MMC
2004 10
MICROMACHINE

MMC Activities

The 10th International Micromachine/Nanotech Symposium

The 10th International Micromachine/Nanotech Symposium will be held on November 11 (Thursday), 2004, at the Science Hall of the Science Museum (Kitanomaru Park, Tokyo), and is being organized by the Micromachine Center.

This is the 10th symposium since the 1st International Micromachine Symposium was held in 1995. Supported by METI and NEDO, the symposium aims to establish and disseminate micromachine technology, as well as promote awareness of micromachine technologies in various industries. Since the 8th symposium, held in 2002, its focus has widened to include the field of nanotechnology, with the sub-title "Foundation of Industrial Technology in the 21st Century".

The symposium was planned by the organizing committee (committee chairman: Professor Isao Shimoyama, The University of Tokyo), and the program and guest speakers decided by the program committee (committee chairman: Professor Hiroyuki Fujita, The University of Tokyo). Furthermore, to reflect international perspectives and to enrich the content of the symposium, an advisory board has been established comprising nine representatives from the U.S.A., Britain, Germany, France, Italy, the Netherlands, Australia, Canada and China, who participated in the 10th Micromachine Summit held earlier this year in Grenoble, France. Speakers from overseas have also been invited to address the symposium.

Micromachine technologies are starting to play a crucial role in supporting peace of mind and safety in our advanced information society. Moreover, bold challenges in the frontier fields of next-generation micromachines and NEMS are taking place in response to trends in the cutting-edge technologies of nanotechnology, biotechnology and information technology, innovative areas of late. A variety of policies are being tried to establish micromachines technology's status as the bedrock for next-generation industrial technologies and the cornerstone for the creation of new industries. The symposium plans to invite speakers from the forefront of the field, from both Japan and abroad, to speak about the state of micromachine technologies and their development. The symposium program will comprise five sessions, and lectures are to be presented by four speakers from overseas and eleven from within Japan.

During Session 1, "the Opening," the Director of the Industrial Machinery Division in the Manufacturing Industries Bureau of the Ministry of Economy, Trade and Industry (METI) will address the symposium. This will be followed by a special lecture by Professor Susumu Sugiyama of Ritsumeikan University, director of the university's Research Center for MicroSystem Technology, entitled "New progress of integration and fusion in MEMS -Expectations for new industry creation." As the keynote speech of the symposium, we can expect this lecture to provide valuable information about technical policies and the future trends surrounding MEMS.

Session 2, "Micromachine technology for safe and secure advanced information societies," will feature the following three lectures by senior figures in some industries that are closely linked to our everyday lives -cars, information equipment and medical devices:

1. MEMS for automotive electronics systems
2. Display and MEMS
3. State of the art technology for endoscopes

It is anticipated that these lectures will convey the power of micromachine technologies.

For Session 3, "New MEMS/systems and technology," we have planned seven lectures about innovative research. The three lectures on feasible future-oriented network systems using MEMS include the views of Crossbow Technology Inc., which developed wireless sensors ideal for ubiquitous environment R&D, and IMEC, which focuses on research about FR-MEMS and innovative network systems using RF-MEMS. There will also be a variety of lectures covering subjects such as smart skin for turbulence control using micromachine technology, biodevices, image sensors, and the nanoimprinting technology that is revolutionizing micro and nanomachining.

Session 4, "Policy trends of MEMS research and development" features four lectures by speakers from Japan and overseas, and takes a look at policies to encourage MEMS R&D. Among the lectures, Professor William C. Tang, formerly a DARPA researcher and now professor at the University of California, Irvine, will speak about America's strategies for research into biomedical applications for MEMS, and Professor Hidetoshi Kotera of Kyoto University will talk about the METI/NEDO MEMS design & analysis support system development project (MEMS-ONE Project), launched in an industry-academia consortium by Micromachine Center.

