# Overseas Mission from Micromachine Center / MEMS Industry Forum Attends the MEMS Executive Congress and Visits Micro-Nano Related Venture Firms in Silicon Valley

The MMC/MEMS Industry Forum dispatches overseas missions as one of its international interchange activities. At the beginning of November, an overseas mission attended the MEMS Executive Congress that was held in Monterey, California. The group also visited universities and companies in North America, particularly those in Silicon Valley in the MEMS and nanotech fields, in order to conduct a survey of current trends. The following is an overview of the overseas mission's activities.

◆**Date:** November 2 (Sunday) - 9 (Sunday), 2008

◆**Purpose:** To attend the MEMS Executive Congress in order to ascertain the latest trends in the MEMS field as viewed from a management standpoint and create a network of MEMS industry managers around the world, and to use the time before and after the Congress to visit micro/nano related companies, universities and other institutions in Silicon Valley in order to conduct a survey of technical trends and forge business relationships.

◆**Itinerary:**

November 2 (Sunday) Depart Japan; arrive San Francisco
November 3 - 5 (afternoon) (Monday - Wednesday) Visit relevant organizations
November 5 (evening) - 7 (morning) (Wednesday - Friday) Attend MIG MEMS Executive Congress
November 7 (Friday) Visit relevant organizations
November 8 (Saturday) Depart San Francisco
November 9 (Sunday) Arrive Japan

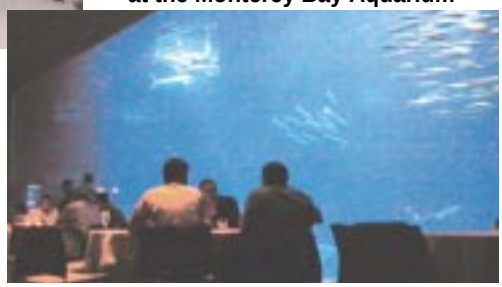
◆**Participants:**

Omron: Sato, Takahashi (Omron Silicon Valley)
Panasonic: Okamoto
Lintec: Nakata
MMC: Adachi

Map showing North American locations visited

Overseas Mission at SiTime

MEMS Executive Congress Dinner at the Monterey Bay Aquarium



## ◆MEMS Executive Congress

The MEMS Executive Congress is an annual conference held by the MEMS Industry Group (MIG), a MEMS Industry Forum overseas affiliate based in Pittsburgh, Pennsylvania. The conference is attended by executives of MEMS-related firms from around the world.

This year, the MEMS Executive Congress was held at the Monterey Plaza Hotel & Spa in Monterey, California. The 133 Congress attendees included four from Japan:
- Mr. Sekiguchi of Omron Corporation, an MIG member firm;
- Professor Esashi of Tohoku University (who also served as a panelist);
- Mr. Okamoto of Panasonic Electric Works Co., Ltd., one of the participating companies making up the overseas mission; and
- Mr. Adachi of the Micromachine Center.

The Congress program included the keynote addresses and panel discussions listed below. One of the most noteworthy features of the MEMS Executive Congress seems to be the long lunch and other break times, designed to encourage networking and the exchange of information among attendees.

### Keynote Addresses

■ Sun Small Programmable Object Technology (Sun SPOTs) Roger Meike Sun Microsystems Laboratories
■ Towards New Paradigms of Sensing, Computing and Communication Tapani Ryhanen Nokia Research Center

### Panel Discussions

■ Panel 1 : Convergence of MEMS in Consumer Electronics and Mobile Communications
■ Panel 2 : MEMS Inside: Enabling Low Power, Energy Monitoring and Conservation
■ Panel 3 : Investments in MEMS Leading to Liquidity Events – A VC Perspective
■ Panel 4 : MEMS Emerging Technology Outlook
■ Panel 5 : MEMS Market Analysis

Next year's MEMS Executive Congress will be held November 4 - 6 in Sonoma, California.

## ◆Company and university visits

The following is an overview of the locations visited in North America.

