MMC

MICROMACHINE

2004 5

No.47

MMC Activities

Overview of MMC's Activities in Fiscal 2004

I. Basic Objectives of Activities

The basic objectives of MMC activities are, firstly, to establish basic micromachine technologies and increase utilization of micromachines through promoting research and investigation of micromachines (MEMS and other minute machines and systems), collection and provision of micromachine information, and exchange and cooperation with worldwide organizations; and secondly, to contribute to the further development of Japan's industrial economy and to international society.

MMC's basic objectives in FY 2004 are, as in the previous fiscal year, The Center's fundamental policies are to promote the industrialization of micromachines/MEMS, and to strive for the establishment of next generation basic micromachine and NEMS technologies in accordance with trends in cutting-edge technological fields such as biotechnology, nanotechnology, and IT.

II. Description of Primary Activities

1. Research and Investigation of Micromachines

Planned activities are aimed towards gaining a clear understanding of the trends in micromachine technologies and industries and conducting investigations of and research on new technological issues regarding the fusion of micro- and nanotechnologies, as well as making adjustments appropriate for the multidirectional expansion of micromachine technology.

(1) Microanalysis/Production System Project (recommissioned NEDO project and contract agreement)

This project involves creation of a database of product information useful in the research and development of microchip devices and systems, and activities aiding the creation of this database, such as information gathering and data provision.

(2) Studies on the future prospects of micromachine/MEMS technology

High expectations are held for micromachine/MEMS technology as a vital technology that will support the future expansion of our economy and society. For this reason, survey research will be conducted regarding the future prospects of micromachine/MEMS technology.

(3) Studies on R & D trends for micromachine technology in Japan and abroad

These studies aim to identify and analyze the latest trends in the rapidly expanding field of micromachine technology, and micromachine R&D in Japan and abroad; and to develop basic technological data to aid in developing micromachine technologies.

(4) Studies on MEMS reliability assessment technology (application submitted to the Japan Machinery Federation as a commissioned project)

This research project involves the investigation and consideration of current status, issues, and policies relevant to the improvement of MEMS reliability.

(5) Studies on the potential of nano-on-micro technology (application submitted to the Japan Industrial Policy Research Institute as a commissioned project)

This survey research will look into technological issues pertaining to the development of nano-on-micro devices and study the directions of this R&D. Furthermore, these research results will be used in the formulation of a technology development roadmap and policy recommendations.

(6) Studies on micro/nanosystem-related processing and assembly/measurement and assessment/handling technology (Application submitted to The Mechanical Social Systems Foundation as a commissioned project)

This research will involve fact-finding missions both in Japan and overseas to examine such areas as processing, fusion, assembly, measurement, and assessment necessary for integrated nano/micro device R&D.

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

Opportunities for the industrial application of MEMS have been opening up rapidly in recent years; in order to further accelerate the industrialization of MEMS, this research will comprehensively tackle such challenges as advancing foundry services and coordinating MEMS devices and materials fields. Joint research with businesses that provide foundry services will also be conducted, as in the previous fiscal year, on specific issues such as overseas foundry fact-finding missions, process standardization, creation of a materials database, and coordination between foundries.

2. Collection and provision of micromachine information

Information and documents on micromachine use in universities, industries, and public organizations in Japan and overseas will be collected, combined with survey results and MCC-produced documents, and made freely available in the MMC library. At the same time, information will be disseminated widely, both domestically and internationally, through the MCC website.

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

Utilizing the MCC website, efforts to exchange and disseminate information will be made proactively. Website content aimed at supporting members will be enhanced.

(2) Publication of a micromachine periodical

"Micromachine Index," containing abstracts of technical documents and information on materials, is issued on a regular basis and supplied to supporting members and organizations concerned with micromachines.

(3) Publication of a newsletter

Information concerning the research and governmental trends related to micromachines is distributed monthly to supporting members and other interested individual and organizations.

(4) Maintaining and upgrading the MMC library

Technical documents and materials are collected and stored in the MMC library and listed in a database together with other relevant information.

3. Exchange and cooperation with micromachine-related organizations worldwide

To promote affiliation, exchange and cooperation with related organizations in and outside Japan, MMC will involve itself in such activities as participating in the micromachine summits, holding international symposiums, inviting to Japan and sending overseas researchers and experts in the field, and building foundry services.

(1) Participation in the 10th Micromachine Summit

MMC will participate in the 10th Micromachine Summit in Grenoble, France, taking part in discussions of a wide range of topics, including worldwide trends in micromachine technology and its fields of application.

(2) Holding the 10th International Micromachine/Nanotech Symposium (partially subsidized by activities promoting the machine industry)

This year MMC will hold the 10th International Micromachine/ Nanotech Symposium focusing on technological issues pertaining to and the future prospects for the fusion of micromachine/MEMS and nanotechnology.

