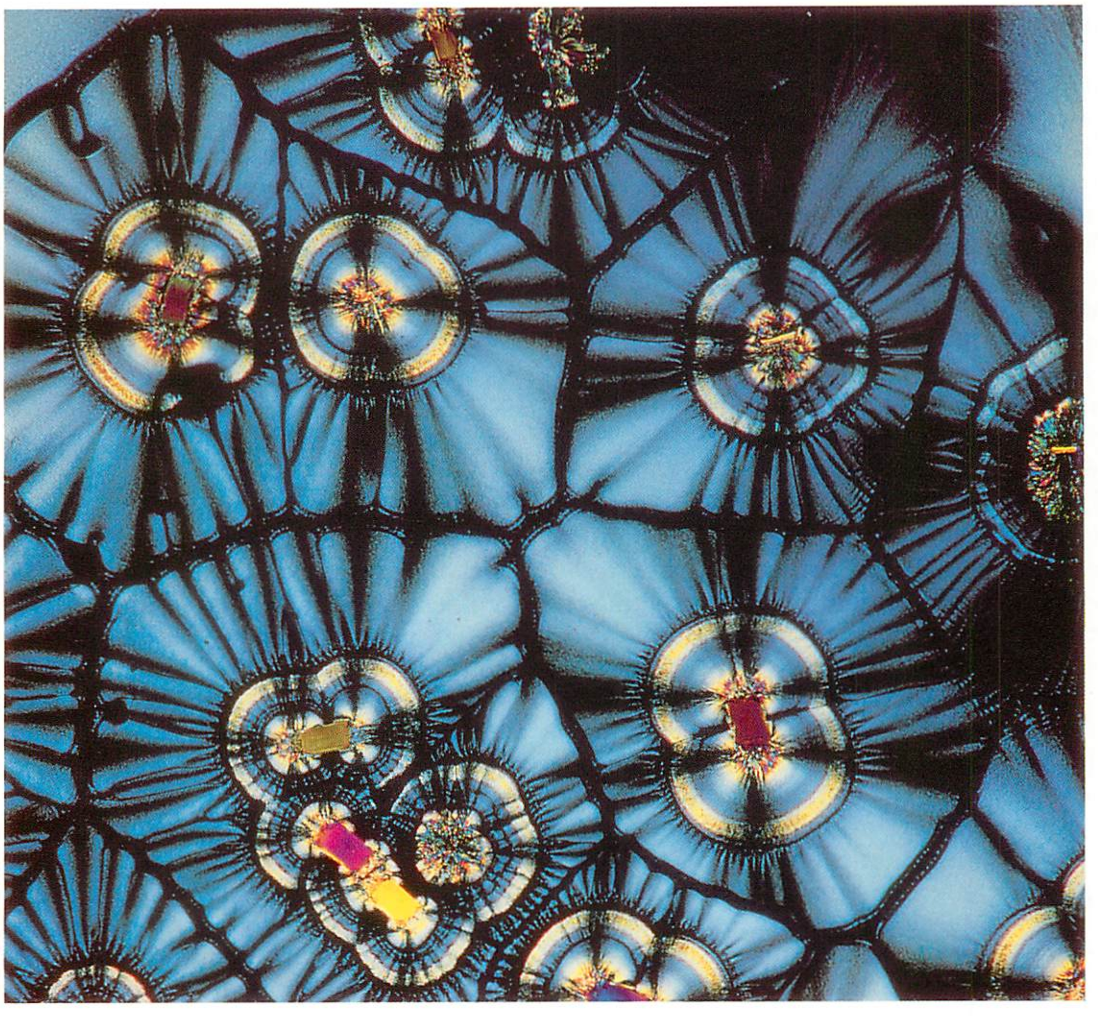
MMC

MICROMACHINE

June, 1993 No.2



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Micromachine Center

Micromachines Open up a New World

Naomasa Nakajima
Director, Research into Artifacts, Center for Engineering, and Professor, Department of Mechanical Engineering for Production, Faculty of Engineering, The University of Tokyo

1. Introduction

From the beginning, mankind seems instinctively to have desired large machines and small machines. That is, "large" and "small" in comparison with human-scale. Machines larger than human are powerful allies in the battle against the fury of nature; smaller machines are loyal partners that do whatever they are told.

