Mask Industry is Ready for Curvilinear ILT

A Decade of ILT!

6 Papers

2 Foundries

1 Memory

1 Mask shop

Luminescent TECHNOLOGIES™

A Decade of ILT!

Fast Inverse Lithography Technology

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6 Papers

2 Foundries

1 Memory

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Luminescent TECHNOLOGIES™

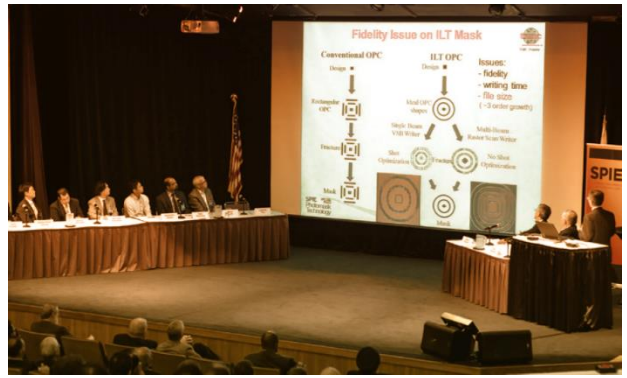
ILT Adopted as the Way Forward

>200

Papers

Officially announced

Today

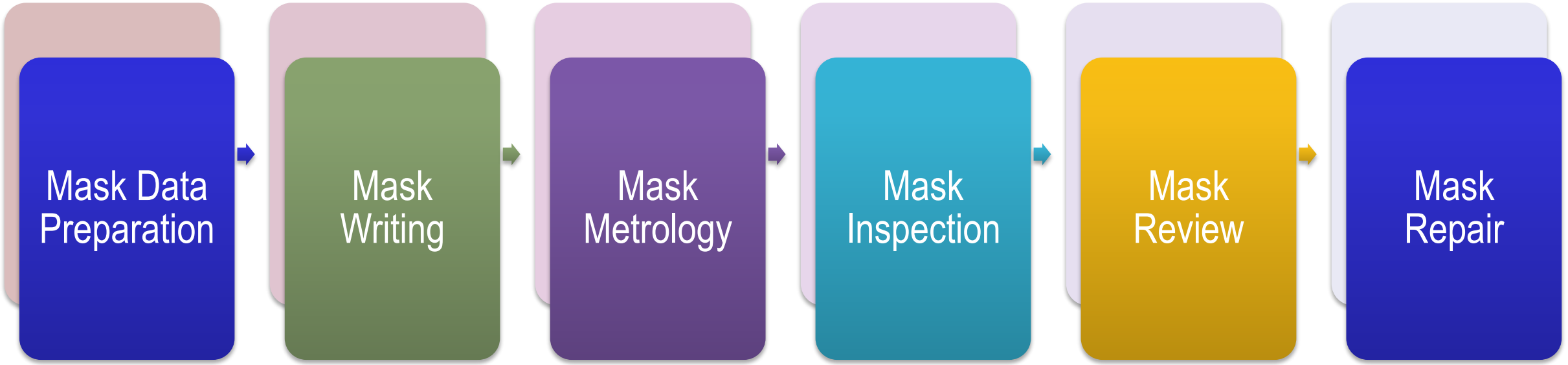


ILT expertise proliferated

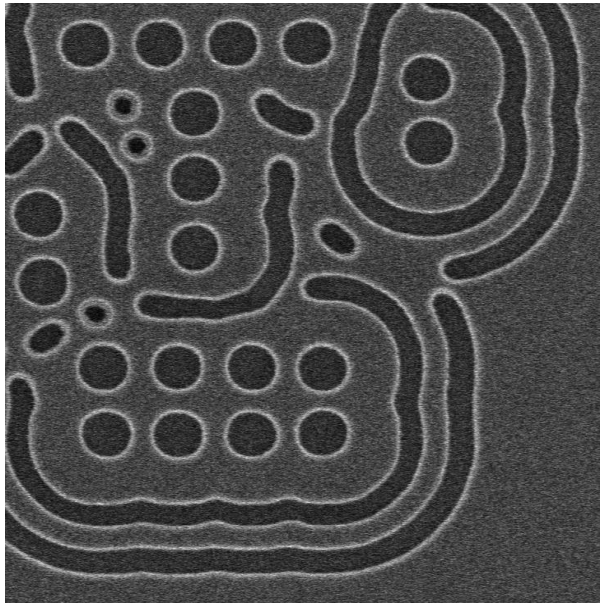
2014 panel

2016 panel

Is the Entire Mask Supply Chain Ready for Curvilinear ILT Masks?