The 15th Micromachine Exhibition will be held at the Science Museum from November 10 (Wednesday) to November 12 (Friday), 2004 and will feature a diversity of exhibits presented by micromachine-related businesses, universities, and organizations. We believe that this micromachine exhibition and the symposium will provide a great opportunity for participants to obtain a clear, comprehensive picture of cutting-edge micromachine technologies, and we recommend attendance at both events in order to see real micromachines in action. Symposium participants can gain free admission to the micromachine exhibition simply by showing their participation cards. The deadline for applications to attend the symposium is October 29, 2004. If seats are available, applications will be accepted on the day of the symposium to enable as many people as possible to attend.

PROGRAM

November 11, 2004, Science Museum, Tokyo

8:45 – Registration

Session 1	**Opening**	**Chairman: Mr. Keiichi AOYAGI**
9:15 – 9:20	Opening Remarks	Dr. Tamotsu NOMAKUCHI, Chairman, Micromachine Center
9:20 – 9:25	Guest Speech	Mr. Yoshinori KOMIYA, Director, Industrial Machinery Division, Manufacturing Industries Bureau, METI
9:25 – 9:55	Special Guest Speech New Progress of Integration and Fusion in MEMS - Expectation for New Industry Creation -	Prof. Susumu SUGIYAMA, Director, Research Institute for Micro System Technology, Ritsumeikan University RITSUMEIKAN UNIVERSITY
Session 2	**Micromachine Technology for a Safe and Secure Highly Information Society**	**Chairman: Prof. Hiroki KUWANO**
9:55 – 10:25	MEMS for Automotive Electronics Systems	Mr. Touma FUJIKAWA, TOYOTA MOTOR CORPORATION
10:25 – 10:55	Display and MEMS	Mr. Yutaka TAKEI, Sony Corporation
10:55 – 11:25	State of the Art Technology for Endoscope	Mr. Hiroyuki FURIHATA, OLYMPUS CORPORATION
Session 3	**New MEMS / System and Technology**	**Chairman: Prof. Hiroyuki FUJITA**
11:25 – 11:55	Anytime-Anywhere Wireless Sensor Networks - Smart Dust -	Mr. John CRAWFORD, Crossbow Technology, Inc., U.S.A.
11:55 – 12:25	Autonomous Microsystems for Health and Comfort Monitoring Applications	Prof. Dr. Chris Van HOOF, IMEC, Belgium
12:25 – 13:10	Lunch	
		Chairman: Prof. Isao SHIMOYAMA
13:10 – 13:40	MEMS Network Systems	Prof. Hiroki KUWANO, Tohoku University
13:40 – 14:10	Development of Smart Skin for Turbulence Control with MEMS Technology	Prof. Nobuhide KASAGI, THE UNIVERSITY OF TOKYO
14:10 – 14:40	Advanced Biodevices Based on Nanomaterials and Microchip Technology and their Biomedical Applications	Prof. Eiichi TAMIYA, Japan Advanced Institute of Science and Technology
14:40 – 15:10	Nanoimprinting - Innovation for Micro and Nano Machining -	Prof. Dr. Ryutaro MAEDA, National Institute of Advanced Industrial Science and Technology
15:10 – 15:40	Integrated MEMS Array - Uncooled Infrared Image Sensor -	Prof. Masafumi KIMATA, Ritsumeikan University
15:40 – 15:55	Break	
Session 4	**Policy Trends of MEMS Research and Development**	**Chairman: Dr. Ryutaro MAEDA**
15:55 – 16:25	Status and Future Trends of MEMS Research in the U.S. for Biomedical Applications	Prof. William C. TANG, University of California, Irvine
16:25 – 16:55	Market Trends of MEMS	Prof. Isao SHIMOYAMA, THE UNIVERSITY OF TOKYO
16:55 – 17:25	EC FP6 Network of Excellence in Multi-Material Micro-Manufacture (4M)	Dr. Stefan DIMOV, Cardiff University, U.K.
17:25 – 17:55	Development of MEMS Design and Simulation System	Prof. Hidetoshi KOTERA, Kyoto University
Session 5	**Closing**	**Chairman: Prof. Hiroyuki FUJITA**
17:55 – 18:00	Closing Remarks	Mr. Keiichi AOYAGI, Micromachine Center

MEMS Foundry Service Provided by Oki Electric Industry Co., Ltd.

