MICRONANO
2009 04
No.67

CONTENTS

MICROMACHINE CENTER
http://www.mmc.or.jp/
BEANS・TRA
http://www.beanspj.org/lab/

Topic

Developing an Infrastructure for the MEMS Industry

Keiichi Aoyagi, Executive Director of the Micromachine Center

The establishment of fundamental technologies in the field of micro/nano technology, including micromachines and Micro Electro Mechanical Systems (MEMS), would further strengthen Japan's industrial competitiveness, which is currently reliant on advanced technologies. This action might be just what Japan needs to ride out the current economic downturn.

To this end, the Micromachine Center (MMC) is focusing its 2009 projects and activities on further reinforcing the infrastructure of the MEMS industry. Specifically, we have been engaged in activities aimed at contributing to Japan's industrial development and to the international community as a whole. For example, we have established micro/nano-related technology development projects through collaboration among industry, government, and academia and have endeavored to make the results of the fundamental technologies developed in these programs widely available. Beginning this year, we have also been developing an administrative system capable of creating a better environment for promoting the industrialization of micro/nano devices. Our activities include conducting investigative research, promoting standardization, and encouraging the dissemination of research findings, as well as holding MEMS conferences to hear policy recommendations and encourage industrial exchange and vitalization.

The Highly Integrated, Complex MEMS Production Technology Development Project, more commonly referred to as the Fine MEMS Project, is a three-year project that began in 2006 and was completed in the last fiscal year. Since the original goals of the project were achieved satisfactorily, this year we will focus on disseminating and promoting the project's achievements related to the fine MEMS knowledge database and the newly developed MEMS equivalent circuit generator and on creating a support system for commercializing these achievements through continuous involvement in such projects. Further, we will actively move to develop an outline for firmly establishing fine MEMS and other advanced MEMS in Japan's industry and to write up drafts and proposals for plans related to relevant R&D projects.

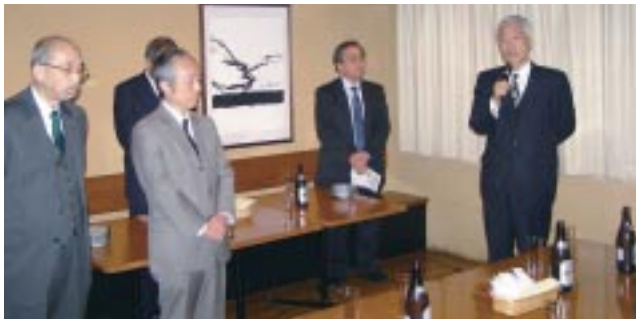
The Project to Develop Next-Generation Device Manufacturing Technologies that Fuse Different Fields, more commonly referred to as the BEANS (Bio Electro-Mechanical Autonomous Nano Systems) Project, is a five-year commissioned project that began in 2008. Though only one year of the project has been completed, we are already beginning to see solid achievements in the form of 27 academic presentations, 2 research papers, and 10 patent applications. In addition, the media has devoted much coverage to the project's accomplishments.

Beginning from this, the second year of the project, the BEANS Laboratory will serve as the main association responsible for implementing the project, with MMC participating as a member of the association. In order to ensure continued smooth implementation of the project, MMC will work in concert with the BEANS Laboratory, providing such support as human and financial resources.

MMC is also involved in developing a MEMS foundry as a framework for supporting MEMS commercialization in Japan.

A milestone will be reached when Exhibition Micromachine/MEMS is held for the 20th time in Tokyo in 2009. The 20th Exhibition Micromachine/MEMS is scheduled for three days on July 29–31, 2009 (Wed–Fri) at Tokyo Big Sight, East Hall 5. MMC and the Beans Laboratory are currently preparing visual aids for an exhibit to outline the BEANS Project and describe its achievements thus far.

Finally, I would like to ask for your continued and unwavering kindness toward MMC's activities together with your understanding and support for the BEANS Laboratory, which launched its operations in April of this year.



MMC Director Tamotsu Nomakuchi speaking at an event to celebrate the founding of the BEANS Laboratory (April 23, 2009)

Takeshi Yonemura, director of the Industrial Machinery Division, METI speaking at the same event

Overview of FY 2009 Project Planning

Micromachine Center

Ⅰ. Basic Policy for Project Planning

The Highly Integrated, Complex MEMS Production Technology Development Project, more commonly referred to as the Fine MEMS Project, is a three-year project that began in 2006 and concluded in the last fiscal year having achieved its original goals satisfactorily. Thus, in 2009 we have turned our attention to promoting and disseminating the project's achievements. Further, as the BEANS Laboratory has now assumed its new role as the primary association responsible for continuing implementation of the Project to Develop Next-Generation Device Manufacturing Technologies That Use Different Fields, a five-year project initiated in 2008 and more commonly referred to as the BEANS project, the MMC will now serve as a member of this association and will continue to provide human and financial resources and other support for the project.