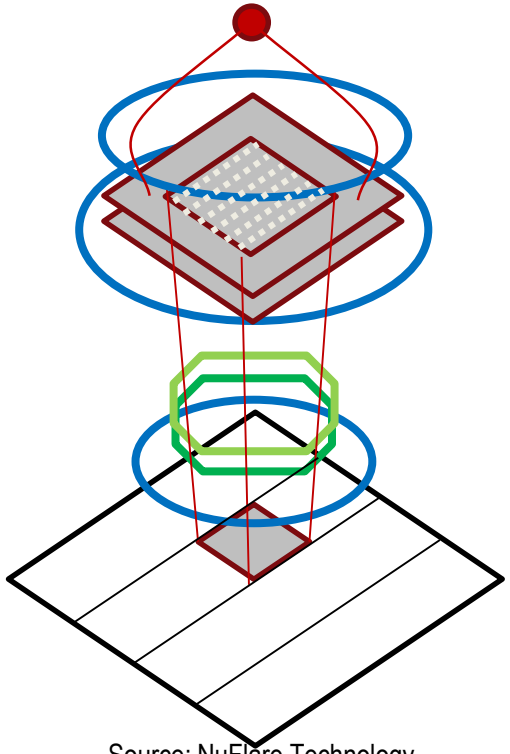


Big Changes Are Coming in Litho and Mask …



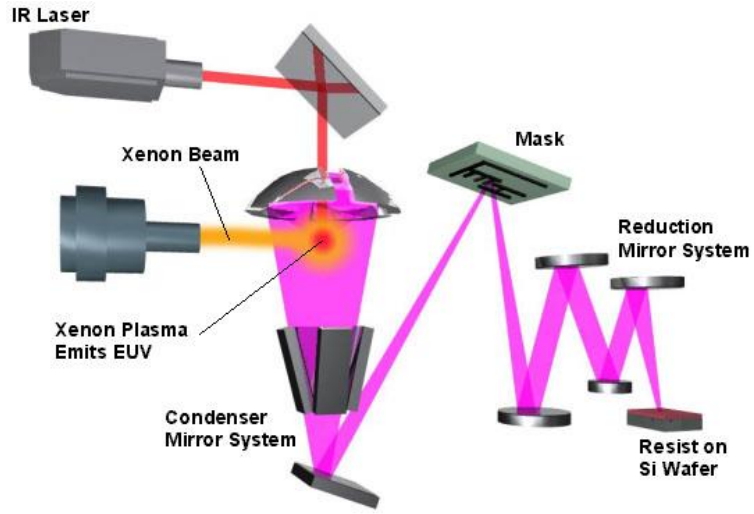
B.G. Kim, et al., BACUS, 2012

ILT Mask Patterns:
Here Today



Source: NuFlare Technology

Multi-beam Mask Writing:
2017-2018

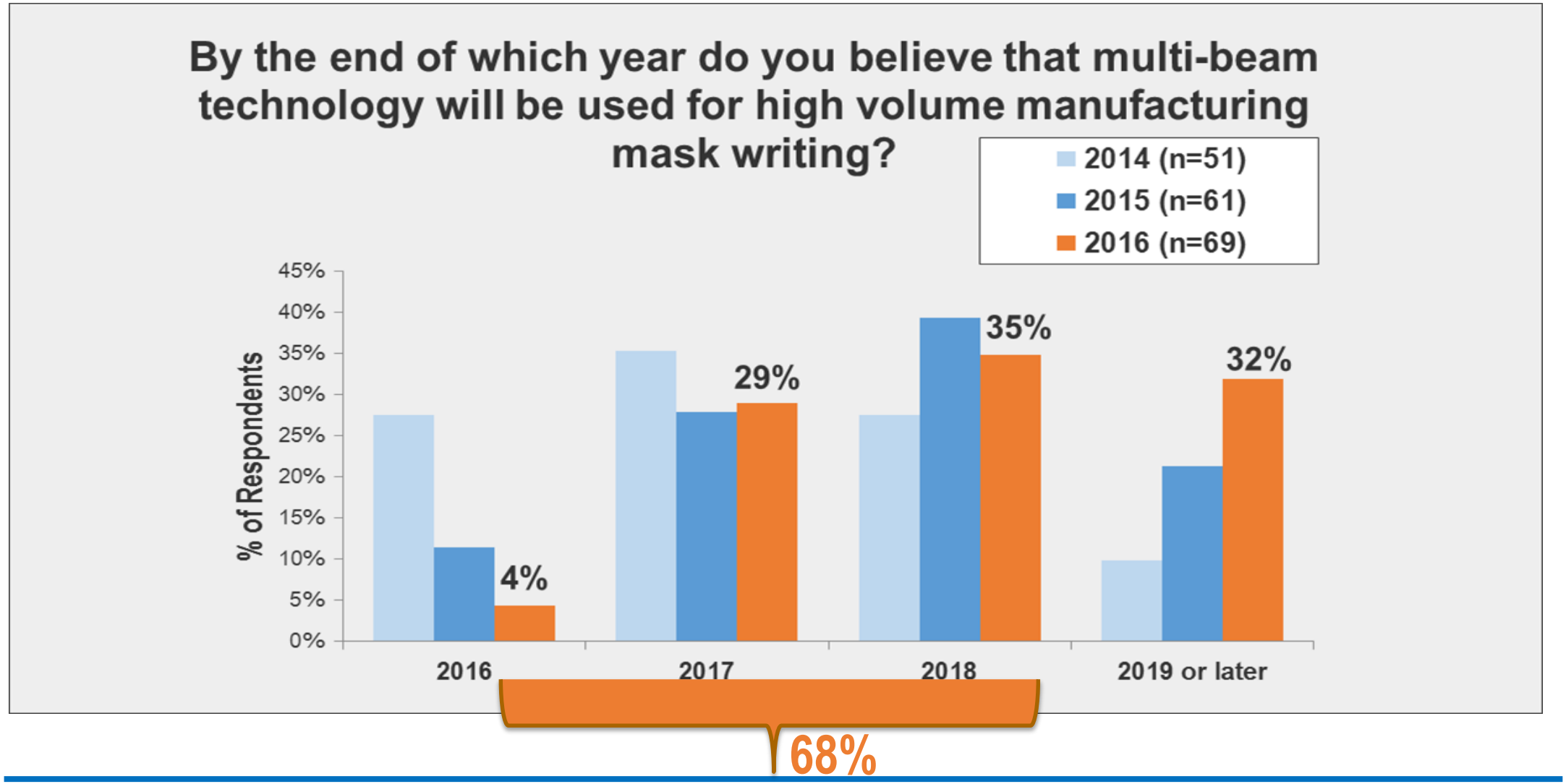


Source: Barrett Research Group

EUV Mask Production:
2018

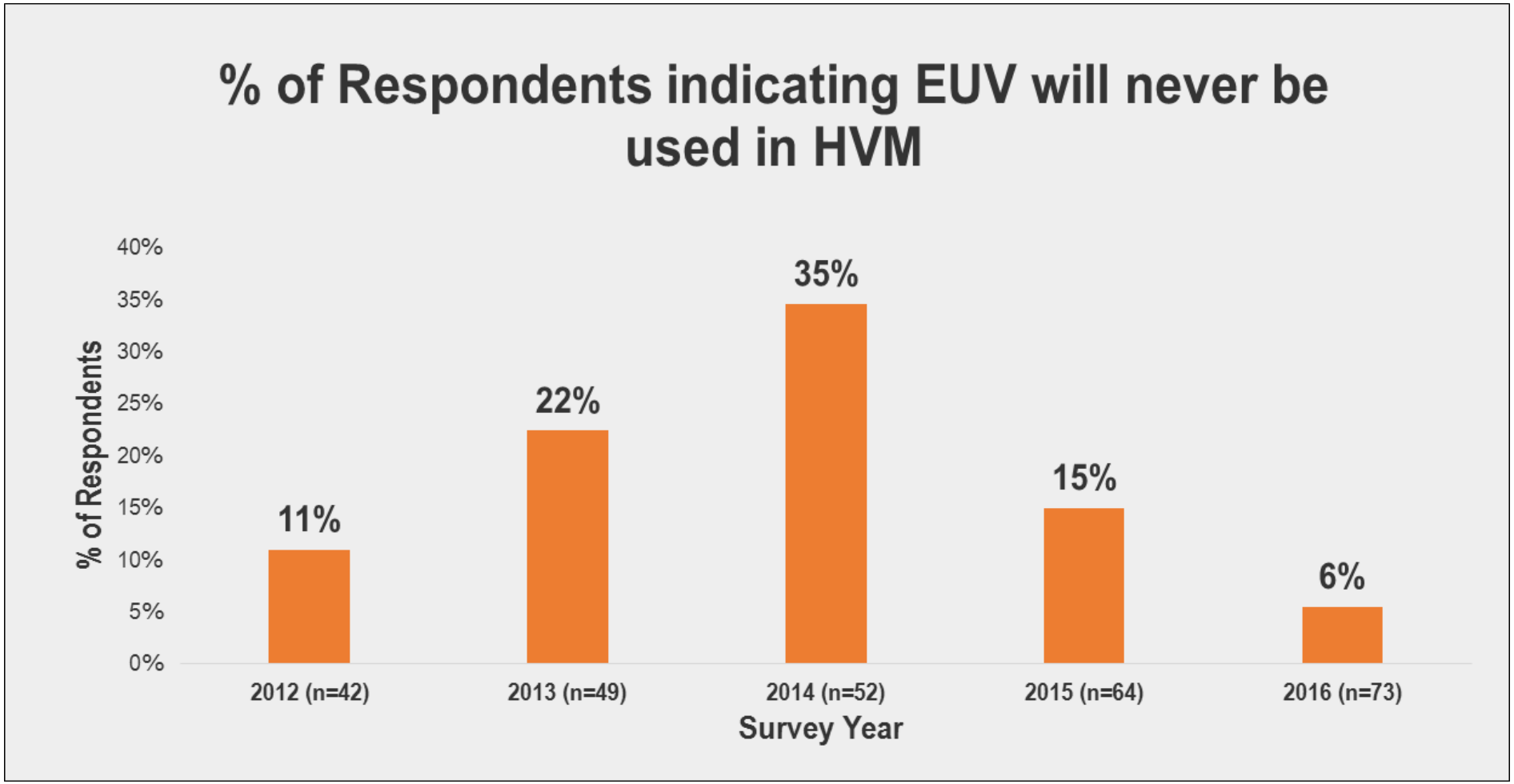
68% Say Multi-beam HVM by end of 2018

2016 eBeam Initiative Survey