Nobuo Ozawa
Manager, MEMS Business Team, WP Business Division,
Silicon Manufacturing Company
Oki Electric Industry Co., Ltd.

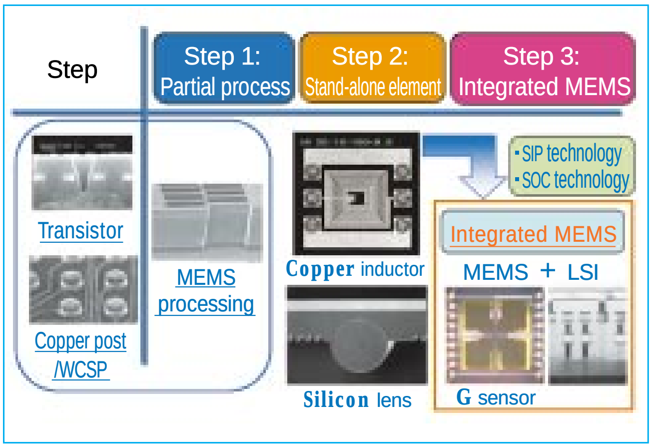
1. Overview

The MEMS Foundry Service at Oki Electric originated as a foundry service for silicon LSI. While the LSI foundry service was limited to wafer processing methods of the 1980s in the beginning, this service has now expanded to include mask production, wafer processing, testing, assembly, and LSI testing. Based on the development of these semiconductor devices and processing and production techniques accumulated during manufacturing, beginning in the 1990s Oki Electric began offering its customers MEMS manufacturing technology through silicon processing as a part of its silicon foundry service. Some of the processes for the MEMS foundry were developed as user-specific processes during the 1990s, but were limited to processes that could be supported on a silicon LSI production line at that time. Beginning from the late 1990s, the range of supported processes gradually expanded.

We are not preparing to offer any packaging services at this time. However, Oki Electric possesses technologies that are applicable to MEMS packaging, such as wafer-level chip size package (W-CSP) and multi-chip package (MCP). Hence, there is potential for developing a foundry service that encompasses packaging.

MEMS-specific processing techniques are being incorporated into silicon semiconductor processing to develop MEMS at the single-element level. Oki Electric is also conducting R&D on integrated MEMS that combine LSI and MEMS to produce systematic devices possessing signal processing and communication functions.

By effectively employing the processing and manufacturing techniques obtained through MEMS development in the MEMS foundry, we hope to provide customers with a higher quality of service.



2. Features of the foundry service

Oki Electric is applying its twenty years of experience in the silicon foundry and its experience in LSI processes from development to mass production to the MEMS foundry. We are pursuing a wide range of foundry services from development and trial production to mass production.

Since development and trial production are primarily conducted at Miyazaki Oki Electric (located in Kiyotake-cho, Miyazaki Prefecture), which has a mass production line, the transition from the trial production stage to mass production is extremely smooth. Further, by a special control division supervises the production facilities, enabling us to provide trial production and mass production results with high reproducibility.

Including processing of partially contracted alliance products, the MEMS foundry has manufactured capacitive pressure sensors, piezoresistive pressure sensors, accelerometers, and silicon microlenses in trial production and mass production.

3. Conclusion

The MEMS Foundry Service at Oki Electric works closely with its customers while producing MEMS products. The Service develops optimal processes suited to the user's concept of the product and the device design, based on silicon processing and analysis techniques, as well as process control and quality control techniques, cultivated over many years of LSI development and manufacturing.

By applying its MEMS manufacturing technology and know-how not only to its own products, but also to a wide range of foundry projects, Oki Electric hopes to provide an environment that fosters the production and development of MEMS products.

For further information, send e-mail to:
SiSC-MEMS@oki.com

Outline of the Oki Electric MEMS Foundry Service

Scope of service	From small-lot trial production to mass-production
Cleanliness	10-1000 class
Wafer diameter	4 and 6 inch
ISO and other certification	ISO9001, ISO14000
Process technologies	Silicon wafer processes -Bulk micromachining -SOI micromachining
Record of mass / trial production (including in-house products)	Accelerometers, pressure sensors, microlenses, various film deposition, etching, etc.

