


Fig. 2 Three modes for "blue device" mounting

Table 1 "Blue Device" Working Group Members(in no particular order)

Yoshio Mita	The University of Tokyo
Masakazu Sugiyama	The University of Tokyo
Takao Someya	The University of Tokyo
Masafumi Kimata	Ritsumeikan University
Susumu Sugiyama	Ritsumeikan University
Masaaki Ichiki	National Institute of Advanced Industrial Science and Technology (AIST)
Masayoshi Higuchi	Omron Corporation
Yuji Saisho	Matsushita Electric Works, Ltd.
Yasuro Irie	Mizuho Information & Research Institute, Inc.
Shin'ichi Izuo	Mitsubishi Electric Corporation
Takaaki Hirata	Yokogawa Electric Corporation

3rd Japan-Korea-China MEMS Standardization Workshop

In order to speed up the design and development process, ensure compatibility and make mass production possible, MEMS international standardization will be crucial. In Japan, the Micromachine Center has played a leading role in pursuing international standardization with the International Electrotechnical Commission (IEC). So far three international standards originating in Japan have been published: Terms and definitions, Tensile testing method of Thin film materials and Thin film standard test piece for tensile testing. Another proposed standard, Thin Film Fatigue Test Methods, is currently under review as a Committee Draft Version (CDV).

Against this backdrop, the first Japan-Korea-China MEMS Standardization Workshop was held in Tokyo in 2005 as a forum for the exchange of information and the promotion of cooperation on the part of Japan, South Korea and China with regard to MEMS standardization. Last year, a second workshop was held in Gyeongju, South Korea. This year, the third MEMS Standardization Workshop was held on June 28, 2007 to coincide with the IEC TC47 Beijing Conference. Two speakers each from Japan, South Korea and China gave a total of six presentations on the evaluation of material properties for MEMS thin film materials. These presentations were followed by a spirited discussion.

The Tian You Hotel (the venue for the Japan-Korea-China MEMS Standardization Workshop)

The following is an overview of the presentations.

(1) J. H. Kim of the Korea Institute of Machinery and Materials (KIMM) gave a presentation on the preparation of test specimens and test methods relating to compression testing of micro/nano pillar shaped test specimens fabricated from thin films. Dr. Kim also presented the results of measurement of polymer and metal thin films. South Korea will propose this material test method as a standard originating in South Korea.

(2) Dr. Zhao of the Chinese Academy of Sciences gave a presentation on the degree of elasticity and fracture toughness of MEMS and bio-MEMS thin film materials. With regard to the degree of elasticity, Dr. Zhao demonstrated analytically that when the thickness of the thin film is less than an atomic layer of 100, a size effect becomes evident in the Young's modulus due to the surface energy of the material.

(3) Dr. Higo of the Tokyo Institute of Technology gave a presentation on the evaluation of bonding properties for MEMS materials. Dr. Higo focused in particular on a discussion of new phenomena that are the opposite of the ordinary size effect – for example, with regard to the size dependency for the bonding strength between polymer (SU-8) and silicon boards, the strength is sometimes reduced when the size is small – as well as the causes for these new phenomena. With regard to methods for measuring the bonding strength of MEMS materials, a new project aimed at standardization has just been initiated in Japan as well, and this presentation played a major role in promoting this project to South Korea and China.

(4) Dr. C. S. Oh of the Kumoh National Institute of Technology in South Korea gave a presentation on the measurement of thermal expansion in thin film materials using laser interferometry. This is an area in which not much research has been promoted in Japan, and thus the presentation was of considerable interest. Moreover, as South Korea plans to propose this method of measuring thermal expansion as an international standard, it is one for which study will be needed in Japan as well.

(5) Dr. Isono of Ritsumeikan University gave a presentation centering on the results of bending tests of nanosize thickness single-crystal silicon thin films. In particular, Dr. Isono presented a great many test results to show that, with submicron thicknesses, the silicon exhibits plastic deformation even at room temperature. This is an extremely important finding in terms of applications for MEMS/NEMS, and it attracted a great deal of attention.

(6) Dr. Ren of Tsinghua University gave a presentation focusing on the progress of MEMS research at Tsinghua University. His presentation communicated the enthusiasm with which MEMS research is being conducted at Tsinghua University as well.

This is the third time the Japan-Korea-China MEMS Standardization Workshop has been held. The major achievement of the Workshop is its role in providing a forum for the exchange of information regarding the current state of MEMS standardization and future prospects in each country, as well as enhancing the common recognition in these three countries. It is crucial that these achievements be utilized in MEMS standardization strategies in Japan. Moreover, most of the presentations in the Workshops held up to now have focused primarily on evaluating the properties of MEMS materials. In the future, the workshop should function as a forum for the exchange of information among Japan, South Korea and China regarding the standardization of MEMS devices and their fields of application.

The 4th Japan-Korea-China MEMS Standardization Workshop will be held in 2008, with Japan once again serving as host.

Members' Profiles

Sumitomo Precision Products Co., Ltd.

