

EUV Reticles at the Inflection Point: Inspection, Repair, and the Path to High-NA with AI-Enabled Mask Shops

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Extreme ultraviolet (EUV) lithography has transitioned from technology development to manufacturing backbone at advanced nodes, placing unprecedented demands on reticle quality, defect control, and lifecycle management. As the industry moves toward High-NA EUV, the margin for error tightens further—driving a fundamental rethinking of inspection sensitivity, defect printability assessment, and repair strategies.

This keynote will present a comprehensive view of the current state of EUV reticles, drawing from practical experience in reticle inspection and repair. Key challenges—including stochastic defects, phase defects within multilayer stacks, absorber edge roughness, and contamination-induced printing variability—will be examined in the context of both current production nodes and emerging High-NA requirements.

The discussion will also highlight the growing gap between defect detection capability and defect relevance, emphasizing the need for smarter filtering, printability prediction, and inline decision-making. In this context, reticle repair is entering a new era, where precision, material interactions, and EUV-specific failure modes demand tighter integration with inspection and verification workflows.

Looking forward, the keynote will explore the transformation of the mask shop driven by artificial intelligence and data-centric manufacturing. AI/ML techniques—applied to defect classification, nuisance filtering, predictive maintenance, and repair optimization—offer a path toward adaptive, self-learning mask ecosystems. A vision will be presented for an autonomous mask shop, where inspection, repair, metrology, and process control are unified through intelligent data pipelines, enabling faster cycle times, improved yield, and reduced cost of ownership.

By bridging current manufacturing realities with forward-looking innovations, this keynote will outline a roadmap for enabling robust reticle performance at future EUV

nodes. The session aims to stimulate discussion across the ecosystem—spanning mask shops, tool suppliers, device manufacturers, and researchers—on how to collectively address the next generation of challenges and opportunities in EUV reticle technology.

Presenting Author

Safak Sayan, Ph.D. is a Senior Principal Engineer at Intel Corporation, where he serves as the technical and operational Area Manager for Reticle Inspection and Repair at Intel Mask Operations, as well as reticle inspection across Intel’s global wafer Factories. His work focuses on advanced inspection and repair methodologies, new tooling and capability development, and the integration of AI and data-centric manufacturing for future technology nodes.

Dr. Sayan received his Ph.D. in Chemistry from Rutgers University, the State University of New Jersey, and completed a postdoctoral fellowship at the National Institute of Standards and Technology (NIST). He subsequently joined Intel, where he has held a wide range of technical and leadership roles spanning lithography equipment and process development, yield and process control engineering, and new tool introduction and qualification.

He has led and contributed to first-of-a-kind capability development, including APMI systems, EUV LDPP Source, AIMS EUV and has extensive experience across advanced lithography infrastructure, including scanners, tracks, metrology tooling and e-beam technologies. He directed Intel’s research programs in Advanced Patterning and Beyond CMOS Devices at IMEC, Belgium, guiding collaborative efforts on EUV lithography, novel materials, and next-generation device concepts.

In addition to his industry role, Dr. Sayan serves as a Visiting Professor in the Department of Chemistry and Chemical Biology at Rutgers University.