In light of the current troubling economic conditions, we recognize the importance of strengthening Japan's industrial competitiveness, which is currently reliant on advanced technologies. Accordingly, we will step up our efforts to create a better environment for further stimulating industrialization and research in the MEMS field through activities of the MEMS Industry Forum (MIF) founded in April 2006, which activities will include policy recommendations and the encouragement of industrial exchange and vitalization. We also remain firmly committed to continuing activities from the previous year; namely, investigative research, and activities to promote standardization and to encourage the dissemination of research findings.

Ⅱ. Major Projects

1. National / NEDO projects

This year, MMC will aggressively continue activities to promote and disseminate MemsONE, a product of the MemsONE Project, and will begin vigorous promotion and dissemination of the fine MEMS knowledge database and the new MEMS equivalent circuit generator developed in the Fine MEMS Project. In addition, we will work to formulate a framework for bases from which we can firmly establish highly integrated, complex MEMS in Japan's industry, and to write up drafts and proposals for plans related to relevant R&D projects.

(1) Promotion and dissemination of MemsONE

In 2009 MMC will work more closely with software vendors to provide support for MemsONE and will carry out activities to disseminate MemsONE with an emphasis on stabilizing the infrastructure for future sales and distribution. Part of the dissemination activities will involve discussions with the Committee for the Promotion and Dissemination of MemsONE regarding promotion and dissemination challenges and strategies. We will also work to strengthen cooperation between the MIF and the Foundry Service Industry Committee (FSIC).

(2) Compilation of MEMSPedia

In order to disseminate the knowledge database of highly integrated, complex MEMS created as part of the Fine MEMS Project and to promote further accumulation of knowledge, MMC plans to make the database available to the general public on the Internet and to use events such as this year's Exhibition Micromachine/MEMS as venues for introducing the database. We will also be establishing a new MEMSPedia Compilation Committee this year aimed at further upgrading and expanding the database. The committee will function as a vehicle for identifying and analyzing technical fields and knowledge of interest to users based on server activity at MMC and management of user registration, and for exploring issues and operations relevant to the highly integrated, complex MEMS knowledge database according to the results of this analysis and discussing the role of MEMSPedia, which will serve as a comprehensive knowledge base for MEMS fields.

(3) Dissemination of the MEMS equivalent circuit generator

One of the products of development in the Fine MEMS Project is the MEMS equivalent circuit generator. The generator is scheduled for release at the end of May 2009 as a Web-based service. There has been an increase in R&D activity on the integration of MEMS and electric circuits and on integration through combinations of different types of MEMS. As more and more successful products emerge through this research, the MEMS equivalent circuit generator will play an important role as a new design tool capable of compensating for the shortcomings in the conventional design methods that focus primarily on MEMS mechanical components. We recognize that creating a better environment for MEMS research through a Web-based service capable of replacing MEMS with equivalent electric circuits will be essential to the growth of fine MEMS. Therefore, we are working hard to make this service available to all MEMS researchers in Japan.

(4) Support for the BEANS Project

With the primary responsibility of the BEANS Project (FY 2008–2012) shifting to the BEANS Laboratory in 2009, MMC will now participate as a member of the association. We will provide personnel and financial resources and other suitable support for implementation of the BEANS Project in order to ensure the project produces adequate results in the remaining years.

(5) Examination of new projects for technological development

Since technological development on circuit integration and the merging of dissimilar fields has recently gained momentum in micro/nano-related fields through the Fine MEMS Project and the BEANS Project, it will be necessary to establish centers for MEMS research, development, and prototype manufacturing to keep pace with this trend. In light of this, we will collaborate with the relevant organizations and businesses to study potential new projects for technological development.

2. Investigative research and standardization

MMC will be conducting investigative research to get a clear picture of technological and industrial trends in micromachine and MEMS technologies, which are emerging as key technologies in the manufacturing industry. We will also investigate new issues in micro/nano technology that arise when merging nanotechnology with technologies in other fields. We hope to demonstrate our initiative on the international stage while promoting standardization in the fields of micromachines and MEMS.

(1) Investigative research on strengthening production centers for highly integrated MEMS

(2) Surveying of technological trends at home and abroad

(3) Surveying of industrial trends

(4) Upgrading of the micro/nano database

(5) Joint research for the purpose of proposing international standards

(6) Follow-up on the international standardization of accelerating life tests, bonding strength tests for MEMS materials, and standard test pieces for calibration conducted in 2006–2008 under the project title "Measurement and evaluation of mechanical properties of MEMS materials and their standardization" ; the project is referred to as a priority follow-up and has been consigned to JSA

(7) Follow-up to a proposal of standards for testing

MEMS wafer-to-wafer bonding strength

(8) Investigative study on overseas standards

Conducted a study on Japan's response to the escalating number of proposals for MEMS standards in South Korea and other countries overseas (including standards related to RF-MEMS and bending test methods).