Column

Thoughts On Micromachines

Kazuhiro Hane, Professor, Department of Nanomechanics,
Graduate School of Mechanical Engineering, Tohoku University

Some twenty years ago after completing my doctoral course, I was accepted to teach in a new department at the university. The new Department of Mechatronics was established in response to developments in mechatronics in the industrial world. The classes were very lively, as the students were attracted to the new field, and there was much expectation placed on the young instructors in the new department. Although micromachines (MEMS) was one of the fields that produced heightened expectations, we organized the course with a broader concept: an integrated mechanical engineering course. One goal of the course was to develop semiconductor micromachining into a mechanical field. News from America such as the trial production of a chromatography system on a silicon wafer drew much attention. With this background, dreams and hopes for micromachines began to grow.

Integrated circuits produced in semiconductors were also developing rapidly in Japan during this time. The level of integration of IC's increased by tens of percentage points each year, and as a result the performance of computers increased dramatically. While more recent increases in memory capacity from, say, 1G to 2G may seem to the ordinary user as merely an increase in an already sufficient memory capacity, back when people were trying to get by with very limited memory, an increase in 1M to 2M was extremely beneficial and a remarkable development in the semiconductor industry. However, the Japanese industry that has shown steady development is mechatronics. This field, which merges machines and electronic systems, demonstrates the superior ability of the Japanese in manufacturing, as is represented by the automobile and automated production equipment. If the equipment and technology could be established, mechatronics, which requires many variations and merged technologies, was expected to be more suited to Japan's capacity for manufacturing than integrated circuits, which are easy to mass produce. Japan is also good at making mechanical and electronic goods smaller and has shown its superiority to the rest of the world in manufacturing compact recorders, timepieces, and camera systems. However, I think that Japan should place more emphasis on micromachines, which can be considered an extension of mechatronics.

Processing techniques for micromachines have advanced considerably in the last twenty years. Flexibility in the 3-dimensional processing of silicon using developments in DeepRIE has improved more than in anisotropic etching of crystals. However, DeepRIE is only capable of about 2.5 dimensions, not the unrestricted 3-dimensional processing that is possible in macromachining. It is expected that 3-dimensional processing will be developed with a higher degree of freedom in the future. As these processing techniques improve, numerous sensors and microsystems are being proposed and experimentally produced. Since many problematic areas in processing must be resolved to complete such trial manufacturing, once a proposal for trial manufacturing is agreed upon, researchers focus on specific problems. Although researchers always like to concentrate on detailed problems, I believe that a broader perspective will be required when developing micromachines in the future.

In the near future, Japan and the world will be faced with such problems as environmental issues, the growing population, and the food shortage. Japan is only about forty percent self-sufficient in food, with about one-fourth of its entire food supply going to waste. Therefore, it is necessary to construct systems for using resources and distributing food that are not wasteful. What will our society be like twenty years from now? Striving for profits in the industrial world is the fate of humankind, but, while it is important to produce products that are at least somewhat efficient, shouldn't ten or twenty percent of our efforts be aimed at some aspect that can contribute to problems facing all of Japan twenty years from now? Since problems facing the environment are pervasive, the issue is somewhat diluted, as most individuals today don't feel these problems affect them. To understand these types of widespread problems, I think it is necessary to study sensing and mobility over a large area. Networks continue to expand in towns and throughout the world, and I believe network technology will be an indispensable means for understanding large areas. By incorporating microsensors in networks, we may be able to place these pervasive problems of distribution and the environment in a context that we can understand. It seems that micro-problems in science can be resolved by tackling them analytically. However, I think it is necessary to develop new techniques for solving macro-problems.

