MEMS Technology— The Fusion of Chemistry, Electronics, & Mechanics

Phillip Miller & Dr. Pat Mentone

Air bag actuators, printer nozzles, flow control systems, Rf switches, phase shifters … all MEMS devices, all currently manufactured. Where does technology reside for making micro-electro-mechanical systems (MEMS) devices? Perhaps the semiconductor industry, because of its utilization of clean rooms? Semiconductor manufacturing technology is typically only two-dimensional. MEMS device manufacturing requires three dimensions. Wet process semiconductor manufacturing typically encompasses copper, lead-tin solder, aluminum, etc. MEMS devices are typically made of nickel (and copper). Also, MEMS devices are typically made, in part, using an electroforming process. Perhaps, MEMS devices could be made by the general metal finishing industry, if there were the ability to incorporate "cleaner manufacturing facilities."

Hopefully, this month's interview will stimulate some creative thinking concerning the future of MEMS and the future of AESF.

In April, we introduced our readers to the AESF Emerging Technology (ET) Committee. As promised, in subsequent articles, we will introduce you further to the happenings of this important venture.

This article is the fourth in a series of articles that include interviews with the Emerging Technologies (ET) Committee, sub-committee chairs. We will conclude this series by interviewing the current Chair of the Research Board to see how some of their R&D funds are being directed toward emerging technologies.

This month's article focuses exclusively on the ET Committee's Sub-Committee on MEMS Technology. We especially thank Dr. Pat Mentone (PM) for his help and expertise on this subject.

AESF: *When was the MEMS Sub-Committee formed and why?*

PM: There is a lot of intense interest in MEMS work as of late. MEMS are unique in the plating world because it utilizes chemistry, electronics and mechanics and brings them all together on a small scale. That's the challenge—getting it all to work on a minute scale. We are part of the Emerging Technologies Committee because of the growing emphasis on MEMS work.

As far as the Sub-Committee on MEMS goes, we plan to become more organized and cohesive after meeting at SUR/FIN® in June. At that time, members will come together and a structural format for the sub-committee will be discussed and formulated.

AESF: *What all does MEMS cover? How is it defined?*

PM: MEMS stands for micro-electro-mechanical systems. MEMS can use semiconductor technology to define particular substrates that will be plated, and it is similar to the electroforming technique used to make ink jet printer nozzles or high-volume replication of CD-ROMs. You can even compare the technology to the way they used to make phonograph records—a stamper tool was used to emboss a particular pattern of grooves on each record. MEMS technology can be used to "stamp" a pattern on a CD, except that the patterns are now extremely small and much more complex.

The main difference in MEMS is that it utilizes three dimensions as opposed to semi-conductor technology, which uses two dimensions. More simply, MEMS is three-dimension electroforming on a very small scale. In that way, MEMS is more complicated to perfect.

AESF: *Can you give some examples?*

PM: Applications of MEMS technology rely on very specific properties. Sensors that are designed to set off air bags in cars rely on a freestanding beam of nickel—it's almost like a flat needle—that can be 1–2 microns thick and 10–20 microns long. These sensors have to be able to recognize sophisticated stress and thickness properties. In order to be successful, the key to MEMS technology is getting it to work the exact same way each and every time. You have to have a way to control the process in a manufacturing setting for MEMS to be the option of choice.

Another example is specialized weighing devices. You can design a beam with a chemical on it that will react with another chemical that is to be weighed. Sensors can be coated with different chemical materials depending on the specific application. The result is the ability to analyze gases or the atmosphere. You could also use this application to detect certain kinds of proteins in liquid.

Additionally, MEMS technology can be used to plate small devices, often those with a silicon substrate. I am hoping to see MEMS impact mass production of wafer testing to reduce waste. Typically, testing is conducted on the chip after it is mounted to a substrate. At that point, finding out a chip is bad means it will be wasted.

With MEMS, you could develop a probe capable of making contact with all the individual pads on a wafer. As you may know, this can total in the thousands. Because the probes match up with the pads on each die you can be guaranteed a "known good die" before placing the wafer on a particular device or circuit. Those of you already making headway in this area will understand what an achievement that is. So, MEMS is also key to moving other emerging technologies forward.

