Corporate Profile

Onto Innovation Focused on Process Control

PETE SINGER, Editor-in-Chief

ONTO INNOVATION (ONTO), WHICH WAS created last year by a merger of Rudolph and Nanometrics — two equally-sized process control and software powerhouses — is primarily focused on optical metrology, macro defect inspection and process control software. According to CEO Mike Plisinski, the company is well positioned to take advantage of the expected growth in almost every aspect of the semiconductor industry, including 5G, 3D NAND and DRAM, RF/MEMS, advanced packaging and displays.

The complexity of leading devices is rapidly increasing, and manufacturers and fabless companies need better ways to measure physical features such as film thickness, feature sizes and defects, as well as better process control. This is particularly true for leading-edge 7nm and 5nm logic and memory, and the complex structures found in 3D NAND.

"The demand for sub-8 nm silicon continues to go up dramatically," Plisinski said, speaking at the recent 22nd Annual Needham Growth Conference. "There is a new set of requirements for the quality control of that silicon, especially around the edge and the backside and also some of the critical epilayers."

There is also a push to embrace new advanced packaging/heterogeneous integration strategies, such as Fan-Out Wafer Level Packaging (FOWLP) and "panelization" where singulated chips and packages are processed in rectangular panels instead of the familiar round wafers. Onto Innovation is also well positioned in this area with lithography, inspection and process control solutions.

In total, the company addresses ten

Product and Process Matrix for Onto Innovation

	Si Wafer Mfg. OQA	Wafer Fab Litho	Deposition / Implant	Etch / Cleans	CMP	OQA	Advanced Packaging Bump / TSV	Dicing	Litho	Etch / Plating
NovusEdge Inspection	●	●								
QS/FTIR Metrology	●		●							
Atlas III+ Metrology			●	●	●					
IMPULSE+ Metrology			●	●	●					
MetaPULSE G Metrology			●	●	●					
Dragonfly G2 Inspection						●	●	●	●	●
NSX / F30 Inspection		●		●	●	●		●	●	●
JetStep Lithography									●	
Discover Software	●	●	●	●	●	●	●	●	●	●

Figure 1. A matrix of key products and processes addressed by Onto Innovation. The gray areas represent opportunities to expand by leveraging existing technology.

market segments with a portfolio of 30+ products (Figure 1). Target markets include bare wafer, logic/foundry, memory, RF/MEMS, industrial scientific, image sensors, advanced packaging, LED/Power, probe test, and flat panel displays. The product portfolio covers unpatterned wafer quality; 3D metrology spanning chip features from nanometer scale transistors to large die interconnects; macro defect inspection of wafers and packages; metal interconnect composition; factory analytics; and lithography for advanced semiconductor packaging.

In January of 2020, Onto Innovation announced that it had received orders totaling 15 systems from two leaders in advanced packaging. Both customers are ramping up to support the ongoing demand for 5G smartphones which drives advanced packages requiring more precise process control solutions. Onto Innovation's 2D inspection systems with integrated machine learning software will be used to help ensure quality and reliability of these leading-edge products.

"5G brings unique packaging complexity to the forefront with the requirement for higher data transfer rates driving higher IO, resulting in higher interconnect density," said Tim Kryman, Onto Innovation's senior director of inspection product marketing. "Our assembly customers are responding to these demands with advanced packaging technology that enables higher density packages. The value of content in these packages is increasing, which in turn demands better inspection for performance, yield and reliability. We see an increasing use of advanced packaging inspection to meet these macro market demands."

According to Gartner's market share data report from 2019, the top four suppliers (Applied Materials, ASML, TEL and Lam) represent about 65% of the overall wafer fab equipment market, and the second echelon of 11 suppliers represent another 21%. In addition to Onto Innovation, this group of 11 includes ASM, Canon, Daifuku, Ebara, Hitachi, KLA, Kokusai Electric, SCREEN, Nikon and SEMES.

Onto Innovation's latest production introductions are the Dragonfly G2, NovusEdge, Atlas III+ and the QS4300/FTIR.

Dragonfly G2 System

The Dragonfly G2 platform delivers up to 150% improvement in productivity over legacy systems as well as exceeds competitive system throughputs. Its modular architecture provides a flexible platform with plug-and-play configurability to combine 2D with 3D Truebump™ Technology for accurate copper pillar/bump height measurements. Clearfind™ Technology detects non-visual residue defects and advanced sensor technology measures 3D features and CD metrology. Additionally, the Dragonfly G2 platform has been specifically architected to allow the measurement, data collection, and analysis of bump interconnects nearing 100 million bumps per wafer using Rudolph's Discover® software and advanced computing architecture.

