MMC

MICRONANO

2007 2

New Year's Greetings

Tamotsu Nomakuchi
Chairman
Micromachine Center

I would like to take this opportunity to extend my best wishes to all for a happy and prosperous 2007. I have no idea what kind of a year this will turn out to be, but I hope to try and make it a good one.

Last year's increases in the price of oil, materials, and parts have cast shadows over the recovery of the Japanese economy, particularly in the manufacturing industry, which had been gradually progressing supported by firm domestic demand. At the same time, major defects damaging the product reliability of well-known companies that are the face of Japan have occurred. These incidents are shaking Japan's manufacturing industry to its core and possibly weakening and endangering the basic technology in design, production, and product evaluation that has thus far supported the manufacturing industry.

Newly elected Prime Minister Abe last year hammered out the Innovation 25 policy, saying that he intended to make Japan the world leader in innovation. This is a long-term strategy initiative aimed at 2025 that should lead to the creation of basic technology innovations to support existing industries as well as innovation seeds in nano, bio, and other frontier technologies.

The Micromachine Center promotes research and development in MEMS (Micro Electro Mechanical Systems). MEMS are small, high-precision, low-cost, low-energy frontier technologies that are now being applied in a diversity of industrial fields such as information and telecommunications, automotives, biotechnology, and medicine, and their market is gradually continuing to expand. MEMS technologies are attracting attention as basic technologies vital for strengthening the international competitiveness of major areas within Japan's manufacturing industry by increasing differentiation and the added value of key parts. Against this background, the MEMS Industry Forum (MIF) was established in April last year as a special committee within the MMC with the purpose of providing support for the further development of MEMS industries and contributing to the strengthening of the international competitiveness of Japanese industry. The Forum's activities are broad-ranging - including the promotion of MEMS technology R&D, a foundry service network, industry-academia-government collaboration, researcher and engineer training, regulation and standardization, and overseas expansion – and the Forum's member businesses take a central role in the promotion of policy recommendations and industrial exchange/revitalization that concern fundamental issues for MEMS industrial expansion.

In November 2006, the Micromachine Center hosted Micro/Nano 2006 at the Tokyo International Forum. Comprising the MEMS Forum – the first public presentation of information by the MIF – Micromachine Exhibition, MEMS International Standardization Workshop, International Micromachine/Nanotechnology Symposium, and the Report of MemsONE Project Achievements, this event provided an excellent opportunity for people to see all at one time the latest technologies and industrial trends in the micromachine field and was extremely well received. In 2007 the event will move to Tokyo Big Sight and plans are for it to be held on an even grander scale than before. I hope that you will kindly participate and cooperate in this event.

Through the generation of innovation, the Micromachine Center will continue with our activities aimed at establishing basic technology for and the industrialization of micromachines and MEMS in order to contribute to the maintenance and further strengthening of the international competitiveness of Japan's manufacturing industry.

In conclusion, I would like to ask for your continuing support and understanding of our efforts and again warmly wish everyone a fruitful and prosperous 2007.

The 2006 International Micromachine/Nanotech Symposium: Report

The International Micromachine/Nanotech Symposium (Micro/Nano 2006) and Micromachine Exhibition were held in 2006 as a combined event for the first time at the Tokyo International Forum (Yurakucho, Tokyo) and other venues.

The MEMS Standards Internationalization Workshop, MEMS Forum, the 12th International Micromachine/Nanotech Symposium, and Report on MEMS-ONE Project Achievements were all held over the three days (November 6-9) of the Micro/Nano 2006, attendance at each event surpassing expectations. The Micromachine Exhibition was held over two days, November 7-9, with the record attendance surpassing the previous record by 2,638 (9,098→11,736) visitors. The 10th Conference on Miniaturized Systems for Chemistry and Life Sciences (μTAS2006) was also held concurrently (November 5-9, 2006) and the synergistic effect of this event also contributed to the tremendous success of Micro/Nano 2006. Detailed reports of each of these events follow. The organizers wish to express their deep gratitude to all those who cooperated or assisted in the organization and holding of Micro/Nano 2006.