If we compare the facility and technology of manufacturing larger machines versus smaller machines, common sense tells us that the smaller machines are easier to make. Nevertheless, throughout the history of technology, larger machines have always stood out. The size of the restored models of the watermill invented by Vitruvius in the Roman Era, the windmill of the Middle Ages, and the steam engine invented by Watt is overwhelming. On the other hand, smaller machines in the history of technology are mostly tools. If smaller machines are easier to make, a variety of such machines should exist, but until modern times, no significant small machines existed except for guns and clocks.

This fact may imply that smaller machines were actually more difficult to make. Of course, this does not mean simply that it was difficult to make a small machine; it means that it was difficult to invent a small machine that would be significant to human beings.

Some people might say that mankind may not have wanted smaller machines. This theory, however, does not explain the recent popularity of palm-size mechatronics products.

The absence of small machines in history may be due to the extreme difficulty in manufacturing small precision parts.

2. Why Micromachines Now?

The dream of the ultimate small machine, or micromachine, was first depicted in detail 27 years ago in the 1966 movie "Fantastic Voyage." At the time, the study of micromachining of semiconductors had already begun. Therefore, manufacturing of minute mechanisms through micromachining of semiconductors would have been possible, even at that time. There was, however, a wait of over 20 years before the introduction, 5 or 6 years ago, of electrostatic motors and gears made by semiconductor micromachining.

Why didn't the study of micromachining and the dream of micromachines meet earlier? Back then, Japan was in the midst of rapid economic growth and may have been too busy to think about micromachines. The United States was another story. The United States had the time and resources for such studies. Until the 1970's, the United States spent generous portions of its resources for promotion of technological development to achieve its dreams. The Apollo Project is a typical example. But, even the United States, which possessed the resources, did not pursue micromachines in those early years.

A possible reason for this is as follows. In addition to micromachining, the development of micromachines requires a number of technologies including materials, instrumentation, control, energy, information processing, and design. Before micromachine research and development can be started, all of these technologies must reach a certain level. In other words, the overall technological level, as a whole, must reach a certain critical point, but it hadn't reached that point 20 years ago.

Approximately 20 years after "Fantastic Voyage," the technology level for micromachines finally reached a critical point. Micromotors and microgears made by semiconductor micromachining were introduced at about that time, triggering the research and development of micromachines.

The background of the micromachine boom which started 5 or 6 years ago can be explained by the above.

3. Micromachines as Gentle Machines

How do micromachines of the future differ from conventional machines? How will they change the relationship between nature and humans?

The most unique feature of a micromachine is, of course, its small size. Utilizing its tiny dimensions, a micromachine can perform tasks in a revolutionary way that would be impossible for conventional machines. That is, micromachines do not affect the object or the environment as much as conventional machines do. Micromachines perform their tasks gently. This is a fundamental difference between micromachines and conventional machines.

The medical field holds the highest expectations for benefits from this feature of micromachines. Diagnosis and treatment will change drastically from conventional methods, and "Fantastic Voyage" may no longer be a fantasy. If a micromachine can gently enter a human body to treat illnesses, humans will be freed from painful surgery and uncomfortable gastrocamera testing. Furthermore, if micromachines can halt the trend of ever-increasing size in medical equipment, it could slow the excess growth and complexity of medical technology, contributing to the solving of serious problems with high medical costs for citizens.

Micromachines are gentle also in terms of machine maintenance, since they can be inspected and repaired without difficulty in reaching and overhauling the engine or plant. The more complex the machine, the more susceptible it is to malfunction due to overhaul and assembly. In addition, there have been more instances of human errors during overhaul and assembly. It is good for the machine if overhaul is not necessary. It is even better if maintenance can be performed without stopping the machine. Repeated stop-and-go operation will accelerate damage of the machine due to excess stress caused by thermal expansion.

Such gentleness of a micromachine is an advantage, as well as a weakness, in that a micromachine is too fragile to resist the object or the environment. This is the drawback of the micro-scale objects.

For example, a fish can swim freely against the current, but a small plankton cannot. This is a result of physical laws and nothing can change it. Still, the plankton can live and grow in the natural environment by conforming to the environment.

Unlike conventional machines which fight and control nature, micromachines will probably adapt to and utilize nature. If a micromachine cannot proceed against the current, a way will be found to proceed with the flow, naturally avoiding collisions with obstacles.

4. Changing View of Machines

It is very important that a machine is easy for people to use. Since the beginning, engineers have worked toward the goal of developing such a machine. Even a classic machine, which may look simple, was the result of an effort to make an easy-to-use device.

