



Beam
Initiative

Welcome to 2010 SPIE Lunch

Aki Fujimura
CEO – D2S, Inc.
Managing Sponsor – eBeam Initiative



Beam
Initiative

Summary of Today's News



- eBeam Initiative grows to 27 members
- Design for E-Beam (DFEB) Mask Technology Launched
 - 22nm logic and beyond
 - High-volume applications
- PMJ papers to be presented in April by Initiative members

Welcome to the New Members





Member Companies & Advisors



Marty Deneroff
Consultant



Jack Harding
eSilicon



Colin Harris
PMC-Sierra



Riko Radojic
Qualcomm



Jean-Pierre
Geronimi
ST



Today's Agenda



Samsung Viewpoint

Dr. Seong-Sue Kim, Principal Engineer, Photomask Team – Samsung
Member – eBeam Initiative

Industry Need for DFEB Mask Technology

Aki Fujimura, CEO – D2S, Inc.
Managing Sponsor – eBeam Initiative

Toppan Viewpoint

Dr. Franklin Kalk, Executive Vice President and CTO – Toppan Photomasks, Inc.
Member – eBeam Initiative

Q&A

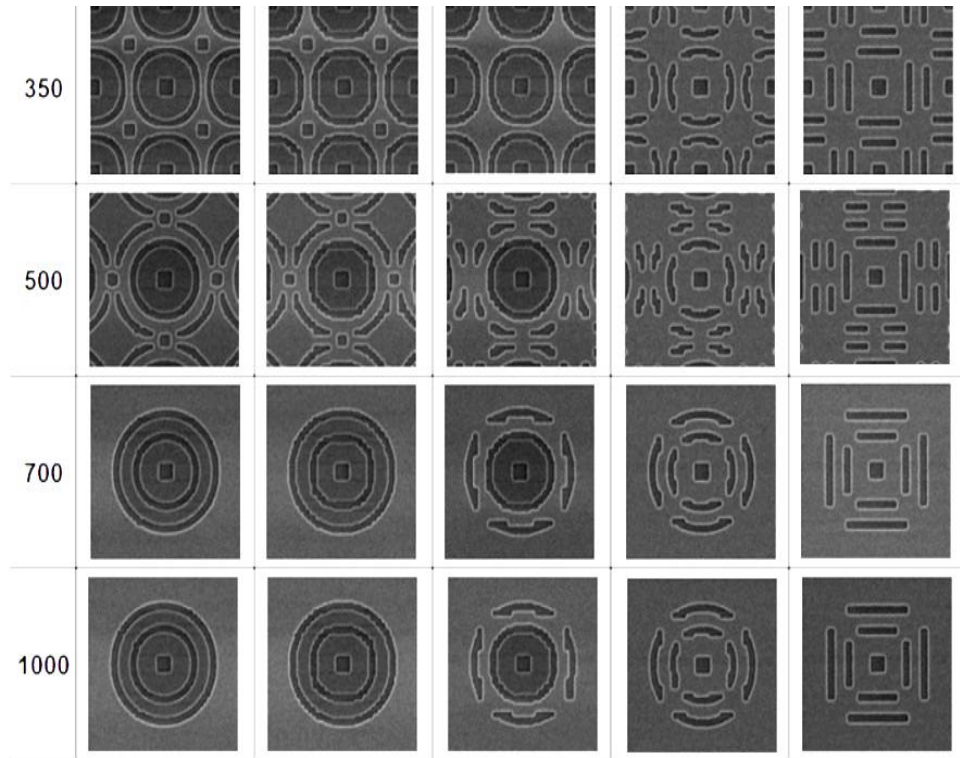
Samsung Viewpoint

Dr. Seong-Sue Kim
Principal Engineer, Photomask Team – Samsung Electronics
Member – eBeam Initiative