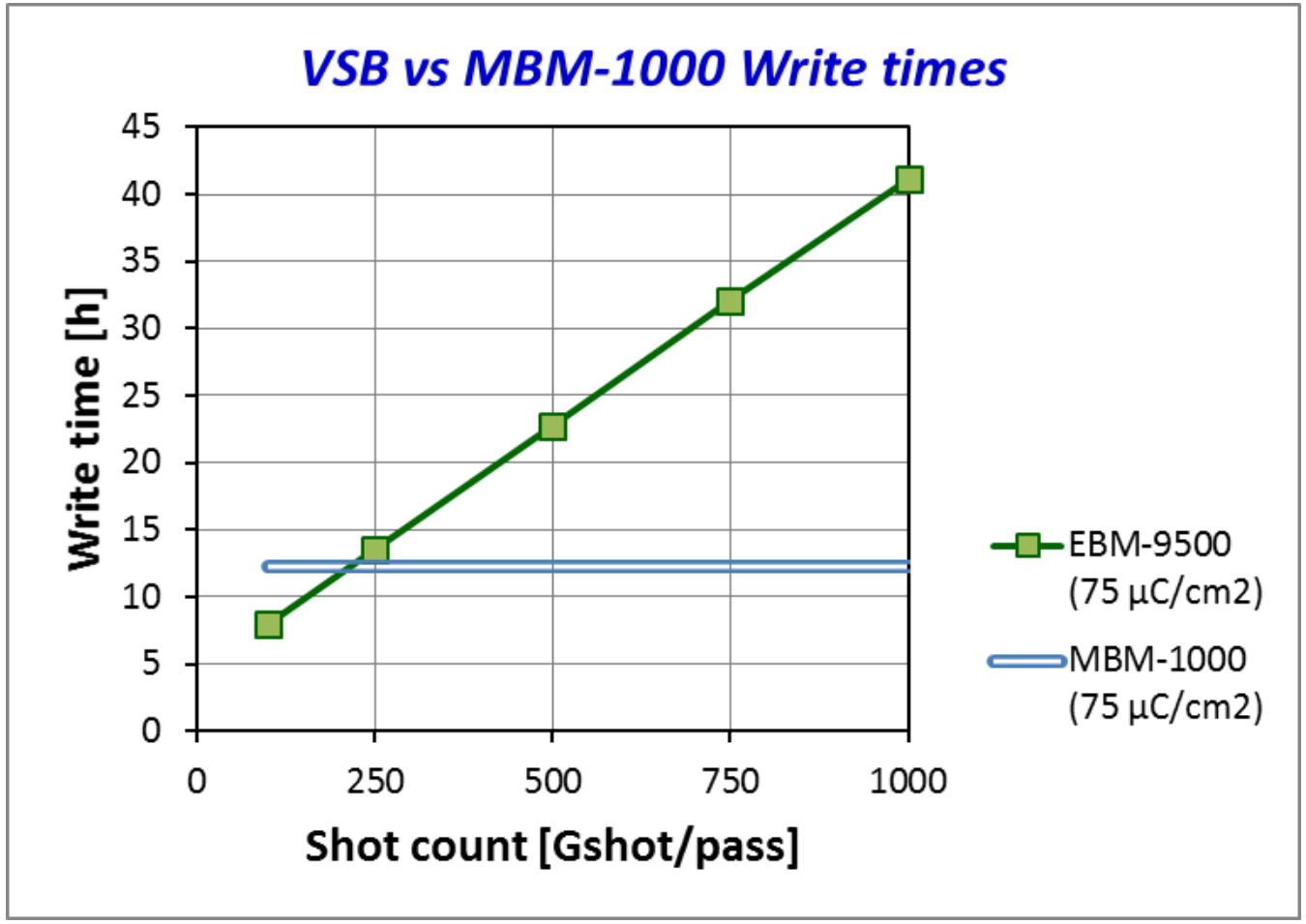
EUV Pessimism is the Lowest in 5 Years

Only 6% Responded with "Never" in 2016



Source: 2016 eBeam Initiative Perceptions Survey www.ebeam.org

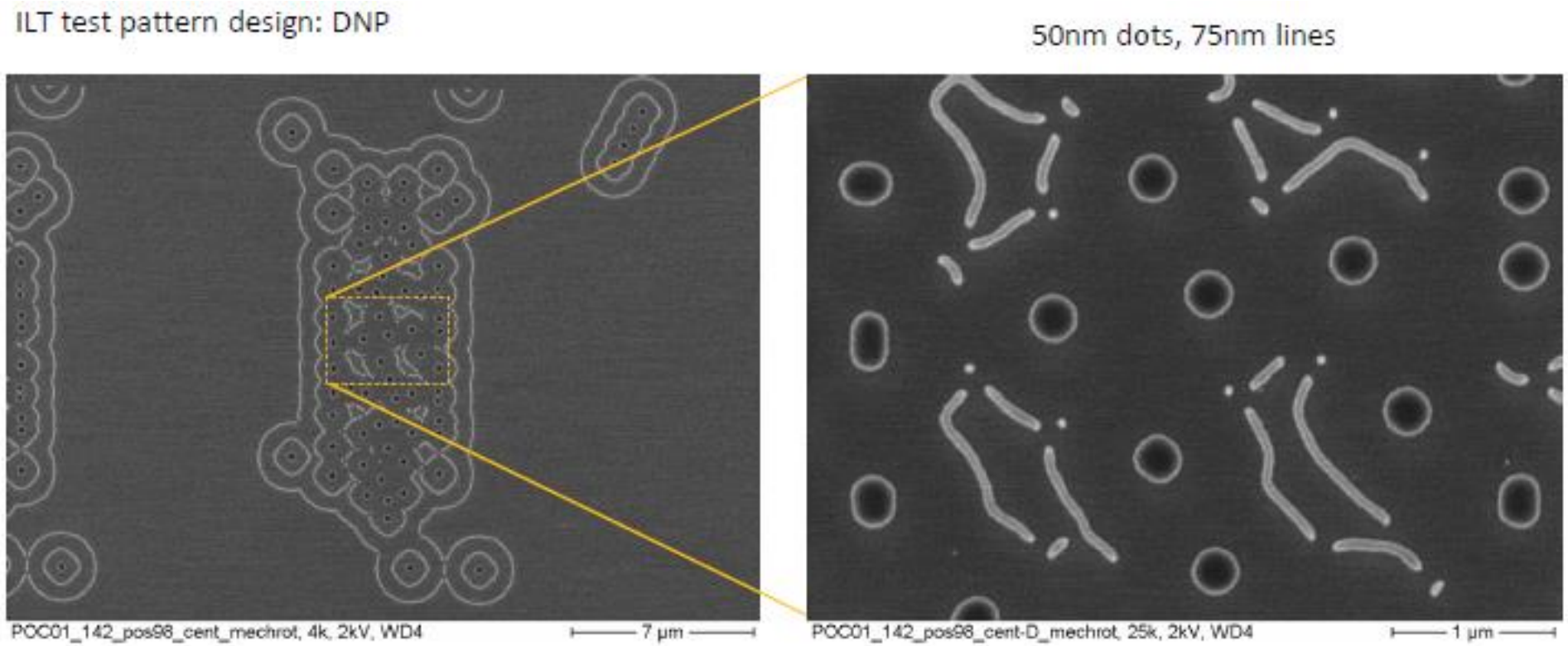
Multi-beam Provides Constant Write Time



Source: NuFlare Technology, eBeam Initiative SPIE lunch 2016

Multi-beam has the shot count advantage > ~200 Gshot/pass

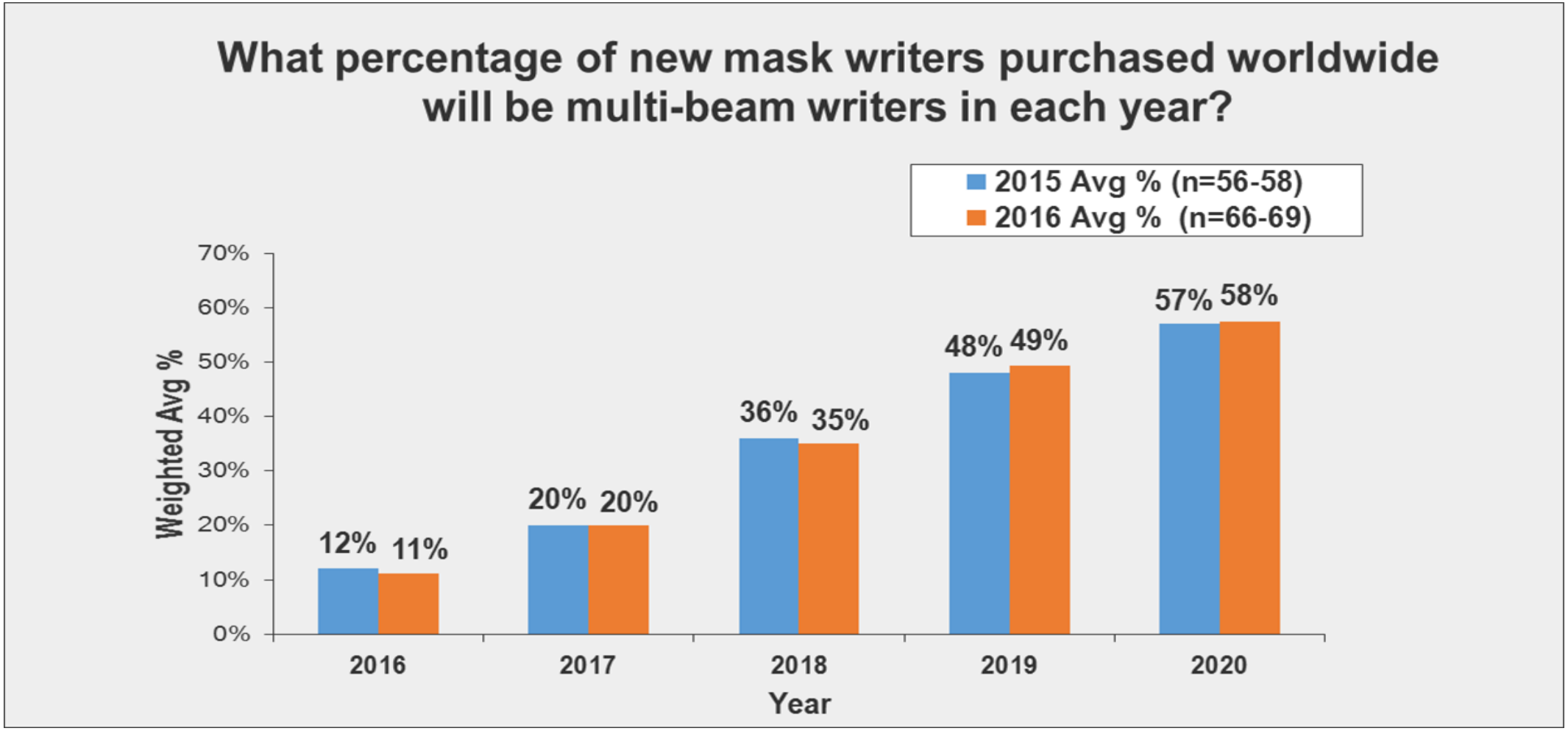
Multi-beam is Great for Curvilinear ILT