1. Overview of business activities

In 1995, the British firm Surface Technology Systems (STS), an affiliate of Sumitomo Precision Products Co., Ltd., marketed the world's first silicon deep etching unit. Building on this unit and its technology, Sumitomo Precision Products became the first Japanese manufacturer to produce a silicon deep etching unit, the MUC-21 ASE, in 2001. In 2006, Sumitomo Precision Products also began domestic manufacture of the silicon dioxide film etching unit, which uses HF vapor, of the U. S. firm Primaxx (which became funded by Sumitomo Precision Products in June of this year), in order to better respond to the MEMS needs of its customers.

Sumitomo Precision Products also handles a wide range of MEMS processing units, including SiO2/SiN etching units, SiC etching units, compound semiconductor etching units, PE-CVD units, silicon sacrifice layer etching units and units for wafer thickness reduction.

2. Domestic products designed for MEMS mass production

(1) MUC-21 ASE Pegasus (new silicon deep etching unit)

The ASE Pegasus is Sumitomo Precision Products' most advanced model and was released in December 2005. It is based on the so-called Bosch switching process, as well as the Advanced Silicon Etch (ASE) technology established by STS by combining various proprietary technologies. The resulting hardware module and processing software offer superior performance that maximizes such switching process features as high etch rate, high mask selection ratio and high aspect ratio processing.

Specifically, the unit offers greatly improved etching shape and in-plane distribution through the use of a newly developed plasma module, as well as an improved plasma matching system and a new type of gas introduction system that includes an MFC capable of high-speed switching processing. The result is a product that offers world-class performance. Moreover, Sumitomo Precision Products continues to focus on development in an effort to achieve further improvements in the future.

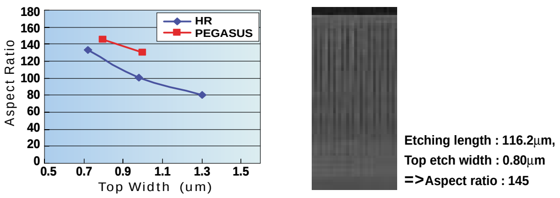


Fig. 1 Example of silicon high aspect ratio etching

(2) VPX-ASE Pegasus (platform for mass-production factories)

In 2007, Sumitomo Precision Products released the VPX-Pegasus cluster type ASE unit for users interested in the mass production of MEMS devices.

In this system, the ASE-Pegasus source is mounted on a cluster type conveyor system. Sumitomo Precision Products is confident that this system will make a major contribution to the production of various types of MEMS sensors, silicon microphones, silicon oscillators and other components already making the transition from the research and development stage to the mass-production stage.

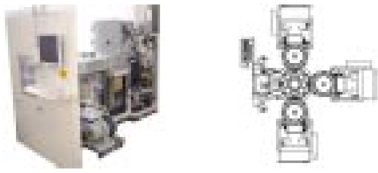


Fig. 2 VPX-ASE Pegasus

(3) APS (SiO2/SiC high-speed etching unit)

Released last year, the APS system employs the highly reliable MUC-21 domestically produced platform and includes a newly developed Advanced Physical Source (APS) plasma source. It enables high-speed etching with SiO2 and SiC and is attracting particular attention for its application in the SiC etching of LEDs, semiconductor components and next-generation power devices. In the SiC etching process, the APS achieves a high etching rate of 4.2 μm/minute or greater. In addition, the mask selection ratio is high, and the side wall angle can also be controlled.

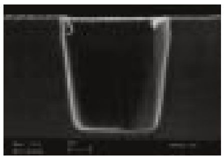


Fig. 3 Example of SiC high-speed etching

(4) SLE (Si oxide film sacrifice layer dry etching unit)

Removal of the sacrifice layer is a typical MEMS process that involves extremely tiny moving parts. Building on the basic concept of the MEMS-CET silicon oxide film etching unit (which uses HF vapor) produced by the American firm Primaxx, Sumitomo Precision Products designed a domestically produced chamber and officially released it domestically in 2006 under the name SLE. The SLE system achieves a high-speed, stiction-free release configuration employing a silicon oxide film sacrifice layer at a low cost. It also offers high selectivity with regard to aluminum, enabling maskless etching even with wafers that have exposed aluminum pads.

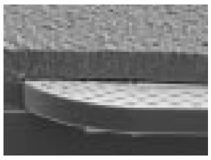


Fig. 4 SOI sacrifice layer etching (in the case of a silicon resonator) (Image provided by SiTime)

3. A final word

Sumitomo Precision Products has a voluminous process library accumulated over many years, centering on silicon deep etching technology. The company is building systems that can respond rapidly to the extremely diverse needs of any MEMS user company. MEMS devices are now being are employed for an ever-widening variety of purposes.

By developing a diverse array of applications and equipment, Sumitomo Precision Products will continue to provide the means to respond rapidly to MEMS development needs.

For more information about Sumitomo Precision Products, access the SPP website at: http://www.spp.co.jp

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