Advanced Processing Capabilities for MEMS Device Fabrication

Jay Sasserath, Graham Muir
Unaxis
St. Petersburg, Florida USA
www.it.unaxis.com

Biographies

Dr. Sasserath joined Unaxis (formerly Plasma-Therm) in January, 1997 as the Vice President of Strategic Marketing. In 1999, he became Vice President and Business Unit Director for Unaxis' MEMS and Compound Semiconductor Business Unit. Here, he has profit & loss responsibility for this Business Unit, which has operations in the US and Europe. Previously, Dr. Sasserath held management positions in Marketing, Engineering, Customer Service, and Process Applications at Materials Research Corporation. Prior to Materials Research Corporation, Dr. Sasserath worked in various semiconductor fabrication facilities as a process engineer at both Hypres Inc. and Standard Microsystems Corporation. He holds Ph. D. and MS degrees in Materials Science from SUNY Stony Brook and BS degree in Chemical Engineering from Rensselaer Polytechnic Institute.

Graham Muir joined Unaxis (formerly Plasma-Therm) in May 1995 as European Customer Service Engineer. In 1997 he became Field Operations Supervisor for the Customer Service group. Since March of 1998 he has been a Customer Program Manager within the Compound Semiconductor Strategic Business Unit based in St. Petersburg, Fl. Previously, Mr. Muir has held positions in Process Engineering and Process Applications in several fabrication facilities. He has also worked for two major Equipment OEMs to the Semiconductor Industry prior to joining Unaxis. MS in Electrical Engineering, Semiconductor Engineering, Semiconductor Physics.

Abstract:

A review of system cost of ownership issues are presented. A number of factors are discussed that customers need to consider when comparing cost of ownership. Although a number of standard items are often discussed when reviewing system cost of ownership, these less tangible items are often not considered, They are found to play a major role in final device cost. As the MEMS industry continues to mature, these factors will be found to play an even larger role in the cost of ownership equation and, hence, must be considered by equipment manufacturers today.

Data:

As the MEMS industry matures, more emphasis will be placed on manufacturability of devices and the overall cost of ownership of producing these devices. Equipment suppliers to these fabricators need to be aware of these trends and need to begin addressing critical issues immediately. The following details a number of areas that equipment vendors can address to ensure that the customer is provided equipment that facilitates the production of low cost product in a very reliable, high volume production environment.

Cost of Ownership, CoO, is defined as:

$$\frac{\text{Fixed Cost} + \text{Variable Costs} + \text{Scrap Costs}}{\text{Equipment Life} + \text{Throughput} + \text{Yield} + \text{Uptime}}.$$

There are a large number of factors that contribute to the overall cost of ownership figure for a given process. Obvious ones include:

- Hardware costs,
- Maintenance costs,
- Consumable costs,
- Wafer breakage,
- System upgradeability,
- # of good die per wafer,
- System availability, and
- many others…..

Although these are all very important, there are a number of other, less tangible factors that the equipment buyer should consider prior to system purchase that directly affect the above equation. These other factors also play a large role in determining final system cost of ownership, yet are typically not considered for an equipment purchase.

Global Presence: Many of today's MEMS producers exist as part of a large, global organization. Large device manufacturers continue to see MEMS technology as a critical part of their offerings and, hence either acquire technology through acquisition or develop an internal capability. In either case, equipment manufacturers must respond to this trend by being able to work globally, but act locally. Local sales and service organizations are needed in all of the major semiconductor regions, within North America, Europe, and Asia. This support network ensures that processes can be supported anywhere in the world, giving the device manufacturer ultimate planning flexibility.

Process Integration: As more complicated devices become produced, the integration of individual process steps will become increasing more complex and provide a more direct influence on device yield. Equipment vendors need to recognize this and can address this issue through a variety of ways. The easiest is by providing a large number of different process technologies, so an integrated process, which may include a large number of individual process steps, can be purchased from a single source. This method greatly relieves the device manufacturer from having to accomplish the integration themselves and often reduces time to market for new devices and increases fab yield.

Another way that process integration can be accomplished by the equipment supplier is through formal or informal relationships with other non-competitive processing companies. These relationships allow for data exchange between technical personnel, which ultimately reduces issues with upstream/downstream process flows. A good example of this would be for a lithography company to work with an etch vendor on developing a next generation etched feature. Here, the lithography company personnel can optimize photoresist processing results that affect the etch process. By doing this, the etch process engineer can ensure that incoming product meets his/her needs for the etch process, resulting in overall success for the program.

Ability to Handle Market Cycles: The semiconductor industry is well know for it's cyclical nature and, as MEMS fabrication matures, it too is likely to be affected by these cycles. Hence, an equipment vendor must be able to work with these cycles to ensure long term survival with minimal disruption to the customer base. A number of methods can be employed by the equipment manufacturer to deal with these cycles, including:

- Outsourcing of non-value added functions.
- Ability to respond to peak demands without adding significant headcount.
- Ensuring minimal manufacturing inventory to free up cash flow for critical functions.
- Maintaining a high level of customer service functions during downturns to ensure a high level of support to the customer base.

Product Standardization: Through engineering design discipline, equipment vendors can provide a common platform strategy that will minimize configuration variances between different production systems. The result of this is that individual processing systems utilize a large number of common parts. This will provide the customer an overall reduction in the number of spare parts they need to maintain to support a large number of tools. Hence, spare parts inventories are minimized and logistics are simplified. Additionally, using the same methodology for software and system operation,

customer maintenance and operations staffs become more flexible, since they can now operate and maintain a large number of systems with a minimal amount of training.

On-Site Support Personnel: It is well known that equipment vendors require large R&D expenses to continually improve system performance and advance technology. One area that is often overlooked is a field support group that can provide development activities on-site at the customer location. This function is critical, especially when integrating new processes into an existing flow. Field process support is critical, but also needs to be backed up with an exceptional group of field service engineers, global logistics personnel, and a technical training department.

Conclusion:

The above clearly lists a number of important parameters that a customer should consider when evaluating processing equipment manufacturers. All have been shown to affect Cost of Ownership and, ultimately, final device cost. As the MEMS industry continues to migrate toward high volume production levels, these areas will become increasingly important to the end user.