MICROMACHINE

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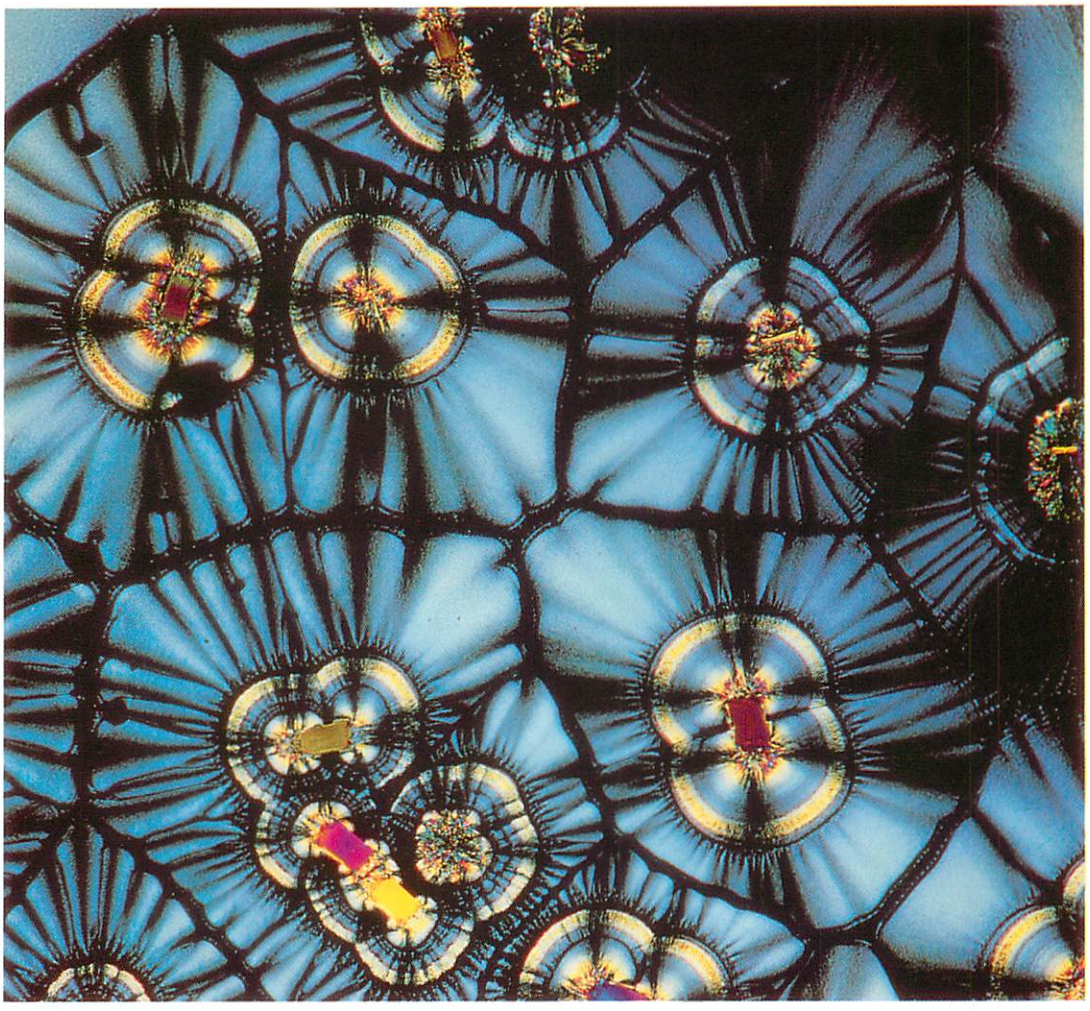
Future Article: Towards the Realization of Micromachines



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Micromachine Center

Message from the New Executive Director

Takayuki Hirano
Executive Director, Micromachine Center

After my appointment to the post of executive director of the Micromachine Center, I have deepened my understanding of the center's business.

To achieve the objective of the center, which is to build a new paradigm of micromachine technology, it is necessary for us to pursue various approaches simultaneously. First of all, the most important point in building a technological paradigm is activity that brings forth technological knowledge—in other words, creative activity.

In this respect, the micromachine technology project of the Industrial Science and Technology Frontier Program, which is currently being implemented by the Agency of Industrial Science and Technology, has a central role to play. This project brings together the potential of industry, academia, and governmental research institutes. It can be described as a locomotive running along the front line of technological development.

At present the Industrial Science and Technology Frontier Program is at the stage of research and development of elementary technologies with a common basis, so the image of machines that it is pursuing focuses on their application in industrial maintenance, such as at power plants, and medical treatment. A second planning stage is scheduled to be formulated in fiscal 1995 on the basis of the results of this research.

While the government is taking the lead in promoting this Industrial Science and Technology Frontier Program, at the same time universities, national research institutes, and industries are engaged in their own individual activities. University research laboratories are conducting innovative academic research concerning microtechnology, and national research institutes similarly are carrying out basic research. Such activities are cultivating the new seeds of micromachine technology. Private companies are pursuing development from the perspective of using micromachines in their existing mechanical systems.

The Micromachine Center provides support for these activities in industrial, academic, and governmental circles. In particular, exchange among them is important for promoting technological innovation.

Next, since the diffusion of newly created technologies is essential, the center has an important role to play in gathering and supplying information and promoting standardization.