Perhaps you remember the catch phrase "Can you work 24 hours a day?" If the trend of today's fast-paced society continues, such a scenario may not be altogether out of the question twenty years from now. I think we must strike a new course toward an affluence different from the materialistic, hurried society of today. It is my hope that MEMS, a technology indispensable for providing input and output between various sensors and computer networks, can contribute to the solution of these problems.

Overseas Trends

COMS 2004 in Canada, from Aug. 30 to Sept. 2

Sponsored by MANCEF, the 9th International Conference on the Commercialization of Micro and Nano Systems (COMS 2004) was held in Edmonton, Alberta from August 30th to September 2nd in order to discuss issues related to fostering MEMS commercialization. Each day during the conference earnest discussions were conducted on a variety of issues, including (1) general trends in industry, (2) starting an enterprise, (3) investment strategies for nanotechnology, (4) marketing strategies, (5) equipment vendors, (6) technical trends and topics, (7) technical transfer, (8) applications in specialized fields, (9) technology for specific disciplines, (10) reliability, (11) foundries, (12) micro/nano technology design tools, (13) NSF training program, (14) collaboration, and (15) dissemination and public relations.

I attended this conference as a representative from the Micromachine Center in order to investigate whether Japan could take any cues from the conference with regard to measures for promoting MEMS/micromachine commercialization. The following is a summary of the results of this investigation and my own impressions.

1) A total of about one hundred companies and institutions from the four hundred members of MANCEF gave presentations at this year's conference. Of the presenters, three were administrative bodies, thirty-two universities and research institutes, fifteen public institutions, and forty-six businesses. It is notable that only seven of the forty-six businesses giving presentations were major firms, while the others were small or medium venture businesses. A related exhibition being held simultaneously included forty-one exhibitor companies and institutes comprising thirteen public institutes, fifteen MEMS companies, three software vendors, and several others, including news agencies and patent firms.

2) There appeared to be about three to four hundred attendees, of which about ten were from Japan.

3) The following are some of the presentations that left an impression on me:

A. The national science advisor of the Canadian government announced that they had invested funds and established research facilities in five locations with the goal of becoming one of the top ten countries in nanotechnology by 2010.

B. A MEMS program representative from DARPA contended that MEMS must be approached differently than semiconductors due to the market scale, lot size, and other characteristics distinctive to MEMS. Specifically, the representative advocated the need for equipment and processing technology capable of performing processes for each chip.

C. The senior vice president of Philips described the progress made in developing LED light sources by system-in-package (chip-level packages), and began such open collaboration activities as co-developing RF MEMS capacitors with Nokia and developing bending displays by sharing facilities with Mi Plaza.

D. The Albuquerque Technical Vocational Institute noted that, based on MEMS growth, some seventy thousand technicians will be needed in the U.S. in 2005. The Institute also reported on training programs that were started in 2002 with cooperation from NASA and Sandia National Laboratories.

4) Overall I felt that this conference provided an opportunity to create a structure of collaboration and systems from the perspectives of technology, capital, and education and strives to foster MEMS/nanotechnology commercialization. This objective differs greatly from that of the MST/nanotechnology trade fair at Hannover Messe, which provides a venue for showcasing individual enterprises and technologies. Further, the major firms engaged in MEMS, such as Texas Instruments, Intel, and Hewlett-Packard, do not give presentations at this conference. This indicates that at large firms capable of producing and procuring their own products, conditions are quite different from those at venture businesses, which must collaborate with each other in respect of market share and capital.

5) On reflection, this is a good time to rethink the objectives and status of Japan's micromachine exhibit. Neither the conference nor trade fair mentioned above has succeeded in creating an opportunity to contact and communicate with users. I felt that this conference had become nothing more than a gathering for members of similar trades and suppliers of knowledge and technological sources. On this point, Japan has diverse industries and numerous businesses that are creating system products, in other words, the users of MEMS and micromachines. Those involved in MEMS and micromachines would place great value on an exhibition that arranges collaborations between manufacturers and users.

The Shaw Conference Centre is built into the banks of Edmonton's river valley. From the entrance, this pedway leads down, down to the conference area.

CANON Inc.