(9) Adoption of thin film material tensile test method standard as a JIS

3. MEMS Industry Forum projects (for policy recommendations and industrial exchange and vitalization)

MIF was established as a special project committee with the goals of supporting the further development of MEMS industries and contributing to the international competitiveness of Japan's industry. Membership in MIF is composed primarily of companies in MEMS-related industries. MIF performs the activities listed below in collaboration with affiliated academies, regional centers, and overseas institutions. This year's goals are to improve its administrative function and further expand its activities.

(1) Policy recommendations

(2) Collaboration with industry and academia

(3) Improvement of the infrastructure for MEMS development

a. Expansion and upgrading of the MEMS foundry network system
b. Promotion and dissemination of MemsONE (mentioned earlier)
c. Strengthening of collaboration among regional public foundries and local clusters
d. Implementation of personnel training projects

(4) Information exchange among businesses in MEMS and other industries

a. Opening of the MEMS Mall
b. Holding of the MicroNano 2009 general exhibition
c. Holding of Exhibition Micromachine/MEMS
d. Expansion of the international affiliate network
e. Participation in the 15th World Micromachine Summit
f. Participation as exhibitor as Hannover Messe
g. Dispatch of overseas fact-finding missions and exchange of researchers

4. Dissemination and publicity projects

MMC will continue to publish and distribute newsletters, hold exhibitions, and otherwise disseminate information on micromachines and MEMS to educate the public and make such information widely available. We are collecting reference materials and documentation related to micro/nano technologies from universities, industrial circles, public organizations, and other sources in Japan and overseas. This documentation will be consolidated with reference materials for surveys studies conducted at MMC and will be made available at the MMC archives for browsing and searching. Information will also be provided internally and externally through MMC's Web site.

We will continue to perform dissemination and publicity activities in 2009, striving for efficiency and effectiveness. In addition to our Web site and the quarterly magazine *MICRONANO*, the *MMC-MIF Monthly* (Japanese only), and the *Micro-Nano Express* newsletter issued in collaboration with the BEANS Laboratory, we will also jointly operate an exhibit with the BEANS Laboratory at Exhibition Micromachine/MEMS.

The 20th Exhibition Micromachine/MEMS will be held at Tokyo Big Sight as part of MicroNano 2009. The event is scheduled for July 29–31.

Research Studies and Standardization Activities

1. Survey of Technological Trends at Home and Abroad

This survey has been conducted every year since 1993 to collect and analyze in detail the latest technological data in Japan and overseas in order to follow trends in technology. Recognizing the growing importance of such trends in Asia, the MMC conducted surveys of presentation categories and trends in field-specific presentations at APCOT 2008 in the first half of last fiscal year. The same surveys were conducted in the second half of the year for MEMS 2009, which is an annual focus of our surveys.

The Asia-Pacific Conference on Transducers and Micro-Nano Technology (APCOT) is an international conference held in the Asia-Pacific region to present R&D findings in the MEMS and nanotechnology fields. The conference has convened biannually since 2002 when the first conference was held in Xiamen, China. Since then, the conference has been held in Sapporo, Japan in 2004, Singapore in 2006, and, most recently, Tainan, Taiwan on June 22–25, 2008 (Sun-Wed). A total of 589 papers (compared to 571 at the previous conference) were submitted for APCOT 2008, with 205 submissions from Taiwan (109 previously), 117 from Japan (66 previously), 111 from China (137 previously), 51 from South Korea (48 previously), and 10 from Singapore (110 previously). Of the 589 submissions, 377 papers were accepted, resulting in an acceptance ratio of 64.0%.

MEMS 2009, the 22nd IEEE international conference on Micro Electro Mechanical Systems (MEMS) was held in Sorrento, Italy on January 25–29, 2009 (Sun-Thu). A record-high 856 papers were submitted for the conference, with submissions from Asia accounting for more than half the total (405 papers, or 47%). Asia was followed by North America with 254 submissions and Europe with 197. As usual, the conference organizers were very selective, choosing only 276 of the submitted papers for a mere 32% acceptance ratio. The findings from the above surveys were summarized in the FY 2008 Survey Results for Field-Specific Trends.

2. Standardization

(1) IEC status

A Final Draft International Standard (FDIS) for Japan's proposal on fatigue testing methods of thin film materials was referred to the IEC, put to vote on March 20, and adopted as an IEC international standard on April 7, becoming the fifth international standard related to MEMS and the fourth submitted by Japan. We also submitted a draft to the IEC in February on fatigue testing methods using resonant vibration, developed under METI's activities for standards certification. While committee drafts (CDs) on RF MEMS switches, FBAR filters, bending test methods, and testing methods for wafer-to-wafer bonding strength proposed by South Korea are currently under review, Japan has submitted many comments, which are being weighed to reflect Japan's opinion. Japan has drafted proposals on a die shear text, 3-point bending test, and blister test as the primary testing methods for wafer-to-wafer bonding strength. Testing methods for micro-pillar compression and thermal expansion coefficients recently proposed by South Korea in August of last year were not approved, because the number of participating nations in the project remains at three, short of the required four.