The 22-nm Challenge: DOF and Reduced Shot Count are Essential

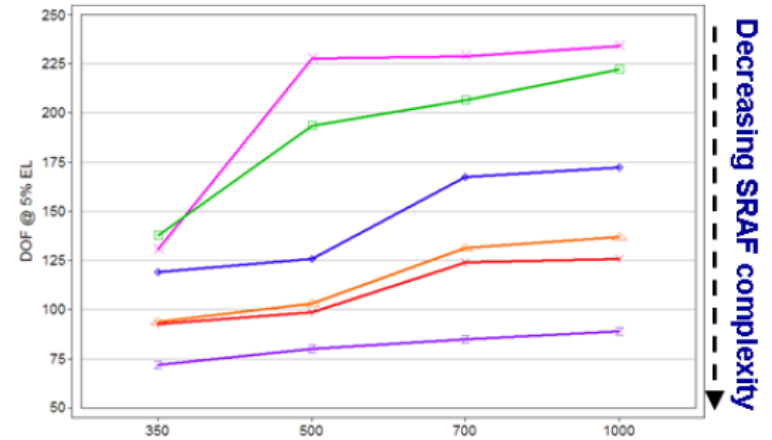


X — C0 □ — C1 ◆ — C2 ▲ — C3 Y — C4

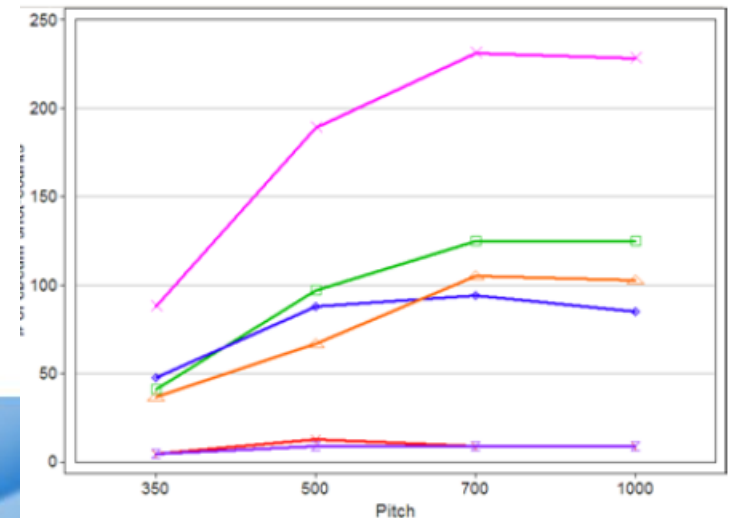


Samsung study : Ref: Byung-Gook Kim, et al., PMJ 2009.