D2S note: Written on IMS alpha machine

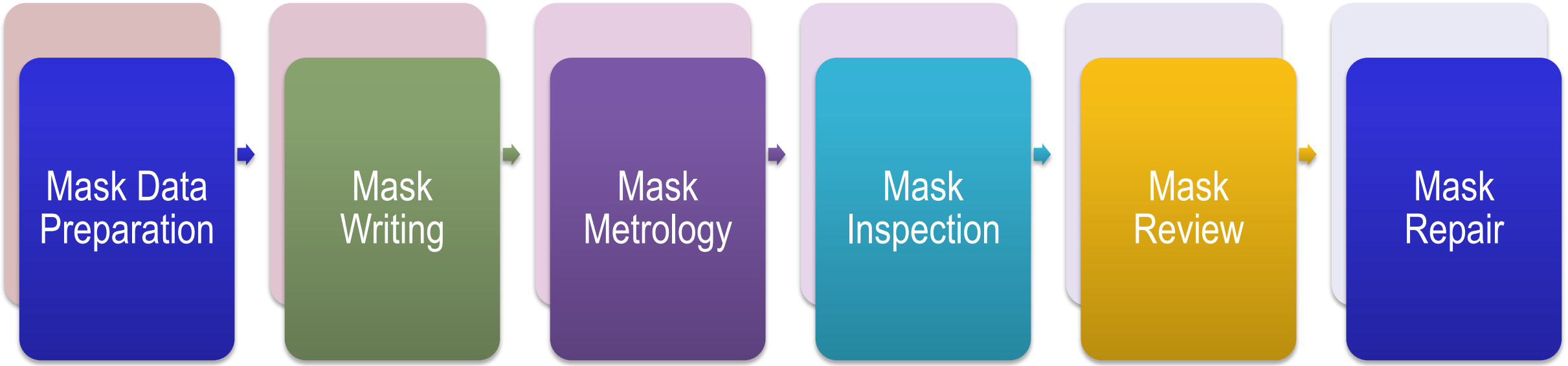
Multi-beam exposure without loss of TPT

But VSB, Multi-beam Will Co-exist for Years



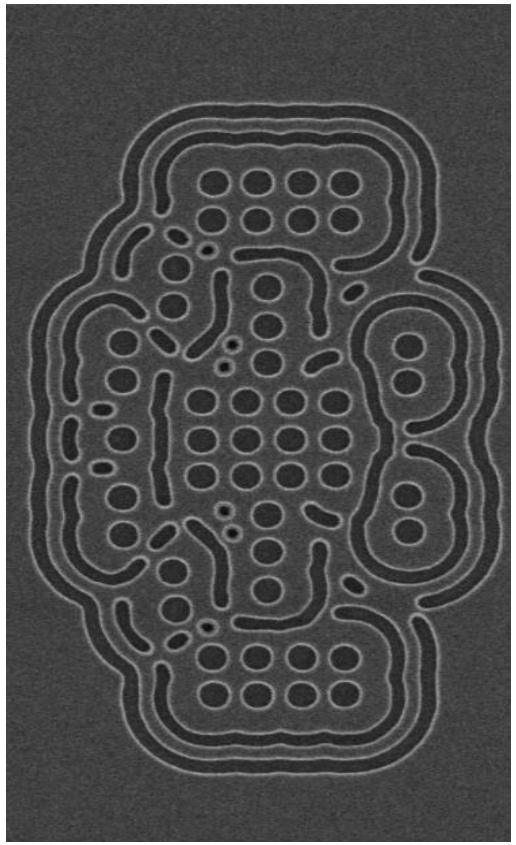
Source: 2016 eBeam Initiative Perceptions Survey www.ebeam.org

Is the Entire Mask Supply Chain Ready for Curvilinear ILT Masks?



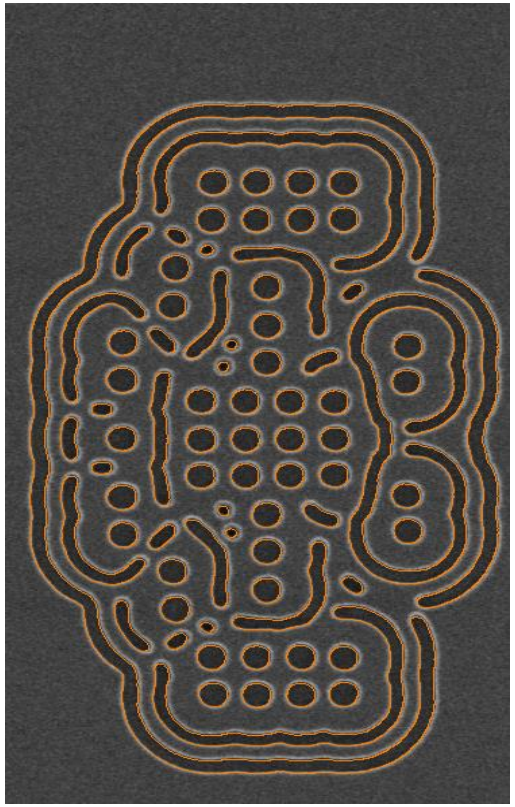
✓ ✓

The New ILT World Calls for New CD Metrology: Mask and Wafer!

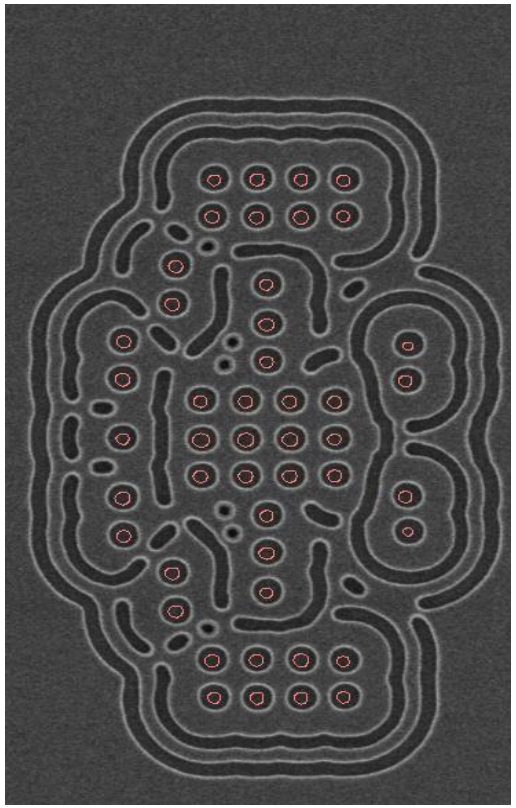


