Accelerating the next technology revolution

Sources of defects in EUV Mask blanks

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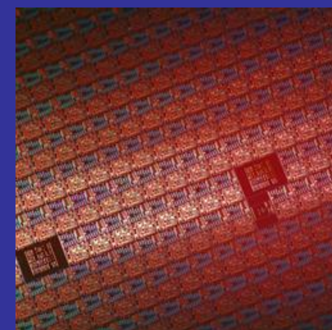

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Outline

- Defectivity overview
- Sources of defects and further reduction strategy
- Next generation tool

EUV Blank Defects: Sources

	Substrate Pits	Substrate Bumps	Particles on substrate	Deposition Particles within ML	Deposition particle on top	Pits/Particles on top of ML
Blank						
Substrate	ML Dep on Pit	Bumps on substrate	Particles on substrate	Embedded Particle due to deposition	Particles on top due to deposition	
	• CMP • Substrate cleaning	• CMP	• Substrate cleaning • Storage • Handling • Front end	• Shields • Target • Deposition	• Target • Deposition	• Front end • Handling • Blank cleaning • Storage

Defect trends by size

Defects/plate

Pits
Particles
Scratches

43-49 | 50-59 | 60-69 | 70-99 | 100-149 | 150-249 | 250-499

Defect Size (nm)

SEMATECH roadmap

	2011				2012				2013				2014			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Blank defects

Pilot start | HVM ramp | HVM start

SMT
- 1 defect > 150nm
- 27 defects < 150nm

Industry Need

Memory:
- 0: > 150 nm, 22 defects @ 50 < x <150 nm
- 0: > 100 nm, 22 defects @ 35 < x <100 nm
- 0: > 80 nm, 22 defects @ 35 < x <80 nm

Logic:
- 0: > 100 nm, 3 defects @ 50 < x <100 nm
- 0: > 75 nm, 3 defects @ 25 < x <75 nm
- 0: > 50 nm, 3 defects @ 15 < x <50 nm

Tool Capability

Inspection
- Available @50nm+ for substrate and blanks
- New tool needed: @25nm+
- Actinic needed

ML Dep.
- Veeco LDD1
- New tool needed YE 12

Cleans
- Current tools at blank suppliers

Current | Tool available | Need

Particle type defects: Position

Size distribution as measured by 1350

40
30
20
150 nm
10
0

On substrate
During deposition
On Top of ML

Killer defects

Major sources:

On substrate	During deposition	On Top of ML
C, substrate bumps, residual particles in FE	Shields, targets-Si	Targets-Ru, C, residual particle in FE

Particle type defects: Composition

Size distribution as measured by 1350

100
80
60
40
20
150 nm
0

SiOx Si SAB Ru C AlOx AlOx +SS SS Others

Killer defects

Defect counts per plate

2.5
2
1.5
1
0.5
0

SiOx Si SAB Ru C AlOx AlOx+SS SS Others

Source of defects- component breakup

- Handling
  - Front end practices, components (valves, seals, robots)
  - Residual level of particles in front end, transfer module and process module
  - Role of charging
- Ion beam and its hidden impacts
  - Beam as a source of particles
  - Divergence of beam causing defects on target
  - Scattered beam and divergence causing shield defects
- Shields
  - Cleaning/Coating processes for shields
  - Residual level of particles on shields after installation
  - Cracking or flaking of deposition
  - Sputtering of shields under ion beam/ plasma exposure
- Targets
  - Surface characteristics, sub surface damage, material properties

Ion beam, geometry and footprint

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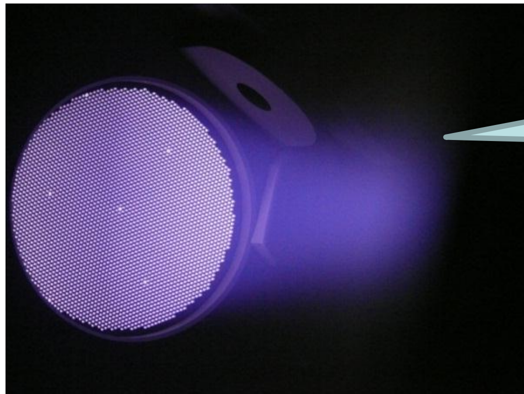
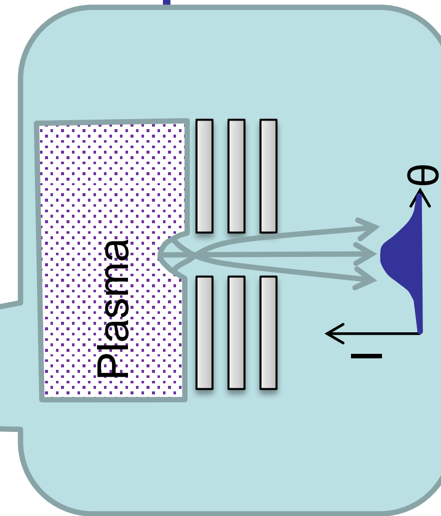
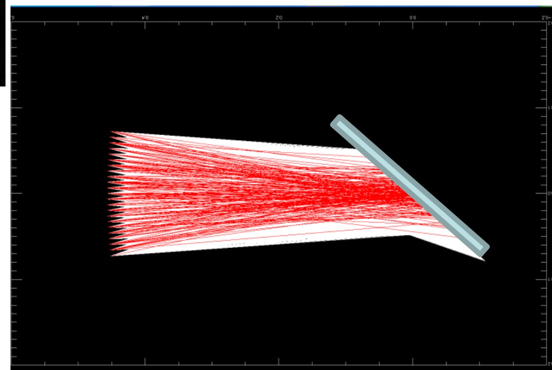
- Ion beam is extracted through many holes in the grids. each hole creates a beamlet, and the beamlets combine to form the whole beam.