(3) International Exchange and Dispatch of Researchers

A group will be dispatched overseas to promote the exchange of information and opinions with micromachine-related research institutes in universities and similar institutions. This group will also participate in international symposiums and academic meetings held overseas. MMC will further promote exchange by inviting experts in the field from America and Europe and by sending our experts and researchers overseas.

(4) Building a foundry network system

Foundries are vital to the industrialization of MEMS. In order to improve these facilities, we will undertake the establishment of a system to improve services through a network comprising members of the Foundry Service Industry Committee, who represent businesses either involved in or related to the provision of foundry services.

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

In order to accelerate the development of cutting-edge micro/nano technology - a basic technology expected to have a diversity of applications in various fields - MMC will hold a meeting for the exchange of technologies as an excavating opportunity of the exchange of information, and joint research as in the previous fiscal year.

4. Standardization of micromachines

In cutting-edge technological fields such as micromachine/ MEMS, standardization is being promoted as international initiatives are being taken.

(1) Standardization of fatigue testing methods for micro-nano materials(application for sponsorship submitted to the Ministry of Economy, Trade and Industry)

Continuing from last year, research on standard fatigue testing methods that enable evaluation of the properties of various thin film materials measuring less than 10μm wide and 100μm long, with the aim of international standardization. Fatigue tests using conventional 1/1000 sized specimens will be conducted in order to clarify the limits of application for fatigue testing methods that use the current standard mm order specimens, and proposals for international standards will be considered.

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

The results of MMC research conducted between Fiscal 1999 and Fiscal 2001 as part of the NEDO project "standardization of evaluation method of properties for micromachine material" have been included in international standardization proposals submitted to IEC in Fiscal 2003, and are now at the CD(Committee Draft) stage. This year MMC will continue its activities towards international standardization.

(3) Standardization of micromachine terminology

The international specifications proposal "Technical Terms in Micromachine Technology" submitted to IEC in fiscal 2002 has been approved at the NP (New Project) stage and is now at the CDV (Committee Draft for Vote) stage. This year MMC will continue its activities towards international standardization.

(4) Research and investigation of micromachine standardization

In addition to the above, the results of relevant survey research will be transmitted worldwide to encourage international standardization, while demonstrating initiative in establishing international standards. In response to demand, the on-line International Standardization Forum will be held, and formulation of a roadmap for future international standardization will begin.

5. Dissemination of information and education about micromachines

By issuing and distributing quarterly magazines and by holding exhibitions, we hope to disseminate information on micromachines extensively in order to educate as many people as possible.

(1) The quarterly magazine "MICROMACHINE" will be published periodically and distributed to those in or connected with the field. The quarterly magazine will also be made available on the Internet through the Center's home page.

(2) The 15th Micromachine Exhibition and other events will be held to present the latest research achievements, as well as the latest cutting-edge micromachine/MEMS industry-related products and product materials.

(3) We will serve as the Federation of Micromachine Technology Secretariat to work with and strengthen micromachine-related organizations.

Preliminary Announcement

The 10th International Micromachine / Nanotech Symposium

November 11, 2004
at Science Hall, Science Museum,Tokyo, JAPAN

Exhibition
MICROMACHINE 2004

November 10 - 12, 2004
at Science Museum, Tokyo, JAPAN

Exhibition MICROMACHINE

MEMS and Opportunities for University/Industry Technology Transfer

Nico. F. de Rooij, Professor, University of Neuchatel, Switzerland

The primarily role of the university is the education that bringing up the students as scientists and researchers in future. However the university has been implementing a collaboration based on the contract with the company for their commercial products.

It is thought some type of contracts for the collaboration such as the company provides only fund to have developed a certain technology by the university or the researchers of a company join to the collaboration at laboratory in the university. In such cases, it is thought some difference in every country regarding the ownership of patents and intellectual properties of developed technology and commercialized products based on the collaboration. However the fruits of the collaboration have been realized as products in the market. Today I will talk about MEMS and opportunities for technology transfer from university to industry.

Consumer products

Swiss is not thought without watch and is famous for that industry.

Recently the watch is incorporated a pressure sensor that can be measured the depth in the water and height on the land, and a gyro that can be showed the direction of north on the earth is also incorporated in a certain watch. In addition to these sensors, mechanical gears that move the watch hands are now all produced by MEMS technologies developed in later half of 1980s.

Nowadays these technologies are applying globally as if shared ones.

By the way I would like to inform you that 30,000 people are working in the watch industries in Swiss and the industry earns 2500 million U.S. Dollars annually.

Microfluidic dispensing system

In the next speech, Professor Nico F. de Rooij introduced us a micro bioreactor that was developed for space application that consists of piezoelectric micro-pump, flow sensor, 3ml chamber, microfabricated PH sensor and electronics controller.