NovusEdge

The NovusEdge™ system is the result of a multi-year collaboration with bare wafer manufacturing partners that require one inspection tool capable of detecting defects near the wafer's edge, bevel, back-side and notch. The NovusEdge system meets the stringent new requirements for defect control at the edge and backside of wafers being manufactured for 10nm process nodes. The system provides up to 50% faster throughput and two orders of magnitude better edge sensitivity than incumbent technology. The system uses multiple cameras and advanced imaging technologies to build a high-resolution, composite image of the entire wafer bevel then applies sophisticated analytical routines to identify and classify defects as small as the sub-micron level. On the backside it utilizes high-speed laser-scanning to detect particles, scratches, area defects and haze.
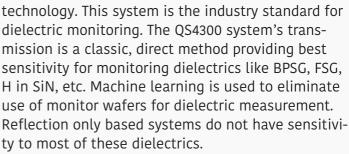
Atlas III+

Atlas® III+ platform for advanced process control metrology. The Atlas III+ has been qualified at multiple memory and foundry/logic device manufacturers, each utilizing Nanometrics' proprietary analysis software including NanoDiffract® and SpectraProbe™. With its unique combination of spectroscopic ellipsometry (SE) with full Mueller Matrix capability and broadband reflectometry (SR), the Atlas III+ provides industry-leading metrology performance while also providing increased productivity on the most demanding devices, both in development and high-volume production.

QS4300/FTIR

The QS4300 system is the tool of record for wafer suppliers for high speed impurity mapping and epi thickness measurement. It is the only tool on the market with the unique combination of transmission and reflection based technology. This system is the industry standard for dielectric monitoring. The QS4300 system's transmission is a classic, direct method providing best sensitivity for monitoring dielectrics like BPSG, FSG, H in SiN, etc. Machine learning is used to eliminate use of monitor wafers for dielectric measurement. Reflection only based systems do not have sensitivity to most of these dielectrics.

A third tier of suppliers makes up another 7% of the market. These suppliers include Accretech, Aixtron, Axcelis, AMEC, Disco, muRata, NuFlare, PSK, TES, Tokyo Semitsu, ULVAC, Veeco and Wonik IPS.

By combining Rudolph and Nanometrics, Onto Innovation was able to jump from the third tier to the second tier, and that brings some specific advantages. "By coming together and by moving into this upper tier of suppliers, our customers are coming to us and saying 'you are more critical to us, we want to share with you a larger, longer

term view of our roadmaps and challenges. At this level, with this breadth of capability, you can help us solve those problems,'" said Plisinski.

This is true not only for traditional semiconductor manufacturers, but large fabless companies such as Apple and Qualcomm that can struggle with the complexity of the devices and putting more and more technologies together in a system package. "When they have a field return or a yield issue at their end, it becomes a brick wall on how they go back and figure out root cause and corrective actions," Plisinksi said. Through its data streams software capabilities, Onto Innovation is able to make those connections. "We're able to help advanced semiconductor device product manufacturers drive faster product ramps and higher yields," he said.

It can also help with manufacturing process control. "We can help customers make a decision either to make adjustments to the process, run new product through the process or in the case of APC, we can do automatic process adjustment, either feed forward or feed back to the process equipment," Plisinski said. "At the end of the day, we're changing the value proposition from just an equipment sale to actually providing a complete solution."

Panelization

Moving from round wafers to rectangular panels (panelization) uses corner space, delivering a roughly 10% more efficiently improvement in surface utilization. The larger size of the substrate and the improved fit between the mask and substrate reduce the transfer overhead by a factor of 5. The potential reduction in throughput resulting from an increase in the number of alignment points is more than offset by the improvements in throughput. Compared to a 1X stepper on wafers, panel-based processes can reduce lithography cost per die by as much as 40%. "The panel market has been talked about for a long time, but it's starting to really get attention," Plisinski said. "We've got multiple customers now."

Another advantage, perhaps even more than cost reduction, is tighter integration of multiple die in a single package. "You can fit a lot more die and process more effectively in a large square substrate or rectangular substrate," Plisinski said. "That's now driving a lot of the investment and excitement towards the panel level packaging."

One of the advantage of Onto Innovation's JetStep panel system is that it can handle rectangular panels. The system features a large printable field-of-view, programmable aperture blades and large on-tool reticle library, large depth-of-focus along with autofocus to accommodate 3D structures in advanced packaging. s⬛