(2) Research and development

METI has commissioned the MMC to perform research studies on standards certification for accelerating life tests (2006–08), standard test pieces for calibration (2006–08), bonding strength tests for MEMS materials (2007–08), and micro-gyroscopes and electronic compasses (2008–10). A draft proposal for a standard on accelerating life tests has already been submitted to the IEC, while drafts on standard test pieces

for calibration and testing methods for bonding strength reflecting the results of round-robin tests currently being conducted at overseas research institutions are scheduled for submission to the IEC around June this year. The MMC has completed an analysis of results for round-robin tests conducted on micro-gyroscopes at research institutions in Japan, as well as a study on standardization items for electronic compasses.

(3) Standardization topics in FY 2009

Three topics were proposed for METI's 2009 collaborative research and development project for international standards: measuring methods and notation for MEMS shapes, bending test methods for micro-cantilever beams, and bulging test methods. Of these, measuring methods and notation for MEMS shapes was adopted and submitted for public review. This is a three-year project to research measuring methods and notation on parameters for shapes characteristic to MEMS devices, such as side wall shapes, angles, and aspect ratios in three-dimensional MEMS structures, and for writing up a draft proposal for an international standard on measuring shapes of MEMS devices, and submitting the draft proposal to the IEC. A written proposal was submitted jointly with Kobe University.

(4) Establishment of the SC 47F national committee in the IEC

While the MMC has been carrying out activities for the IEC for some years, a national mirror committee corresponding to the IEC body was established at the MMC as the IEC assembly in charge of reviewing MEMS standardization was upgraded from a working group to a subcommittee (SC 47F). It was decided that the SC 47F national committee would be established in the IEC from 2009 based on the need for deliberating bodies to clarify national and international stances.

IEC SC 47F plenary meeting held in Tokyo

Recent Activities of the MEMS Industry Forum

The MEMS Industry Forum (MIF) was established with the goals of supporting the further development of MEMS industries and contributing to the international competitiveness of Japan's industry. Membership in the MIF is composed primarily of companies in MEMS-related industries. The MIF conducts various activities in collaboration with affiliated academies, regional centers, and overseas institutions to encourage exchange among and vitalization of MEMS-related industries. This article describes some of the recent activities at the MIF.

1. Initiation of MEMS Personnel Training Projects

The market for micro electro mechanical systems (MEMS) is expected to grow to 1.17 trillion yen in 2010 and to 2.4 trillion yen in 2015. In order to develop a sufficient number of skilled personnel to accommodate this expansion in the MEMS market, the MIF is examining ways to implement MEMS personnel training programs aimed at improving in-house personnel training at companies with the strategy of stepping up the number of MEMS skilled personnel in stages to meet expected industry needs, enhancing MEMS personnel training through industry-academia collaboration, and improving the environment to make MEMS fields more accessible to personnel wishing to transfer from other fields.

The MIF is currently helping out with a personnel training program spearheaded by the National Institute of Advanced Industrial Science and Technology (AIST) entitled "Personnel training program for pioneering new innovative projects related to micro/nano mass production and applied device fabrication." The MIF has also begun a study in concert with regional consortia on a tangible personnel project aimed at expanding practical personnel training with industry-academia collaboration and offering more MEMS lectures and training courses for working people, as well as launching a Web site for personnel training in MEMS fields. During 2009 the MIF plans to work with regional consortia, public research institutes, and universities to build the foundation for integrated course management with curricula structured around the local characteristics of each region.

2. The 12th MEMS Seminar

On February 6, the 12th MEMS Seminar organized by the MEMS Foundry Service Industry Committee (FSIC) of the MIF (chair: Fumihiko Sato of Omron Corporation) was held at the Grand Hotel Hamamatsu in Hamamatsu, Japan. It was the first time held in the Tokai region. The seminar mainly targets beginners in MEMS field and middle class engineers of the member companies. Entitled "MEMS Design and Processing Techniques and Their Applications," the seminar was cosponsored by the Organization for Hamamatsu Technopolis and the Innovation and Joint Research Center of Shizuoka University and was held concurrently with Hamamatsu Messe 2009 organized by the Organization for Hamamatsu Technopolis.

The 12th MEMS Seminar

The "MEMS Design and Processing Techniques and Their Applications" seminar covered a wide range of topics through academic lectures on advances in MEMS integration and fusion and expectations for the creation of new industries (Prof. Susumu Sugiyama of Ritsumeikan University) and MEMS design techniques using electric equivalent circuits (Prof. Gen Hashiguchi of Shizuoka University); a lecture on stealth dicing (a fully dry process) gaining popularity in MEMS mass production plants (Naoki Uchiyama of Hamamatsu Photonics) as an introduction to technologies used in MEMS businesses in the Tokai region of Japan; lectures on MEMS devices, processes, and simulations developed by member companies of the FSIC; and talks on MEMS technology and trends, MEMS foundries, and the MEMS Open Network Engineering System of Design Tools (MemsONE).