Makoto Shibata
General Manager, Inkjet Technology Development Center

1. Endeavors in Micromachine Technology

At Canon, we provide our customers with reliable products in a wide range of fields, including imaging equipment from personal cameras to broadcasting and professional uses; business machine such as printers, copying machines, and scanners; manufacturing and ultraprecision equipment for semiconductors and flat panel displays such as mask aligners and etchers; and medical equipment such as X-ray digital cameras and fundus cameras. These key components for our products in-house incorporate a variety of innovative technologies that adopt micromachine technology, and ensure that Canon always remains ahead of the competition.

Our R&D organizations are actively developing new products featuring micromachine technologies. To accomplish this, we are collaborating with experts in a variety of fields, including material development, simulation analysis, physical analysis and chemical analysis.

2. Development of Micromachine Technology

A specialist in high-precision processing, Canon was early to begin developing devices with micromachine technology, such as sensors and optical devices. The representative example of our MEMS devices is the print head lie at the heart of our inkjet printer, developed by our original technology in the 1970s. To produce micro fine droplet accurately, the nozzles, the most important part of the print head (Fig.1), must be made highly precise. Combining our micromachine technology and material technology into every nozzle manufacturing step, Canon has developed the original nozzle manufacturing process to produce highly precise integral nozzles and eliminated the use of bonding process. This technology also enables high-density nozzle packing and leads to the breakthrough in printhead performance. We have named this technology as FINE (Full-photolithography Inkjet Nozzle Engineering).

At Canon, we are also actively engaged in the development of processing technologies for MEMS in next generation products, such as the Einzel lens arrays (Fig.2) and Micromirrors (Fig.3). Einzel Lens arrays perform aberration correction which is essential for achieving high throughput in next generation maskless exposure systems employing a multi-electron beam, and is useful to large items and small production. Micromirrors are expected to be applied in laser scanning displays and optical switches in next generation.

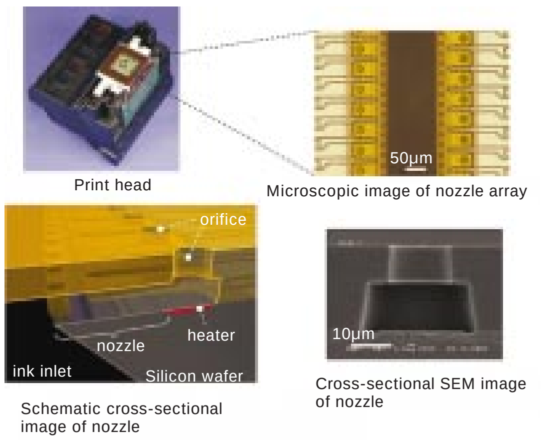


Fig. 1 Inkjet head

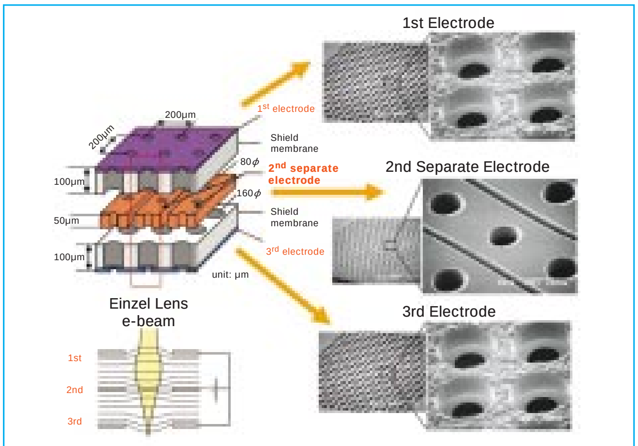


Fig. 2 Einzel lens array

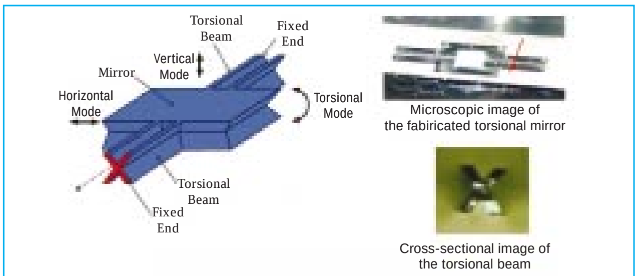


Fig. 3 Micromirror

3. Future Endeavors

The importance of micromachine technology will continue to increase for its use in product discrimination. We will continue to cultivate this technology in pursuit of new potential, and then the ongoing development of reliable products ensure to satisfy our customers.

