SCIS Working Group Addresses Defectivity, Variability and Reliability

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This is the first in a series of articles on the work of the newly formed SCIS (Semiconductor Components, Instruments, and Subsystems) working group

For many generations of our complex industry it has been said that addressing, as well as eliminating particles is elusive. It has become one of the most pressing imperatives of our generation to refine the process parameters and define absolute requirements that eliminate contamination and the source of such contamination. The amount of money and resources committed to this "hunt" are massive. The integrated device manufactures (IDMs) have invested millions; the OEMs are prone to cater to such research consortiums as a part of their own contribution to satisfy those requirements, yet the hunt goes on. More and more of those struggles lead to the enormous cost of attempting to eliminate all contamination sources that could, but in all probability are unlikely to achieve the 10 nm and below world of tomorrow. Even more elusive, and the real brunt of the problem today, is the need to manufacture devices that will be developed for the sub 10 nm world in a reliable, consistent manner. Variability in the process, downtime, inexplicable events or early failures are often left unresolved with equipment replacement as the protocol to deal with those issues. Anything else would require expertise, time, and resources unavailable during the manufacturing processes.

But, the big "but" is, that so much effort has been focused on the process and improvements of the process, that most often, if not always, the hardware that is utilized for decades is never the focal point of these massive research funds in defining the contamination source. And there lies the crux of the problem. The semiconductor industry exploded onto the scene only in this amazing last century. Yet subcomponents, typically, parts such as seals, valves, filters, pumps, robots, actuators—all those parts built to the chamber, wet bench, track, etc. have no official requirements or standards that align with the requirements of this unique industry. How is this possible? How, in an industry that is so advanced that it is approaching the size of atoms with its sophisticated chemistry, exact ionic dispersions and trajectories, is it possible NOT to have exacting scientific specifications for the hardware that is utilized in the manufacture of these advance technologies? In most cases, such specifications are hidden as part of the supply chain and not associated with the painstaking process of investigating the cause and effect of defects. Even more disturbing, as there are no standards and no general understanding of what goes into making these components, is that many of the unresolved issues do not seem to warrant investigation. Unnoticed, years will go by before these areas are sought out for improvement and the misapplications, the cost implications of these events, and the huge economic fall-out of these issues will continue. Education, awareness, and communication are the only ways to address these issues and move forward.

This is the path of the development of SCIS (Semiconductor Components, Instruments and Sub-systems), more specifically, the Defectivity Committee developed

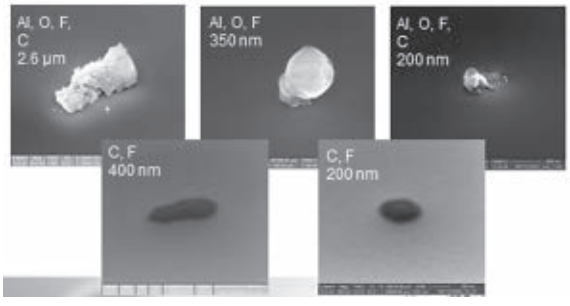

Figure 1. Shown are SEM images of the typical defects: (22nm and Beyond (SEMATECH & ASNA) Joint Development-Defect Reduction: L-series Valve: ASNA Seal #1; Large defect SEM images)

specifically in the past year to answer that call. After years of frustration in attempting to address these requirements, ASNA forged ahead with the support of its many great partners such as Pall and Edwards to create a group to bring about awareness and promote industry cooperation to address this gap. The industry needs to do what has not been done to date: bring all the parties together and decide what the first steps towards answering this critical gap will be. IDMs, OEMs, subcomponent manufacturers, as well as those prominent

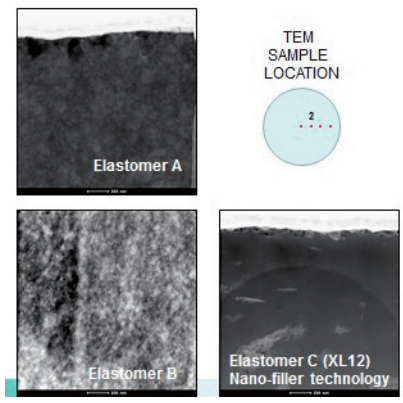

Figure 2. Improved seal performance by manufacturing a more homogenous material with consistent uniformity.(Center 2—Stem imaging at 58000X; Scanning Transmission Electron Microscope-Energy Dispersive X-Ray Spectroscopy (STEM-EDS))

organizations formed to guide the industry such as SEMI and SEMATECH are now a part of this indelible mission as it progresses on a new path towards improvements long overdue in our industry.