Also, it is important for us to keep an eye on the international progress being made by micromachine technology. The technological paradigm of micromachines stretches across an extensive range of technological fields, so research activities today have a global dimension. It can be expected that the mutual exchange of information will lead to the promotion of stimulating research.

There are other projects that the Micromachine Center must implement, too. For example, the young generation's move away from science and engineering in recent years has become a matter of concern. Several reasons can be cited for this tendency, but I think that one of them is that no attractive new technologies or lively machines have emerged. Of course we have a lot of advanced technologies, like electronics, biotechnology, and new materials, but these are too specialized. To put it another way, they seem to have created their own closed world, as if encased in a black box. Young people have less chance now to develop a first-hand interest in science and technology.

Micromachines not only have near-at-hand applications but also expand their image into the world of science fiction. Adults can appreciate near-at-hand applications, too, but when it comes to the distant future, adults are no match for young people with their pliable minds. I believe, therefore, that gaining the participation of the younger generation in formulating images for the use of micromachines in the future is an important issue.

In addition, it is important to establish a common awareness among leading people in industries, government, and academia that this technological development will provide an important support for the industrial base in the future. Unceasing and creative efforts of researchers are essential for micromachine R&D, so it will be necessary to create a favorable environment for this. I believe that the Micromachine Center is expected to play a leading role in conducting educational activities targeted at this broad spectrum of people.

While Japan is being asked to make an international contribution in a variety of areas, we should remember that maybe science and technology are our strongest points. Micromachine technology is still in the stage of infancy around the world, so it would be extremely beneficial for Japan to play a leading international role and promote technological progress in this field.

I firmly believe that micromachine technology possesses the strength and potential to bring about "a renaissance in mechanical engineering." I am aware that I have been given a valuable opportunity to immerse myself in the whirlpool of this renaissance. At the same time, I realize that I have been given a very important mission. I intend to move forward hand in hand with the people concerned, so I ask for your cooperation.

International Symposia on Micromachines

– History through The Fourth International Symposium –

Toshio Fukuda
Faculty of Engineering, Nagoya University

1. Micromachine Technology and Industry

The Tokai District has traditionally been the hub of the flourishing machine, transport and aerospace industries, and it is now also the center of industries involved in robotics, mechatronics and factory automation. A variety of establishments related to mechatronics, including developing sensors, sophisticated systems and equipment items can be found here. Micromechatronics is viewed as the advanced mechatronics with further value added, and is now recognized as a micromachine technology.

Dr. Isemi Igarashi, at the Toyota Central Research and Development Laboratories and his group have been researching silicon sensor technology for the past thirty years at this location, giving the district a lead in microsensor technology also. Investigations began in the mid-1980s into merging the technologies of micromachining, measuring, controlling, systematizing and information communication into the previously traditional mechatronics technology and this is now viewed as a new industrial area.

Micromachine technology in particular, which covers the fields of information and electronics that are currently lacking in this district, has been advanced as the potential core of this latest industry. The city of Nagoya is, coincidentally, promoting the construction of a science park centering around electronics at Shidami in that city.

The following is a review of the International Symposia on Micromachines held to date.

2. The First International Symposium

In response to the expectations prevailing for micromachine technology, the First International Symposium was held in Nagoya in October, 1990 with the title, "Micromachine and Human Science" (Photo 1). It was jointly sponsored by the Technical Committee on Decentralized Microrobotics, which belongs to the robotics and mechatronics branch of the Japan Society of Mechanical Engineers, and the Micromachine Study Group, established by the City of Nagoya and the Chubu Industrial Advancement Center. The title of this symposium was selected based on the belief that micromachines represented a technology contributing to human betterment. The

Photo 1 The 1st International Symposium

Toyota Conference on Micromachines was held in 1989, but was a closed conference, so that this 1990 event was actually the first truly international symposium open to the public in Japan and 450 people took

Photo 2 The 2nd International Symposium

part. The subject was then still quite novel, so the topics varied widely from an introduction of micromachine technology to a description of the most advanced technology. The enthusiasm and efforts of those concerned in Nagoya's municipal government and in other organizations were largely responsible for the success of this first undertaking.

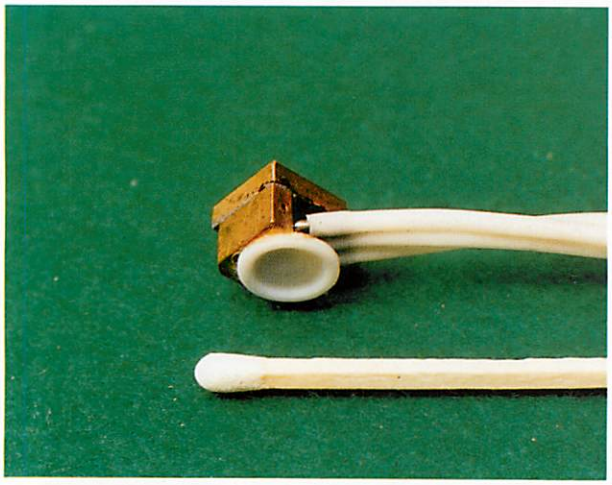


Photo 3 Robots for the International Climbing Contest

3. The Second International Symposium

The second in this series was held in Nagoya in October, 1991 (Photo 2). In addition to the special lectures, panel discussions and general sessions, a climbing microrobot contest was held for micromachines smaller than 1cm x 1cm x 1cm (Photo 3). Billed as a demonstration of these units, the contest was the brainchild of Professor Teru Hayashi of Tokyo Institute of Technology and others; in the years following it has gradually become a kind of benchmark test. The contests have been reported on television, in the newspapers and in other media and have aided the general public outside the field to understand and learn about micromachines. It was at one of these contests that the microrobot "Monsieur" made its first appearance. This robot was later placed on the market by Seiko Epson Corp.