This miniature bioreactor has been developed for the cultivation of yeast cells aboard in a space laboratory (space lab) and was used in three Space Shuttle missions.

The first experiment was conducted in "Spacelab 2nd International Microgravity Laboratory on STS-65" in 1994, secondly in "Spacelab in the Shuttle to Mir Mission SMM03" in March 1996, and the third mission in "Columbia STS-107" in February 2003 that was totally lost due to the terrible accident. However the first results suggest that biological effects are indeed occurring in microgravity.

Since the flow sensor allowed measuring from micro to nano little, it was applied to microfluidic dispensing systems for pharmaceutical company. The system have advantages that are able to control the liquid quantity at the dispensing site, to read directly real time measurement of the aspirated or dispensed volume and to indicate the status of diagnostic of the system functionality (clogging etc). Nowadays a dispensing system equipped with a nozzle arrays with sensor controlled liquid handling, 5000nl to 25nl has been commercialized for pharmaceutical company.

Optical MEMS, Lab-on-Chip, Tool for Nanoscience

In addition to above systems, Professor Nico. F. de Rooij introduced us following MEMS products, as optical MEMS product : amplifiers, switches for optical communication, optical cross connectors, variable optical attenuators, fourier transform spectrometers, as lab-on-chip product : gas sensors, PH sensors, glucose sensor and μTAS (Micro Total Analysis System) that equipped small analyzing system and as nanotool : a cantilever which is required for study in the nanoscience and nanotechnology and using for the probe of Scanning Tunneling Microscope (STM) and Scanning Force Microscope (SFM). The cantilever is a probe of new type that fabricated by MEMS technology.

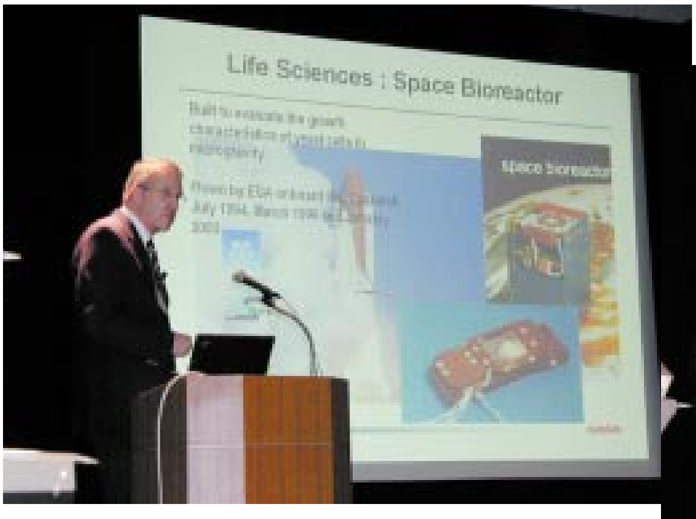
Conclusion

I have been talked about MEMS technologies that transferred to the companies and I would like to close this lecture after I introduce the name of the companies.

Swiss is a small country that has a population of only 7 million and not having big enterprises like Japan and U.S.A. Now I would like to introduce the companies that transferred MEMS technology from Neuchatel University.

Intersema is an existing company fabricating pressure sensor, and MicroFlow Engineering is also an existing company which is producing inhalers.

Regarding the recent start-up companies: Seyonic SA (founded in 1998) which is engineering and manufacturing microfluidic systems for life science and space research, Sercalo Microtechnology SA (1999) which is producing optical MEMS switches and attenuators, and NanoWorld SA (2000) which is fabricating nonotools for scanning probe microscopy.



Turning MEMS ideas into MEMS products

Stephen D. Senturia, Professor Emeritus, Massachusetts Institute of Technology, U.S.A.

Today I would like to talk about MEMS, on how to think the MEMS.

In July 2003, I had a lecture on "Turning MEMS ideas into MEMS products" at the conference of "Transducers 03'" which held in Boston, U.S.A. and Professor Fujita, who is here today, was participating in my lecture. After that I was asked by Professor Fujita to have a lecture on the same theme in Tokyo. This is why we are meet here today. And I feel happy to have a lecture here for you. The contents have modified to make much more interesting. The items in my talk are MEMS's viewpoint in the future and review in the past and I would like to talk on "Turning MEMS ideas into MEMS products" in the last.