(2006 International Micromachine/Nanotech Symposium and Micromachine Exhibition Secretariat)

The 2nd Workshop on Characterization of Materials for MEMS/MST Devices

Used in many fields from sensors to man-machine interface and medicine, the automobile industry to IT and AV, MEMS has become a leading growth industry on a worldwide scale, yet the MEMS industry has almost no universal standards, a fact which is a significant impediment to industrial expansion.

A workshop was thus held on November 6, 2006, at the Mitsubishi Building in Tokyo with the purpose of having invited researchers – world leaders in the MEMS filed whose research had produced outstanding results – speak on the very latest MEMS-related micro/nano technologies and evaluation as well as to provide a forum for the exchange of opinion and deepening of mutual understanding between countries with respect to the formulation of international standards.

The workshop began with an opening address by Organizing Committee Chairman Higo (Professor, Tokyo Institute of Technology). This was followed by a total of eight presentations – Europe (3), North America (2), Korea (2), Japan (1) - divided into two sections, "Frontline of MEMS Devices" and "MEMS Evaluation Methods and Standardization". The presentations were listened to by a closely attentive audience of approximately 80 participants comprising representatives or associates of businesses, universities, and research institutions. In order of presentation, the speakers were as follows.

"Frontline of MEMS Devices"

- Professor Park, Kyunpook National University, Korea
- Professor Hierold, ETH Zurich, Switzerland
- Professor Brugger, EPFL, Switzerland

"MEMS Evaluation Methods and Standardization"

- Dr Huh, KRISS (Korea Research Institute of Standards and Science), Korea
- Professor Paul, University of Freiburg, Germany
- Professor Muhlstein, Pennsylvania State University, USA
- Professor Takashima, Kumamoto University, Japan
- Professor Ritchie, University of California, Berkeley, USA

Bringing together leading researchers whose work focuses mainly on the characterization of materials for MEMS/MST devices, this workshop provided many valuable opportunities; the opportunity to exchange opinions about standardization with the two researchers from Korea was particularly meaningful from the standpoint of developing an international network in the future.

The fact that we were able to gain the understanding of the American participants with regard to Japan's promotion of standardization efforts was also a significant move forward, providing an important pointer for international standardization activities in the future.

Photograph 1: Workshop in progress

Photograph 2: Workshop speakers and participants

The 17th Micromachine Exhibition Concludes in Success

The 17th Micromachine was held over three days, from November 7 to 9, 2006, at Tokyo International Forum (Yurakucho, Tokyo); blessed with a great venue and excellent weather, the exhibition was a resounding success.

The theme for this year's exhibition was "International Tradeshow for Micro/MEMS and Nanobio Technologies".

In addition to 13 of supporting Micromachine Center member organizations and 8 associate members of the MEMS Council, willing and generous cooperation in the arrangement of exhibits was also provided by private businesses, organizations, universities, and independent public organizations. A record total of 313 displays (429 booths) were exhibited by businesses, organizations, universities, and research institutions; 19 enterprises from abroad also presented exhibits.

A record attendance of more than 11,736 people was achieved over the three days of the exhibition, making the event a runaway success. Next year the exhibition will be held at Tokyo Big Sight.

The 18th Micromachine/MEMS Exhibition will be held at Tokyo Big Sight (Ariake, Tokyo) from July 25 (Wed.) to 27 (Fri.), 2007.

MEMS FORUM

The MEMS Forum, the first public presentation of information from the MEMS Industry Forum, was held in Hall D of Tokyo International Forum on November 11, 2006. Due to the high expectations held for the expansion of MEMS applications in a diversity of fields, attendance at the forum was far greater than venue capacity, with the hall packed with some 378 participants.

Under the theme of "Aiming for Expansion into MEMS-related Industries", the forum featured presentations on policies for raising foundry capacity, regional clusters, and regional public facility testing activities – all from the standpoint of strengthening the MEMS industrial foundation, MEMS industrial policies, and MEMS business perspectives – and presentations on the future expansion of MEMS from the standpoint of building and strengthening the MEMS technological base.

MEMS Forum Chairman Nomakuchi

Division Director Takahashi of METI

We were gratified to receive comments from participants who said that they found the forum content very meaningful because of the opportunity it presented to see all at once the current situation and future outlook for MEMS policies, business, and technology - thank you to all those who kindly gave us feedback.

