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A faster route to better overlay

Product lifecycle management: added-value across the industry

Focus on a new star

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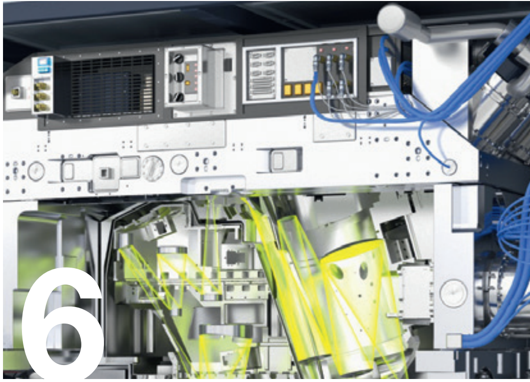

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Editor's note

30 years down, 30 plus to go

By Michael Pullen, Senior Communications Specialist

As 2014 comes to a close and we look back on our 30 year history of providing lithography solutions for the ever growing and changing semiconductor industry, it is amazing to see the challenges that we have overcome, and the accomplishments that we have made, together as an industry. As we look to coming years, there are obvious hurdles and roadblocks that we must overcome to continue down the path set forth by Moore's Law.

In this issue of Images Magazine, we will take a look at how we, at ASML, are preparing to clear those hurdles and continue down the path for another 30 plus years.

Going back nearly to our start in 1984, the PAS 2500/5000 is still in use today at several customers. While its End of Service is approaching, the Mature Products Service team is redefining the life cycle of all ASML products and mapping out four major lifecycle stages that will increase transparency with customers and help them improve their own business planning in the future.

You will hear how ASML's new Design for Control (D4C) Overlay software is tackling the current industry requirements for overlay, focus control and critical dimension uniformity (CDU) and will meet the future demands by allowing customers to design and optimize metrology targets that can be used to deliver significant improvements to overlay performance.

Another hurdle you will read about is the cost ineffectiveness of transitioning from node to node and how ASML's System Node Extension Packages (SNEPs) are breaking through this by converting any TWINSCAN NXT system to a newer model in the field, effectively extending its capabilities another one or two production nodes.

As you may have read recently, our EUV tools are meeting and exceeding the 500 wafer per day barrier, with one machine at IBM exposing 637 EUV wafers in a single day! Additional advancements and improvements are being made to source power, availability and particle contamination.

Last, but not least, you will read about the latest YieldStar system, the 250D. It is the first metrology system capable of measuring overlay, focus and CD in a production environment, helping customers maximize their yields of good wafers-per-day.

I hope you find this issue informative and of value. Please feel free to provide direct feedback to me at michael.pullen@asml.com so that we can continue to improve the magazine and your experience.

Happy reading!
Mike

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A faster route to better overlay

By Paul Tuffy, Product Manager BRION Wafer Fab Applications

Abstract | ASML's new Design for Control Overlay software identifies the best metrology target design for any given layer combination and process in the shortest time. It allows customers to design and optimize metrology targets that deliver the ideal balance of printability, detectability, accuracy and device matching. These targets can be used in an automated feedback loop to deliver significant improvements to on-product overlay performance.

Fast, precise and accurate, ASML's YieldStar diffraction-based metrology tool has made it possible to continually monitor on-product overlay performance and provide faster feedback to the scanner. This is done through a feedback loop where overlay data from an in-track YieldStar module is converted into smart exposure corrections by system enhancement packages like Litho Insight. These corrections are fed back to the scanner for subsequent wafers, resulting in improved on-product overlay performance.

These overlay measurements are based on grating targets included in the reticle designs for the many overlay-sensitive layer combinations in a product. The design of these targets needs to fulfill certain performance requirements. It must print well across the process window, and deliver an easily detectable diffraction signal to ensure precision and short measurement times. It also needs to help ensure the measurements are accurate and not affected by variability in processing steps such as etching and chemical mechanical planarization (CMP).

As design features shrink, more and more overlay targets are needed to capture the overlay fingerprint at the required level of detail. At the same time, placing targets within the actual device becomes advantageous as it allows more accurate and higher-order corrections. This in-die placement is only feasible with very small targets, making it important to optimize the target design for a strong diffraction signal. Moreover, the increased use of opaque materials in the latest technology process stacks – such as the sacrificial layers used in spacer processes – make target optimization for signal strength doubly important.

Identify the best target designs in the shortest time

Design for Control

ASML's new Design for Control Overlay (D4C Overlay) software package helps semiconductor manufacturers identify the best metrology target designs in the shortest time. It does this by simulating the lithography process and resulting YieldStar measurements of candidate targets including the full layer stack, allowing the design parameters of the target for a given layer to be optimized.

D4C Overlay transforms target optimization from a lengthy trial-and-error process to a quick and reliable computational one. It avoids the need to carry out repeated wafer experiments on different test designs – significantly speeding up process development. And it allows users to try out thousands more targets and fully explore the design space – enabling the development of

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the final target design in a single reticle tape out cycle.

