

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 at 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 test, 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 METT'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 "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 Phototonics) 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).



The 12th MEMS Seminar

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