Let's review the MEMS in the past

The conference of Transducers was initiated in 1981, then there was no name of the abbreviation "MEMS" and the field of research and development initially called solid-state sensors and actuators, which over time, morphed into Micro Electro Mechanical Systems MEMS or Microsystems. The state of the MEMS field in the early 1980's, I can divide such three groups as basic research, engineering science and product development. There was much work in basic research on materials, sensing methods, actuation methods and phenomena on a micron scale. There was even more work on the engineering science of building practical devices, with emphasis on materials and process technology, integration methodologies, and system design. At that time there were only a few microfabricated devices such as pressure sensor, gas sensor and ion sensor on the market. However there were no journals devoted to MEMS, no regular conferences, and limited access to design and fabrication infrastructure. The impact is sufficient that there are now multiple journals devoted to MEMS and a variety of technical meetings. Individual disciplines that have a MEMS component are now holding their own meetings, and it is now possible to go to a meeting involving MEMS or microsensors almost every week of the year. There are newsletters and trade magazines devoted to the microworld, and a growing infrastructure of fabrication vendors and equipment suppliers. Whereas only a few of these were on the market in the early 1980's, sensors for acceleration, flow, and angular rate as well as a variety of optical MEMS and microfluidic and bioMEMS devices are now commercially available. And there are products - many products.

Trends for the Future

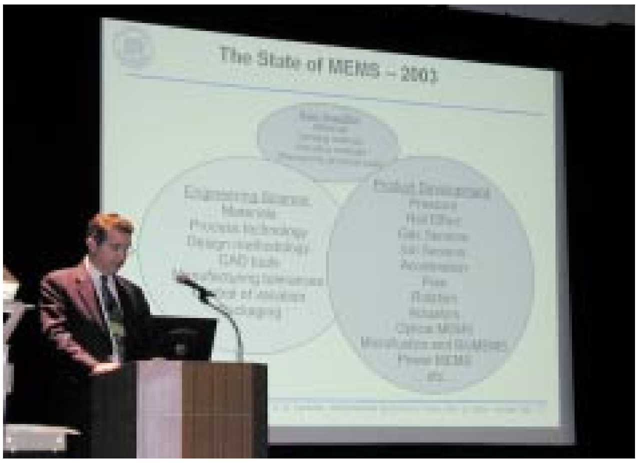
Looking forward from today, several trends are clear. The first is that both the emphasis and the funding for basic research are shifting into "nanotechnology," whatever that means. To some, it means simply making smaller versions of what is already familiar in the "micro" world. But to most, it is a completely different subject, building objects from the bottom up, with molecular manipulation and self-assembly. Nanometer-sized objects are being built for research uses. Such devices inherently must include quantum effects in their description. Given this shift, the MEMS practitioner has a choice: either go into "nanotechnology" (and many are doing that), or get into an area that does not depend on basic-research funding, namely, products. The problem, of course, is that building products is difficult.

MEMS vs. MEMS-Enabled Products: An Example

It is useful to distinguish between two types of MEMS-based product. In the first category, referred to as a "MEMS product", the MEMS chip, with or without its primary package, is the product. Electronics may be integrated into the chip, as in the Motorola pressure sensor and the Analog Devices accelerometer. The second category, referred to as a "MEMS-enabled" product includes not only the MEMS chip and its package but also ancillary components, external electronics, possibly embedded software or firmware, and an overall product package. Both categories of product require test, calibration, documentation, and some kind of quality-management system (ISO or equivalent). The Polychromix Dynamic Channel Orchestrator provides a good example of a MEMS-enabled product. The core technology is the polychromator, an electrically programmable diffraction grating with up to several thousand parallel mirror elements suspended above a substrate, each one of which can be actuated to change its height above the substrate. This creates an aperiodic programmable diffraction engine capable of creating synthetic spectra. While this technology was originally developed for chemical sensing applications using optical spectroscopy, it is now being applied to optical telecommunications by Polychromix. The product operates over the telecommunications C-band (wavelengths near 1.55 microns), controlling the power in 100 channels spaced 50 GHz apart over a 40dB dynamic range under program control.

Conclusion

I have explored some of the challenges facing real-world MEMS products, with emphasis on the higher-value-added MEMS-enabled products. Even with these many difficulties, there is enormous vitality and creativity in the MEMS community, and with appropriate attention to the many risks and challenges ahead, it will be possible to build, and successfully sell, new MEMS-based products to a welcoming world. As a conclusion, ideas for MEMS have been already fulfilled and the development of MEMS technology has been become ready in every relating fields. Moreover infrastructures to fabricate commercial products such as foundry services, and CAD tools have been completed. What the next step for MEMS is only to make products.



Olympus's MEMS Foundry Service

Ryo Ohta, MEMS Technology Division, Olympus Corporation

1. Outline of MEMS Activities at Olympus

Olympus Corporation is involved in the fields of medicine, imaging, industry, and life sciences. Our areas of business rely largely on basic optical and precision technologies. Micro-electromechanical systems (MEMS) is a element technology that has enabled us to further develop these basic technologies in line with our goals. In April 2003, Olympus formed the MEMS Technology Division in order to unify all MEMS-related departments. Our division is committed to developing the core competence of MEMS technology, as well as new business enterprises. The MEMS Foundry is directly linked to our efforts in developing the latter and is expected to yield many developments.