The New ILT World Calls for New CD Metrology: Mask and Wafer!

Mask



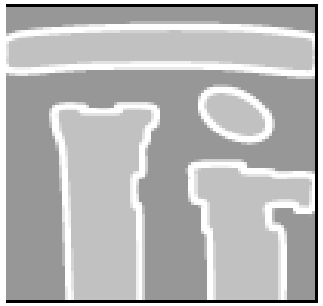
Wafer



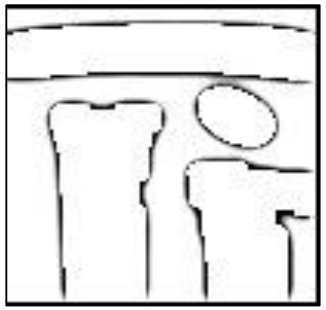
Simulation Can Provide Aerial Image from High-Resolution SEM Image

SEM

SEM Image



Contour



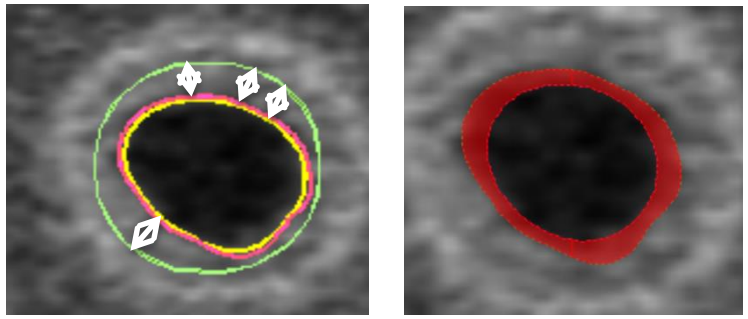
Aerial Image

SEM Contour Extraction

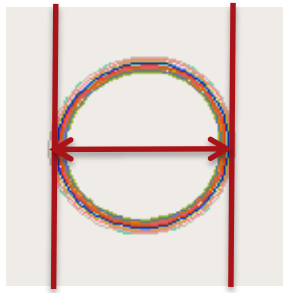
Aerial Image Simulation

The New ILT World Calls for New CD Metrology: Mask and Wafer!