For example, it is well known that Watt's steam engine had a speed regulating mechanism called a governor, but the windmills of the Middle Ages are also said to have included automatic brakes that prevented excessive rotation speed. The brakes were needed to avoid high-speed rotating, which would cause the turning stone mill to float, thus reducing its efficiency.

When ease of use is required of a machine, the number of mechanisms generally increases, and such mechanisms must be arranged efficiently within the space inside the machine. The placement of the control mechanism mentioned above was probably not a problem because of the device's large size, but the problem is not so easily solved in a small machine.

One of the reasons for the difficulty in developing smaller machines may have been the problem just mentioned.

When there is no more room for additional mechanisms in the machine, it is necessary, to reduce the size of the parts. In general, the size of the smallest part possible to process with current technology is approximately 1mm. This size limit is even larger if productivity and economy must be considered.

To make a machine easier to use, the degree of integration of the parts must be increased. Thus, the current size of parts must be drastically reduced; micromachine technology makes such size reduction possible. Micromachine technology can probably reduce the part size to 1/100 to 1/1,000 of current sizes. This will make future versions of current machines far more convenient and useful.

Micromachine technology is essential not only for the development of micromachines themselves, but also for improving the convenience of machines in general.

When micromachine technology brings gentle machines into existence and makes machines in general far more convenient than they are today, our view of machines will also change. The new world opened up by micromachines may also contribute to guiding the development of modern machine civilization in desirable directions.

MICROMACHINE LABORATORY AT TOHOKU UNIVERSITY
(ESASHI LABORATORY)

Masayoshi Esashi
Professor
Department of Mechatronics and
Precision Engineering
Tohoku University

1. Description of the Laboratory

The Micromachine Laboratory at Tohoku University was established in 1990 and even today is the only laboratory in Japan known to bear that name. It is situated on a green hill in Sendai, a city with many trees in the Tohoku district.

In addition to the author (Masayoshi Esashi), Associate Professor, Shuichi Shoji, two research associates, Kazuyuki Minami and Toru Kurabayashi, and others are engaged in research and investigations into micro sensors and micro systems which utilize semiconductor micromachining technology.

The staff consists of a total of 40 members including 17 graduate and undergraduate (senior) students, 15 researchers from businesses, students from abroad, and university employees. Part of the staff is also researching micromachining and new semiconductor device processing technology at the Semiconductor Research Institute (President: Jun-ichi Nishizawa of the Semiconductor Research Foundation). Individuals from companies can either be admitted as researchers to learn micromachining or engage in joint research. Part of the staff at the Institute is also engaged in particular research requested by companies, thereby cooperating in the industrialization of micromachine technology.

2. Research Policy

The Laboratory has all the equipment necessary to manufacture CMOS integrated circuits from beginning to end, and trial manufacturing of micromachines allow experimentation over a field which extends from the materials used to the system itself. Members seek projects which integrate a knowledge of different fields and which have practical application. They also want to be involved in innovative studies employing new ideas.

The integrated circuit manufacturing equipment has been made by the laboratory members themselves, and there are also various processing facilities such as laser beam or ion beam machines, measurement and analysis apparatus and more. The facilities are devised for the greatest efficiency to be multi-functional and to operate safely and in a short cycle time. The laboratory operates on a system that is lean and rational and maintains itself on a limited budget with restricted staff.

3. Research Activities

Micromachines integrating sensors, processing circuits, and even actuators are being developed. Their manufacture is based on semiconductor micromachining in combination with various other technologies.

The laboratory plans to produce a smart system with advanced intelligence employing micromachines placed close to an object and capable of dealing with small objects skillfully in a very small space. The system will also have a number of sensors and actuators tenderly working in collaboration with each other.

One long-term aim is to develop an active catheter 1 mm in diameter and able to bend automatically (see Figure 1), for use in measurements and treatments in a tiny area like the