DOF @ 5%EL



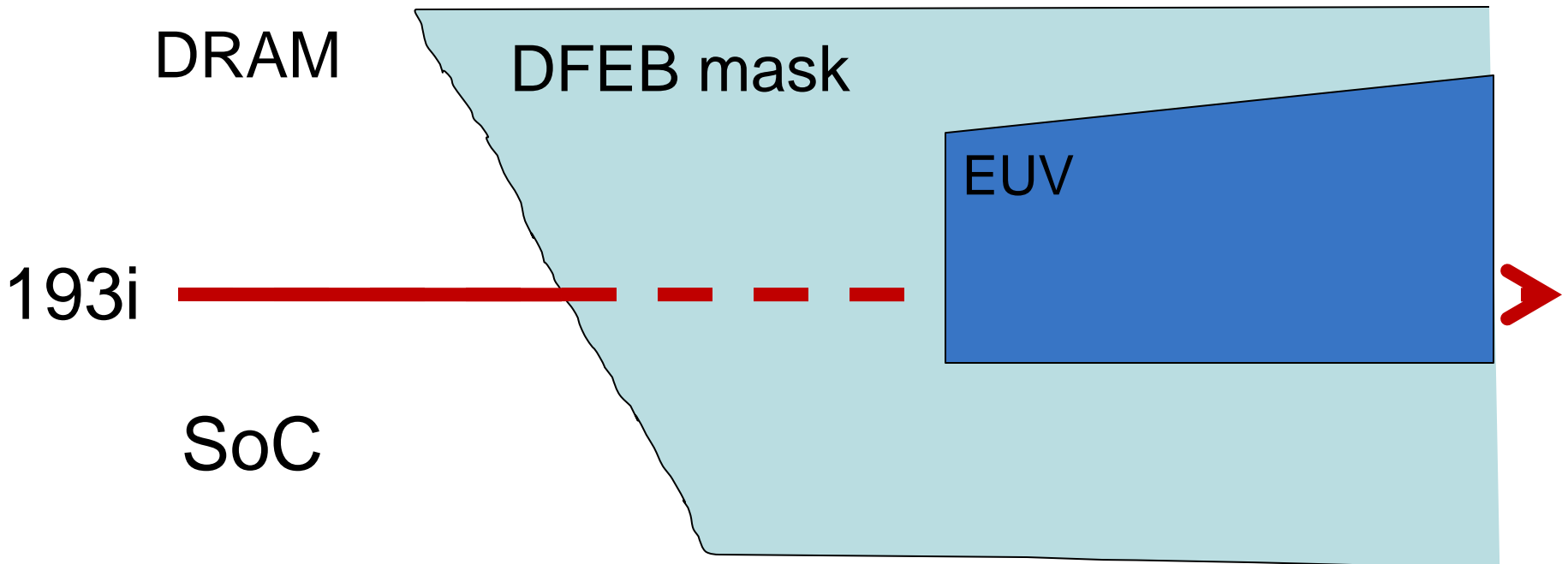
of eBeam Shot-counts



DFEB Mask Is An Enabler at 22-nm

- Without DFEB mask, 193i at 22-nm forces you to choose between a good wafer (high yield) and a good mask (simple pattern).
- We must have both and DFEB mask enables that.
- Samsung collaboration on DFEB mask with eBeam Initiative members is underway.

DFEB Mask Can Extend 193i Roadmap



DFEB Mask Is Also Good for EUV Masks

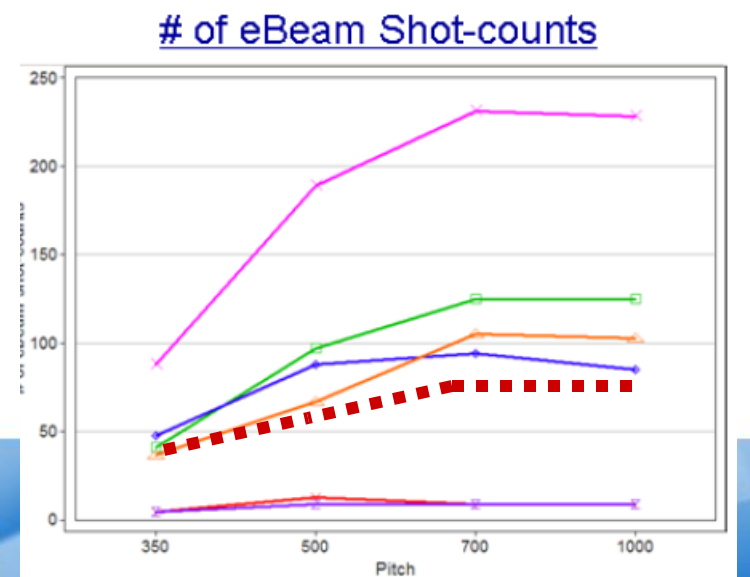
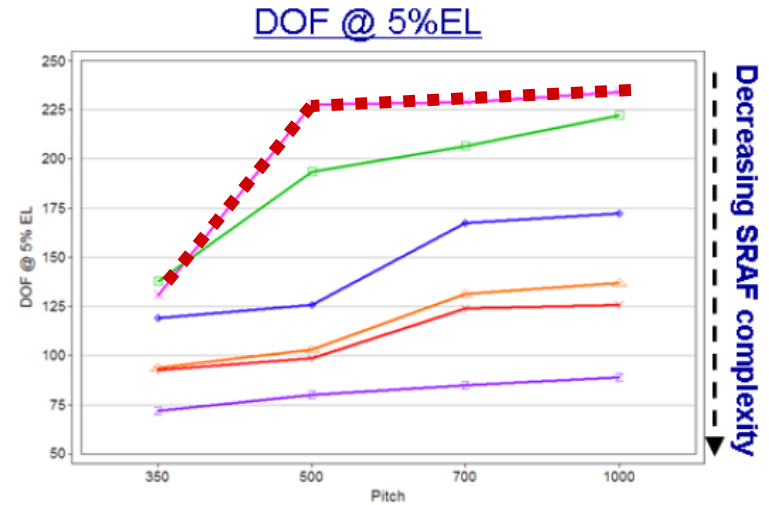
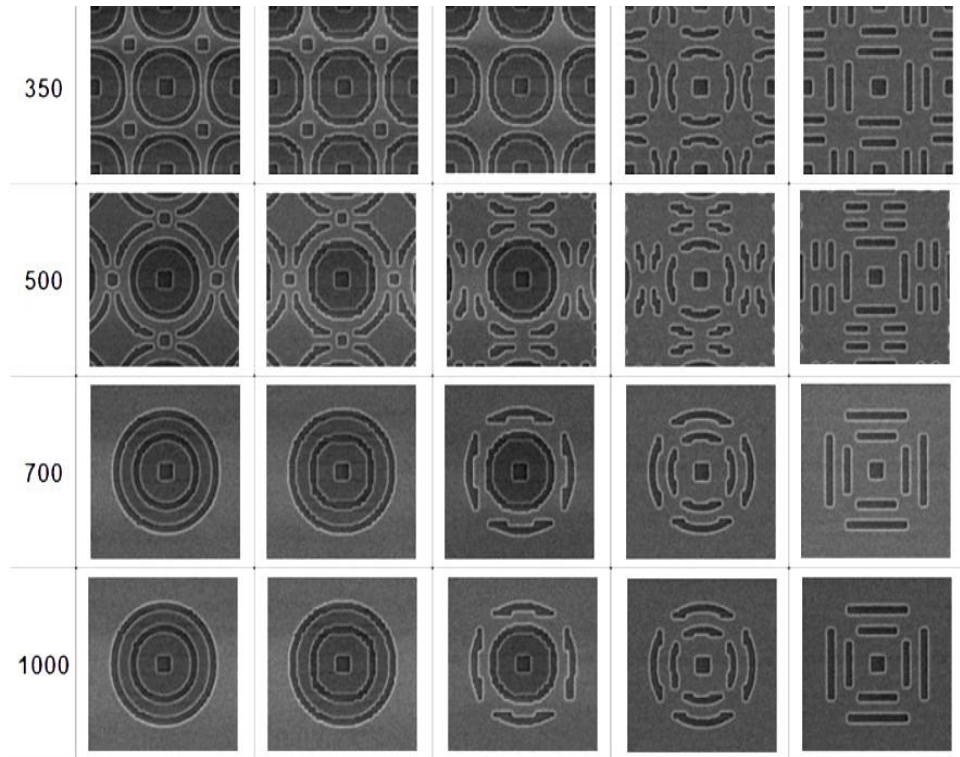
Industry Need for DFEB Mask Technology