12th International Micromachine / Nanotech Symposium

The 12th International Micromachine/Nanotech Symposium was held in Hall D7 of Tokyo International Forum on November 8 (Wednesday). This symposium was held as part of Micro/Nano 2006 and supported by METI and NEDO under the sponsorship of the Japan Motorcycle Racing Organization. Under this year's subtitle, "Innovations on Nanotech/Integrated MEMS and Forerunners of MEMS Business", invited speakers from the United States (4), Germany (2), Belgium (1), and Japan (5) gave presentations on a wide range of topics, from the trends in cutting-edge MEMS and micro/nano systems research to future business fields for which high expectations are held. The hall was packed with 246 participants and the discussions were lively.

The symposium was also addressed by a distinguished guest, Taizo Takahashi (Director of the Industrial Machinery Division, Manufacturing Industries Bureau, METI), who spoke about the current positioning of MEMS and expressed a hope that in the future MEMS would contribute to the strengthening of Japan's international competitiveness as a "seed of industry".

12th International Micromachine / Nanotech Symposium in progress

Report on MEMS-ONE Project Achievements

The Report on MemsONE Project Results was held on November 9 (Thurs.), 2006 at Tokyo International Forum as part of Micro/Nano 2006. The meeting was attended by two distinguished guests, Mr. Hiroshi Tsuchiya (Deputy Director of the Industrial Machinery Division, Manufacturing Industries Bureau, METI), and Dr. Masami Takayasu (Executive Director, NEDO) and Professor Isao Shimoyama (Graduate School of Information Science and Technology, University of Tokyo) , Project Leader for the "High-integration Composite MEMS Production Technology Development Project" (Fine MEMS), who spoke about MEMS development in a network with MemsONE at the center in a presentation entitled "Expectations from Fine MEMS to MemsONE".

The MemsONE Project Leader, Professor Hiroyuki Fujita (Institute of Industrial Science, University of Tokyo) presented the welcoming address on behalf of the organizers; Project Sub-Leader Professor Hidetoshi Kodera (Department of Microengineering, Graduate School of Engineering, Kyoto University) gave an outline and demonstration of MemsONE functions; Mr. Atsushi Sato, Promotion activity Committee Chairman Atsushi Sato announced the α and β version releases; and in conclusion, Micromachine Center Executive Director Keiichi Aoyagi presented a report on the support center framework. The meeting was attended by 250 participants, vividly demonstrating the high expectations held for MemsONE.

Micro / Nano 2007 and 18th Micromachine / MEMS Exhibition

Dates : July 25 (Wed.) -27 (Fri.), 2007
Venue : East Hall, Tokyo Big Sight (Tokyo, Ariake)
Times : 10:00-17:00
Concurrent Events : 13th Micromachine/Nanotechnology Symposium; Introduction of National/NEDO Projects; MEMS Forum, etc.

MEMS Foundry Service Industry Committee

Kazushi Tomii, Matsushita Electric Works
Chair, Foundry Service Industry Committee of the MEMS Industry

1. Overview

As micro-electro-mechanical systems (MEMS) have gradually become more practical, a vast market has begun to open up for MEMS devices. In recent years, the role of foundry services has become increasingly important in developing and manufacturing MEMS devices. The MEMS Foundry Service Industry Committee (FSIC) has been involved in constructing a network of Japan's foundry services. This article outlines the activities of the FSIC.

2. Activities of the FSIC

Formed within the Micromachine center in 2002, the FSIC has regularly held conferences on issues shared by MEMS foundries and has performed activities for promoting services at MEMS foundries to potential users. The membership of the committee is currently at eleven businesses and organizations involved with MEMS foundries having varied strengths and specialties. Below I will describe the committee's primary activities and endeavors planned for the future.