There were more than 600 participants in this second symposium which was cosponsored by the Japan Society of Mechanical Engineers, the Society of Instrument and Control Engineers, the Robotics Society of Japan and IEEE. Many companies exhibited trial micromachine products and other items they had developed, and these too helped to further understanding of the field. Participants particularly enjoyed the very humorous special lecture presented by Professor H. Guckel of University of Wisconsin, U.S.A.

4. The Third International Symposium

Since the first two meetings had been held in October, the Third International Symposium was also

Photo 4 The 3rd International Symposium

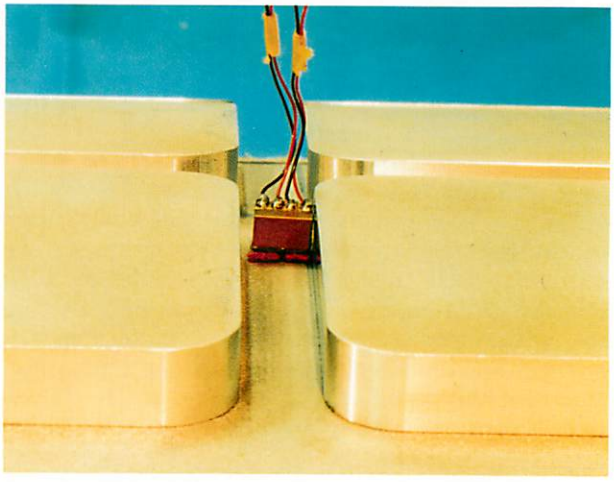


Photo 5 The Microrobot Maze Contest

held in Nagoya in October, 1992 (Photo 4), and this time, in addition to the special lectures, panel discussions, general sessions and exhibition which had now become the basic framework, a microrobot maze contest was held (Photo 5). Small, remote-controlled robots 1cm x 1cm x 1cm were to go through a maze as quickly as possible from the starting point to the goal, passing specified points. The contest was greatly appreciated by other participants and onlookers because it offered a good opportunity to learn what kind of micro-actuators were being used, how energy was conveyed, the remote-control apparatus used to operate the machine and what kind of microrobotic interfacing was used for optimum operation. Some regarded it as an intermediate stage of micromachine technology, since the point was to make a truly autonomous microrobot carrying a micro-sensor and microprocessor and also to realize completely decentralized microrobots in the future. The sizes of the

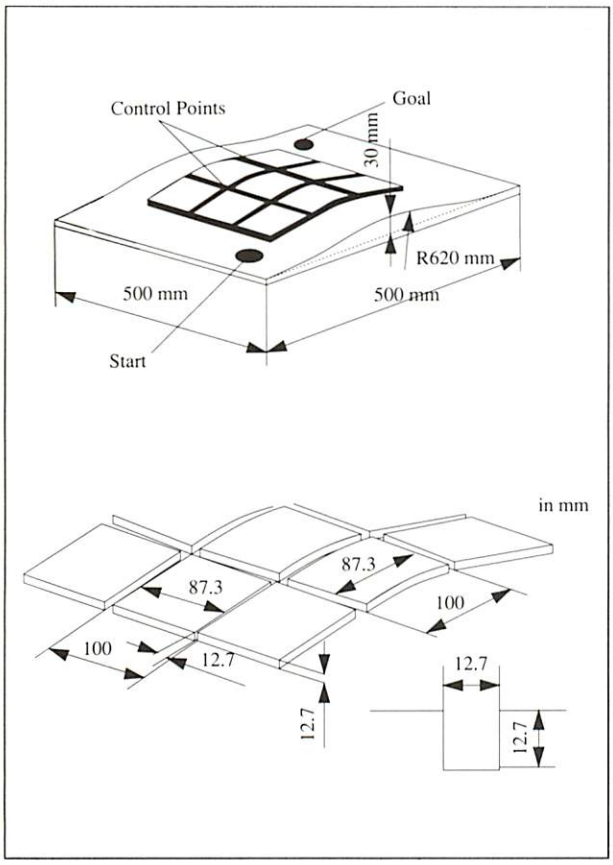


Fig. 1 Game Board for Microrobot Contest

contest boards are shown in Fig. 1.

At this symposium the Micromachine Center (MMC) joined the other societies and institutes as a cosponsor, and this has proven to have a positive impact on information exchange in micromachine development and in other ways.

Photo 6 The 4th International Symposium

5. The Fourth International Symposium

The fourth symposium was held in Nagoya in October, 1993 (Photo 6). Besides the cosponsors previously involved, the newly established Federation of Micromachine Technology and local universities joined as cosponsors. Again, the academic and exhibition segments and microrobot contest were offered. In view of the creation of the Federation of Micromachine Technology, it has been decided that a national symposium will be held each spring in Tokyo and the international symposium will continue to be held in the autumn in Nagoya.