Seiko Instruments Inc.

Yoshinobu Hirata
Vice President

On September 1, 2004 our company name in Japanese was changed from *Seikô Insutsurumentsu* to *Seikô Insutsuru* (romanized form of the Japanese; the English name remains unchanged as Seiko Instruments Inc.). *Insutsuru* is derived from the Latin word *instruere*, meaning to prepare, provide, or build. This word embodies our desire to build a new value in society by preparing and providing products and services that anticipate any new era. It is also our wish that, by adopting a unique name, we can cultivate a business that is easy to remember and familiar to everyone. We look forward to your continued patronage.

The following is a description of the micro-technologies in which Seiko Instruments is engaged.

1. Micro-technology and nano-technology

Seiko Instruments was established as a watch manufacturer in 1937. Using several of its original technologies, we produced what could be called the first commercialized micromachine, a mechanical watch that achieved unparalleled precision. During a subsequent process to develop a quartz watch with even higher precision, we worked with such components as semiconductors, quartz oscillators, batteries, and liquid crystals display. We have since applied these technologies fostered through watch manufacturing to other products for which compactness and efficiency have become an obsession.

Seiko Instruments began working on micromachines in a recent project on micromachine research. We participated in the technological development of a microfactory in an effort to conserve energy, space, and resources in production equipment and produced a trial manufacturing system for micromachining and assembly in a joint project involving seven companies. During this project, we uncovered much information regarding various issues and advantages in producing compact production equipment. With this trial production system we succeeded in performing electrochemical micromachining at the micron-level.

Seiko Instruments has conducted R&D on a scanning probe for use in an atomic force microscope (AFM), one commercialized product using MEMS technology. An AFM normally employs a highly sensitive optical lever for detecting displacement of a cantilever. This is disadvantageous in that the displacement sensing system must be large in order to ensure a sufficiently long optical path for the optical lever system, and the system does not operate well when submerged. Accordingly, we produced a self-sensing cantilever that incorporates a displacement sensing function in the cantilever. Fig. 1 is a photomicrograph of the self-sensing cantilever.

Our recent endeavors in nanotechnology that have attracted attention are the development and sales of scanning probe microscopes with sufficient resolution to observe atoms and molecules and focused ion beam systems enabling measurement and processing on the order of several nanometers. These devices are primarily employed in advanced nanotechnology research, but may also be used in semiconductor fabs.

2. Future Endeavors

By pursuing compactness and efficiency, Seiko Instruments continues to create useful products that are unique in the world. We are developing products through a combination of MEMS and machining technology, which we developed when manufacturing watches to form micro-parts, and creating devices through the fusion of MEMS and nanotechnology. We are also working actively to produce more compact manufacturing equipment and to achieve innovations in manufacturing and production technology.