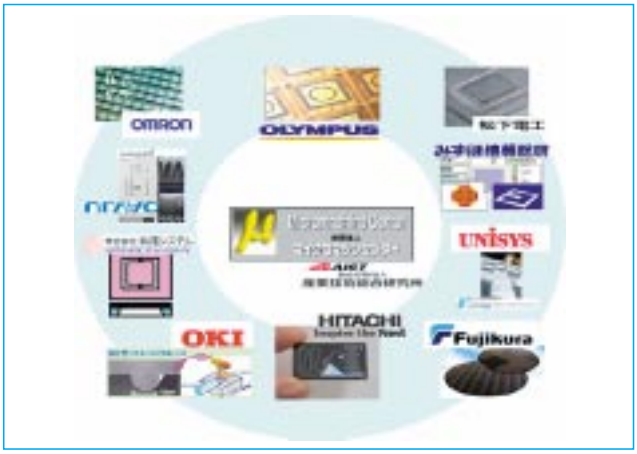


Photo 1 Members of the MEMS Foundry Network

Photo 2 How the MEMStation works

(1) Managing the foundry service network

In order to enhance contact between users and manufacturers, we have provided a help desk on the FSIC Web site entitled MEMStation for accepting inquiries from users. Beginning services in July 2005, MEMStation provides a relatively easy approach to choosing a suitable foundry business.

(2) Instruction and joint public relations activities through MEMS seminars

Since 2003 the FSIC has planned and conducted MEMS seminars targeting MEMS engineers. Held twice a year in Tokyo and Kyoto, for a total of seven times thus far, the seminars have received favorable reviews. We have also organized various joint seminars with exhibitors at the Micromachine Exhibition in order to promote the foundry network. Last year through the collaboration with regional public research and testing institutions, we were able to explain the services of various companies offering foundry services to more than 100 people.

(3) Dissemination of the MemsONE MEMS design and analysis tool

The FSIC currently plans to participate in post-project dissemination activities for the NEDO project currently underway to develop a design and analysis support system for MEMS called MemsONE.

(4) Motion to expand the MEMS industry

Conventionally, MEMS has been more difficult to standardize than semiconductors, with each company developing their own designs and processes. As a result, more time is often needed to commercialize MEMS devices, and small and medium sized companies using research findings from universities and the like cannot easily reach the stage of MEMS mass production and commercialization. In light of these problems, we would like to discuss and propose measures for enhancing the foundry's functions, such as creating design guidelines and developing process menus, in order to promote use of the foundries.

3. Conclusion

Beginning this year, the FSIC will operate within the MEMS Industry Forum under the Micromachine Center. Our objectives for this year include developing broader intercourse with the industrial world and strengthening the collaboration among industry, government, and academia, while continuing to advance the construction of the foundry network.

Initial Release of MemsONE

In November of last year, we began releasing an evaluation version (alpha version) of the MEMS design and analysis software developed through a three-year consignment project entitled the MEMS Open Network Engineering System of Design Tools (MemsONE) under the New Energy and Industrial Technology Development Organization (NEDO). As of the end of November, some 250 requests had been received for about 600 licenses. We have been processing and distributing these requests in the order received. We expect to make needed revisions based on user evaluations on the alpha version and release a version for widespread (beta version), including all components developed in the project by May 2007. It is hoped that the software will be used by companies for product development and/or design and by universities for research and as a teaching tool.

1. Goal of the Project and Features of the System

The goal of the MemsONE project was to develop a system capable of providing advanced MEMS-related knowledge and data , not only for leading experts in MEMS research, but also for newcomers (engineers and researchers in a wide variety of fields and of various experience levels to the field of MEMS), with the aim of furthering growth in the MEMS industry.

To develop the MemsONE system, three software development companies took on areas of their respective strengths. Five companies with experience in MEMS devices used their experience and achievements to design specifications and plan evaluations. Faculty members at thirteen universities provided cutting-edge knowledge and wisdom. And one research institute provided measuring techniques fostered over many years. The net result was a system comprising not only a standardized analysis and design tool, but also a unique inverse problem program for designing masks and processes based on the final structure; a program for evaluating joining/packaging, which can be problematic in device development; a knowledge database containing a wealth of information; and a material database containing materials acquired on process lines.

