MEMS Front-End Manufacturing Trends

Though MEMS standardization will never happen, companies are optimizing their own technology platforms. Such process innovations will drive MEMS equipment and materials to a 7% CAGR over 2012-2018.

Innovative processes are fueling the MEMS equipment & materials market. We forecast that demand for MEMS-related equipment will grow from ~$378M in 2012 to > $510M by 2018, at a CAGR of 5.2% over the next five years. It’s interesting to note that our MEMS equipment market forecast will follow a cyclical up/downturn similar to what the mainstream IC equipment market underwent. The demand for materials and related MEMS consumables will grow from ~$136M in 2012 to > $248M by 2018 at a CAGR of 10.5% over the next five years.

AS MEMS BECOME COMMODITY PRODUCTS, MANUFACTURING WILL CHANGE AND MATURE

Today, MEMS fabrication is still very diversified and lacking in standardization; Yole Développement’s rule « one product, one process » still applies. Indeed, MEMS has a different story than IC and doesn’t follow the same roadmap as the semiconductor industry. Thus, it’s still common to see many players with radically different manufacturing approaches for the same MEMS device, sometimes within the same company (i.e. both the CMOS MEMS and hybrid approaches can be used for inertial devices or microphones).

However, as MEMS becomes a commodity product with a quicker time-to-market compared to previous generations, anything that speeds up the commercialization process is welcome. MEMS packaging is evolving in a different direction than front-end processing, and Yole Développement has already identified that packaging standardization will become increasingly critical in order to support the massive volume growth in unit shipments, and decrease overall costs associated with MEMS & sensor content. For example, microphone packaging is very similar between one manufacturer and another. Additionally, this report shows that at the front-end level, companies are developing in-house technological platforms targeted for different MEMS devices.
MEMS Front-End Manufacturing Trends report highlights the major front-end manufacturing changes. For example, TSV for CSP is gradually seeping into the MEMS industry. To this end, we’ve analyzed STMicroelectronics’ unique approach to making TSVs in its MEMS die in-house, in order to attach the die to the motherboard. This approach eliminates the area needed for the bond pads by replacing them with polysilicon vias isolated by etched-out air gaps, made with its basic MEMS process but on about a 10x larger scale. STM reports that the 20%-30% reduction in die size more than offsets the modest cost of the TSV process, resulting in a lower total cost.

However, since miniaturization will be limited, new detection principles are currently being developed at various R&D Institutes (i.e. Tronic’s M&NEMS concept) in order to lower MEMS size at the silicon level. This technology is based on piezoresistive nanowires rather than pure capacitive detection, and is poised to be a leap forward in terms of device performance and chip size. This will set the stage for a new generation of combo sensors for Motion Sensing applications, achieving both significant surface reduction and performance improvement for multi-DOF sensors.

Amongst the large array of MEMS technologies, we’ve identified several that will have the widest diffusion in the years to come. The list includes:
- Through Si Vias
- Room temperature bonding
- Thin films PZT
- Temporary bonding
- Cavity SOI
- CMOS MEMS
- Other MEMS technologies, i.e. gold bonding, could be widely used to reduce die size while maintaining great hermeticity for wafer level packaging.

In this report, we’ll also show that as MEMS moves from competing on process technology to competing on functions and systems, a move towards more standard solutions will be necessary to drive down package size and cost. Currently, MEMS foundries still compete at the process level and have to propose a wide range of processes in order to cope with new MEMS designs and structures. This approach differs from fabless companies, which usually focus on one type of MEMS design. Their main objective is to find the most experienced and reliable foundry partner in order to convince customers of their expertise. IDMs, meanwhile, generally rely on robust and established MEMS processes to manufacture their products (i.e. THELMA for ST). Foundries, which must always remain at the forefront of changes in the MEMS manufacturing landscape, have the biggest challenge.
OBJECTIVES OF THE REPORT

- To provide a forecast in units and $M for front-end MEMS equipment & materials
- To offer an overview of the equipment & materials used for the wide range of MEMS devices
- To present examples of MEMS manufacturing processes
- To show MEMS cost structures
- To highlight what’s changing in MEMS manufacturing, and why

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Founded in 1998, Yole Développement have grown to become a group of companies providing marketing, technology and strategy consulting, media in addition to corporate finance services.

With a strong focus on emerging applications using silicon and/or micro manufacturing, Yole Développement group has expanded to include more than 50 associates worldwide covering MEMS, Compound Semiconductors, LED, Image Sensors, Optoelectronics, Microfluidics & Medical, Photovoltaic, Advanced Packaging, Nanomaterials and Power Electronics.

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