### ■Cavendish Kinetics: **Venture firm specializing in the development of CMOS-compatible MEMS**

The goal of Cavendish Kinetics is to provide memory, sensors and switches using a 100% CMOS-compatible process.
The basic technical concept is to control silicon-to-silicon adhesion and form cantilever structures by means of a CMOS-compatible process, creating memory, sensors and switches solely by changing the mask designs. The company has a business model under which it utilizes SVTC technologies in a fabless manner and licenses its technology.

■Kovio, Inc.: **Venture firm specializing in nanoink and printed electronics**

Kovio was founded in 2001 by Dr. Jacobson of the MIT Media Lab and has 51 employees. The company obtained USD $23.5 million in Series D funding; Japanese companies Yasuda Enterprise Development Co., Ltd., Mitsui Ventures, Panasonic Venture Group and Toppan Forms Co.have invested in the company. Kovio currently specializes in the development of silicon ink (synthesized using the wet method) and silicon ink printing technologies used for manufacturing RF-ID tag transistor circuits. The smallest circuit width is 10 $\mu$m with mobility of 70 - 80. These circuits have greater mobility and durability as compared to organic semiconductors.

■Nanochip, Inc.: **Venture firm specializing in cantilever memory development**

This fabless startup company, founded in 1996, developed prototype devices based on a concept similar to the Millipede project at the IBM research lab in Zurich. Nanochip has received funding since 2004. This company introduced the concept of creating memory through the combination of three layers: a CAP wafer (with a pocket for storing a magnet), a Mover wafer and a CMOS wafer. An electromagnetic system with high drive force in the X and Y directions is used to enable displacement of ± 100 $\mu$m, and an electrostatic system was adopted due to the low cantilever displacement of 0.4 $\mu$m.

■NanoGram Corporation: **Venture firm specializing in nanoparticle / nanoink and solar cell development**

Founded in Silicon Valley in 1996, this venture firm has received funding of USD $68.7 million from Yasuda Enterprise Development Co., Ltd., Mitsui Ventures, Inc, Nagase & Co., Ltd., Tokyo Electron Limited and other companies. It has 85 employees and offices in Japan and South Korea. A core technology of the company is a process through which a precursor is thermally decomposed using a laser beam and condensed into nanoparticles. Using this technology, NanoGram has generated numerous nanoparticles while maintaining control of particle size and composition. Currently the company's primary focus is on developing the technology to form multicrystal silicon foil (SilFoil) directly on substrates using the laser reaction deposition method, with the aim of producing solar cells. As this method enables large-area film formation in a non-vacuum environment, the cost is low as compared to conventional multicrystal silicon solar cells. Design of a 5 MW pilot line is currently underway.

■Qualcomm MEMS Technologies, Inc.: **MEMS display development company**

Qualcomm MEMS Technologies is a 100% subsidiary of Qualcomm, a company famous for its achievements in 3G CDMA technology. Qualcomm MEMS Technologies develops and manufactures reflective "IMOD" displays that reflect ambient light and output specific wavelengths. The principle is to use surface micromachining to form resonant structures that move individual pixels through electrostatic drive, using light interference to reflect RGB wavelength light to an external location. A black and white display product developed for use in Chinese cellular phones is being manufactured in Hsinchu, Taiwan. Development of a full color display for use as the display in MP3 music players is also progressing, and the initial customers for this product have already been secured. As the device is a reflective one, the screen is easy to see even in direct sunlight, and no backlight is required. Electrostatically driven hysteresis is used to maintain "off" status at low voltage, so power consumption is much lower than that of a liquid crystal display. On the other hand, as the screen is dark in indoor locations, a front light is used to improve visibility.

■Silicon Clocks, Inc.: **Venture firm specializing in Si resonator and MEMS/CMOS integration**

Dr. Howe of Stanford University serves as chief scientist for this startup firm. A new CEO has been brought on board to oversee a shift in the business model from the previous emphasis on silicon oscillator product development to the licensing of element IP ("MEMS on CMOS" integration process, wafer-level vacuum sealing, resonator and other device design, and analog circuit design). Silicon Clocks is currently seeking licensees and has shown great interest in Japanese firms. The company integrates MEMS resonators on CMOS using LPCVD polysilicon-germanium.