3. The 17th MEMS Advanced Technology Forum

The forum was established to encourage the exchange of ideas among industry and academia and to disseminate information and raise awareness on micro/nano technologies. It mainly targets skilled researchers and engineers of the member companies. Held three times annually, the forum invites experts from universities, the AIST, and other organizations to give lectures on cutting-edge technologies in the micro/nano and MEMS fields.

The 17th MEMS Advanced Technology Forum was held on February 17 (Tuesday) at the MMC Techno Salon, where the

MIF had the privilege of welcoming Prof. Shuichi Shoji of Waseda University's Faculty of Science and Engineering and Associate Prof. Yoshio Mita of the University of Tokyo's Graduate School of Engineering.

Prof. Shoji introduced a case study entitled "MEMS devices designed for cell function analysis" on applied MEMS devices that enable a cell culture system, cell disruption, and biomolecular separation and analysis for analyzing the functions of specific cells. Associate Prof. Mita introduced an innovative MEMS technology in his lecture entitled "Study on MEMS integrated through an autonomous distributed micro-robot." As an example, he described a MEMS device that moves autonomously over a water surface according to low-voltage electrowetting-on-dielectrics (EWOD) droplet propulsion employing a three-dimensional photodiode structure having a depth of 10μm and a width of 150 nm.

Prof. Shuichi Shoji of Waseda University

Associate Prof. Yoshio Mita of the University of Tokyo

Dissemination and Publicity Projects

The Micromachine Center (MMC) publishes newsletters, holds exhibitions, and distributes information on its Web site as a means of disseminating information on micromachines and MEMS to educate the general public and of making information on its activities widely available. This article will describe some of the MMC's recent activities.

1. Expansion of Participants in the MEMS Mall

The MEMS Mall was launched on October 1, 2008 on the MMC Web site to provide information on products and technologies developed by MEMS-related companies. While participation in the mall was limited last year to members of the MEMS Industry Forum (MIF), this year we have relaxed the requirements to include non-member companies.

In the past, a person wishing to collect information on MEMS products had to access each company's Web site individually. The MEMS Mall is a site that brings all MEMS product information together and provides online visitors a method of accessing information, much like visiting booths at the MMC-sponsored Exhibition Micromachine/MEMS. To participate in the MEMS Mall, please visit the following Web site.

http://www.mmc.or.jp/mall/

2. MemsONE Sales and Distribution

Sales and distribution of the MEMS design and analysis software MemsONE began in February this year. The software was developed under the project entitled the MEMS Open Network Engineering System of Design Tools and has been receiving glowing reviews. An academic version of the software for universities and public research institutions is distributed by the MMC, while an enterprise version designed for general company use is sold through software vendors.

See the table below for the schedule of MemsONE training courses to be held in Tokyo and Osaka. For more information on the training courses and features of the MemsONE software, please visit the following Web site.

http://mmc.la.coocan.jp/mems-one/

Schedule of training courses

Tokyo	Osaka
5/19 (Tue) : Basic operations 6/22 (Mon) : Analysis 9/18 (Fri) : Applications 10/21 (Wed) : Basic operations 11/18 (Wed) : Analysis 1/20 (Wed) : Applications	5/22 (Fri) : Basic operations 7/17 (Fri) : Analysis

3. Micro/Nano 2009

The general exhibition Micro/Nano 2009 provides a venue for businesses in the micromachine and MEMS industries to showcase their leading-edge products and materials and to present their latest research findings. Details of the event are given below.

(1) 20th Exhibition Micromachine/MEMS

The world's largest exhibition covering both the micromachine and MEMS industries, the 20th Exhibition Micromachine/MEMS will be held July 29–31, 2009. At Tokyo Big Sight (Tokyo International Exhibition Center), East Hall. Some special exhibits are planned for the event to commemorate its 20th anniversary.

(2) Seminars and symposiums

This year, two special conference areas A and B will be set up at the venue of Exhibition Micromachine/MEMS for holding various presentations on micro/nano-related research activities. The following table shows the schedule of events for these conference areas.

	Conference area A	Conference area B
7/29 (Wed)	10:25–16:45 The International Micromachine/Nanotech Symposium – MEMS World –	11:00–12:20 MEMS Industry Forum Workshop on Industry-Academia Collaboration 13:00–15:50 MEMS Packaging Forum
7/30 (Thu)	Japanese-German Micro/Nano Business Forum	11:00–12:20 MEMS Industry Forum Workshop on Industry-Academia Collaboration 13:15–17:00 BEANS Project Seminar
7/31 (Fri)	10:30–16:15 MIF Forum	10:30–16:45 Presentation of Results from the Fine MEMS Project

For more information on the exhibition and visitor registration, visit the Web site **(http://www.micromachine.jp.)**