Mask

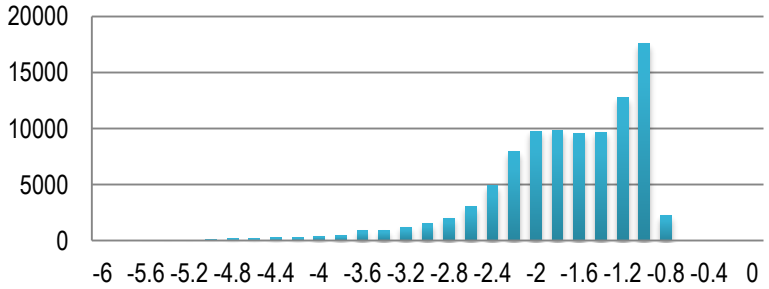


Wafer



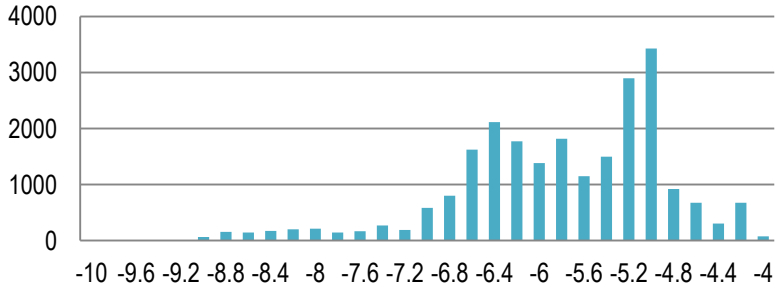
GPU = Real-time for mask + wafer

EPE Histogram (Mask)



Contour, EPE,
PV Band, Histogram

EPE Histogram (Wafer)



CD, EPE,
PV Band, Histogram

Is the Entire Mask Supply Chain Ready for Curvilinear ILT Masks?

Mask Inspection Tools Adding Aerial Image Inspection Mode

KT Teron™ 630

Selectable imaging modes to provide the necessary signal-to-noise ratio (SNR) to ensure defect-free 1Xnm generation reticles, whether optical reticles with complex OPC or EUV reticles (Source: KT website)

Applied AERA™4

Designed to emulate a scanner, the Aera4 system delivers superior first-time inspection success rate over other high-resolution inspection systems on advanced masks, including those with aggressive OPC, such as inverse lithography. (Source: AMAT website)

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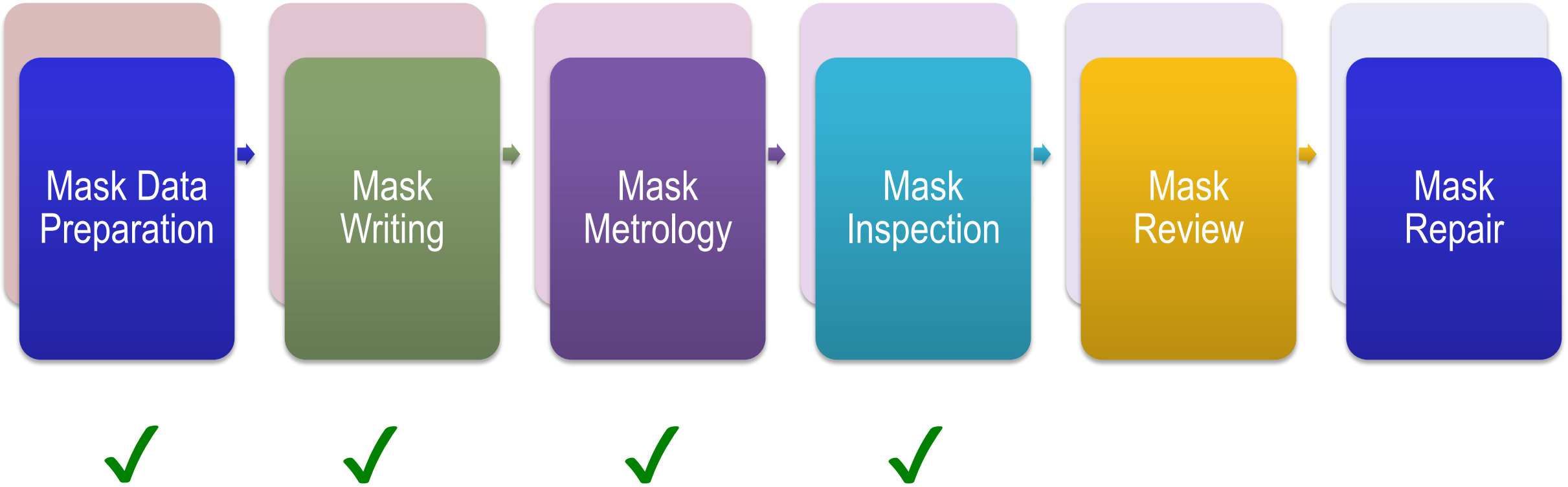
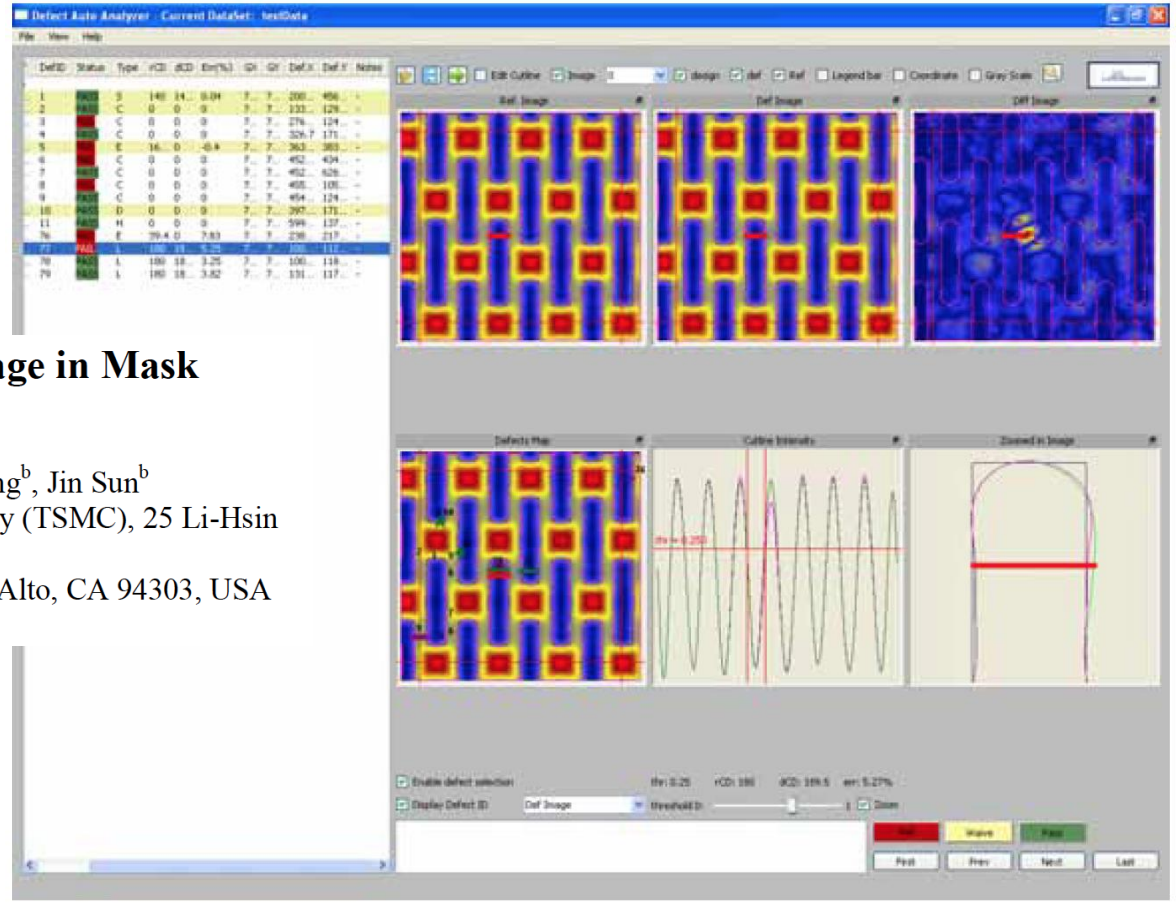


