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The state of standards: MEMS

A survey of MEMS industry players reveals points of agreement and divergence on the ever-controversial topic of production standards.

BY MICHAEL GAITAN AND MONICA TAKACS

The growing MEMS industry is similar in many ways to its predecessor—the semiconductor industry—but as MEMS developers know, there are also disparities between the two. We can borrow from the semiconductor industry's standards and best practices (e.g., the parallel shift from an in-house development and fabrication model to a "virtual," foundry/fabless one), but in other areas, we have no model to emulate.

Whether we borrow from the semiconductor industry or establish a standard from scratch, fundamental questions remain: Is the MEMS industry ready to take on the challenge of standards development? Or does the industry perceive that it's unnecessary, or that standardization might hinder the process for new innovative device technologies? MEMS Industry Group (MIG), a trade association representing MEMS and microstructure manufacturers, interviewed a cross section of its member companies to find out.

"It's a hard question to answer because there is such a variation on MEMS products that are out there," says Nicole Kerness, vice president of product engineering for Silicon Microstructures. The industry is already required to follow a variety of standards. For example, AEC Q100, which is specifically for automotive applications, regulates reliability testing. Silicon Microstructures will typically borrow from existing tests to quantify the life expectancy and reliability of their electronic components. Because the MEMS industry is so diverse, specifications supplied by the customer are different for each segment of manufacturing, especially for packaging. For them, standards would simplify their manufacturing process, because it would limit unique customer specifications.

Yes, but...

Peter Ernst, director, marketing sensors, for automotive electronics at Robert Bosch, says, "I believe that standardization is indeed an important key for increasing market penetration of semiconductor and MEMS products. An example is the AEC Q100 [a critical stress test qualification for automotive ICs put forth by the Automotive Electronic Council]. The establishment of this testing standard has helped a lot and made the communication between customer and supplier much easier." Bosch has been very active in establishing open standards in airbags and other systems. Because the company uses standard interface components, it has been able to provide products with more functionality and decreased costs.

Bosch has also contributed to the development of standard manufacturing practices. After Bosch implemented a process for trenching silicon in the 1990s, called deep reactive ion etching (DRIE), the company decided to allow the industry broad access to its technology by licensing it to plasma processing equipment vendors. The Bosch process was quickly accepted by the industry and is used widely by MEMS manufacturers throughout the world. Bosch believes this licensing policy has contributed considerably to the spread and success of this useful MEMS fabrication technology.

Paul Werbaneth, director of strategic projects for equipment supplier Tegal Corp., feels comfortable working with standards and has benefited from the many reliability and fabrication standards developed by groups such as SEMI and Sematech that serve the semiconductor arena. However, Werbaneth is skeptical about the benefits of developing additional standards specifically for MEMS fabrication—for example in packaging and reliability testing—solely because of the unique steps involved in MEMS device manufacturing. Werbaneth also believes MEMS standards should be a subset of existing IC fabrication standards, which he says could help companies improve their equipment and reliability between customers on different continents.

Materials and fragmentation

Wafer manufacturer Okmetic already uses SEMI standards for silicon wafers, initially developed by the semiconductor industry whenever applicable, but requirements for MEMS can often be extraordinarily different. Anna-Riikka Vuorikari-Antikainen, senior VP for sensor business development, agrees that the MEMS market is still very diverse and fragmented. She worries that if there is too much standardization too early, the best technologies may not be chosen, which would not be good for business in the long term. "More than standardization, we see that open cooperation within the whole supply chain is needed," according to Vuorikari-Antikainen. "For example, silicon suppliers could introduce cavities and openings to their SOI [silicon on insulator] wafers, which would allow sensor manufacturers—the next link in the chain—to get straight down to

their core specialization.”

Raymond Wiley, North American sales and marketing for IceMos Technology, an SOI substrate manufacturer, does not believe there is a need for additional materials standards within the MEMS industry. In most cases the materials standards have already been developed. A common example is the “Flatness Specs,” where the measurement methodology is the same for both the MEMS and semiconductor devices. One area where Wiley sees an opportunity for standardization is wafer bond strength analysis testing.

“Most of the standards that have already been created by SEMI are being used and applied by the MEMS industry. The risk with standards developed specifically for the MEMS industry is that there is a possibility that larger organizations, like SEMI or the Automotive Electronics Council, may come along and override those standards later,” says Wiley.

Chris Milne, manager of MEMS process and support engineering, at Honeywell’s foundry, does not see a need for standards in the MEMS industry for a company like his, which has the resources to vertically integrate. Milne believes standards could ease product transition between foundries and allow customers to take advantage of excess fab capacities across multiple fabs. The result would increase total foundry capacity utilization, which directly benefits its customers by spreading overhead expenses.

Consultant Alissa Fitzgerald, managing partner of A.M. Fitzgerald and Associates, uses customer-specified standards typically adopted from the semiconductor industry. Her company’s general philosophy is that where there are ASTM, automotive, or SEMI standards, you can usually find something close enough to apply it to the MEMS industry. Certain properties like stiction and hermeticity of bonded cavities are unique to MEMS and cannot be addressed with non-specific solutions. Fitzgerald sees the need for standardization, but believes development of actual standards may not be necessary. She believes a set of best practices should be established within the industry as a guide for MEMS fabrication.

Diversity makes the difference

We have observed a wide range of opinions for MEMS standardization needs from our equipment and materials suppliers, developers, and manufacturers. This study made one thing clear: The industry agrees across the board that it has greatly benefited from the many standards that have already been developed. Where we diverge from the semiconductor industry is in the great diversity of materials, fabrication processes, device architectures, and applications that define our industry. Participants agree there is a need for certain industry specific standards, such as one for testing wafer bond strength, and for standards to facilitate testing and transitioning products and processes between foundries.

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The good news is that successful standards are by definition developed through industry acceptance, whether they are established de facto or through formal standards organizations. Standards organizations must work closely with our industry to develop standards that will be used widely. If the industry communicates effectively with each link in the supply chain from the start of product development to product delivery, then we can determine best practices for working together and move the entire MEMS industry forward.

Watch for coverage of nanotechnology standards in the next issue of Small Times.

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