2. Dissemination Activities

In 2006, we expanded our promotional activities aimed at popularizing the MemsONE system. For example, at the 23rd Sensor Symposium on Sensors, Micromachine and Applied Systems held at Sunport Takamatsu in Kagawa in October, we provided a technology exhibit, and our project subleader (Hidetoshi Kotera, professor at Kyoto University) gave a presentation as a guest lecturer on the features of the MemsONE system. These activities enticed many people to try out the evaluation version. In the same month of last year, we provided an exhibit at the 9th Design Engineering and Manufacturing Solutions Expo Kansai held in Osaka at INTEX Osaka, as well as a seminar to promote the products and technologies of various exhibitors. These events offered large stages to promote the features of MemsONE.

We also gave a presentation on the achievements of the MEMS Open Network Engineering System of Design Tools at the 17th Exhibition MICROMACHINE in November, drawing some 250 interested spectators. At the same exhibition, we showed a video explaining the MemsONE project and system in easy to understand terms. Approximately 1,000 pamphlets describing the system were handed out at the exhibition and presentation, showing the large amount of interest in and expectations for MemsONE.

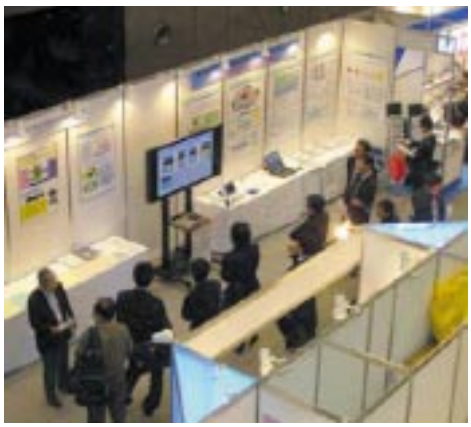


Photo 1 Activity at the exhibition booth

Photo 2 A MemsONE demonstration given by project subleader Hidetoshi Kotera

3. Future Plans

As we prepare to distribute the beta version of the MemsONE system in May this year, we will work toward resolving all remaining development issues in the system and incorporating the comments of people who have been using the evaluation version to complete a user-friendly system. We would like to encourage all who have tried the alpha version, to fill in and submit the questionnaire.

Column

Gen Hashiguchi Laboratory
Intelligent Formative Engineering Course, Faculty of Engineering, Kagawa University

Gen Hashiguchi, Professor, Kagawa University

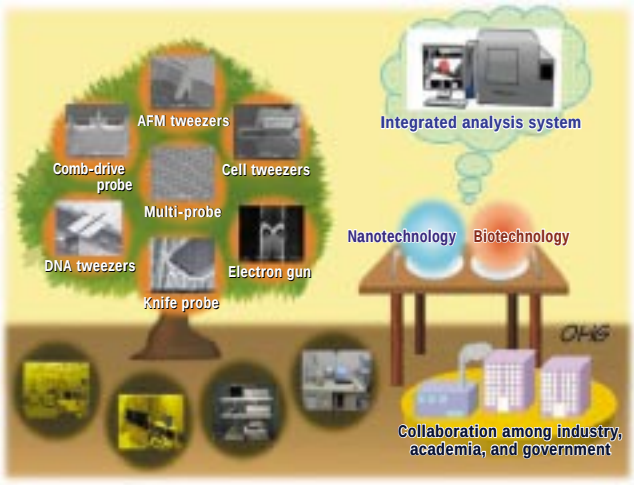
In my laboratory, we have been developing devices for nanotechnology research that combine nanoprobes with MEMS to produce new functions. My first opportunity to study probes dates back to my early years working at a company. The company had a policy of proposing research topics to the junior employees in their second year so I began researching field emission displays, which was beginning to attract attention in those days. Primarily, I was etching silicon by a wet etching process to manufacture arrays of silicon electron guns. While silicon electron guns were normally manufactured by controlling the under-etching time with a circular mask, I wondered if the electron guns could not be produced without under-etching. My idea was to combine local oxidation with KOH etching. By performing anisotropic etching with KOH on pattern edges to expose the crystal face and subsequently protecting the face with an oxide film and repeating this process three times, I could produce an excellent needle shape with good uniformity and reproducibility. Moreover, when using the edges of the pattern, this process is not dependent on the precision of lithography. While the silicon electron guns formed through this technique had good properties, ultimately silicon did not come to be used for electron guns.