The goal and objectives for this group are to find a consensus of the possible methodology for identifying the weak points and then measuring the levels of improvements. Such methodology is meant to forge new specifications and guidelines to resolve the lack of uniformity and resulting downtime of manufacturing for any and all chip-makers and even more importantly, to find a common area of alignment between the manufacturers of subcomponents (often just viewed as supply chains) OEMs and end-users, who too often cite each other as the source of defectivity. Realistically, it is a lack of common ground and open communication between all manufacturers. The need for collaboration—a word overused yet rarely manifested in this industry—is now seriously required.

In that spirit Applied Seals North America (ASNA) in recent years supported a program through the EUV project at SEMATECH that attempted to dissect its own ideas for improvement. One result was an emphasis on the need for a closer examination of application-specific requirements when choosing components; with regards to ASNA this means "the smart seal for the right application." As Figures 1 and 2 illustrate, a careful examination of defects, researching their genesis and finding a solution for their elimination is another step toward improvement. Such could be the model for most sub-components, but the implementation for major improvement will not succeed unless all involved share a common understanding of the need to communicate with each other, and align themselves to the methodologies agreed upon for reaching improvement.

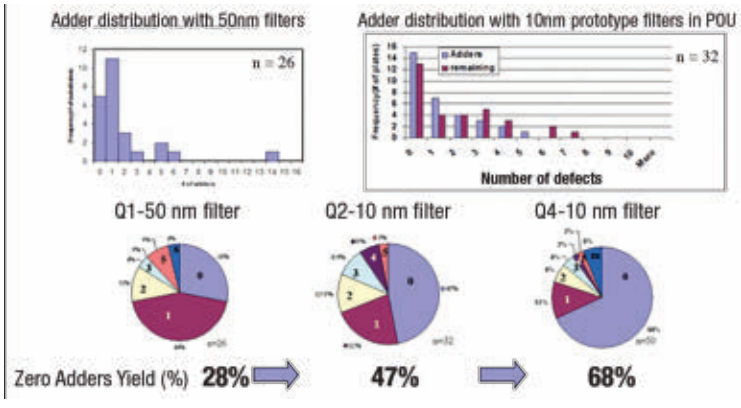

Figure 3. Long-term impact of 10nm DI filter on cleaning

It is well known that filtration provides risk mitigation for particle contamination, as well as the control of particle contamination from other, often undefined, sources. However, there are few standards for filters, leaving the development of techniques that define the degree of performance and level of cleanliness to the supplier. In addressing the development of EUV mask cleaning, Pall worked with SEMATECH on improved filtration for EUV mask cleaning, as seen in Figure 3, with very convincing results.

Taking this to the next step, Pall is actively participating in SEMI standards committees to drive performance standards for filters used in ultra-pure water (UPW) and ultra-pure chemicals, in both Japan and North American task forces. Working with OEMs and IDMs on new requirements for next generation issues for filtration will further enable improvements to be made in particle control. With the efforts of SCIS, the origin of contamination can further be elucidated.

SEMI's Defectivity Committee is the first of its kind to move the industry to this point—a true paradigm shift in working to bring the industry together to be both aware as well as to understand the level of contamination contributing to the problems. Sub-components make up the majority of tools, yet there is a lack of attention paid to cleanliness, to manufacturing procedures, and to satisfying any set of standards that comply with industry needs. The reason for this is because such standards mainly do not exist. Since ASNA has forged a standards document for Seals (F51-0200), it is also encouraging leaders of many other sub-component companies interested in serving the industry to join them in this endeavor. Pall Corporation is one such company contributing its technological expertise for the common goal. There is no excuse for the huge parity that exists between process and hardware and it is definitely time to address it. G&I

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