Simulation and Aerial-based Defect Review Has been Used in Production For Years



Mask Defect Auto Disposition based on Aerial Image in Mask Production

C.Y. Chen[a], Laurent Tuo[a], C. S. Yoo[a], Linyong Pang[b], Danping Peng[b], Jin Sun[b]
[a]E-Beam Operation Division, Taiwan Semiconductor Manufacturing Company (TSMC), 25 Li-Hsin Rd. Hsinchu, Taiwan 300-77, ROC
[b]Luminescent Technologies, Inc., 2471 East Bayshore Road, Suite 600, Palo Alto, CA 94303, USA

Ref: C. Y. Chen, et al., "Mask defect auto disposition based on aerial image in mask product", Proc. SPIE 7379, Photomask and Next-Generation Lithography Mask Technology XVI, 73791F (May 11, 2009); doi:10.1117/12.824292; http://dx.doi.org/10.1117/12.824292

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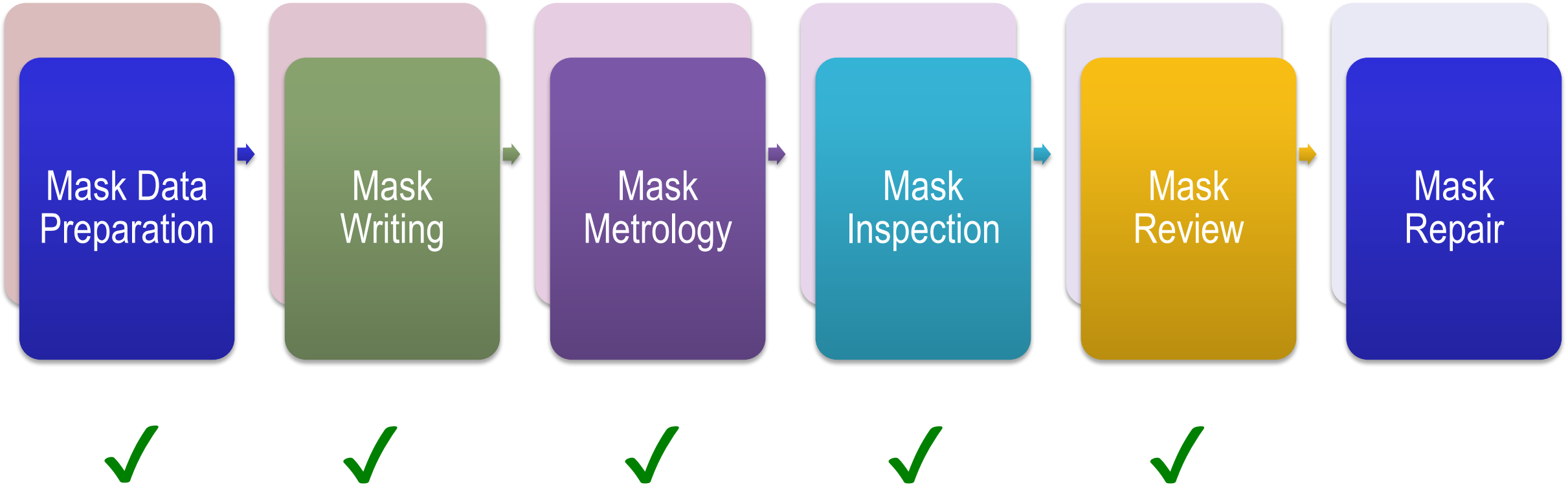
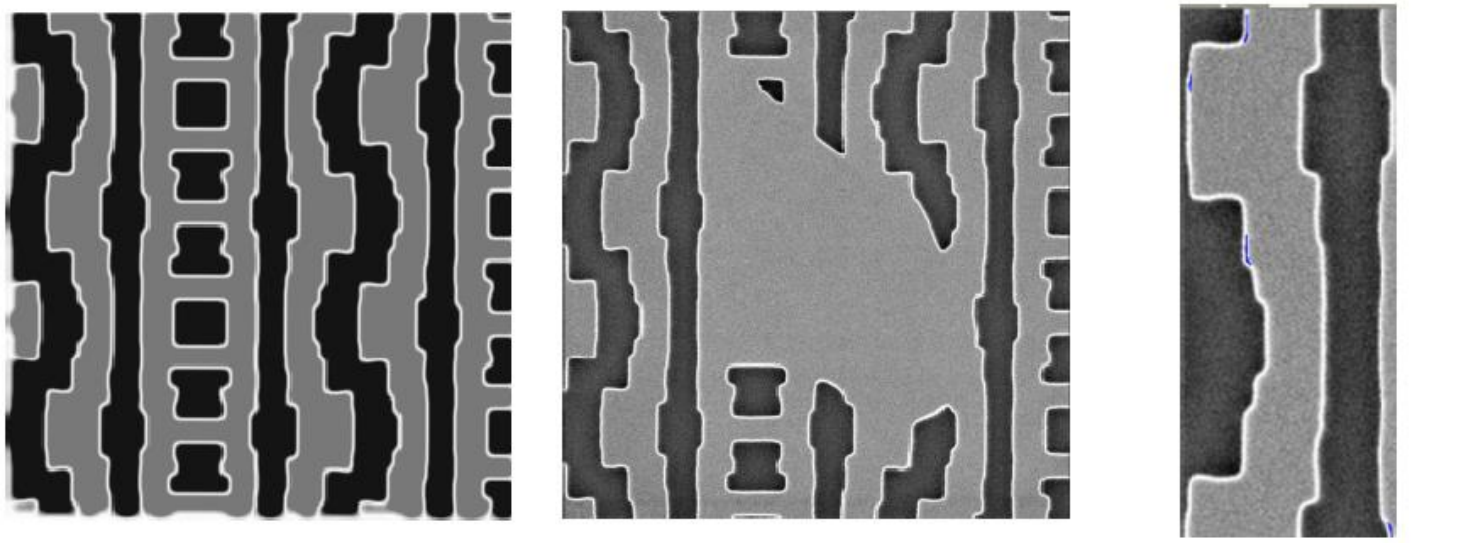