2. History of Micromachine and MEMS Development at Olympus

MEMS development at Olympus originated with research on semiconductor devices. Beginning around 1980, we worked on developing general-purpose semiconductor devices and imagers for use in the office. In the 1990s, our research and development of MEMS was sparked through participation in the micromachine project and development of probes for an atomic force microscope called AFM cantilevers.

An AFM cantilever is a micro-device composed of Si or Si nitride films formed in a semiconductor process. The tip of the cantilever is formed of a probe having a curvature radius of 10 nm or less, the production of which requires ultra low stress thin film technology. This thin film technology differs from ordinary fabrication technologies for IC devices. Successful commercialization of our AFM cantilever made it possible for us to develop a foundry for MEMS devices.

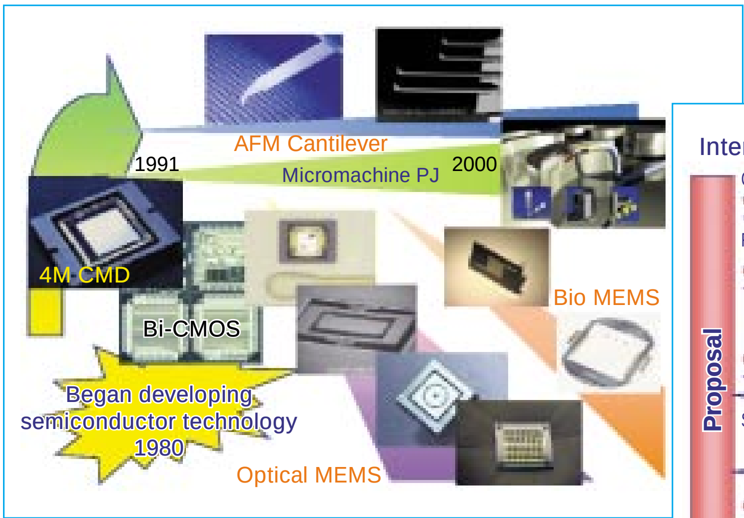
Through the micromachine project, we succeeded in developing various sensors and a 3D packaging technology integrating ICs with MEMS devices. Participation in the micromachine project allowed us to develop such advanced technologies as structure formation using polyimide and on-chip integration of piezoelectric materials, which have had a significant effect on our MEMS development.

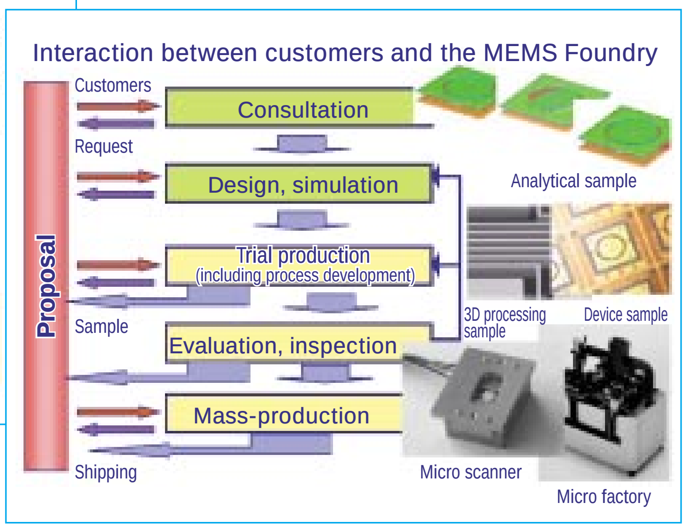
Subsequent MEMS activities included the development and commercialization of optical MEMS used in optical instruments and research on Bio MEMS for the human genome. Last year, Olympus was accepted in the MEMS Project to develop a fabrication technology for high-precision optical MEMS aimed at the optical communications market. Accordingly, we have been developing advanced fabrication technologies and introducing state-of-the-art MEMS fabrication facilities.

3. Features of Our MEMS Foundry Services

The Olympus foundry handles all phases of development and production in accordance with the customer's needs, from consulting to device and process design and mass-production. We make the most of our accumulated MEMS-related technology assets and advanced, flexible trial production line. By making use of our accumulated knowledge for customer service, we will strive to achieve a high degree of customer satisfaction.

Please contact us via e-mail at
MEMS_Lab@ot.olympus.co.jp.





Column

Can MEMS become an Academic Discipline?

Osamu Tabata, Department of Mechanical Engineering,
Graduate School of Engineering, Kyoto University

One of the many questions that I have long been asking myself is "Can MEMS become an academic discipline?" If it were you, how would you answer? Here I would like to present the background behind this question and my own tentative answer, which has finally begun to take shape. I would appreciate any comments you may have.

