MAKING A **MATERIAL** DIFFERENCE

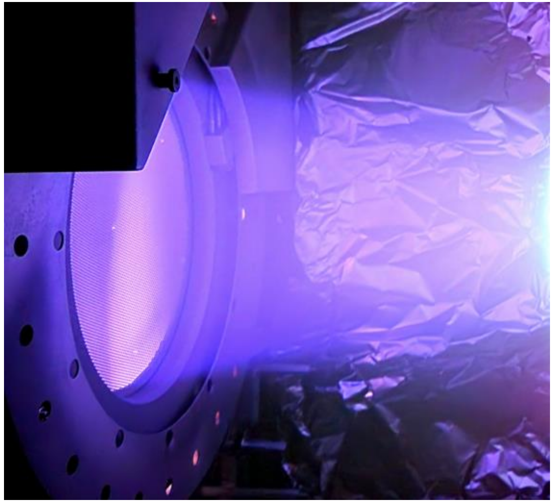
Veeco
Ion Beam Deposition Technology for EUV Photomask

Meng Lee

Session 2B

2022 EUVL Supplier Showcase

Ion Beam Deposition Technology



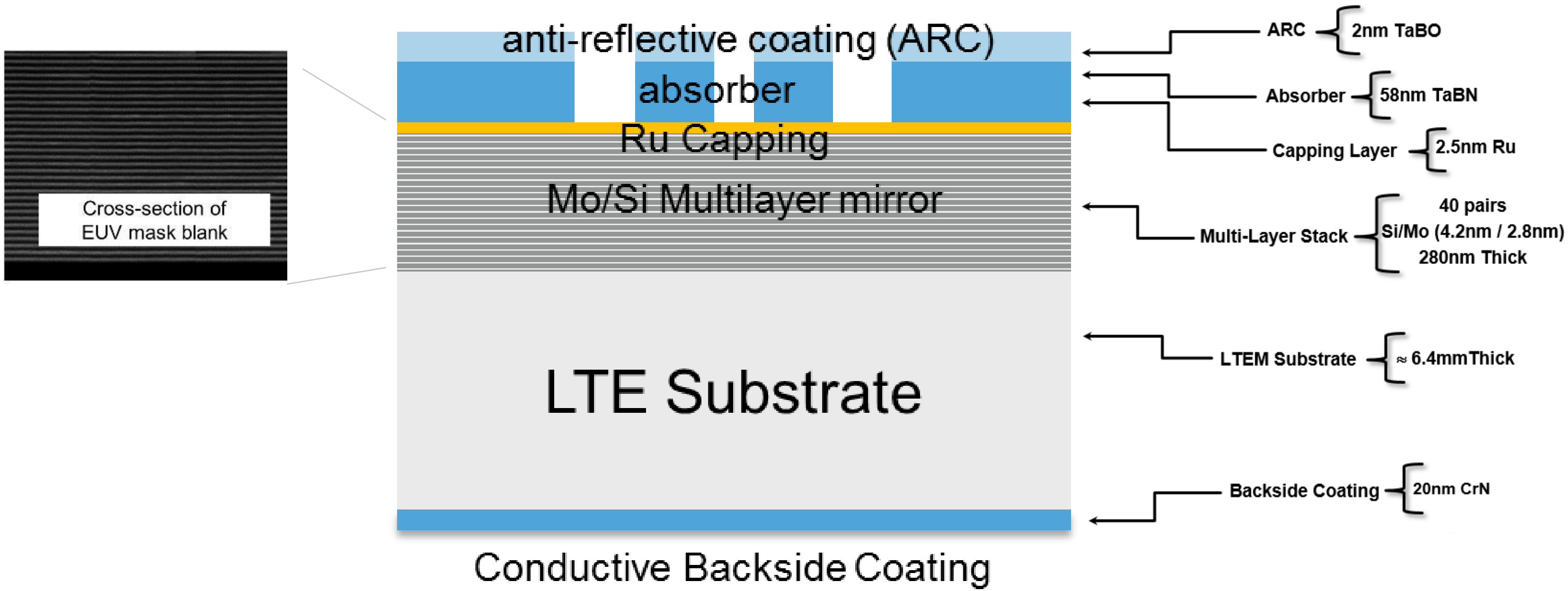
Method used to deposit highest quality thin film with tight control over film thickness and uniformity

Key Benefits

- Smooth surface quality
- Dense films
- Low scattering and optical losses
- Particle defect control
- Excellent uniformity
- Excellent process repeatability
- Maximum process flexibility
- Range of applications

