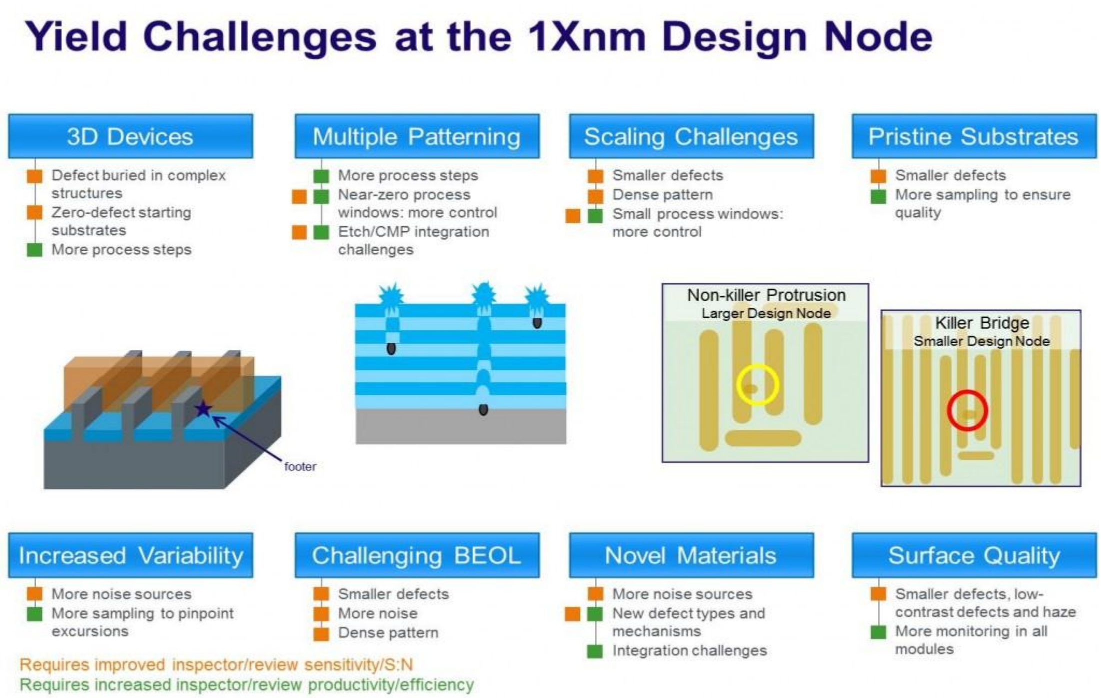
INSPECTION AND REVIEW PORTFOLIO FOR 3D FUTURE

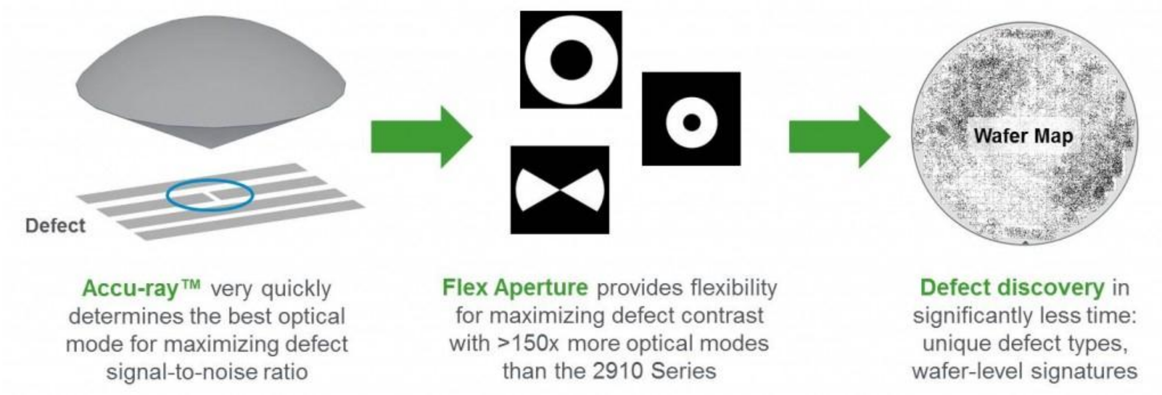
This week announced updates to four systems—the 2920 Series, Puma 9850, Surfscan SP5 and eDR-7110—intended for defect inspection and review of 16/14nm node and below IC devices in both development and production.