2D Mask Repair, Simulation-based Mask Repair Verification Used in Production For Years

Expanding the Applications of Computational Lithography & Inspection (CLI) in Mask Inspection, Metrology, Review, and Repair

Linyong Pang, Danping Peng, Peter Hu, Dongxue Chen, Lin He, Ying Li, Chris Clifford, Vikram Tolani
Luminescent Technologies, Inc. 2471 East Bayshore Road, Suite 600,
Palo Alto, CA 94303, USA



Rendered Image | Acquired Image | Difference in clean area (blue)

Ref: L. Pang, et al., "Expanding the Applications of Computational Lithography & Inspection (CLI) in Mask Inspection, Metrology, Review, and Repair", Proc. of SPIE 7971 79712A-1

2D Mask Repair, Simulation-based Mask Repair Verification Used in Production For Years

In-situ Repair Qualification by Applying Computational Metrology and Inspection (CMI) Technologies

C.Y. Chen[a], Ivan Wei[a], Laurent Tuo[a], C. S. Yoo[a], Dongxue Chen[b], Danping Peng[b], Masaki Satake[b], Bo Su[b], Linyong Pang[b]

[a]E-Beam Operation Division, Taiwan Semiconductor Manufacturing Company (TSMC), 25 Li-Hsin Rd. Hsinchu, Taiwan 300-77, ROC
[b]Luminescent Technologies, Inc., 2300 Geng Road, Suite 250, Palo Alto, CA 94303, USA

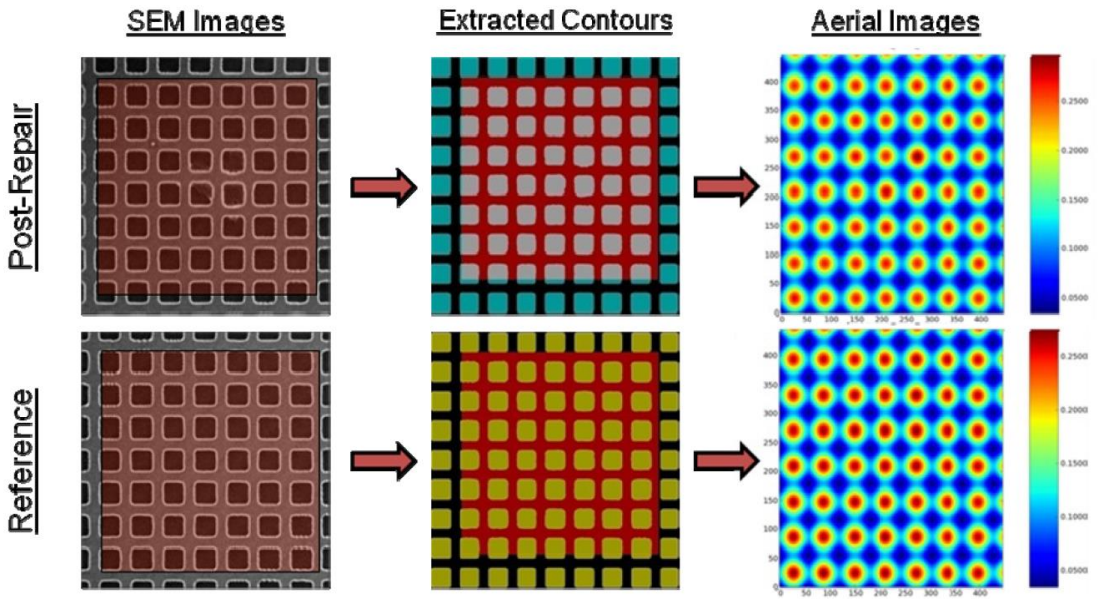
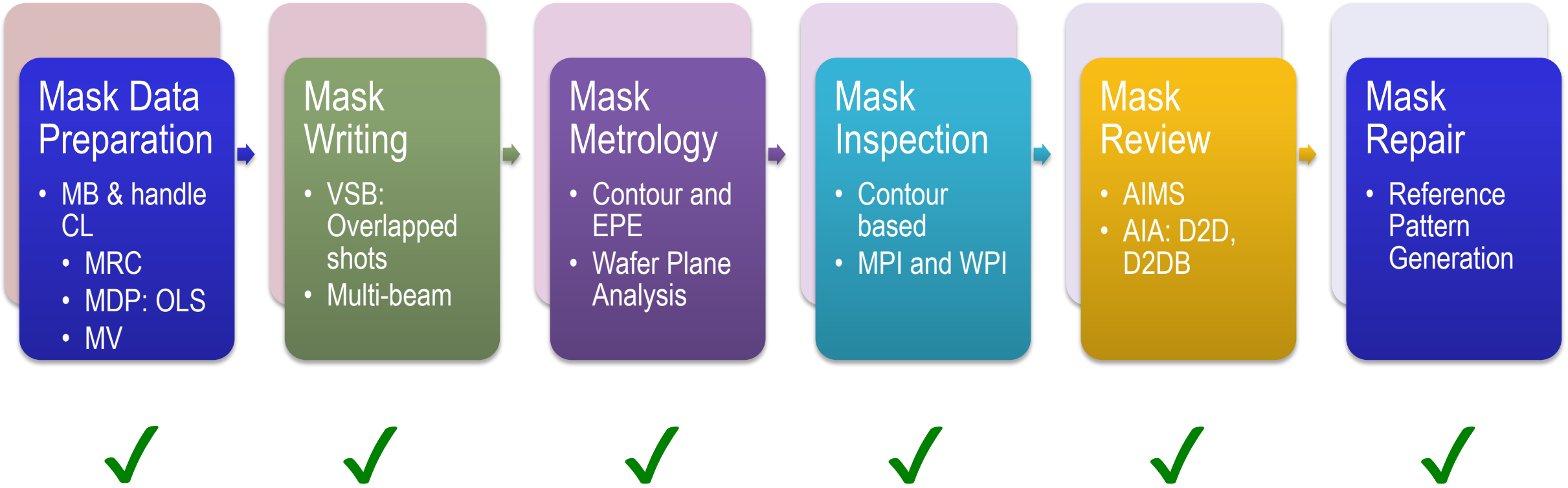


Figure 4 – IRQ data flow from SEM images to aerial images

Ref: C. Y. Chen, et al., "In-situ Repair Qualification by Applying Computational Metrology and Inspection (CMI) Technologies", Proc. of SPIE Vol. 8701 870108-11

The Entire Mask Supply Chain is Ready for Curvilinear ILT Masks




D2S