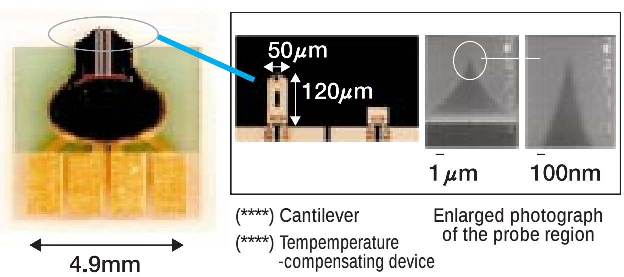


Fig. 1 Photomicrograph of an AFM cantilever

Worldwide R&D

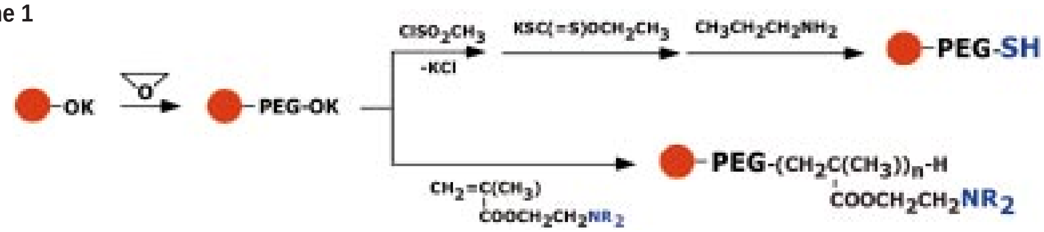
Designing a Bio/Nano-Interface

Yukio Nagasaki, Professor, Nagasaki Laboratory, Department of Materials Science and Technology, Faculty of Industrial Science and Technology, Tokyo University of Science
E-mail: nagasaki@rs.noda.tus.ac.jp

Our laboratory strives to design biomaterials that function within a living organism. The laboratory currently has twenty-five members, including Dr. Yukio Nagasaki, assistant Yoshinori Katsuyama, postdoctoral fellow Hajime Oishi, three doctoral students, ten masters students, and nine undergraduate seniors.

We could almost completely suppress nonspecific adsorption by immobilizing PEG chains with different molecular weights (Fig. 1). Highly sensitive biosensors and other devices can be created on this material surface by immobilizing specific functional groups (antibodies, enzymes, sugars, etc.) on the termini of the PEG chain.

Scheme 1



The basic goal of our laboratory is to manufacture "biomaterials," which are materials that function within a living organism. It is particularly important to design a contact interface between blood or tissue and the material in the organism. Hence, the design of "bio/nano-interfaces" has become our most important task. In designing this interface, we have also focused our studies on polyethylene glycol (PEG), commonly found in living organisms. A hetero-bifunctional PEG having functional groups introduced in different quantities on its termini can be employed as a useful material for designing various surfaces (see Fig. 1).

By immobilizing a hetero-bifunctional PEG synthesized in this way on the surface of various materials, it is possible to design an interface on which such biological components as proteins, lipids, and cells are not adsorbed. We discovered that

Further, we discovered that by similarly pegylating the surface of micro- or nano-size particles, it is possible not only to control nonspecific adsorption on the surface, but also to improve dispersion stability drastically.

This revolutionary technique facilitates the use of such particles, which were previously very difficult to disperse in biological fluids with high ion concentration, such as sodium and potassium. These pegylated nanoparticles make it possible to employ various nanoparticles of gold, semiconductors, silica, and fullerene to be used in a bioenvironment.

We are now working day and night with the students to develop practical bio/nanomaterials such as these.

On October 1, 2004, our laboratory will be transferred to the Tsukuba Research Center for Interdisciplinary Materials Science (TIMS).

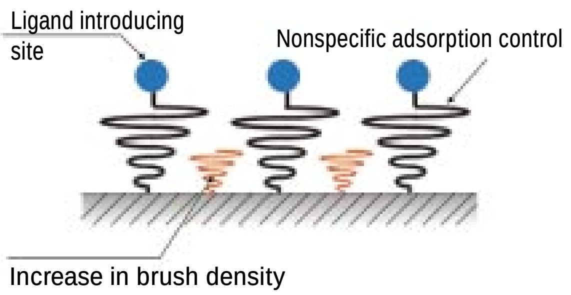


Fig. 1 Developing a highly functional bio/nano-interface

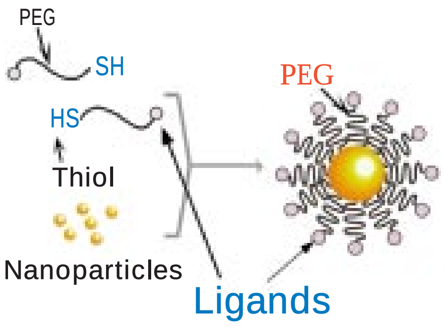


Fig. 2 Regulating pegylated nanoparticles to function in a living organism

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