6. Achievements of the Micromachine Symposia

These symposia make available to those interested knowledge on how far and in what direction micromachine research and development are advancing:

(1) The latest information from Japan and elsewhere about the manufacturing of micro parts by silicon-based micro-processing is discussed, as well as the latest research on and development of micro-processing technology and the production of parts by such methods as that using advanced traditional micro electron discharge machining techniques.

(2) Broad knowledge on systematization can be gained through an understanding of those micro parts and the methods of their application. For maximum benefit, it is important that participants take an active part in the discussions.

(3) Opinions are exchanged on how to make microsystems, how to evaluate their function, and how to develop them in a database. A researcher cannot do all these things alone even if he has good access to micromachine material data. Moreover, benchmark tests can be utilized as an evaluation method.

(4) Because micromachine is a new technology and there are no clear international boundaries in its development, the symposia have become a lively topic of discussion as they are viewed as promoting international cooperation in a future society where there will also be no borders drawn. These symposia are anticipated to give everyone in the world an opportunity to participate freely in all aspects of micromachine research and development. They will also be instrumental in creating a global framework to realize this participation and in establishing research centers where it can actually be carried out.

(5) As research advances, standardization and guidelines will become necessary on each level from parts to systems. These will have to be drawn up from an international point of view and will require input by agreement of many nations. The symposia will provide a forum for this international discussion and decision-making.

Thus, the international symposia are expected to stimulate not only the exchange of technological information but also human cooperation, and to have many other benefits. To further the intended purpose will require cooperation and a great deal of effort and patience on the part of all individuals involved.

Research into Micromachines at the Mechanical Engineering Laboratory, Agency of Industrial Science and Technology

Yoshitaka Tatsue
Director, Machinery Department,
Mechanical Engineering Laboratory,
Agency of Industrial Science and Technology,
Ministry of International Trade and Industry

1. Introduction

The major tasks for which national research institutes are responsible can be roughly divided into two aspects: implementing their own research and development activities in their fields of specialty, and helping to promote national projects. Successfully balancing these two different types of tasks is always a challenge to researchers working for national research institutes. Research and development of micromachines was inaugurated as a national or international project, defined as a long-term topic, extends beyond the time frame of the Government's direct budgeting. We, at the Mechanical Engineering Laboratory, being deeply aware of our basic responsibility to promote the development of industrial science and technology, are currently discussing how best to pursue research into micromachines from the two aspects described above.

For the Government to inaugurate a research and development program, investigation and planning in advance are required for looking into the necessity, development themes, impact, etc. It is particularly essential to set down a clear technological framework beforehand. The national research institutes are responsible for taking care of these matters. Once programs are begun, the national research institutes support directors for the Industrial Science and Technology Frontier Programs of AIST, which take roles as coordinators for joint R&D development activities implemented by industry, Government, and university, while at the same time carrying out their own research activities. Three national research institutes (Mechanical Engineering Laboratory, Electrotechnical Laboratory, and National Research Laboratory of Metrology) are involved in the research and development of micromachines. This special edition will give a brief introduction of our research activities at the Mechanical Engineering Laboratory.

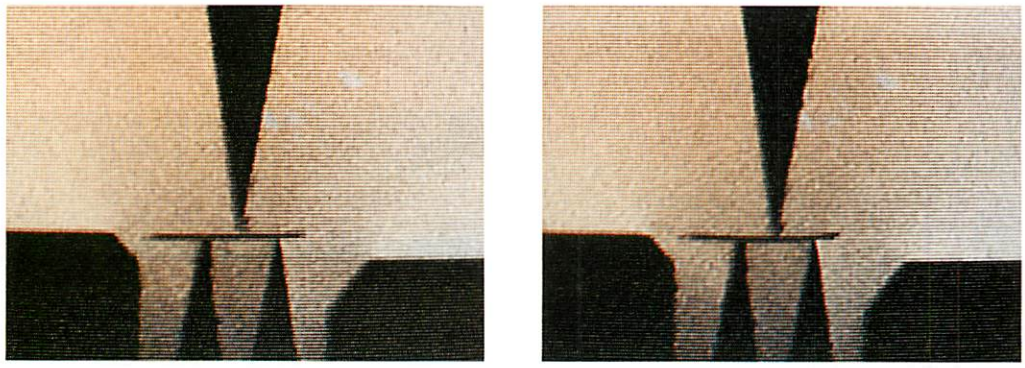
2. Our Basic Stance for Research

As you may know, behind the significantly rising expectations toward micromachines lies the challenge from semiconductor technology. At the root of this new interest may be recent cases proving that the use of semiconductor technology, basically intended for two-dimensional micromachining, is capable of giving quasi-three-dimensional machining effects.

There should be, then, approaches to micromachining technology employing mechanical engineering, which essentially handles three-dimensional machining and three-dimensional mechanisms. The results of our own prior investigation for establishing a micromachine program reveal that products or components in the 10 to 100μm level are in highest demand, which clearly indicates the industry's extremely high expectations toward mechanical engineering. When we position the micromachining technology somewhere between semiconductor technology and mechanical engineering, approaches from both of these technologies will be necessary. This will automatically determine our course.

To create meaningful micromachines, we need to establish a new technological system equivalent to the conventional mechanical engineering system, but this will not be accomplished in a short time. The Micromachine Center was founded to implement multifaceted projects rather than merely working on research activities specified by the Ministry of International Trade and Industry. This course was elected since we considered it necessary to develop extensive, continuous activities to establish micromachine technology. Our research activities at the Mechanical Engineering Laboratory are also being implemented with the same viewpoint, and this has led us to clearly define the pursuit of "micro-oriented" endeavors as one of our basic policies for implementing our research activities.