The 19th Exhibition Micromachine/MEMS held in 2008

Foundation and Overview of the BEANS Laboratory

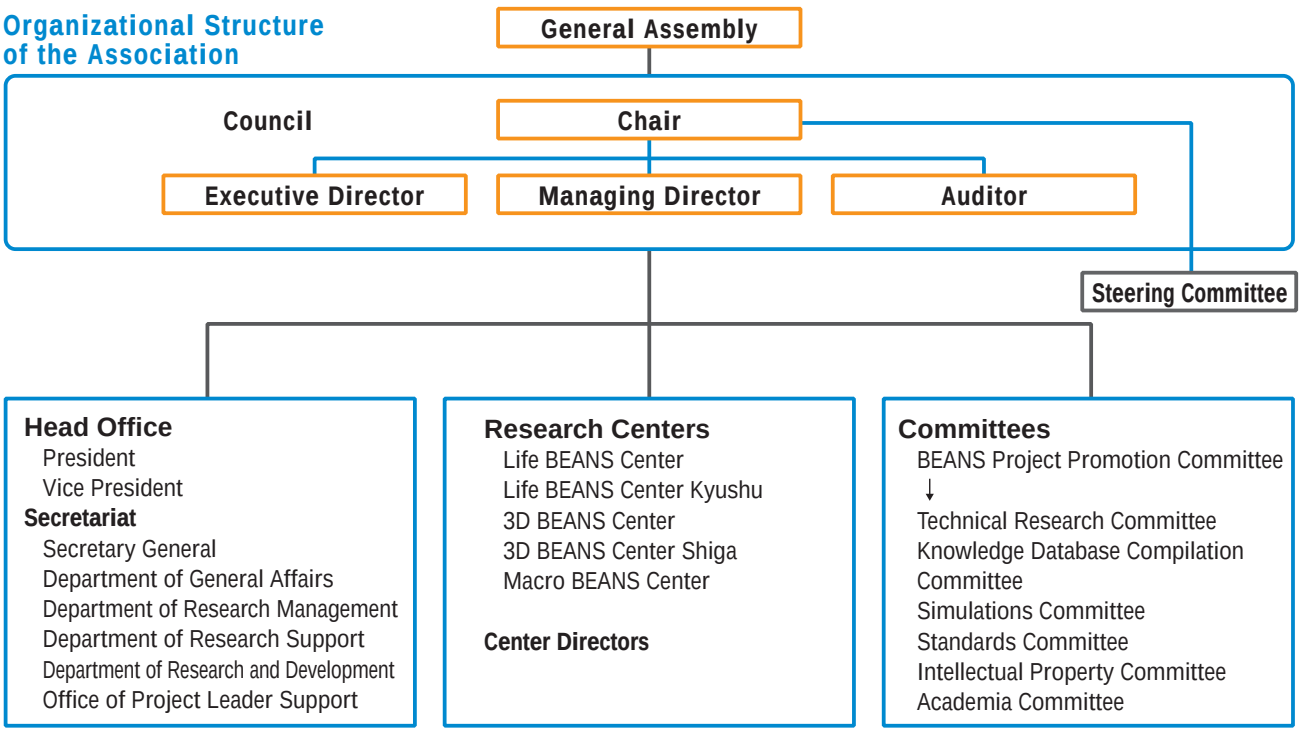
The Bio Electro-mechanical Autonomous Nano Systems (BEANS) Project, which has been implemented under the Micromachine Center (MMC) since July 2008, has been transferred to the control of the BEANS Laboratory, a technology research association, in April 2009. After much effort–though only a three-month period of preparation–the technology research association was officially established on March 24 of this year. We are immensely grateful to all association members and concerned parties for their support and cooperation during this period.

Owing to the cooperation of the member companies, an application for approval of the technology research association was prepared through a process that included a briefing session with interested parties (preparatory meeting for establishment of the association) on January 16, a meeting of promoters on February 3, and an inaugural general meeting and council meeting on February 20. The application submitted to the Minister of Economy, Trade, and Industry on March 6 was approved on March 19, and the association was officially registered on March 24. An extraordinary general meeting was held on that very day to approve the project plans and budget for fiscal year 2009, and operations of the association were off to a smooth beginning on April 1.

Since the launch of operations, the association has joined forces with the MMC under the direction of Director Nomakuchi, with the goal of further expanding activities aimed at encouraging growth in Japan's MEMS industry.

Name	BEANS Technical Research Association (BEANS TRA), commonly referred to as the BEANS Laboratory
Address	MBR Building, 6th Floor, 67 Kanda-Sakumagashi, Chiyoda-ku, Tokyo 101-0026
Establishment dates	February 20, 2009 (inaugural general meeting) March 19, 2009 (approval of establishment) March 24, 2009 (official registration)
Chair	Tamotsu Nomakuchi
Members (18 organizations)	Olympus Corporation Seiko Instruments Inc. Terumo Corporation Toshiba Corporation Fuji Electric Systems Co., Ltd. Panasonic Electric Works Co., Ltd. Mitsubishi Electric Corporation Lintec Corporation Omron Corporation Mathematical Systems Inc. Denso Corporation Fujikura Ltd. Furukawa Electric Co., Ltd. Mizuho Information & Research Institute, Inc. Mitsubishi Chemical Medience Corporation Micromachine Center (MMC) Institute for Unmanned Space Experiment Free Flyer Foundation (USEF) Japan Resources Observation System and Space Utilization Organization (JAROS)

Organizational Structure of the Association



Visit the following Web site for more information: http://www.beanspj.org/lab/index.html

An Overview of Projects Planned for 2009

The BEANS Laboratory will be implementing the following R&D projects in 2009.