The 2920 Series broadband plasma patterned wafer, Puma 9850 laser scanning patterned wafer, and Surfscan SP5 unpatterned wafer defect inspection systems deliver enhanced sensitivity and significant throughput gains. By enabling discovery and monitoring of yield-critical defects, these inspectors support chipmakers' integration of complex structures, novel materials and new processes at leading-edge design nodes. Each of the inspection systems seamlessly connects with the eDR-7110 electron-beam review system, which uses improved automatic defect classification (ADC), providing chipmakers with accurate information to improve manufacturing yield of the most advanced commercial ICs.

Process control of advanced IC manufacturing can only occur with pragmatic use of metrology and inspection, since 'you can't build it if you can't see it.' In an exclusive interview with *The Show Daily*, Brian Trafas, KLA-Tencor's chief marketing officer discussed how industry attitudes toward inspection have changed for the better in recent years, but lingering misunderstandings remain. "Even in the area of adding cycle time, some people have a pretty archaic view that this can increase cycle time," said Trafas. "But if you don't monitor you can put an enormous number of lots at risk."

Multiples of all four systems have been installed at foundry, logic, and memory manufacturers worldwide, where they are being used for development and production at advanced technology nodes. All four systems are expected to be shipping to customers in volume in the second half of this year.



However, due to industry consolidation, there are perhaps only five organizations remaining that are pushing IC manufacturing down to sub-22nm node technology. Each organization is understandably concerned about information leaking to competitors, and so each organization insists upon extreme confidentiality when evaluating strategic manufacturing technology such as that involved in defect inspection and review. KLA-Tencor has customer-specific modifications to it's tools, and each customer will build its own database of defect signatures using its own proprietary test structures.

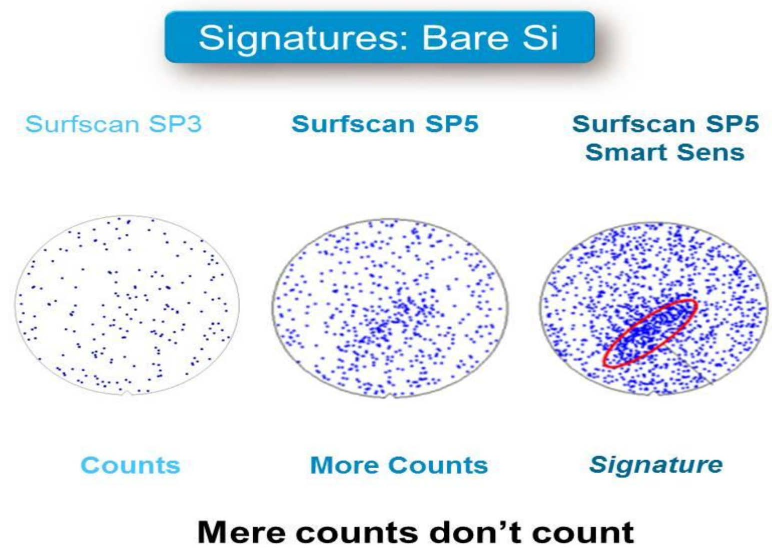
"There are general things that are the same, like if it's a poly layer it's best to use a certain wavelength," elaborated Trafas, "but beyond that the device differences lead each customer to optimize inspection in different ways."

Broadband Inspection of Patterned Wafers

Broadband inspection of patterned silicon wafers is needed both in R&D and in volume production of advanced ICs. Different wavelengths reflect differently from different thin-film materials, and the ability to capture broadband information thereby proves more valuable as the industry integrates more materials into advanced device structures. For example, advanced on-chip copper interconnects may use cobalt and ruthenium barrier layers.

“Our competitor, Applied Materials, has a single-wavelength laser…but depending upon the material you may get better resolution with a different wavelength,” explained Trafas. “We are the only company providing a broadband source from a plasma, and that’s unique intellectual property from KLA-Tencor that we’re also using on our metrology tools.”

KLA-Tencor began investing in this broadband plasma source technology around 10 years ago, the first-generation was released four years ago with the 2835 tool, and the second-generation was released two years ago with the 2900 tool.



Using a third-generation broadband plasma illumination source, the 2920 platform delivers twice the light of its predecessor, enabling the use of a new deep ultra violet (DUV) wavelength band and the industry's smallest optical inspection pixel. Along with new advanced algorithms, these optical modes boost sensitivity to subtle protrusions, tiny bridges and other pattern defects on complex IC device architectures, such as FinFETs. The 2920 tool's Accu-ray and Flex Aperture technologies combine to provide the best optical settings for capture of critical defect types, significantly reducing the time required to discover and solve process and design issues. The company claims that instead of the days formerly required to establish a new R&D inspection recipe for a new material in a novel device, the new algorithms and recipes allow for setup in just a few hours.