Mechanical engineering, which over the past few thousand years has been "macro-oriented," has established a technological system for that purpose. But we now face a new challenge, a 180-degree reversal to "micro-oriented" endeavors. Micro-oriented research and development activities naturally bring new risks. If national research institutes, which are not limited



Un-LOAD 10mN LOAD —— 200 μm

Photo 1 Micro 3-point Bending Test with Si-ion Implanted Part

by the pursuit of profits, have a duty to pioneer new research fields, then micromachine technology should be a likely target.

Our research, focused on the obtaining of knowledge, information, and understanding in the more basic fields, is also of course, striving to reach the micromachine project goal. The research involves a variety of activities, but they all converge at one ultimate goal – the establishment of "micro science engineering."

3. Outline of Our Research Activities

Our research into micromachines is extremely wide ranging. The research topics directly involved in the present project are listed below, but we are also engaged in researches into topics in other fields of technologies that are also necessary for micromachines. Such fields include materials, instrumentation, energy, and biomechanical technologies. Implementing this project involves all of the research fields in which we are engaged. Specifically, we are working together with the Micromachine Center for the materials-related research and development.

The following shows the research topics on which we are working for the project:

(1) Complex processing technologies

(a) Micro-shape grinding technology (Removing-machining) :
Establishment of a three-dimensional machining technology using extremely thin diamond grinding wheels.

(b) Modification technology mainly based on ion-implantation technology (Machining with no change in volume):
Establishment of a new processing technology for providing particular sections of parts with specific characteristics such as toughness and wear resistance. Pursuit of a feasible removing-machining technology and adding-machining technology.

(c) Joining technology (Adding-machining):
Pursuit of a technology which enables joining at low temperatures and low loads. Also aiming for possible application as an assembling technology.

(2) Mechanism technologies

(a) Microtribology technology:
Elucidation of the phenomena, which do not conform to Coulomb's law, from a principle aspect, and search for a new lubricating mechanism.

(b) Technology for evaluating mechanical characteristics:
Elucidation of shape factors, surface layer factors, etc. associated with microstructures and the establishment of test methods.

(c) Technology for creating new device mechanisms:
Founding of a micromechanism design system.

(3) Control technologies

(a) Micromanipulation technology:
Development of the mechanisms and control technologies for a variety of handlings in assembly operations and others.

(b) Tele-operation technology:
Establishment of control technologies for impedance shaping for interfacing between micromachines and humans.

We would, thus, like to implement multifaceted research to achieve micromachining technology. Due to space limitations, we cannot introduce all of our research topics, so we present just two examples. (Photo 1 and Fig. 1)

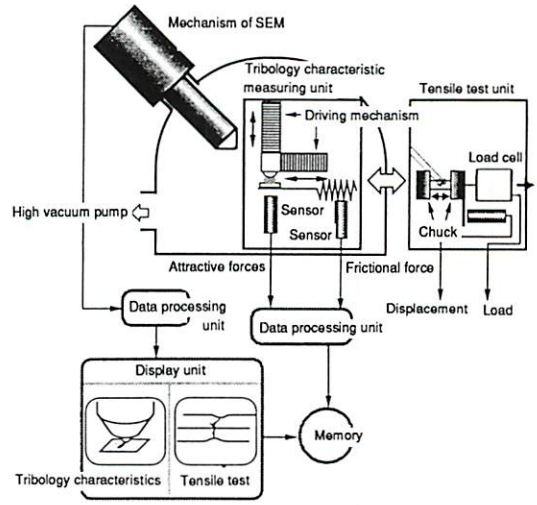


Fig. 1 Concept of the Evaluation of Microtribology Characteristics in SEM

4. A Final Word

At our Laboratory we have only begun our research into micromachine technology. We are pleased to present, through this magazine, a detailed report on our research activities in the future.

SANYO Electric Co., Ltd.

R&D Headquarters (Hirakata)

1. Introduction

SANYO Electric Co., Ltd., since its founding in 1950, has developed many products including electric and electronic household appliances. With the percentage of non-household products rising to more than half its sales in recent years, Sanyo Electric has become a general electronics manufacturer, developing also semiconductors, electronic devices, batteries, information systems equipment, industrial equipment, and many others. Sanyo's R&D headquarters, which support activities in many fields, currently encompasses eight laboratories which independently develop activities in the four major regions of Osaka (Hirakata, Kadoma), Gifu, Tokyo (Yushima), and Tsukuba. Today, I visited their Hirakata facility where four of their laboratories are situated. This facility, located on a small hill along Route 1, sits amid lovely scenery and commands a view of the suburban districts of Osaka.

2. Characteristics of Their Technology Development

Under the corporate slogan "Total Dedication to Saving the Earth and Saving Its People," the entire Sanyo Group is working with an emphasis on two themes "Earth-Friendly Clean Energy" and "People-Friendly Softronics." The clean energy project includes (1) the technologies for soft energies typically represented by solar energy and (2) the clean cooling and heating technology, such as non-fluorocarbon air conditioners. The softronics project includes (3) intelligent HA (home automation), (4) AV & CC business typically of which are high-definition TV and personal communications equipment, and (5) optoelectronic and semiconductor business handling key devices. Of these, the clean energy project most distinctively illustrates the technological characteristics of Sanyo Electric who was the first in the industry to meet the challenge of this task.