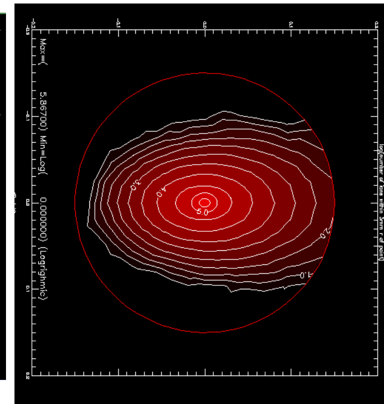




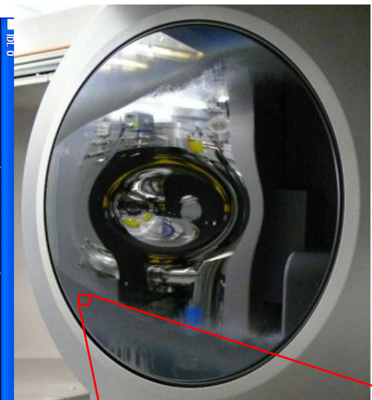
One beamlet

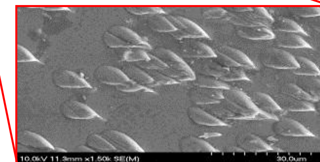


Many beamlets make one beam



Net effect of beam on target

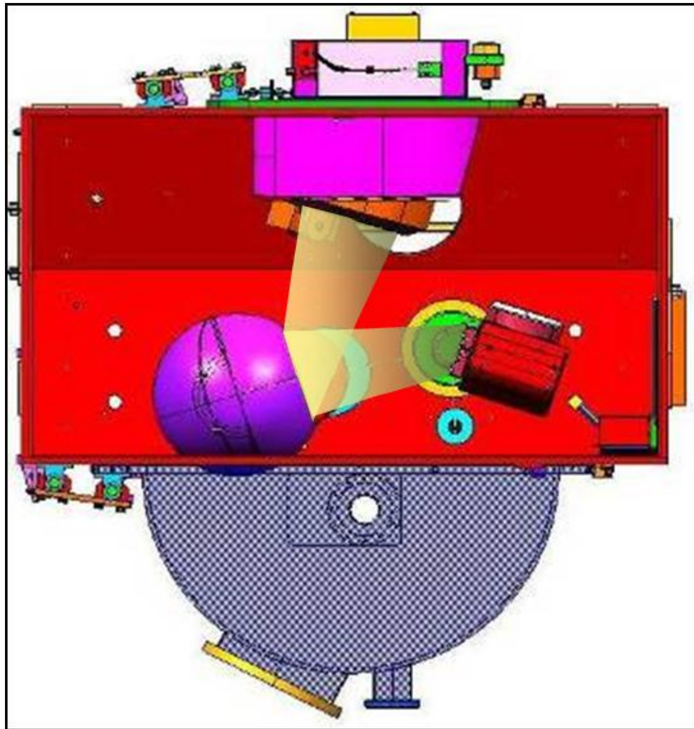




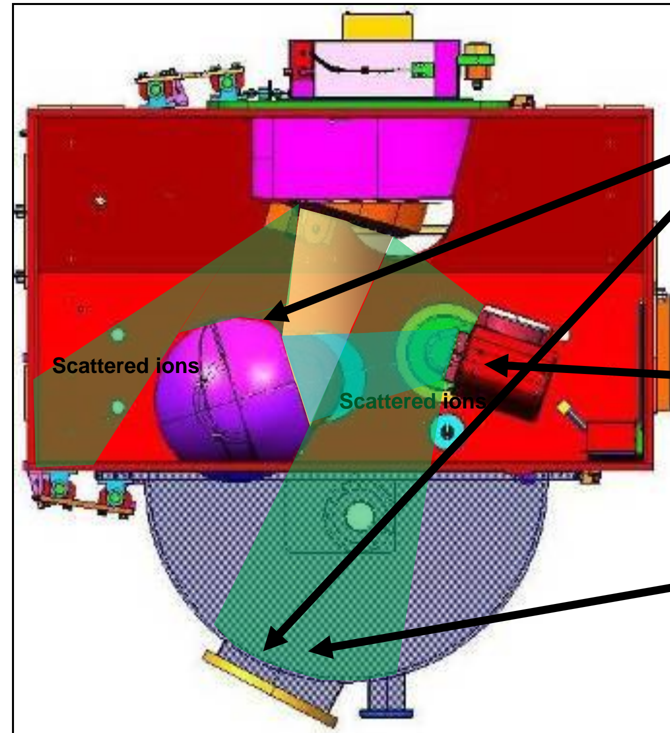
- Divergence of each beamlet is critical.

Overspray of Ion Source

Ideal Ion Beam Profile



Current Ion Beam Profile



- Divergence of the ion beam result in ions hitting shields

Limitations of current tool

- Source
  - Control of overspray of the target
- Front-end
  - Dual pod front-end is required solution
- Ru target
  - Density is ~94% of bulk, need to be closer to 98 to 99%
- Substrate position
  - Impacts deposition process window
- Shields
  - Too close to substrate
- Particle detection and transport
  - Down to 10 nm in vacuum with plasma conditions