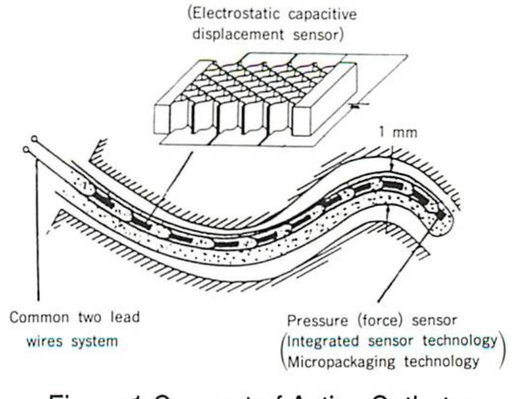


Figure 1 Concept of Active Catheter

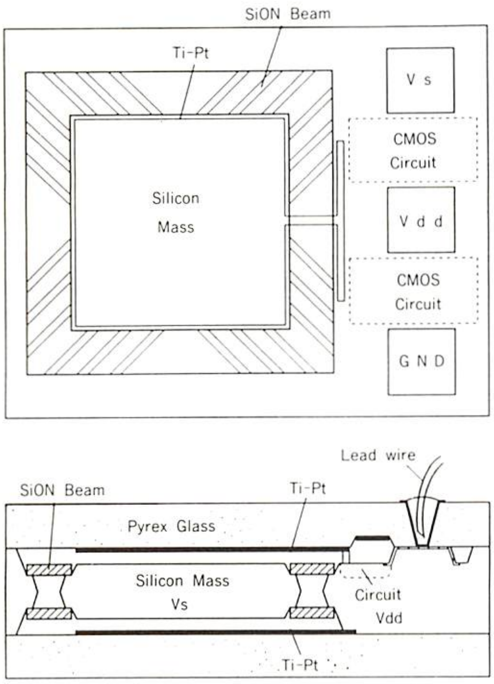


Figure 2 Structure of Integrated Capacitive Acceleration Sensor

inside of a blood vessel. It will have to be equipped with more than one sensor and with actuators to allow the bending. Communication technology will also be required to minimize the number of lead wires. For this purpose, the laboratory is developing a common two lead wire system in which the two lines supplying power also convey signals and select the sensor to be activated; micropackaging technology for assembling and electrostatic microactuator techniques are also being studied.

Since the electrostatic micro-actuator being worked on also acts as an electrostatic capacitive displacement sensor, the apparent flexibility of this active catheter must be alterable by closed loop control.

A packaging technology which will integrate a capacitance detection circuit, a capacitive sensor in a parallel electrode structure, an electrostatic actuator and a resonator are being devised; technology for three-dimensional micromachining, called bulk micromachining is also under study.

The laboratory staff is divided into four groups, each of which is working on one of the following projects.

3.1 Integrated Sensors

These are micro-sensors for which a particular packaging technology is being devised. An integrated capacitive pressure sensor has been realized using silicon tips as a container. Taking this technique even further, this group is researching acceleration and other sensors in which the electronic circuit is integrated. Figure 2 and Photo 1 show an integrated capacitive acceleration sensor which employs an electrostatic force-balancing servomechanism.

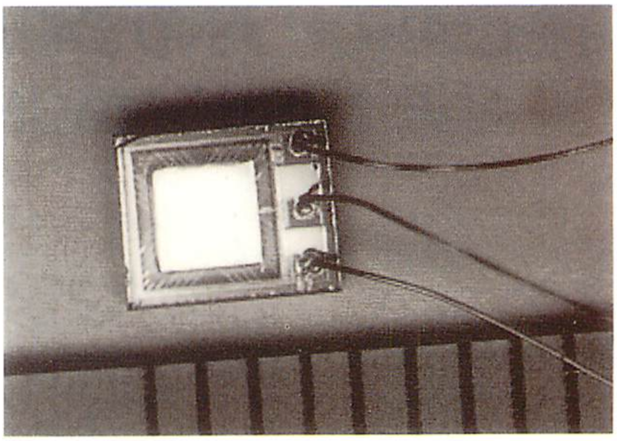


Photo 1 Integrated Capacitive Acceleration Sensor

3.2 Ultrasensitive Sensor System

Utilizing the characteristics of micromachining, this group is producing sensors with extremely high sensitivity, including various oscillatory and thermal types. Integrated mass flow controllers capable of controlling extremely small quantities of fluid are also being investigated.

3.3 Distributed Electrostatic Microactuator

None of the actuators currently used as basic elements of a micro motion system is sufficiently small or efficient. This group is looking into a distributed electrostatic microactuator with many minute elements, just as a muscle consists of a large number of cells. Control of the apparent rigidity is possible through a closed loop control by detecting displacement from the measurement of capacitance. The closer the electrodes are set together the greater can be the electrostatic force. Micronization and integration are thus expected to create a highly efficient microactuator.