Especially in the field of solar cells, Sanyo Electric succeeded in mass-producing the world's first amorphous silicon solar cells in 1980. Since then, Sanyo Electric has been engaged in top-level research into this new energy source, which will replace fossil fuels. The aim is to achieve greater energy conversion efficiency and lower costs.

In the field of chemical batteries, Sanyo Electric was the first to sell nickel-cadmium batteries in Japan, under the trade name "Cadnica rechargeable batteries" in 1964. They were also the first in the world to develop manganese dioxide-lithium batteries and lithium secondary batteries. Then in 1990, they developed nickel-hydrogen batteries having an energy density double that of nickel-cadmium batteries. Thus, Sanyo Electric leads the world in the technological development of chemical batteries.

3. Approach to Micromachine Technology

To develop original products as a general electronics manufacturer, Sanyo Electric believes that it is necessary to promote further reductions in the size and weight of equipment and also that it is important to reduce energy consumption and enhance functions such as high-speed responsiveness by high-performance sensors developed using micromachining technology. As part of their efforts in the micromachine-related technology, Sanyo Electric has developed small sensors including ultra-thin optical sensors, pressure sensors, and micro mechanical elements including compact, lightweight, ultra-thin optical pickups and ink jet printer heads. They have also developed semiconductor micromachining technologies involved in optoelectronics that include short-wave, high-output semiconductor lasers and the microelectronics technology for VLSI, etc. These element technologies are expected to prove very useful in the future development of micromachines.

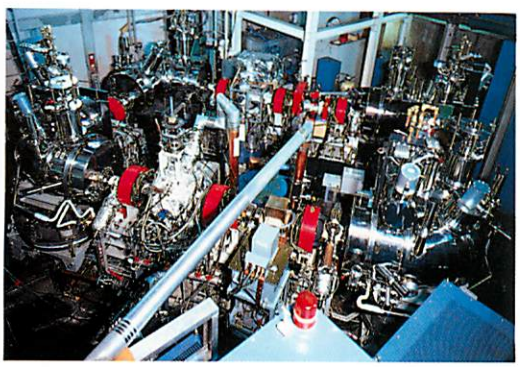
Sanyo Electric has a rich store of energy technologies acquired through the development of solar cells and chemical batteries as described above. They believe they will be able to apply these technologies to the supplying of energy to micromachines by further reducing size and weight. Sanyo Electric has been focusing its efforts on a new micromachining technology based on laser beams, which played a powerful role in the development of solar cells. Recently, they have been emphasizing the research and development of ion-plasma beam machining which will be a key technology for surface modification of materials, atom-level surface machining, and forming thin films at low temperatures. They are planning to develop these technologies for the machining and forming of micromachine element components, actuators, etc.

After my visit to Sanyo Electric, my conventional image of them as a household electric and electronic appliance manufacturer was utterly changed; now I think of them as a manufacturer that wants to contribute to the people and the society while committing themselves to the search for ways to preserve the global environment. This concept lies behind their approaches to micromachines. I am convinced that Sanyo will make great contributions to the development of micromachine technology.

SUMITOMO ELECTRIC INDUSTRIES, LTD.

Today I visited Osaka Works, SUMITOMO ELECTRIC INDUSTRIES, LTD. which was founded nearly 100 years ago. This company's early technology development activities were based on their electric wire manufacturing technology. Since then, they have been cutting their way into various new businesses. Sumitomo Electric has developed powdered alloy products such as cutting tools, special metal products such as steel cords used for radial tires, rubber and plastic products such as the fluororesin-coated aluminum plates which are extensively used for household rice-cooking pots because of the material's outstanding non-stick property, braking products such as antilock braking systems, and new concept products such as navigation systems that tell a driver the current position and provide guidance information. They also, supply a wide range of new electric wires and cables which have continued to be their key products since the company's founding. Currently, Sumitomo Electric Industries is aiming to enhance their R&D activities in new fields, drawing upon their vast experience in developing creative technologies. The new fields include optoelectronics such as optical fibers, a field with great growth potential, new materials such as compound semiconductors, synthetic diamonds and superconductor which is attracting great attention in the industry due to the discovery of high-temperature superconductivity, new concept fields including the systems incorporating new media such as optical LAN and CATV, and the energy field. I was very impressed by their commitment to developing their own original technologies, diversifying their product lines by utilizing their accumulated technologies. They are also striving to create products and systems, which the new age calls for, through their unrelenting efforts to meet the challenge of creative technologies that may radically change conventional technologies in the great flow of the times toward an information-intensive society and globalization.

Sumitomo Electric Industries is engaged in research and development activities for some of the world's most advanced technologies in diverse fields that range from new materials to devices and new



Small SR System NIJI-III

Conceptional Drawing of the Completed Harima Research Laboratory

concept products. The organization of their R&D division seems to have undergone some changes to meet the needs of the times. Currently, the R&D division consists of eight laboratories, one development center, one development department and one staff department. The Electric Power System Technology Research Laboratory where I visited today is located at the east end of Osaka Works, and three research departments are located there. They are successfully exploring the technologies related to ocean development and the synchrotron radiation (SR), in addition to energy-related technologies that include ultra-high-voltage power cables, batteries, as well as monitoring and controlling systems for transmission and distribution lines. The research and development of micromachines are being carried out under the leadership of Electromagnetic Application Systems R&D Department. They are working on the signal issuing devices to be incorporated in micro-capsules.