Aki Fujimura
CEO – D2S, Inc.
Managing Sponsor – eBeam Initiative

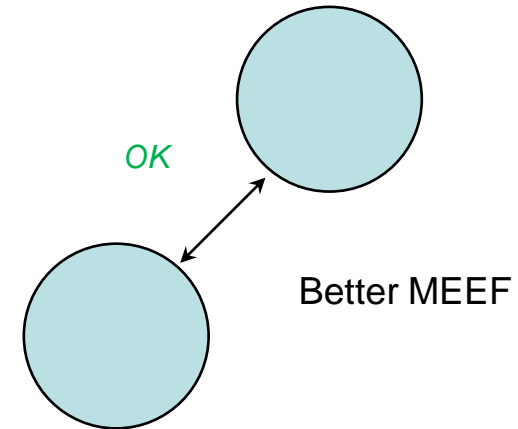
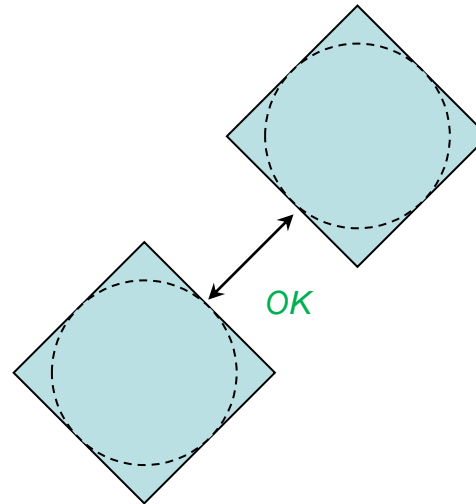
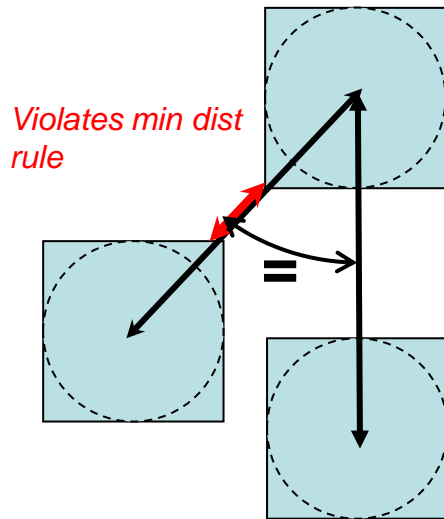
DFEB Mask: Delivers Best DOF with Reduced Shot Count