Before getting into the main topic, I would like to explain briefly about how I become involved with MEMS. I first became interested in the field commonly known as MEMS in 1979 when I was a 1st year Master's student. I was part of Prof. Naito's research laboratory in the Instrumentation Engineering Department of the Nagoya Institute of Technology, but I also researched information processing of electrocardiogram under Prof. Yamada of the Division of Circulation, Research Institute of Environmental Medicine, Nagoya University (RIEM), with which our department conducted joint research. My days were taken up with conducting animal tests jointly with medical doctors; devising an machine language for programming the just-released microprocessor, 8080, jointly with engineers working for medical instrument manufacturers; and going back and forth to the computing center, my arms heavy with bundles of punch cards. One day, when I was in the RIEM library reading the Journal of Bio Medical Engineering, my eyes were arrested by an article on silicon chip with multi hole active electrodes that could be used to measure the action potential of nerve fiber bundles.(1) This was my first encounter with silicon microfabrication technology, and I was fascinated. This led to my meeting with the late Dr. Igarashi, who was conducting research on silicon piezo-resistive semiconductor pressure sensors, and to my joining in 1981 Toyota Central R&D Labs., Inc., where I was involved in research on silicon micro-flow sensors. At that time, the terms "Micro Electro Mechanical Systems (MEMS)" and "micromachines" did not exist. K. Petersen's historic review(2) was published the following year, and I remember my excitement as I collected and read through all the reference materials listed. After that, the micromachine boom began in earnest with the release of the microgear(3), and as many of you will know, the Micromachine Project was begun in 1991 under the direction of the former Ministry of International Trade and Industry (now the Ministry of Economy, Trade and Industry). In 1996, I moved to Ritsumeikan University and poured my energies into establishing a MEMS research laboratory even as I pondered how MEMS research could be integrated into academia. In September 2003 I moved to Kyoto University, where I am in charge of micromachine engineering.

To think, it's been 25 years since my introduction to MEMS in 1979. During this time, I have been frequently asked, "What's your background?" My reply is always, "I began in instrumentation engineering, which is a jack-of-all-trades field including electricity/electronics, machinery, physics, control, and mathematics, so it was excellent preparation for MEMS research." Certainly, on the one hand, the field of MEMS research has thus far more than satisfied my intellectual interest and curiosity. However, on the other hand, I am always asking myself, "What is my field of specialization?" and I found that there was a part of me that was not satisfied by the answer "MEMS." This was because I felt uncomfortable claiming as my specialization a field that was not recognized as an academic discipline.

Here I will use my own definition of "academic discipline" without delving into a deep discussion of how to define the term. I regard an "academic discipline" as a research field in which the essence of various phenomena and questions pertaining to a particular field are probed and theories explaining the structures and phenomena therein and techniques for resolving these questions are systemized. There are sure to be some fields in which this cannot be achieved by simply adapting theories and techniques developed in other disciplines. Taking mechanical engineering as an example, it used to be that the so-called "3 dynamics" -hydrodynamics, thermodynamics, and material mechanics - were the basic "academic disciplines." These "academic disciplines" centered on analysis, and it was the vital mission of those in academia involved with mechanical engineering to perpetuate and deepen these "academic disciplines." However, when MEMS came on the scene in the late 1980s, it took the opposite approach to that of conventional "academic disciplines." MEMS is a systemized body of knowledge incorporating a broad range of science and technology that supports modern civilized society. In other words, it is an unprecedented, sophisticated system built from a base comprising various conventional "academic disciplines": at its core is not analysis, but synthesis (generation/combination). This complex system involving synthesis in areas measuring several tens of millimeters or less, as a result of complex interactions between physicochemical phenomena, is gradually showing the way to an amazing range of new possibilities.

After much thought, I decided to clearly acknowledge that synthesis, which had not conventionally been regarded as an "academic discipline," was in fact an academic discipline. By doing this, I am able to answer the question I posed initially, "Can MEMS become an academic discipline?" with a "Yes." However, at the present time MEMS is still far from being an "academic discipline." The insight and efforts of many people is still very much needed if MEMS is to not simply adopt theories and techniques from other fields, but to systemize knowledge and theories as to how best to create a system that most effectively synthesizes multidisciplinary phenomena in minute areas. In MEMS, which has shifted focus from analysis to synthesis, there are many opportunities for young researchers who can perform synthesis without being influenced by the conventional "academic discipline" framework. One of my colleagues, who specializes in heat transfer engineering, told me that when he recently reviewed the latest heat transfer developments in the MEMS field, he had been impressed by the remarkable contributions of young researchers. At the first faculty meeting I attended after arriving at Kyoto University, all the newly appointed Professors and their areas of specialization were introduced by the director of graduate school of engieering. In the introduction I wrote for myself, I listed my areas of specialization as "cutting-edge processing," "nano-system integration engineering," "micromachines/micro-electro mechanical systems."