AESF: *How vast are the applications for MEMS?*

PM: I noted in your previous article on Nanotechnology that it could be applied on everything from nuclear reactors to sunscreen. MEMS are really coming into their own now and will eventually have similar appeal and reach. And, since MEMS utilizes chemistry in a molecule-by-molecule and atom-by-atom process, it can work on even smaller dimensions than Nanotechnology.

MEMS also allows for the combination of sensors with plating tools and semiconductor technologies. In that way, more specific and useful tools can be made to aid in a variety of production innovations. However, unlike Nanotechnology, MEMS has been relatively slow to develop. Right now, sensors are the most prominent application.

Having said this, I am excited about another futuristic possibility in the field of biology. I think this will be a huge emerging field for MEMS. For example, a person with diabetes relies on keeping glucose under control throughout the day. The more fluctuation there is, the more stress on the body. MEMS could eventually be used in a real-time monitoring device that could even be implanted. This real-time reading will enable people with this disease to prevent large fluctuations in their blood sugar.

AESF: *What are your strategies for the MEMS Sub-Committee? What can people expect from this committee?*

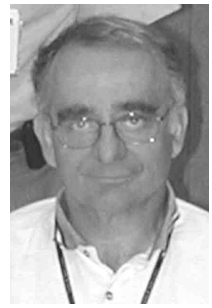
PM: Since I am talking to you before the SUR/FIN® conference is held, again I have to defer to that timetable. In June, the members will convene to decide specific goals and meeting agendas for the MEMS Sub-Committee. I hope some very clear initiatives will be forthcoming.

I can tell you this: Our sub-committee will be charged with making MEMS more common in the marketplace and within appropriate scientific circles. I want to see our members help shorten the learning curve of MEMS applications. Hopefully, interested parties will be able to quickly obtain the latest information about MEMS and this, in turn, will fuel more MEMS development.

AESF: *Is there anything else you want to say about the future of MEMS?*

PM: I anticipate the use and understanding of MEMS to become quite common. It is even possible that our sub-committee will have a five-year life span simply because MEMS will take off so much and our job will be done. As with other technologies, MEMS will continue to be usable at smaller and smaller scales, and will also begin to use less and less power consumption to work effectively. Like most commodities—with time—MEMS will become more reliable and easily affordable. It can't help but grow.

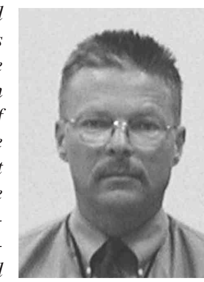
About Pat Mentone



Dr. Pat Mentone has 30 years' experience in etching, plating, electroforming and electro-polishing of electronic and medical components. Since 1985 he has consulted on plating, etching and electroforming projects for the electronics industry, and has worked with a variety of customers, including Dyna Craft, Tektronix, Timex and BF Goodrich Aerospace. Mentone specializes in pinpointing process problems and recommending changes that will increase yield, reduce cost and improve customers' satisfaction. Recognized as an international expert in his field, Dr. Mentone is also an adjunct professor at the University of St. Thomas.

About Phillip Miller

Phillip Miller is the marketing director at Faraday Technology, Inc., 315 Huls Drive, Clayton, OH 45315. He coordinates the technical marketing and business development activities in support of Faraday's technology platform. Prior to joining the company, he worked as an independent business consultant and a senior business analyst for a Manufacturing Small Business Development Center sponsored by the U.S. Small Business Administration.



Miller has received honors as a Business Counselor of the Year by the Dayton Area Chamber of Commerce and the Ohio Department of Development. He currently teaches college-level small business management and planning classes. At Faraday, Miller is responsible for new business development, technical marketing, and program management.

How Old is Your Job Shop?

Plating & Surface Finishing is looking for the oldest job shops affiliated with the American Electroplaters and Surface Finishers Society. We already have the name of one shop that was established in 1905. If you know of a plating shop that dates way back in history, please let us know. We'll compile a list of the shops and dates established to publish in a coming issue of Plating & Surface Finishing. Send information to editor@aesf.org, or mail to *P&SF*, 12644 Research Parkway, Orlando, FL 32826.