X — C0 □ — C1 ◇ — C2 ▲ — C3 Y — C4



Circles are Better for Design AND Manufacturing



Printing circles as characters



Dose provided:

16.0 $\mu\text{C}/\text{cm}^2$

19.7 $\mu\text{C}/\text{cm}^2$

24.3 $\mu\text{C}/\text{cm}^2$

Shot diameter = 118

Hole Diameter on mask (measured)

89nm

106nm

115nm

Shot Diameter = 142

Hole Diameter on mask (measured)

132nm

141nm

150nm

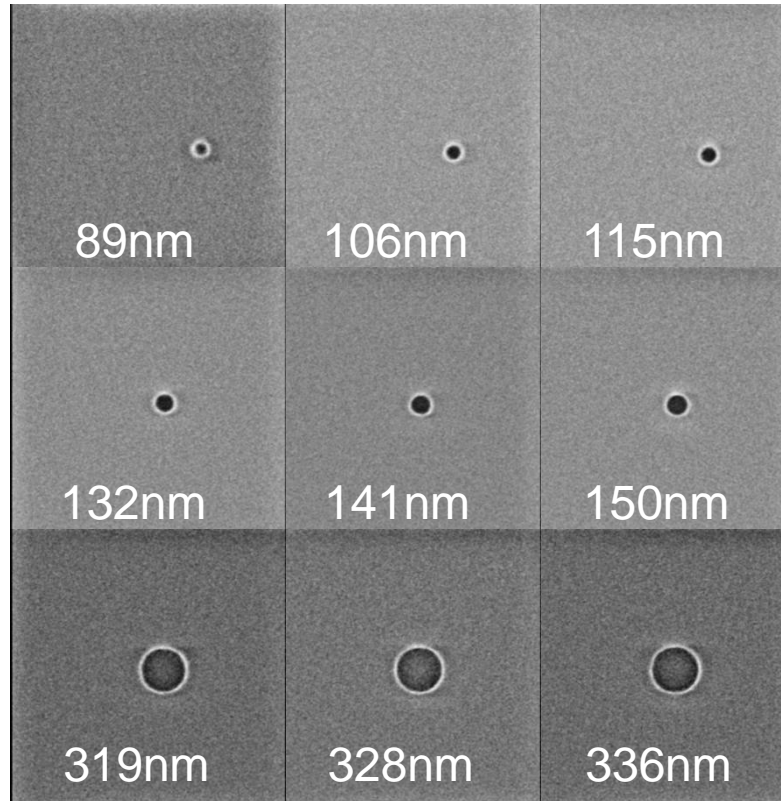
Shot Diameter = 334

Hole Diameter on mask (measured)

319nm

328nm

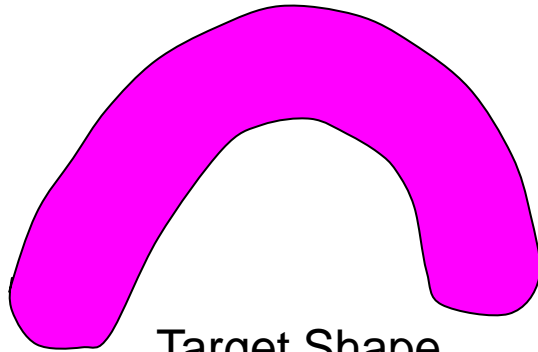
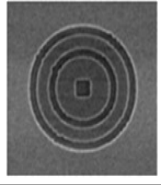
336nm



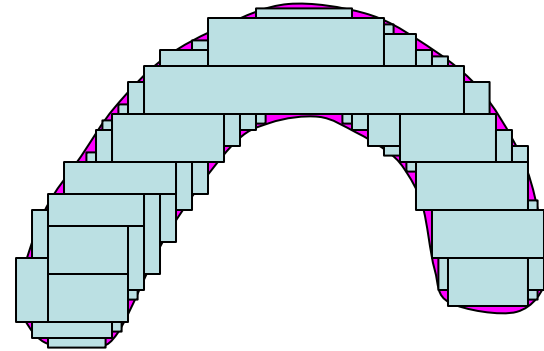
Courtesy JEOL, Ltd. More details at PMJ 2010

Patents pending, D2S, Inc.