"We've pushed the sensitivity of the tool in die-to-die comparison mode to see thousands of signals, but some are spurious so the algorithms are needed to extract new defect types," elaborated Trafas. "The tool can resolve 10nm defects. This is an optical-based tool, so some people say that even if you're in the DUV range you can't resolve 10nm. They're somewhat correct, but all we're trying to do is resolve the differences between dice. In some cases we use a contrast mode, where we suppress data from one layer and enhance data from another layer based on the different frequencies. The result is the best overall sensitivity and the best overall capture rate."

Laser Inspection of Patterned Wafers

Compared to broadband plasma inspection, laser-based inspection doesn't see as many defects but is very fast and so can be used for production checks. For example, an integrated patterning process may be controlled by laser-based inspection after each unit-process step—photoresist development, etch, clean—monitoring the same device feature to see how it evolves. With multiple platform enhancements, the Puma 9850 laser scanning patterned wafer defect inspection system provides improved sensitivity across a range of production throughputs to support a diverse array of FinFET and advanced memory inspection applications.

Higher speed modes, operating at up to twice the throughput of the Puma 9650, allow for cost-effective excursion monitoring in the film and chemical-mechanical planarization (CMP) process modules. “As a customer gets into routine production, the Puma can be used to track performance of a particular process step to catch excursions,” explained Trafas. “So heavy use of the 2920 in the beginning of production ramp, heavy use of the Puma in the end of mature manufacturing, and a mix of the two in the middle.”

The Puma 9850’s higher sensitivity operating modes allow for efficient defect capture on after-develop inspection (ADI), photo-cell monitor (PCM), and front-end-of-line line-space etch layers. “The new system has better defect capture, and sometimes at up to 7x better throughput,” claimed Trafas. “With additional capabilities the price of the tool is going up, but we’re off-setting some of that with increased throughput so the overall cost-of-ownership should be the same or possible better.”

Unpatterned wafer inspection

Silicon ICs need pristine silicon or silicon-on-insulator (SOI) starting wafers, and defects in the wafer surface tend to propagate into dis-functional defects in final fabricated devices. The Surfscan line of unpatterned wafer inspectors has now been upgraded with an improved light source and more of those better algorithms. “The

SP5 is a critical platform, I can't emphasize this enough," emphasized Trafas. "Customers wanted a tool with greater sensitivity to be able to monitor defects in advanced wafer production, such as epi-growth. We have actually had this in the market space at leading companies doing some of that contamination monitoring."

The Surfscan SP5 unpatterned wafer inspector incorporates enhanced DUV optical technologies that produce sub-20nm defect sensitivity at production throughput, enabling detection of tiny substrate or blanket film defects that can inhibit successful integration of multi-stack IC devices. With throughput up to three times faster than the previous-generation Surfscan SP3, the Surfscan SP5 maintains high productivity while qualifying and monitoring the increased number of process steps associated with multi-patterning and other leading-edge fabrication techniques.

The greater sensitivity of the SP5 compared to the SP3 allows for more defect counts to be captured, but unless those counts are properly accounted for as defect categorizations the process engineers don't know which actions to take to recover yield. Thus, "mere counting doesn't count."

E-beam Defect Review

When all else fails in categorization of a yield loss due to a defect, a wafer is sent to an electron-beam (e-beam) tool for review. The eDR-7110 e-beam review system includes a new SEM Automatic Defect Classification (S-ADC) engine that can produce an accurate representation of the defect population during production, and can also be used during development to reduce the time required for defect discovery.

Moreover, S-ADC results can automatically trigger additional in-line tests, such as compositional analysis or imaging with alternative modes, while the wafer is still on the eDR-7110. Automatic triggering of additional tests is a unique capability of this tool, which enhances the quality of the defect information provided to engineers for process decisions.

“We want to automatically classify that defect,” reminded Trafas. “We made a lot of improvements in the classification algorithms, improved the optics, and improved data-transfer links to eliminate so-called ‘SEM Non-Visuals.’ In some cases we may use the image from an inspector.”

All of these tools combine to create a ‘virtuous circle’ of defect learning. An inspection tool feeds information to an eDR tool, which feeds information to S-ADC for attribute-based classification, which feeds information to manual classification, which ultimately leads to a Pareto chart of defects. Pragmatic evolution of these inspection and review systems enables leading IC fabs to extend manufacturing to sub-22nm nodes.

Source: http://electroiq.com/mysemicondaily/2014/07/10/kla-tencor-evolves-inspection-and-review-portfolio-for-3d-future/