Ion Beam Deposition (IBD): EUV Mask Blanks Use Case

Standard Structure of a EUV Mask Blanks



Cross-section of EUV mask blank

anti-reflective coating (ARC)

absorber

Ru Capping

Mo/Si Multilayer mirror

LTE Substrate

Conductive Backside Coating

ARC 2nm TaBO

Absorber 58nm TaBN

Capping Layer 2.5nm Ru

Multi-Layer Stack 40 pairs Si/Mo (4.2nm / 2.8nm) 280nm Thick

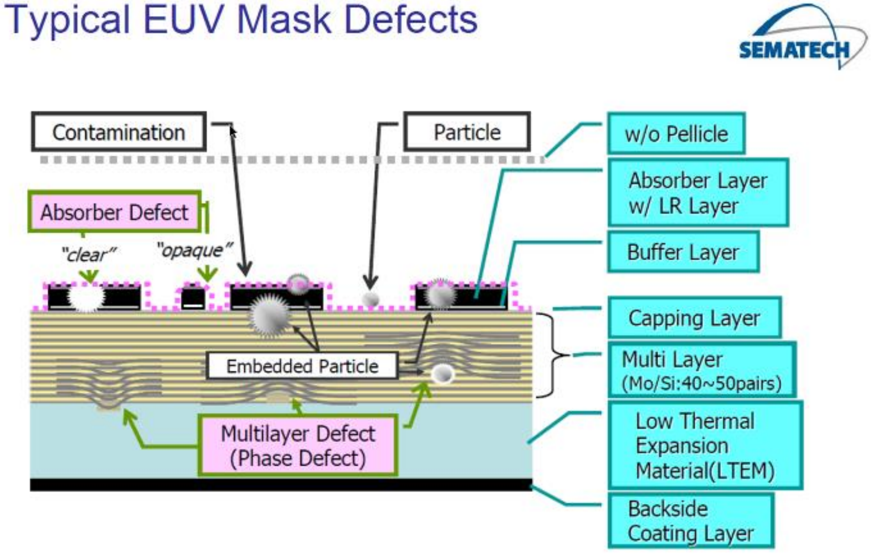
LTEM Substrate ≈ 6.4mmThick

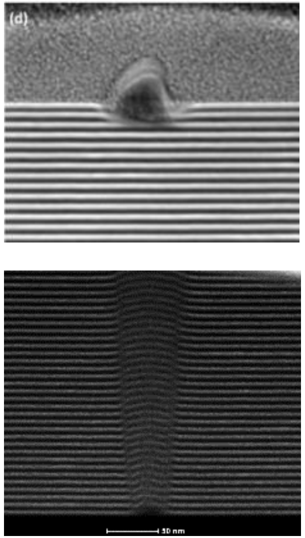
Backside Coating 20nm CrN

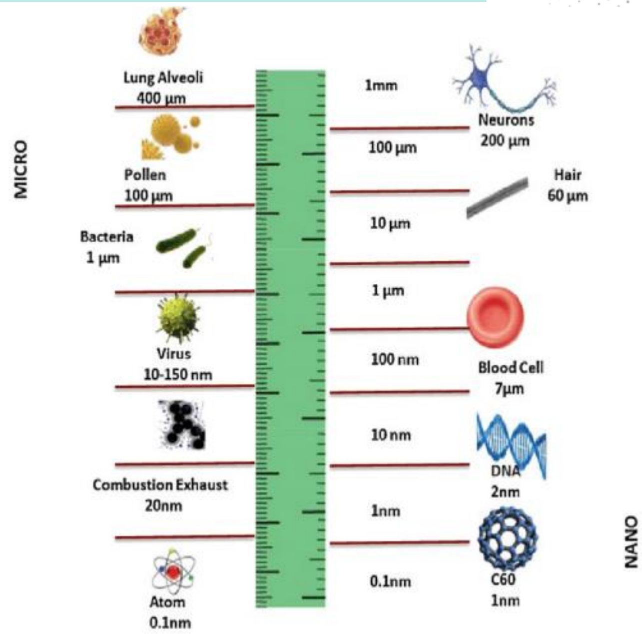
IBD is Used for Mo/Si ML and Ru Capping Deposition