3.4 Three-dimensional Micromachining

New processing technology is being investigated for the creation of three-dimensional micro-structures like electrostatic microactuators. This includes a technique to etch through a silicon substrate by low temperature reactive ion etching, a laser-assisted processing to treat the non-planar surfaces like a needle point, and room temperature anodic bonding which would allow bonding of solid surfaces of materials with different thermal expansion.

RESEARCH AND DEVELOPMENT ACTIVITIES OF THE MICROMACHINE CENTER

The Micromachine Center is engaged in activities relevant to the Industrial Science and Technology Frontier Program (refer to page 10) of the Agency of Industrial Science and Technology entitled "Micromachine Technology," as well as others described in the previous issue. This issue will relate studies of materials which are fundamental in the technology of micromachines and standardization of micromachine technology with which researchers and engineers in various fields are concerned.

Research into Materials for Micromachines Started

Joint Research with Mechanical Engineering Laboratory, Agency of Industrial Science and Technology

1. Necessity

Material technology is viewed as one fundamental technology for micromachine R&D, and is in many respects also related to micro functional elements and micromachining technologies. Therefore, the Industrial Science and Technology Frontier Program "Micromachine Technology" of the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry has targeted various functional elements and their processing methods, and optimal materials for use are being investigated.

The mechanical characteristics of micromachine materials, however, vary greatly according to micronization of the components, processing methods, processing conditions, and other circumstances; also, in testing it is often difficult to apply an conventional method. This makes it necessary to investigate materials from a common fundamental viewpoint.

Since it is important that these two routes of research and investigation advance in parallel, the Micromachine Center independently seeks answers to common basic problems on structure and materials of micromachines, and has begun joint research on this subject with the Mechanical Engineering Laboratory of the Agency of Industrial Science and Technology.

2. Outline of Joint Research

(1) Survey on the Working Environment of Micromachine Components
The working environment for the functional elements of micromachines (viscosity of fluid, corrosiveness, temperature, etc.) in each field of application (industrial, medical, etc.), and the characteristics of the materials required in that environment (mechanical properties, compatibility with organs, etc.) will be determined. A data base on micromachines will be created.

(2) Research into Materials for Micromachines
Each material involved in the research and development of various functional elements of micromachines and those materials which it is assumed will be used as the processing technology advances will be investigated, and a data base on micromachining methods and characteristics of these materials will be created.

(3) Feasibility Studies
(A)Studies on Environmental Tolerance
To improve environmental tolerance of the materials in which micromachines are used such as corrosive fluid or those inside the living body, the corrosion phenomena of minute components will be made clear and methods to improve this tolerance will be studied fundamentally.
(B)Studies on Dynamic Scale Effect of Materials
The difference in the material characteristics of strength and rigidity required in the components of existing machines and of micromachines will be evaluated, and the mechanics and failure phenomena of the materials for use in micromachines investigated.
(C)Studies on Materials for Minute Elements
The use of perfect crystal materials like whiskers and materials applicable in various

micromachining methods as well as engineering methods like crystal growth which are applicable at various phases will be examined experimentally and theoretically. Materials suitable for various minute components and their characteristics will be identified.

(4) Schedule
The joint research is scheduled for completion in fiscal year 2000. Emphasis will be given to survey during the first stage.

This work will focus primarily on the structure and materials of micromachines. The broad range of materials technology for micromachines including actuators and sensors will necessitate that private enterprises and universities conduct cooperative studies utilizing to the fullest the advantages of both organizations to establish a workable technology.

Investigation of Micromachine Standardization Started

Setup of Standardization Section

1. Necessity

Micromachine technology touches the boundaries of mechanical engineering, electronics, physics, chemistry, biology, and other fields, in each of which research and development of micromachines is ongoing. Technical terminology which can be used in common by researchers in each field must therefore be decided on if information is to be exchanged accurately and understandably.

Since the area of micromachine technology does not have a long history and its systematic research has just begun in the large-scale project of the Agency of Industrial Science and Technology, there is concern that standardization such as that employed in mature technology could actually hinder creativity and the development of new ideas. Nonetheless, it is apparent that micromachine technology contains aspects such as measurement, evaluation, material characteristics, micro science and engineering which cannot be handled by extrapolation of existing methods, making a completely new approach to standardization necessary.

The Micromachine Center has therefore taken upon itself the job of researching to find a way to provide a foundation for this standardization.

2. Research Outline

(1) Fundamental Standardization Policy
A fundamental policy will be established utilizing an approach in which a synergetic effect can be expected between the standardization and the research and development of the technology. Technological items related to micromachines will then be examined and those requiring standardization identified.