References

(1) Jun Yamaguchi. Trial Production of multi hole active electrodes for Use with Nerve Fiber Bundles. 17th ME Society Meeting 1978; awarded the Science News Research Advances Prize, April 28, 1979
(2) K. Petersen. 1982. Silicon as a Mechanical Material. Proc. IEEE, Vol.70, No.5: 420-457.
(3) Fan L.S., Tai Y.C., Muller R.S. Pin joints, gears, springs, cranks and other novel microstructures. Tech. Dig., 4th Int. Conf. on Solid-state Actuators and Sensors: 849-852.

MEMS 2004

MEMS 2004 (IEEE The 17th International Conference on Micro Electro Mechanical Systems) was held from January 25 (Sun.) to 29 (Thurs.), 2004, at the Maastricht Exhibition and Convention Center (MECC) in Maastricht, The Netherlands. The conference welcomed over 600 participants in total; furthermore, the number of pre-registered participants (546) was a significant increase over last year's pre-registered attendance of 513, continuing the growth trend of recent years. Aided by the European venue, the conference enjoyed a good balance of participation for an international academic conference with 247 attendees from Europe, 118 from North America, and 178 from the Pacific Rim.

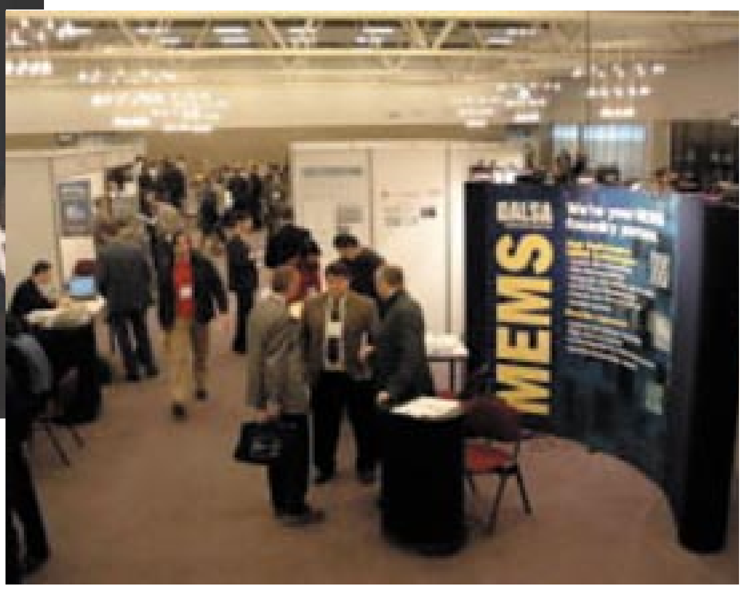
A total of 217 papers were presented (compared to 176 last year): 3 invited lectures (same as last year); 41 oral presentations (22 last year); and 173 poster presentations (151 last year). Due to the increase in MEMS R&D, the number of papers submitted for this conference has ballooned year on year (629 submissions this year as opposed to 500 last year: a 20% increase). Consequently, with the single session format for oral presentations employed again this year, presentations could not be contained in morning sessions as it was last year, and so a full-day program was implemented. By nationality, the most presentations were made by North Americans (80), followed by Japanese (48), Swiss (14), South Koreans (13), Germans, and Taiwanese (11). The European venue played some role in the high number of Swiss presentations. By field, a large proportion of presentations focused on bio & chemical microsystems; presentations on production, packaging, and mechanical-physical issues were also prominent.

In the first of the invited lectures, Prof. Nico de Rooij of the University of Neuchatel, who has also addressed an MMC-sponsored symposium, spoke on the topic "MEMS for Watches," introducing the value MEMS can add to watches giving the examples of Si gears and position sensors, and arousing great interest in the potential to create new value through the integration of conventional and MEMS technology. In the invited lecture held on January 27, Prof. Toko of Kyushu University spoke on the topic "Measurement of Taste and Smell using Biomimetic Sensors." The high expectations held for future results of this research were reflected in the eager applause that this presentation received.

Session 1, chaired by Prof. Tabata of Kyoto University, focused on self-organization, which has recently been attracting growing interest, and Session 2 focused on cell and particle handling. Together these two sessions provided a taste of the future directions of this research field. In Session 4, "Bio Medical Devices," presentations such as "Parylene Flexible Neural Probe with Micro Fluidic Channel" by the first speaker, Prof. Takeuchi of The University of Tokyo, provided a sense of overall future trends in the MEMS field, with high expectations held for NEMS (Nano Electro Mechanical Systems) and broad expansion of MEMS applications. Session 6, "Nano Electro Mechanical Systems," introduced the 3D nanofabrication technology using electron beam lithography that has been developed by NTT Basic Research Laboratories. The seconds-long around-the-world demonstration performed using the world's smallest globe - a 60μm diameter globe created using the NTT technology - met with enthusiasticapplause.

With respect to RF technology applications, oscillators and switches developed with MEMS have performed amply at the R&D level, indicating that we are moving even further towards full-fledged practical application.

