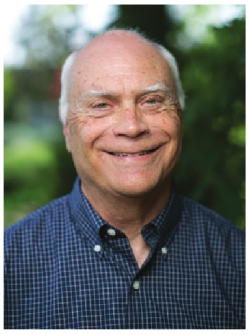
Materials science creativity is paving the road to innovation

Dr. Terry Brewer, president and CEO, Brewer Science



Brute-force methods for achieving incremental growth will continue to be the focus of our industry in 2018. Growth in China through government investment and fab construction will ensure this fact. But, the leadership our industry must rely on is its people, its organizations and their combined individual and collective creativity to deliver new material designs that will solve our current circuit density challenges. These materials will then transcend these obstacles—opening doorways to new science and technology integrations.

The current market drivers of simplicity, balance and accessibility will continue to take the front stage as technology becomes increasingly seamless with human existence. Steve Jobs, Gordon Moore and Albert Einstein have shown us that solutions must be elegant to be sustained. To this point, companies and individuals that put their focus on deep science and material design will bring about technologies that drive sustainable economic growth. A brief glance at the stone, bronze, iron, steel, plastics and silicon ages show how this is true. By the end of 2018, we will already know what this new material age might be.

To foster economic, environmental and societal sustainability, our industry will be more present in encouraging people to embrace deep science through the support of STEM education programs. No longer will education and industry be separate, nor will we see the traditional technology transfer push of post-secondary institutions as the leading driver of innovation. Industry has recognized the need for new creativity, and 2018 will see visible evidence of industry nurturing even more creativity within their own organizations as well as our youth; both inside and outside the classroom. STEM education will be supported in the classroom, but also not be confined by it.

2018 will once again see growth in our industry. Incrementally more transistors, incrementally smaller features, incrementally increased investment. Many of the methods used will be familiar to us, such as mergers and acquisitions, and investments from Asian governments. But, the real story in 2018 will be realized by at most two or three years from now when we reflect on the new, creative materials design threads being sewn into the fabric of our industry and ultimately woven into our daily lives. The future will validate that the material design leaders of 2018 will pave the road for the sustainable economic growth of tomorrow.

New technological trends will increase the focus on sub-fab operations

Paul Rawlings, President, Semiconductor Division, Edwards Vacuum

It has been a good year for the semiconductor industry. We have seen high levels of investment across all sectors: memory, logic, discrete and foundries. Looking forward, we see expansion continuing well into 2019. Reducing total cost-of-ownership, improving safety and limiting negative environmental impacts remain primary drivers across the industry and continue to drive our product development at Edwards.

There are several technological trends that we expect to impact sub-fab operations. First among these is the dramatic growth projected for 3D NAND memory products. Flammable process gases requiring high dilution rates, larger tools with 5-7 multi-wafer chambers, and longer process cycles will all contribute to higher gas flows and increased risks. Integrated vacuum and abatement systems can provide higher capacity and energy efficiency in a single enclosed module that is inherently safer and more reliable. Etch process steps are also growing longer and more numerous, requiring advanced protective coatings to extend the lifetimes and improve the reliability of the harsh duty pumps used to with corrosive gases.

In another area, we are expecting significant growth in the number of EUV systems coming on line in 2018, introducing, for the first time, critical vacuum requirements in photolithography process modules. Finally, we are seeing dramatic expansion in the application of data-based fleet management techniques to optimize performance and reliability in the sub-fab. All of these trends can only be addressed effectively by

complete solutions that begin with detailed analysis of specific process requirements and develop into a comprehensive support model throughout the product life-cycle.

On the human side, our industry is challenged to meet the increasing needs for talented and well-educated technologists, particularly in regions of rapid growth. We at Edwards are committed to playing our part in encouraging young people into Science, Technology, Engineering and Math careers and encourage everyone in the industry to support the initiatives the SEMI Organization is making in this area to develop this critical talent pipeline.

3D NAND requires new approaches to automated metrology and process control

Jack Hager, Sr. Product Marketing Manager, Materials & Structural Analysis, Thermo Fisher Scientific

NAND memory manufacturers will continue their rapid transition from planar to three-dimensional (3D) stacked architectures, with 64- and 96-layer devices expected to come into full production in 2018. This transition is driven by the significant advantages offered by 3D NAND in both size and cost. Stacking multiplies the number of bits that can be stored in the same footprint, thus reducing cost per bit in a process where costs are roughly proportional to the area of the device on the wafer. It also relaxes the resolution requirements on photolithographic processes, permitting the use of less expensive tools and technologies. The market for high capacity 3D NAND currently comprises solid state drive and mobile applications, but this space is expected to expand.

As high layer-count 3D NAND moves into production, manufacturers are looking for metrology and process control solutions that can measure the critical dimensions (CD) of the very high aspect-ratio tube-within-tube vertical structures used to trap charge and connect individual memory cells across many layers. Critical dimension scanning electron microscopy (CD-SEM) is limited by its top-down point-of-view and challenge to see below the surface. Optical techniques can look below the surface, but are limited, especially in development and early ramp phases, by the need to develop complex models based on empirical data from the measured structures.

Existing subsurface techniques are continuing to evolve to provide solution pathways. Focused ion beams (FIB) can cut conventional or oblique cross sections to reveal structural information at varying depths to measure with a scanning electron microscope (SEM). This technique takes advantage of the relatively large dimensions of particular 3D NAND features to collect sub surface data quickly. Another approach creates thin-section samples in the horizontal plane (planar) at various depths for imaging in a transmission electron microscope (TEM). The TEM approach provides much higher resolution and the ability to enhance contrast among the multiple concentric layers inside each "container" by adding information from other analytical signals, such as Energy Dispersive Spectroscopy (EDS). Both approaches are being enhanced to provide automated, robust and repeatable process control insights.

Perspectives from a materials supplier

Adam Manzonie, Dow Electronic Materials, Slurry Business Director

2017 was a very active year for the semiconductor industry with strong loading across mature nodes, and strong ramps in advanced logic and memory. Many suppliers were put to the test just to keep up. Analysts don't expect the same ramp rate in 2018, but they don't expect utilization to drop off either. In addition to demands on volume, our customers are looking for efficiencies in their manufacturing operations. It's also more evident than ever that suppliers must be able to deliver on consistency and quality.

This has become a critical challenge for the industry. Emerging needs for 3D integration (FinFET, NAND, TSV) make processes more challenging for our customers leading to considerably tighter product specifications. Manufacturers must be confident their integrations are solid and processes are tightly controlled. Our customers place a high level of trust in us to supply consistent high-quality materials, in increasingly large volumes, so they can produce sophisticated devices to meet end market demand.