(2) Creation of a Data Base for Standardizing Technology
Related technological data on the items deemed to require standardization in (1) will be collected and classified, and a data base set up. This will be the basis for micromachine standardization of all stages from technological research and development to practical use.

(3) Standardization and Distribution of Technical Terms
Relevant technical terms will be collected and classified according to the fields in which they are used, the meaning and implication of each one examined, standardization made where necessary for their use for micromachine technology, and the terms made available to all researchers and involved institutions.

(4) Schedule
The standardization and distribution of technical terms of micromachines is viewed as the most important feature in this research, and efforts will begin on this work immediately. In addition, collection and classification of technical data necessary for the standardization of related technologies will be started.

In its current stage micromachine technology is still being researched, so standardization such as that of technical terms which will aid this is being promoted. For the long term, a technical data base will be necessary to standardize the technology for practical use.

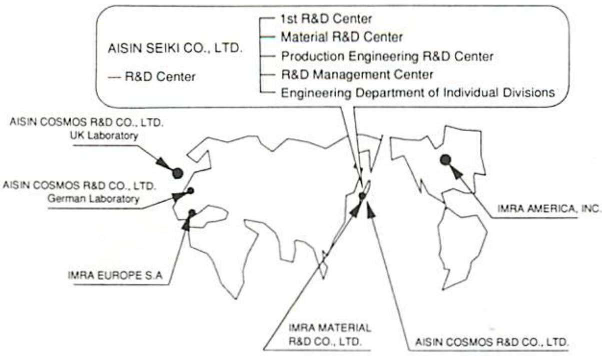
AISIN SEIKI CO., LTD.

1. Outline of the Company

AISIN SEIKI CO., LTD. has its head office in Kariya City, Aichi Prefecture, and manufactures and sells automobile parts and domestic and industrial equipment. It is one of the largest automobile parts manufacturers in Japan, producing more than 10,000 items annually. These are primarily functioning parts like brakes and transmissions which are supplied to Toyota and other automobile manufacturers in Japan and abroad. Household equipment such as beds and sewing machines known as Toyota Brand products are also made, as well as gas heat pump air conditioner (GHP) and other industrial equipment.

2. Characteristics of Technology Development

In addition to providing products to consumers all over the world, the company is actively involved in technology development on a global scale. Through various laboratories and research and development bases in America and Europe, it is actively engaged in international cooperation, information gathering, and joint research, and explores possible applications of the most advanced technology in many fields. Small laboratories are also established in Tokyo and Sapporo where research is conducted in unrestricted surroundings free from stereotypical thinking. While using the technology evolving from this worldwide research setup to develop new automobile and household equipment, the company is also taking aim at new areas. Stirling engines, which are external combustion engines driven on any type of fuel, a stirling cycle cryocooler for the cooling system of a linear motor car being developed by Japan Railways, and the supplementary drive unit for the artificial human heart system for organ transplants anticipated in the future are being produced.



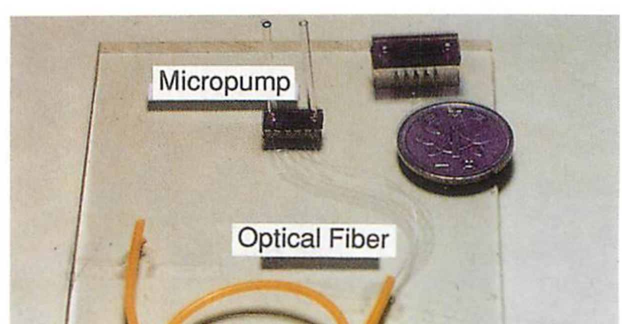
Technology Development Structure

Main Technology Building

3. Involvement in Micromachine Technology

Fundamental to all mechanisms is precision machinery technology. As is symbolized by the name "Seiki" (precision machinery), AISIN SEIKI are steadily challenging the possibility of minute and exact engineering. There are a number of products which utilize micronization technology (IC and sensors using photolithography, for example), but the development of micronized machines or micromachines is still in the initial stage. The more micronized a machine is, the more the kinetic loss (friction or viscosity) increases, while the obtained mechanical output decreases. Realization of a micromachine, therefore, requires the development of actuators which are effective in minute areas. Because of its extremely small size, the precise control of a micromachine is impossible unless the sensor and controlling circuit are integrated. The technological problems unique to micromachines must be surmounted to establish the most applicable technology for practical use.