After taking up my new position at the University, I continued studying probe devices based on this technique. Through similar processes, we have produced DNA tweezers (currently being studied in a Japan Science and Technology Agency project on the development of systems and technology for advanced measurement and analysis) for stretching and fixing DNA, a nanoknife for cutting chromosomes, and AFM tweezers (currently being studied by the Consortium Research & Development for Regional Revitalization under METI) for gripping and recovering nanomaterial. Wet etching is advantageous for producing nanostructures reliably and at a low cost, with good uniformity over a large surface area.

I have also focused on self-sensitive AFM probes using the immittance properties of comb actuators. This probe uses variations in a resonant frequency produced when an atomic force is applied to a comb actuator subjected to self-excited vibrations in a circuit similar to a crystal oscillator. Currently we are able to produce two-dimensional images with this probe. In addition to its application as an AFM probe, this technology can also be used as a touch sensor or force sensor by applying the same principles to tweezers, and is being developed for such applications as cell tweezers used to grip soft material. Eventually I hope to work on developing a functionalized AFM probe for use in a solution so as to be able to link this technology to biotechnology research. Recently AOI Electronics Co., Ltd. has begun manufacturing and selling MEMS tweezers. They have made innovations not only in the MEMS part but in the control system as well. This device can be used for sample transport in transmission electron microscopes and in the recovery of foreign matter generated in manufacturing processes. The AFM tweezers will also likely be incorporated in products in the near future. It is my hope that the use of MEMS tweezers in AFM devices will become commonplace.

On a different subject, I read the transcript of a nanotechnology talk given by the well known physicist Richard Feynman in which he describes miniaturization achieved by first creating a mechanism on a scale of one-fourth and subsequently creating a mechanism at a scale of one-fourth the first mechanism, for an overall scale of one-sixteenth. Through the development of scanning probe microscopes, we are currently capable of manipulating atoms and molecules with a probe. However, we must also deal with the so-called meso-spaces in which antagonistic micromechanical forces such as electromagnetic forces and meniscus forces are quite complex. For example, it is possible to grip but not release some samples with AFM tweezers, and we are currently laboring over this resolution.

At this point, we have created micro-sized cutting mechanisms and handling mechanisms through MEMS aimed at applications in nano-spaces. While at last we can see the “bottom” in terms of miniaturizing mechanisms, I suspect we have a long battle ahead of us before we can produce nano-mesomechanical structures with micro-mechanisms.



MEMS Industry Forum Joint Fact-Finding Mission (USA, Canada)

As part of MEMS Industry Forum Global Trends Research Mission activities, a fact-finding mission comprising representatives of MEMS-related organizations and MEMS member businesses visited the United States and Canada from October 9 (Monday) to 13 (Friday), 2006. The mission visited 9 locations with the aim of researching the development of advanced devices vital for the promotion of MEMS industrialization, design support software, foundry service, and industry-academia-government industrialization support systems in North America – the leader in these areas - and thereby contributing to the enhancement of MEMS-related industries in Japan.

Canada: Edmonton, Alberta
- Micralyne
- NINT (National Institute for Nano Technologies)
- University of Alberta

USA: Massachusetts
- Analog Devices
- Intellisense
- MicroCHIPS
- MIT : MEMS@MIT
- Boston Univ : Fraunhofer Institute USA CMI

USA: New York
- Infotonics Technology Center

Mission Members (alphabetical order, titles omitted)

Junji ADACHI	(Micromachine Center)
Hiroshi FUKUMOTO	(Mitsubishi Electric Corporation)
Kazuhisa KARAKI	(Olympus Corporation)
Atsushi SATO	(Mizuho Information and Research Institute)

Itinerary Outline

USA: New York

- Infotonics Technology Center : a center with such capacities as industry-academia-government design collaboration in the MEMS/photonics fields, manufacturing, packaging, testing/evaluation consulting, and foundry.