Key Process Challenge – Particle Defects

Typical EUV Mask Defects







Ref: T. Kamo et al., Proc. of SPIE 7823

Particles on EUV mask cannot be greater than 50nm

Veeco’s >20 Years History of EUV Mask Blanks Deposition

Our Partners

S&S TECH

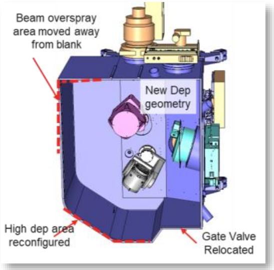
ASML

AGC HOYA

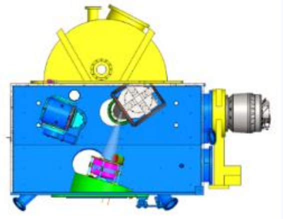
SEMATECH

Lawrence Livermore National Laboratory

2024 NEXT GEN HVM Platform

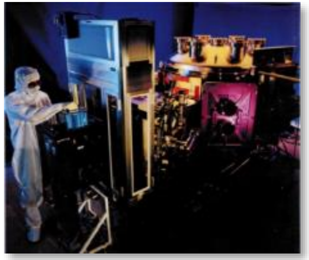


2023–2014 CIP/N+1 Upgrades



2010–2003 SEMATECH JD A/ System Optimization

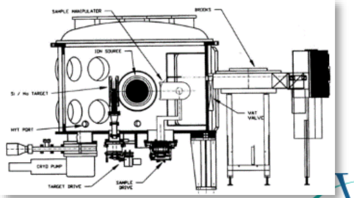
1999 New Source Configuration



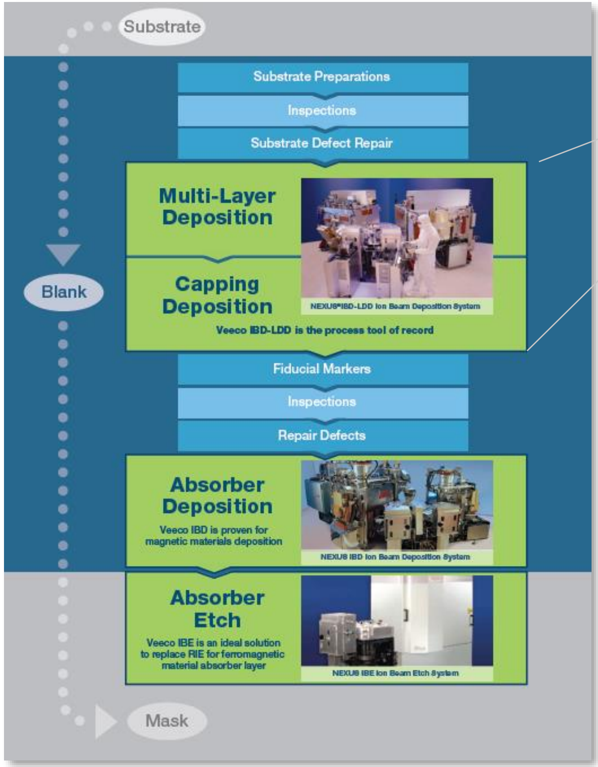
1997 LLNL RD 100 Award 1997

R&D Research & Development Award

1996 First EUV Multilayer R&D System



Veeco Involvement in EUV Mask Blanks Manufacturing



Substrate

Substrate Preparations

Inspections

Substrate Defect Repair

Multi-Layer Deposition

Capping Deposition

NEXUS®IBD-LDD Ion Beam Deposition System

Veeco IBD-LDD is the process tool of record

Blank

Fiducial Markers

Inspections

Repair Defects

Absorber Deposition

Veeco IBD is proven for magnetic materials deposition

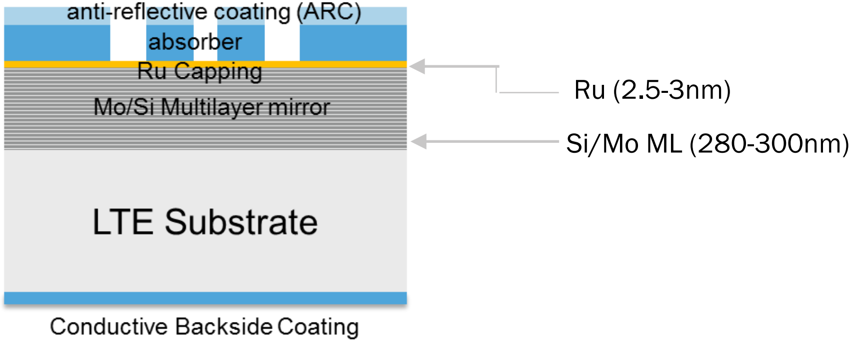
NEXUS IBD Ion Beam Deposition System

Absorber Etch

Veeco IBE is an ideal solution to replace RIE for ferromagnetic material absorber layer