In October 1992 AISIN SEIKI established a research and development company, AISIN COSMOS R&D CO., LTD., which conducts primarily basic research. Results obtained will also serve to further improve and advance the quality of automobile parts and other products of AISIN SEIKI.



Optically Driven Micropump

OMRON Corporation

We visited the Tsukuba Research Institute of OMRON Corp. Here, OMRON manufactures control equipment such as relays, switches, timers, and sensors; FA (Factory Automation) systems including programmable controllers and FA computers; ATM and other banking systems; automatic ticket gate system which has revolutionalized urban train stations; traffic control systems for the alleviation of traffic congestion; and many other systems. In recent years, OMRON has become well-known for its popular electronic thermometers, electronic blood pressure monitors, blood test devices, and other health and medical equipment, and the fuzzy PAT, which is No. 1 in the world. OMRON has led the world in introducing these product groups, all of which belong to the growth field of the future. Visiting the research and development base which creates such products was an exciting experience. Our goal was to find out how OMRON, a technology pioneering company, is proceeding with micromachine R&D.

North of the Ministry of Education's High Energy Physics Research Institute in Tsukuba Science City, located in the Northern Industrial Park are nineteen of Japan's high-tech companies' research institutes. Beautiful, new laboratory buildings standing in the huge industrial park remind us of Silicon Valley in the United States. OMRON Tsukuba Research Institute is one of these buildings. The conservative, light beige building is a 10,000m^2 laboratory sitting amid 33,000m^2 of land covered with trees and plants. Approximately seventy R&D staff members work in this research institute.

The goal of OMRON is to "realize an optimization society". It will be a comfortable society where human beings and machines coexist in ideal harmony, and people will be able to live fully human lives. This goal is pursued under the corporate philosophy of "To the machine the work of the machine, to man the thrill of further creation." Based on this goal and philosophy, the mission of R&D is "to be a leader in developing and providing merchandise which responds to the society's needs through user-friendly technology." The four core technologies that provide the driving force for this effort are: the 3C's (computer, communication, and control), fuzzy technology, microcomponents, and life science. The Tsukuba Research Institute, which we visited, concentrates on microcomponent R&D.

OMRON Tsukuba Research Institute

The Research Institute consists of four laboratories. Each laboratory has a name such as Micromachining Technology or Interconnection Technology; however, the R&D themes are not restricted at each laboratory, but managed under a cross-sectional project system, with the slogan, "Creation of small and smart components (microcomponents)." Micromachine-related research themes include a National Large-scale Project research, wobble motors, electrostatic relays, and piezoelectric actuators. Large-scale Project research is studying the microsensor with a small optical scanner that has recognition capability, based on the active sensing concept.

At this Institute, all research themes pursue development not only of "small," but also "smart" machines. This is achieved by applying "fuzzy" technology, one of the four core technologies, to microcomponents. The sensor signals formed by micromachining technology are analyzed and inferred through fuzzy technology, and compared with existing knowledge to recognize the situation. Furthermore, situations are studied and predicted based on the knowledge obtained through learning. A single chip that can perform all these tasks by itself is now being studied. Such studies are "based on the possibility of an 'on-chip component' having a number of different functions."

We also toured the Research Institute. Most of the test lab building is the cleanroom, the layout of which clearly separates the normal semiconductor process, micromachining process, and the shared space, to prevent interference between processes while integrating a single chip. OMRON has a vision of "on-chip components," backed by established technology. We left the Institute with a belief that Large-scale Projects are sure to succeed, with many corporations such as OMRON participating.

☆ TOPICS

MMC Mission Attends MEMS '93 in USA

A mission from the Micromachine Center (MMC) attended the IEEE MEMS '93 Workshop, held from February 8 to 10 at Fort Lauderdale, a very attractive resort district in Florida about 40 kilometers roughly north of Miami along the Atlantic coast.

This was the sixth workshop to which an MMC mission was dispatched, and the first in three years held in the U.S. The workshop was attended by approximately 250 participants this year, down by about 100 from the previous workshop held in Germany, which was a slight disappointment. Nevertheless, there were some lively discussions on 53 reports, ten more than at the previous workshop. Twenty-four were presented by American institutions, eighteen by Japanese, four by Dutch, three by German, three by Swiss, and one by a Korean organization.