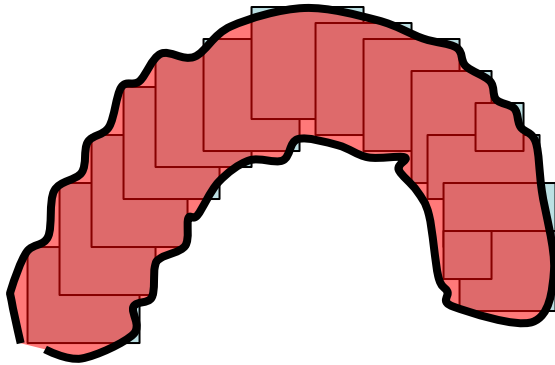
Overlapping Circles = Smooth Curvilinear Features with Fewer Shots



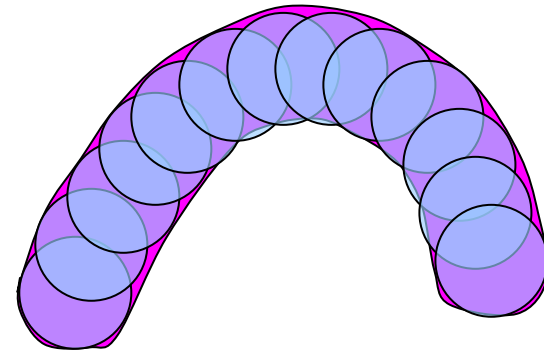
Target Shape



40 Conventional VSB Shots



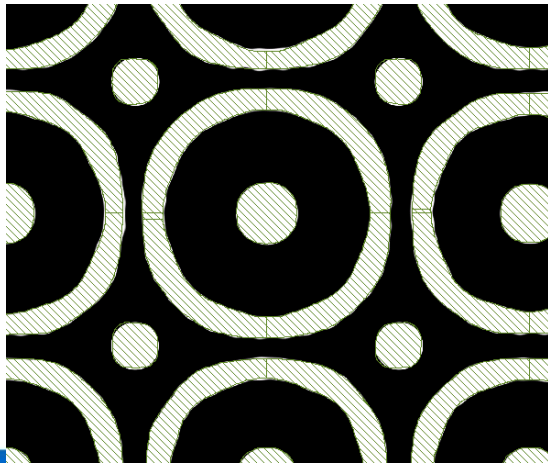
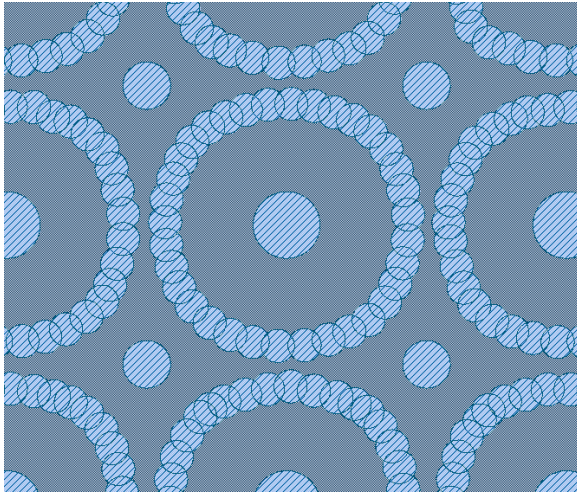
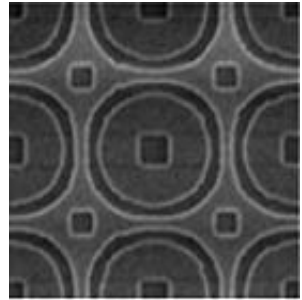
15 Overlapping VSB Shots



13 Overlapping Circles

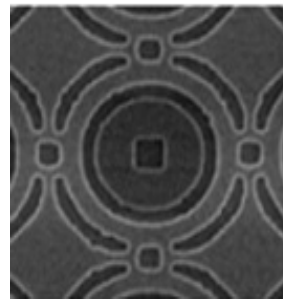
Overlapping Circles = Smooth Curvilinear Features with Fewer Shots