Sumitomo Electric Industries became interested in the promise of synchrotron radiation early on and started research and development of it. They have already developed three small SR devices (NIJI series). The NIJI-III, a small SR device, employs a superconductive magnet for the deflecting magnet that bends the electron orbits. Using this SR device, they are developing a micromachining method with a high aspect ratio (a ratio of the machining width to the machining depth) which appears great promise as an innovative technology, the micromachining breakthrough. The technology takes advantage of high luminance, high penetrability and good directivity.

Currently, they are building the Harima Research Laboratory in Harima Science Garden City located in the western area of the Hyogo Prefecture. There, they plan to install NIJI-III in the new laboratory and continue their research and development centering around the SR-related technologies. Harima Science Garden City is designed as a place for creating leading-edge technologies for the 21st century, following the motto "High-quality function city in Harima with people, science and nature." In this city, a large radiation facility "SPring-8" is being built which is expected to add even more to their store of knowledge.

I am convinced that, once their Harima Laboratory is completed, their micromachining research and development will be accelerated further, bringing them continued successes backed up by the comprehensive capabilities of Sumitomo Electric Industries.

Fourth Exhibition of Industrial Micromachines Held

From April 20 (Tue.) through 22 (Thu.) 1993, the Fourth Exhibition of Industrial Micromachines (MICRO SYSTEM Technologies Japan '93) – Opening New Possibilities for the Future – was held at the Science Museum in Kitanomaru Park in Tokyo. It was jointly organized by the Micromachine Center (MMC), the Micromachine Society (Tokyo) and MESAGO Japan Corporation and was sponsored by the Ministry of International Trade and Industry and supported by fifteen concerned organizations.

1. Number of booths: 72
2. Number of exhibitors:
   Universities ... 10
   National research institutes ... 6
   Private enterprises ... 47 (including 6 from abroad)
3. Number of visitors:
   Over 3,500 (more than triple the previous number attending)

The exhibition was opened and the ribbon cut at 10:00 a.m. on the 20th by Mr. T. Adachi, Director of the Industrial Machinery Division, MITI, Dr. N. Nakajima, Representative of the Micromachine Society (Tokyo), Mr. K. Yonemoto, Senior Managing Director of the Micromachine Center, and Mr. A. Hirose, President of MESAGO Japan Corporation. It was closed at 4:30 p.m. on the 22nd. It was a great success.

Fifth Micromachine Symposium Held

On April 20 (Tue.) and 21 (Wed.), 1993, the Fifth Micromachine Symposium was held at the Science Museum in Kitanomaru Park in Tokyo under the joint organization of the Micromachine Society and the Micromachine Center (MMC), sponsored by MITI and supported by 22 concerned organizations. The most up-to-date research was reported on 20 subjects in the following fields:

- ○ Three dimensional vision and micromedical technology (4 reports)
- ○ Artificial life and genetic algorithms (3 reports)
- ○ The present status and unique features of the photoforming process (4 reports)
- ○ Small parts (5 reports)
- ○ New actuators (4 reports)

Additionally, three special lectures were given by invited speakers, and two reports made on international conferences. There were also three papers presented by participants from abroad.

Over 500 people attended. The hall was filled to capacity, confirming the growing interest in micromachines.

Micromachine Research Mission Sent to Europe

– Research Results Presented at IARP Workshop –

On June 15 and 16, the First IARP (International Advanced Robotics Programme) Workshop on Micro Robotics and Systems was held in Karlsruhe, Germany. To present some of our latest results and to visit institutes and laboratories in the field of microtechnologies, the Micromachine Center (MMC) sent a mission to Europe composed of five people from the MMC and supporting organizations.

IARP is one of the programs promoting international cooperation in research and development on advanced technology, especially in the field of robotics, with the lead being taken by the countries participating in the Economic Summit. The workshop held in Karlsruhe was particularly concerned with microrobotics and systems, and speakers from eleven countries presented their results and the present status of their projects.

Four papers were presented from Japan, two of which were presented by a supporting organizations of the MMC: one on micromotors (Yaskawa Electric Corp.), and the other on microturbine generators (Mitsubishi Electric Corp.). These two presentations were made showing samples, and the audience was attracted very much.

Following the workshop the mission divided into two groups and visited several universities and research institutes working on micromachines: Institute of Microtechnology (IMT) of University of Neuchâtel and ETH Zürich in Switzerland, Delft University in the Netherlands, Ecole Polytequnique Federal, Ecole Center, and the Institute National des Sciences Applique in France. Members also presented the results of their research at each institution they visited.

The program undertaken by IMT, University of Neuchâtel is being developed assuming very practical applications from the basic research. A new laboratory building is in the process of construction to further advance this work.

At ETH Zürich the emphasis is on the control of robots. Micro-processing technology is focusing on the development of unique magnetic sensors, integrated sensors, and C-MOS technology.

The mission visited other institutes focusing on tribology, and studied the manner in which research in this field of the technology is being carried out.

The MMC is producing satisfactory results in its research, and so will strive to deepen its relationships with overseas institutions and researchers through activities such as presentation of its results.