The overall impression of the presentations was the noticeably solid and steady progress being made to toward predetermined goals in the industrial and medical fields. For this reason, perhaps, we saw a greater number of presentations on the research conducted by companies as well as those that were carried out jointly by academic or governmental organizations. This trend was especially strong among Japanese and European (German, Dutch, Swiss) participants — roughly 40 percent of Japanese presentations and 70 percent of European presentations had some corporate researchers involved. The American participants were somewhat different — of their 24 presentations, only three had corporate researchers (and, of these, two were from Ford and one from IBM; that is, there were only two corporate participants).

The European participants, in contrast, showed great interest in application. More than a few pointed out the lack of an international forums for the promotion and diffusion of micromachine development. Their hope is that a proper forum would help to supplement each other's technological capabilities and also promote international standardization for micromachines.

Actuators with an innovative idea which has always been the bright spot in any MEMS workshop, has recently been somewhat one step off center-stage. Nonetheless, the spotlight this year was on sliders and motors that work by intermittent or vibratory motion through elastic deformation. In terms of processing, this year marked the appearance of electrochemical etching with visible light and ultra-precision processing with ultraviolet curing resins.

By Naomasa Nakajima
Leader, MEMS '93 Mission
Professor, Faculty of Engineering,
The University of Tokyo
Director, Research into Artifacts,
Center for Engineering

Restructuring of MITI's AIST R&D System

The Agency of Industrial Science and Technology of the Ministry of International Trade and Industry previously carried out research and development through the following 6 groups.

1. The National Research and Development Program (Large-Scale Project)
   To develop large-scale industrial technology such as that used by systems and plants
2. The Research and Development Program on Basic Technologies for Future Industries (Jisedai Project)
   To develop basic element technology and innovative fundamental technology
3. The National Research and Development Program for Medical and Welfare Apparatus
4. The Research and Development on New Energy Technology (Sunshine Project)
   To develop clean energy technologies except nuclear
5. The Research and Development on Energy Conservation Technology (Moonlight Project)
   To develop technologies which improve the efficiency of energy use
6. The Research and Development of Technologies Related to Global Environment

However, technological progress today encourages the integrated operation of projects and their organic linkage due to the close contact of science and technology as well as mutual responses, in this April, these projects were integrated and two groups formed:

- The Industrial Science and Technology Frontier Program : Integration of 1, 2 and 3
- The Comprehensive Research and Development Program on Energy and Environmental Technologies (The New Sunshine Program) : Integration of 4, 5 and 6

Excellent results are anticipated by this accelerated and more effective cooperation in use of research and development.

Joint Meeting of The 3rd Study Meeting on Micro Science and Engineering and The 2nd Study Meeting on Micromachining

Date : July 13 (Tues.), 1993
Venue: Lecture Room, The Institute for Solid State Physics, The University of Tokyo (7-22-1, Roppongi, Minato-ku, Tokyo)
Organized by: Japan Society of Next Generation Sensor Technology

• Invited Lectures

"Next generation information machines based on micro science and technology"
Kiyoshi Itao (Department of Precision Mechanical
Engineering, Faculty of Science and Engineering, Chuo University)

"Mechatronics in atomic scale"
Hideki Kawakatsu (The 2nd Division, Institute of Industrial Science, The University of Tokyo)

• Laboratory Visiting (Forenoon of July 13)

Micromechatronics Research Group (Masuzawa Lab., Kawakatsu Lab., and Fujita Lab.), Institute of Industrial Science, The University of Tokyo

For more information, please contact the secretariat of Japan Society of Next Generation Sensor Technology (Tel. 03-3293-2758)

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 Large-Scale Project "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.
(Please refer to page 4 for a Center profile)

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.

List of Supporting Members

Research Supporting Members

AISIN COSMOS R&D CO., LTD.
FANUC LTD
Fuji Electric Corporate Research and Development, Ltd.
FUJIKURA LTD.
Hitachi, Ltd.
KAWASAKI HEAVY INDUSTRIES, LTD.
MATSUSHITA RESEARCH INSTITUTE TOKYO, INC.
MEITEC CORPORATION
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It is our ultimate goal to continue to improve future issues.
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1. Essay (2 pages)
- Micromachine development makes dreams come true (presented by a renowned researcher)
- Micromachines and their future
- Micromachines found in the nature
2. Worldwide R&D (2 pages)
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3. MMC Activities (2 pages)
4. Member Company Profiles (2 pages)
- Introduction of supporting members (2 enterprises)
5. Topics (2 pages)
- Reports on symposia, missions, etc.
6. Events (1 page)
- Announcement of exhibitions, etc.

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