Target Shape

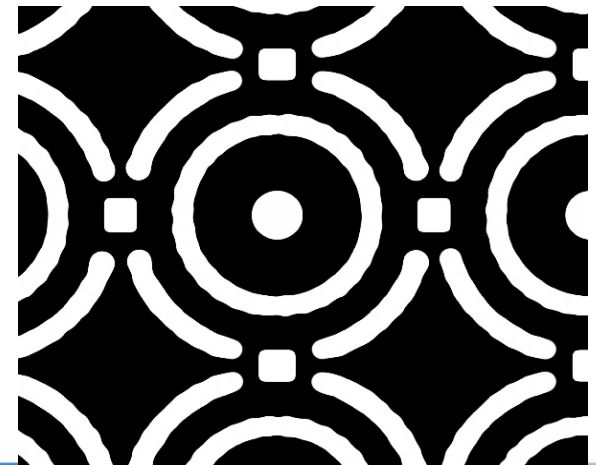
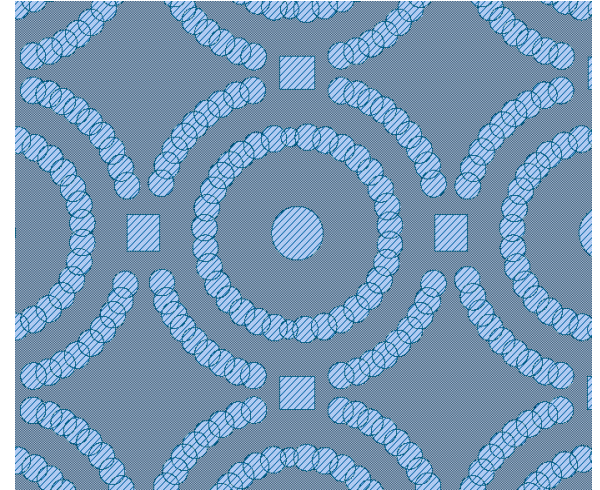


Shots Used

Target Shape



Simulated Mask Shape



Courtesy Luminescent, Inc.

Patents pending, D2S, Inc.

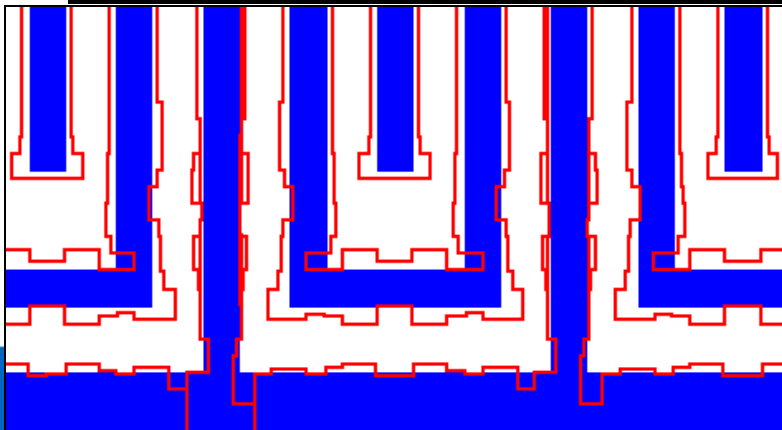
Toppan Viewpoint

Dr. Franklin Kalk
Executive Vice President and CTO – Toppan Photomasks, Inc.
Member – eBeam Initiative

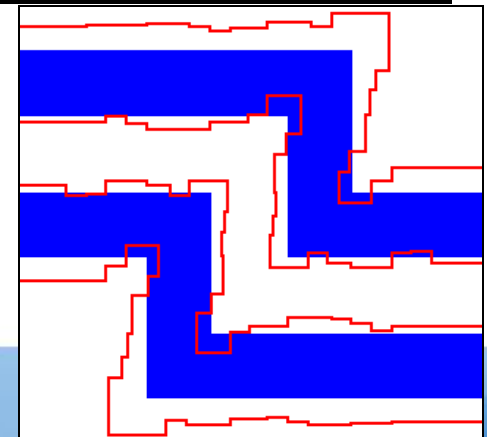
The 22-nm Challenge: Complex Mask Shapes Required



	Technology cycle							
	250nm	180nm	130nm	90nm	65nm	45nm	32nm	22nm
Circuit design					DFM-aware libraries			
					OPC guidelines			
Mask design	DRC		OPC rule-based		OPC model-based		DE	DE/SMO
			PSM, Dummy fill			Hotspot analysis		
Mask build	Tapeout							
				MRC	Auto-DNIR	Criticality review		
Wafer build	Fracture							
				Illumination optimization			DE	DE/SMO
	Design rules			Recommended rules				



Aggressive OPC increases e-beam shot count (penalty shown is >10x).