This year's presentation themes cut a particularly good balance, highlighting both practical applications of MEMS technology and possibilities for the future.

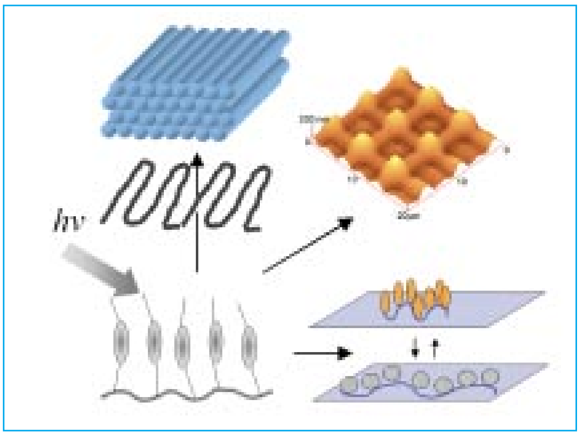


Laboratory Profile: Development of a Photoinduced Molecule System

Seki Laboratory, Graduate School of Engineering, Nagoya University

Seki Laboratory was established in July 2002 by Professor Takahiro Seki, formerly of the Chemical Resources Laboratory at the Tokyo Institute of Technology. Assistant Professor Shusaku Nagano joined our laboratory in November 2002. Our laboratory has now been conducting research for a year after the enrollment of students in April 2003. Associate Professor Yukikazu Takeoka joined us in April 2004, and we are now pursuing our research interests with a total of 25 members: three supervisors, a secretary, a JSPS Postdoctoral Fellow, five PhD students, ten masters course students and five undergraduate students.

Our principal topic of research involves developing assembly methods for new soft materials having photoresponsive functions, such as organic polymer films, liquid crystals, colloidal materials, and compounds thereof, and controlling dynamic functions of these materials. Professor Seki has been particularly interested in conducting research on monomolecular film with nanometer thickness in order to verify that the film provides useful photoresponsive properties. Azobenzene molecules reversibly change molecular shape and other properties in response to light. Professor Seki has incorporated these molecules in high polymers to construct molecular systems in which photoresponsive information at the molecular-level can be effectively conveyed to and amplified at the material level. While much research has been conducted on the manipulation of electrons, holes and optical information using light, our research is distinguished by our efforts to realize dynamic functions in molecules or the material itself that exhibit photoinduced motion, such as expansion and contraction , migration, or molecular alignment. We discovered a photoresponsive monomolecular film that exhibits the world's largest level of expansion and contraction, as well as the most sensitive photoinduced mass transfer. In addition, we succeeded in developing a new technique using light to align polymer films and mesoporous inorganic material. The diagram shows the concept of our research. Our focus is not on the behavior of a single molecule, but on the strong molecular cooperativity (interaction) exhibited when an aggregation of molecules and high polymers behave as a group. The concept of driving molecular systems with light can easily be applied to micromachine technology.



Assistant Professor Nagano has been studying a new approach using the Langmuir-Blodgett (LB) method to form a nanofilm on the surface of water. He developed a technique to create a monomolecular film on the water surface with completely hydrophobic polymers by hybridizing polar liquid crystal molecules. Since LB thin films normally require a polar group in the polymer for fabrication, usable materials are limited. With the technique developed by Nagano, however, LB thin films can be fabricated from many hydrophobic (non-polar) polymers. Accordingly, his technique has attracted a lot of attention as a potential new method for fabricating nano-materials. Nagano has also focused on block copolymers and using light to control their two-dimensional nano-scale phase separation.

Associate Professor Takeoka, who transferred from the School of Engineering at Yokohama National University in April, specialized in providing functions to polymer gels. He prepares a hydrogel material using crystals composed of molecules having uniform particle size as a genetic template. The hydrogel selectively reflects incident rays to emit various colors based on its periodic structure. The wavelength of reflected light varies because the hydrogel expands and shrinks in response to such stimuli as temperature, pH, light, and enzyme activity , causing changes to the periodic structure distance. Accordingly, the hydrogel can be used as a sensor for reflecting various responses to the environment. There is also much interest in employing this gel for directly observing cooperative movement of polymer chains.

Our laboratory has been actively working with other research groups in the field of soft materials, focusing on liquid crystals, gels, and nanofilms. We are committed to continuing studies aimed at developing a system to drive photoresponsive molecules that will be directly useful in practical applications.

Seki Laboratory Website:
http://www.apchem.nagoya-u.ac.jp/butsu3/sekilabo/index.html

MICROMACHINE No. 47

MICROMACHINE is published quarterly by Micromachine Center (MMC) to promote the international exchange of information related to micromachines, R&D and other technical topics, and is circulated free of change. Please send your comments about **MICROMACHINE** to the publisher :

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/

Date of Issue : May 17, 2004