USA: Massachusetts

- Analog Devices : One of the world's leading MEMS businesses in the field of acceleration sensor development.
- Intellisense : Business that develops MEMS design software. In collaboration with Infotonics of New York, the company also conducts software training seminars and consultancy services.
- MicroCHIPS : An MIT-related venture business involved in the development of drug delivery devices. Micro cavities are created in devices implanted internally using MEMS technology and drugs are delivered by periodically dissolving the membrane electrothermally.
- MIT : One of the United States' 3 major centers for MEMS research and development together with UC Berkley and Michigan University.
- MEMS@MIT : An MIT-affiliated research center.
- Boston University (BU) : The mission visited the Photonics Center, Fraunhofer USA CMI, which conducts MEMS-related research.

Canada: Edmonton, Alberta

- Micralyne : A MEMS foundry with sales of $14 million (4th highest in the world) specializing in low-quantity, high added value MEMS.
- NINT (National Institute for Nano Technologies) : Canada's national nanotechnology research base. The research facilities were completed in June 2006. The institute was established with the purpose of promoting the industrialization of university research results.
- University of Alberta : An institution central to MEMS research in Canada. The university has a close collaborative research relationship with Micralyne.

Members' Profiles

KOA Corporation

1. Endeavors in Ceramic Packages

KOA Corporation has specialized in the manufacturing of electrical resistors for more than sixty years since its foundation and is a world leader in the types and production of electrical resistors through its worldwide sales network. Utilizing our base technologies in thin films, thick films, electroplating, and ceramics and innovative production activities, our objective is to contribute to production that respects humanity, reduces environmental impact, and enriches our lives.

Since 2001 we have been developing and manufacturing LTCC (Low Temperature Co-fired Ceramics) multilayer substrates as one of our newest endeavors, incorporating base technologies developed through the production of electrical resistors and various other electronic parts. The LTCC multilayer substrate is formed of a material that supports electronic devices, which continue to be made faster, smaller, lighter, and thinner, with more advanced functions. Moreover, KOA LTCC substrates not only have the excellent properties characteristic of ceramic substrates, but also have the capacity to respond flexibly to special shapes. There is also expectation that, in addition to electronic devices, these substrates will be developed as packages for use in MEMS technology.

2. LTCC Multilayer Substrates

LTCC is a ceramics technology in which glass material is added to alumina, enabling the alumina to be fired at a "low temperature" of 900 ℃ or less and can be used for simultaneously firing Ag as a conductor. In addition to their excellent heat resistance and humidity resistance, ceramic substrates also have excellent frequency characteristics (low loss) in high frequency circuits. Employing KOA's multilayering technique facilitates the formation of wiring patterns in surface layers and inner layers, making it possible to produce three-dimensional multilayer wiring at a high density. Since the LTCC substrates have a thermal expansion coefficient closer to silicon than do other organic substrates and ceramic substrates, less stress is produced during mounting, giving the LTCC substrates broad applications in high-frequency, multi-chip modules and circuit boards for semiconductor packages.

Photo 1 Cavity package

General Manager, LTCC Business Center
Takuo Hayasi

3. Features of KOAs LTCC

Through KOA's own shrinkage control technology and multilayer technology, LTCC substrates can be produced with a high accuracy of ±0.05% the design specifications. These technologies also make it possible to form thick films, thin films, and fine patterns using inkjet technology and to form resistive elements in surface layers and inner layers. By adding a green sheet layer with a cutout portion, cavities, hollow structures, and other complex shapes can be produced accurately. While LTCCs are widely used as substrates for small modules, the excellent properties possessed by LTCC materials suggest that applications for these substrates could be expanded through processes using the latest technologies.

Photo 2 One example of a special shape in which (squarecolumns have been formed in a cavity)

4. Endeavors in MEMS Packages

While LTCC substrates have been primarily used in high frequency modules, development is currently underway on other applications for these substrates, such as in MEMS packages.

We are working to provide high-precision packages that draw out maximum performance in MEMS devices developed by our customers, such as ultrafine, high-level sensors and functional components. By further improving the LTCC technology for high-precision, high-density wiring and producing packages having a higher added value, KOA believes it can contribute to MEMS development and product commercialization. It is our hope that customers see the advantages of LTCC and incorporate these substrates in various applications.

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

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Date of Issue : February 14, 2006