■Silicon Microstructures, Inc.: **MEMS development division (pressure sensors) of the German firm Elmos Semiconductor AG**

Founded in 1991, this company has 90 employees and is a specialty manufacturer of piezoresistance type MEMS pressure sensors (10 mbar - 10 bar). In 2001, it was acquired by and became a 100% subsidiary of the German firm Elmos Semiconductor AG (a manufacturer of automotive ASIC). Since 2004, Silicon Microstructures has manufactured pressure sensors on 6" lines for automotive use (TPMS, etc.) and for the medical care (blood pressure meters, etc.), industry and consumer markets. Its product line also includes absolute pressure sensors that utilize vacuum sealing.

■SiTime Corporation: **Venture capital firm specializing in Si resonator development**

The aim of this company is to create new markets by replacing crystal oscillators with its Si resonators, utilizing their properties of compact size, low cost, high reliability and CMOS compatibility. The 4" crystal oscillator achieved through joint research between Bosch and Stanford University professor Tom Kenny were expanded to an 8" process in 2005 by SVTC Technologies in order to shift to mass production. In the latter half of 2006, the achievements were transferred to Jazz Semiconductor, and a mass production system was put in place in 2007. This year, production of 2.5 million units was achieved. Future goals are to achieve a market shift from crystal oscillators amounting to JPY 1.7 trillion yen, and to develop new markets for these devices. The MEMS division has been consigned to Jazz Semiconductor and the CMOS divisions to TSMC, with packaging conducted through fabrication in Malaysia and Thailand.

■SVTC Technologies, LLC: **8" CMOS/MEMS process development foundry**

In the SVTC business model, ideas from users and concept models developed at the university laboratory level are brought in, and customers dispatch engineers to conduct process development using SVTC facilities (in some cases, the customer provides the equipment needed for process development). In this way, the company serves as a bridge to mass production. Major benefits include the fact that customers are able to use the process recipes accumulated by SVTC and own 100% of the intellectual property relating to the processes they develop. Fabrication is conducted using the R & D facility of Cypress Semiconductor, and facilities are currently being expanded. This year, SVTC acquired a company with a large fabrication plant in Texas, and the company also has a third center of operations in south San Jose that is dedicated to the fabrication of solar cells. Process development is conducted by users or by SVTC based on agreements with users. SVTC also conducts consulting relating to process development and provides engineering services to meet user needs.

■MEMS research by Berkeley Sensor & Actuator Center (BSAC), University of California at Berkeley

◆**Case studies of nanotech research at BSAC presented by Dr. Javey**

- Printable nanowire
- Nanocolumn GaAs solar cell
- High-strength adhesion by means of nanowire with polymer coating

◆**Advanced MEMS Inc. – Endoscope equipped with MEMS mirror**

This startup firm, founded by a U. C. Berkeley post-doctorate researcher, is developing the technology to integrate an electrostatically-driven MEMS mirror and laser light source at the tip of an endoscope in order to obtain images of areas beneath the surface of the skin using the light coherence tomography method. Information contained in 2mm$^2$ sectional slices are continually obtained at a resolution of 10μm, making it possible to quickly detect cancer cells that previously were difficult to discover through surface observations.

At the places we visited, the worsening economy resulting from the financial crisis has made it difficult to secure venture capital, even in Silicon Valley. As a result, some companies were switching from cost-intensive product manufacture and sale to a business model based on licensing, and some have even been forced to lay off some of their employees due to cash flow problems. Yet some companies were still doing well; for example, this year SiTime shipped 2.5 million MEMS resonators.

With attendance at an international conference and visits to 10 different companies in the space of five days, the overseas mission had a very busy schedule. However, the companies were located near one another in Silicon Valley, where MEMS related companies and universities are concentrated, and the weather was good. As a result, the trip was a resounding success, and the Micromachine Center would like to express its appreciation to those who participated.

The MEMS Industry Forum plans to dispatch overseas missions in the future as well. If there are any particular regions or companies that you think it would be instructive to visit, please let us know.