Invitation to Join the General Supporting Membership

Micromachines are minute devices capable of performing complex, microscopic operations, despite being composed of functional elements less than a few millimeters in size. It is believed micromachines have strong potential use across many industrial spectra, particularly in areas requiring sophisticated, advanced maintenance technology in response to increasingly complex and precise machine systems and in medical services where sensitive, advanced medical technology is required, but with minimal discomfort to patients.

The Micromachine Center (MMC) was established on January 24, 1992, with the approval of the Minister of International Trade and Industry. Its objective is to promote the dissemination of micromachine technology in Japan, and contribute to the development of Japan's industry, economy, and the advancement of international communities.

MMC promotes research and development work under the Industrial Science and Technology Frontier Program "Micromachine Technology," a 25-billion-yen mega-project begun in 1991, delegated by the Ministry of International Trade and Industry's Agency of Industrial Science and Technology.

The center will also engage in independent research, promote cooperative research involving industry, government, and academia, and organize international symposia on micromachine research and development.

MMC would like to invite your interest and support for its projects and activities—and call for your direct support through membership in MMC itself.

Membership privileges include:

1. Participation in surveys and research undertaken by MMC, and use of the results.
2. Use of delegated survey, research and development results not classified as secret.
3. Participation in study groups and other activities of the center.
4. Use of MMC's data bank.
5. Receipt of publications.

To apply for membership, please fill in the designated application forms and submit them to the secretariat.

Membership requires an initial payment of ¥ 4 million and annual dues of ¥ 2 million.

For further information, please contact the General Affairs Department of the Micromachine Center.

Evening Seminar Scheduled

To increase understanding and friendly relations among industries, the government and universities concerning micromachine technology, the Micromachine Center (MMC) holds an evening seminar each month. This year the overall topic will be "Research and Investigations on Basic Technology of Micromachine Systems", which the MMC was assigned by the Mechanical Social Systems Foundation and researched in 1992. The results of investigations on seven subjects in micro science and engineering, materials technology, design technology and control technology are reviewed by the chairmen for respective investigations in the following schedule:

Date and Time: Third Wednesday of each month from September 1993 on (subject to change)
15:30 - 17:30 (question-and-answer period included)

Place: Conference room of the MMC or another appropriate room (buffet dinner to be held following each lecture)

Subjects:

- Sept. 14, '93 — Micro Science and Engineering (mechanical dynamics) ... Isao Shimoyama, Associate Professor, Faculty of Engineering, The University of Tokyo.
- Oct. 20, '93 — Micro Science and Engineering (tribology) ... Nobuo Omae, Associate Professor, Faculty of Engineering, Osaka University.
- Nov. 17, '93 — Materials for Medical Use Adaptable to the Living Body ... Teruo Okano, Associate Professor, Institute of Biomedical Engineering of Tokyo Women's Medical College.
- Dec. 15, '93 — Materials for Medical Actuators ... Kou Imachi, Professor, Institute of Medical Electronics, Faculty of Medicine, The University of Tokyo.
- Jan. 19, '94 — Design Technique ... Tamotsu Murakami, Associate Professor, Faculty of Engineering, The University of Tokyo.
- Feb. 16, '94 — Materials for Industrial Actuators ... Koji Ikuta, Associate Professor, Department of Computer Science and System Engineering, Kyushu Institute of Technology
- March '94 — Control Technique ... Yoji Umetani, Professor, Department of Control Information Engineering, Toyota Technological Institute

(Others will be announced at a later date.)

Participation Fee: Supporting members ... ¥2,000 per person
Non-members ... ¥5,000 per person
(includes buffet and tax)

Application and Other Information:
Research Department, Micromachine Center
(Ms. E. Fujii and Mr. H. Narumiya)
Floor 3, Sanko Building, 3-12-16 Mita, Minato-ku, Tokyo 108
Tel: 03-5443-2971, Fax: 03-5443-2975

Seventh IEEE International Workshop on Micro Electro Mechanical Systems — MEMS '94

Date: January 25 (Tue.) - 28 (Fri.), 1994

Place: Oiso Prince Hotel (546 Kokufu Hongo, Oiso-machi, Naka-gun, Kanagawa, Japan 259-01)

Sponsored by: IEEE Robotics and Automation Society

In Cooperation with: Micromachine Center (MMC), ASME Dynamic Systems and Control Division

Supported by: The Institute of Electrical Engineers of Japan, Robotics Society of Japan, The Japan Society of Mechanical Engineers, The Japan Society of Precision Engineering, and others

Schedule: January 25 (Tue.), 1994, Afternoon: Registration and Reception
January 26 (Wed.) : Opening Sessions 1 and 2, and Banquet
January 27 (Thu.) : Sessions 3 and 4
January 28 (Fri.) : Sessions 5 and 6
January 29 (Sat.) : Inspection Tour (Optional)

Papers to Be Presented: 50 (20 papers in Poster Session)

Participating Countries: Japan, U.S.A., Germany, Switzerland and others (16 in all)

Main Subjects: Micro Fabrication Technologies (new processes, 3D micro fabrication), Micro Actuators, Smart Sensors, Micro Optics Devices, Industrial and Medical Applications of MEMS, Micro Science and Engineering (fluid, heat, materials), Microrobotics, CAD for MEMS, and various simulations

Participants: Those whose applications have been accepted.

For further Information: MEMS '94 Secretariat
MESAGO Japan Corporation
4-28-20, Yotsuya, Shinjuku-ku, Tokyo 160
TEL: +81-(0)3-3359-0894
FAX: +81-(0)3-3359-9328

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