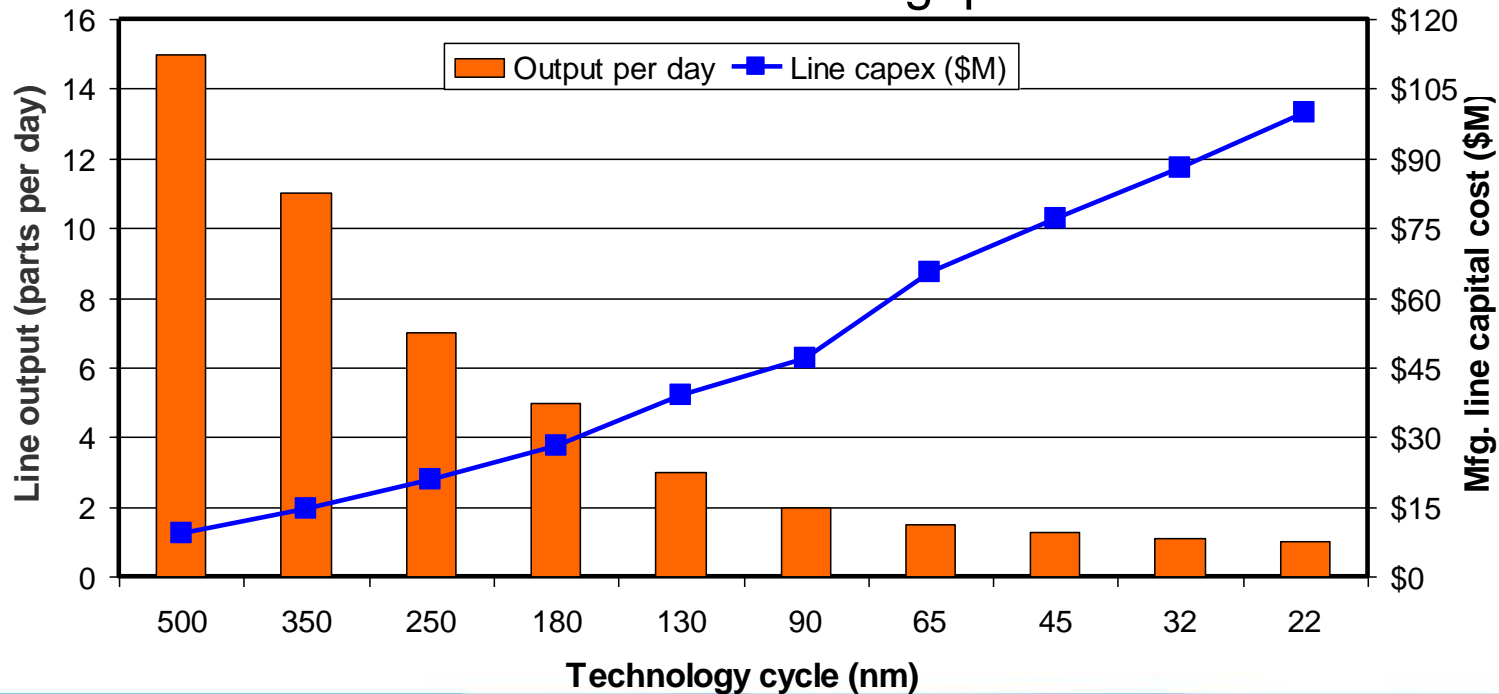
The 22-nm Challenge:



Complexity \Rightarrow Mask Write Time \Rightarrow Cost

- Complex features increase shot density and mask cost
- The forecasted per-mask capital cost at 22nm is ~\$60k

Mask Production Line Throughput and Cost



Merchant Mask Viewpoint

- EUV is likely to be too expensive for mainstream SoCs
- Extending 193i lithography is critical
- Critical layer masks should be written in 8-12 hours to be economically viable
- Mask write time for complex shapes is a critical issue

Circles and DFEB mask are good for merchant mask makers

Summary of Today's News



- eBeam Initiative grows to 27 members
- Design for E-Beam (DFEB) Mask Technology Launched
 - 22nm logic and beyond
 - High-volume applications
- PMJ papers to be presented in April by Initiative members



Beam
Initiative