R&D Project 1: Development of processes for integrating biomaterials and organic matter

1) Process technologies for nano-interface fusion
2) Process technologies for the formation of higher order bio/organic structures

R&D Project 2: Development of processes for the formation of 3D nanostructures

1) Technologies for forming ultra-low damage/high-density 3D nanostructures
2) Technologies for forming hetero-functional integrated 3D nanostructures
3) Technologies for forming 3D nanostructures for space applications

R&D Project 3: Development of micro/nanostructure large-area continuous manufacturing processes

1) Process technologies for large-area formation of high-grade nanofunction membranes in a non-vacuum environment
2) Process technologies for continuous micromachining and integration of fibrous substrates

R&D Project 4: Development of a knowledge database for next-generation device fabrication technologies integrating dissimilar fields

We are also collecting information from dissimilar fields on tangible requirements for producing innovative devices that may lead to new lifestyle improvements.

Entering the 2nd Year of the BEANS Project

Atsushi Yusa, BEANS Project Leader

The initial year of the BEANS Project spanned a shorter-than-usual nine-month term, which seemed to be over before it began. Our work during this period could be described succinctly as start-up activities for launching the project. For example, we provided facilities at the University of Tokyo's Komaba Research Campus, the Kyushu University Center for Future Chemistry, and the Tsukuba East Office of the National Institute of Advanced Industrial Science and Technology with clean rooms, private sitting rooms, and labs for the exclusive use of the BEANS Project. We also worked on equipping the labs and enhancing the environment of the facilities by installing large machinery and lab equipment during the early stage of the project. At the same time, we naturally focused our efforts on research tasks scheduled for the first year by taking advantage of the university-owned research facilities. This quickly resulted in some ingenious research results, that could only have been made possible by the BEANS Project. Our research findings were covered in academic publications and other media under the subject of MEMS and transducer research, raising the profile of the BEANS Project.

By working to coordinate research centers and integrate research tasks, which is a goal of the BEANS Project, we are beginning to develop integration among research topics. Of course, not all research projects go according to plan, and progress can be erratic depending on the nature and degree of difficulty of the topic. However, I believe the project as a whole is proceeding in the right direction.

After reviewing the results from the initial year, as well as the problems or difficulties that were encountered, we have set a primary objective for the second year to achieving smooth and efficient project implementation. From the first year, we have learned the importance of establishing expected results and clear target values at the time of drafting the plan. Even when a plan is drafted, however, there are always unforeseen circumstances that prevent research from proceeding as anticipated. This is also the enjoyment and thrill of research. Consequently, even though researchers go through the motions of drafting a plan initially, they tend to feel that such a plan is pointless and neglect to conduct mid-year reviews of the plan and to monitor progress. In other words, at times researchers can become mired in research conducted for their own interests or research that produces immediate results, losing sight of the original goals. Of course, one cannot completely negate such digressions because they occasionally lead to important discoveries and inventions. However, within the BEANS Project research we cannot allow researchers to stray from the end goal or expected achievements. We also cannot simply assume that results will necessarily be produced thorough research management. Therefore, all the managers of this project the research directors and the project leader, must attempt to achieve balance in their management so as to anticipate a degree of uncertainty in the original plan and respect the researchers' independence and spontaneity, while guiding the researchers in a direction that does not veer from the basic plan. In this case, the implementation plan serves as the fulcrum of the balance and helps the managers determine the correct approach when research does not proceed as hoped. Based on such determinations, the managers may revise or modify the initial plan within the scope of the basic plan. More important is that all researchers fully understand their goals and share their results with other researchers and centers. Cooperative relationships among research topics and members of the BEANS Project will come about naturally as a result. I realize that this approach was not adequately achieved in the first year of the project and feel strongly that these ideas can be better incorporated in our project management this year.

The next goal for the second year is to strengthen collaboration among research centers, as mentioned earlier. This year we will begin a new topic of integrated research between the 3D BEANS Center and Life BEANS Center Kyushu, which was suggested and planned based on preliminary experimental results produced in the first year. By applying low-damage etching technology, the core technology at the 3D BEANS Center, to organic thin film formation technology at Life BEANS Center Kyushu, we have begun to see some potential for forming 3D structures of organic matter that do not occur in the natural world. This is a research topic appropriate for the BEANS Project, and I am confident that it will be received as creative and revolutionary throughout the world. We are also planning similar topics of integrated research between the Macro BEANS Center and the Life BEANS Center and between the 3D BEANS Center and the Life BEANS Center. Hence, the second year of the project will be shifting from the preparation stage to serious topics of integrated research, and I anticipate that we will produce results worthy of the BEANS Project that will attract much attention.