By identifying targets that balance precision and accuracy, D4C Overlay helps deliver significantly better on-product overlay performance. What's more, it can match the aberration sensitivity of the target to that of the critical device features being printed in the specified layer, enabling further overlay gains. (See Fig. 1)

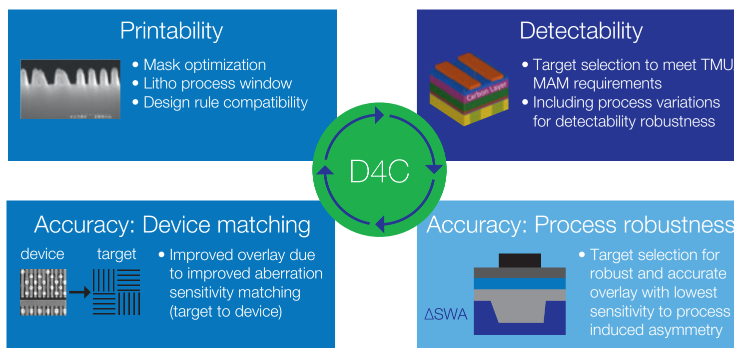

Fig. 1

Tailor-made targets

Design for Control Overlay is a complete target optimization software package. Its easy-to-use graphical user interface guides the user through the target design process step by step. This includes a flexible interface for defining the process stack in the same way as it is built in the fab: adding etch, deposition, CMP and patterning steps to build each layer. This approach allows almost any stack design to be simulated. (See Fig. 2)

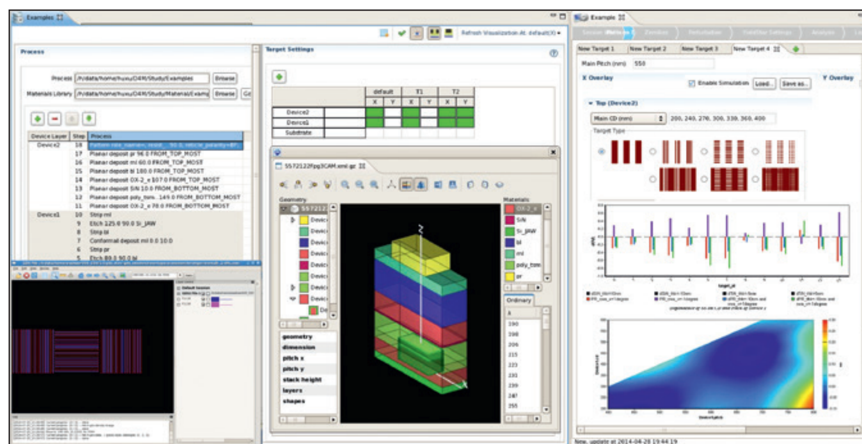

Fig. 2

Once the user has specified the process design rules and constraints, the software runs an initial simulation to identify target candidates that meet the printability and detectability specifications. The detectability, overlay accuracy and lens aberration performance of these candidates are then tested in a further round of simulations.

An extensive set of built-in analysis features including 2D heat maps and 3D amplitudes simplifies the selection of optimal targets. Once the user has chosen a number of best candidates for experimental validation, the D4C Overlay software outputs the complete reticle pattern for that layer in the GDS format. (See Fig. 3)

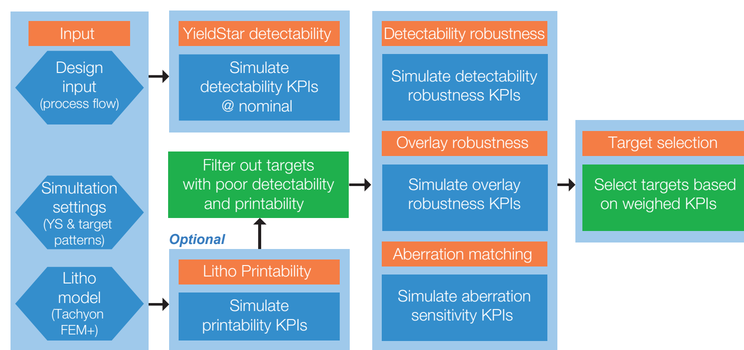

Fig. 3

In-house design and optimization

D4C Overlay runs on any fab server cluster using the Tachyon Flex platform. We offer extensive training and detailed user manuals on how to get the best from the package. This allows companies to keep target design and optimization completely in house.

D4C Overlay was initially released in late 2013 in a version that focused on target printability and detectability. The full version including overlay accuracy was launched in Q3 2014. It is designed for use with ASML's TWINSCAN NXT immersion ArF and NXE extreme ultraviolet scanners in conjunction with YieldStar YS 200C or YS 250D metrology tools and Litho Insight overlay optimization software.

Together these systems deliver a holistic solution to the current industry requirements for 5 nm overlay, 60 nm focus control and 1.6 nm CDU (after etch). Planned enhancements to all these products will support roadmaps towards 2017 that demand 2.5 nm overlay, 50 nm focus control and 1.1 nm CDU (after etch).

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