If we liken the first year of the BEANS Project to a period of preparing for takeoff, then the second year will see us spread our wings to lift off of the runway. With diligence and hard work, we can skillfully catch an updraft and ride it to great heights where the flying is smoother. In this I ask for your continued support and cooperation.

Members' Profiles

Nippon Avionics Co., Ltd.

1. Company Profile

Since 1963, Nippon Avionics has been assisting customers through the development of resistance welders primarily for use with electronic parts, and such joining technologies as microsoldering, thermocompression, and bonding. In 1966 the company adopted parallel seam sealing as a highly reliable hermitic sealing method for optical devices and hybrid integrated circuits. The applications for this parallel seam sealing technology expanded with the surface mounting of crystal oscillators and SAW filters in the early 1980s. When vacuum seals became necessary for the miniaturization of crystal oscillators around 2003, we quickly introduced a vacuum seam welder that is still the primary sealing method today. Recently there has been an increase in the use of seam sealing for MEMS devices, such as accelerometers, gyroscopes, and infrared sensors and our sales of seam welders has reached more than 800 units.

2. Parallel Seam Sealing

The principle of parallel seam sealing is to supply electricity to a lid, a seal ring, or a metal package, thereby applying Joule heating to melt a brazing filler material preset between the lid and the package. The melted filler material fills the gaps and forms a mechanical bond between the lid and the package.

As shown in **Fig. 1**, tapered roller electrodes are provided on the left and right edges of a device so as to apply a moderate load to the device. As the device is moved at a constant speed, a welding current flows intermittently between the electrodes, generating heat to melt the filler material around the lid.

Since parallel seam sealing can produce a high temperature instantaneously, the seal can be formed with nickel, which is very reliable but has a high melting point. Nickel also has a very high cooling rate, producing a dense filler composition when solidified and, thus, a high bonding strength. Further, parallel seam sealing uses localized heating and, therefore, generates only a small heat-affected zone. Accordingly, this technique can produce a hollow structure that is strong and reliable.

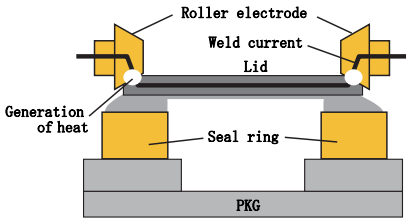


Fig.1 Principle of seam sealing

3. Sealing Product Lineup

As a specialist in welding, Nippon Avionics explored the most suitable control technologies for seam sealing and developed a dedicated power supply to install in its sealing equipment. The company has manufactured sophisticated, high-performance equipment using its own software, and mechanical, image-recognition, and application technologies and has held the top market share since its product lineup was first introduced.

We have a wide array of products ranging from manually operated units for research or low-volume production to automated inline units for mass production. Our products also perform constant pressure control and are capable of sealing vibration devices such as accelerometers in helium or other inert gases when the devices must be accommodated in a constant internal pressure environment to maintain a uniform vibrating state.

Fig.2 Full Automatic Vacuum Sealing Equipment NAW–1265A

4. Future Endeavors

In addition to the seam welding method introduced in this article, Nippon Avionics possesses a joining technology employing heating units to implement a pulse heating method. Pulse heating adjusts the temperature through feedback control to reproduce a specified temperature profile accurately. This feature can conceivably be applied to batch sealing and die bonding in MEMS devices using filler material with a low melting point.

By refining the conventional seam welders, we offer user-friendly equipment that achieves higher yields. As a pioneer in micro-joining technology, the company supplies pulse heating units suitable for use in MEMS devices. We are confident that you will find this equipment advantageous when developing or fabricating such MEMS devices.

For a more detailed description of our products, please refer to our Web site at **http://www.avio.co.jp.**

Note:

With the launch of the BEANS Project in April this year, the format for this issue (No. 67) of the MICRONANO magazine has been updated to include information in the micro/nano fields distributed by both the Micromachine Center and the BEANS Laboratory, which is the association overseeing the BEANS Project. Thus, in addition to including a description of activities performed at the Micromachine Center, future issues of the magazine will also include activities and achievements by the BEANS Laboratory.

MICRONANO No. 67

MICRONANO is published quarterly by Micromachine Center (MMC), BEANS Technical Research Association (BEANS·TRA) 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 :

Keiichi Aoyagi, Executive Director, Micromachine Center (MMC)
MBR99 Bldg., 6F., 67 Kanda Sakumagashi, Chiyoda-ku, Tokyo 101-0026, Japan
Tel : +81-3-5835-1870, Fax : +81-3-5835-1873
Internet Home Page http://www.mmc.or.jp/
Date of Issue : May 15, 2009