NEXUS IBE Ion Beam Etch System

Mask



anti-reflective coating (ARC)

absorber

Ru Capping

Mo/Si Multilayer mirror

LTE Substrate

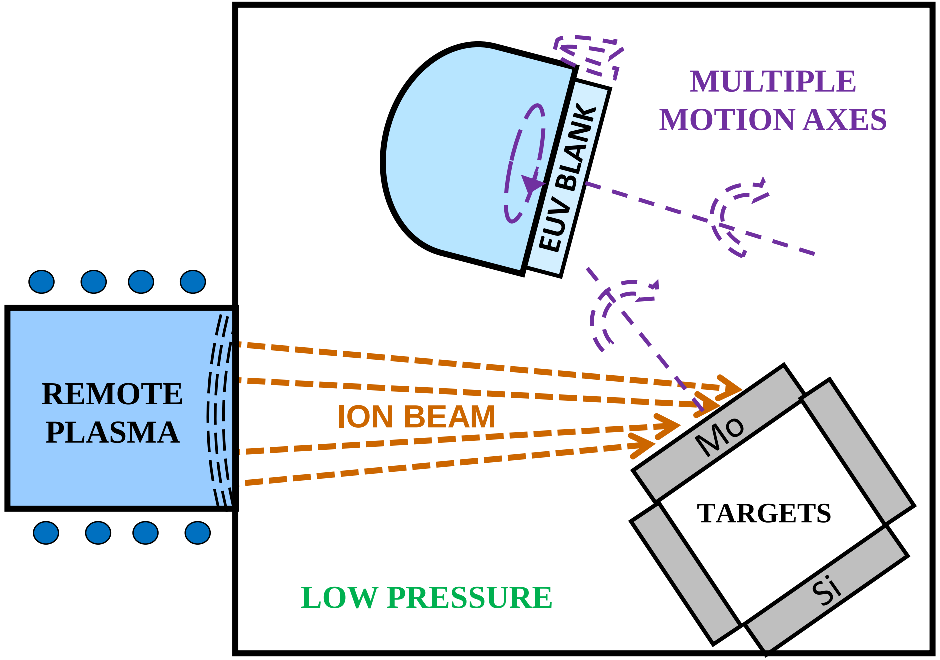
Conducive Backside Coating

Ru (2.5-3nm)

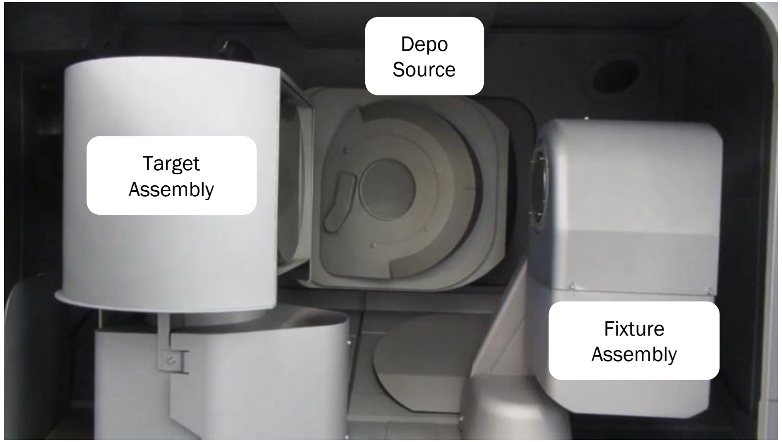
Si/Mo ML (280-300nm)

- IBD-LDD is the process tool of record for EUV mask blank’s Mo/Si layers and Ru capping deposition process
- Current IBD-LDD platform qualified for 5nm technology node
- Ongoing improvement efforts and roadmap are required to address 3nm and beyond technology node

Low-Defect-Density Ion Beam Deposition (IBD-LDD)



Ion Beam Deposition



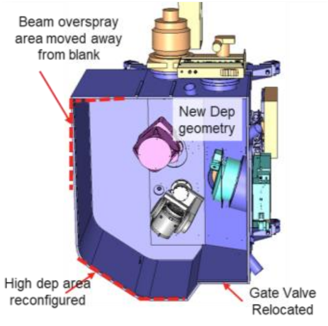
- All horizontal deposition
- Larger chamber / attention to shielding
- Target angle recipe driven
- Extra fixture tilt axis

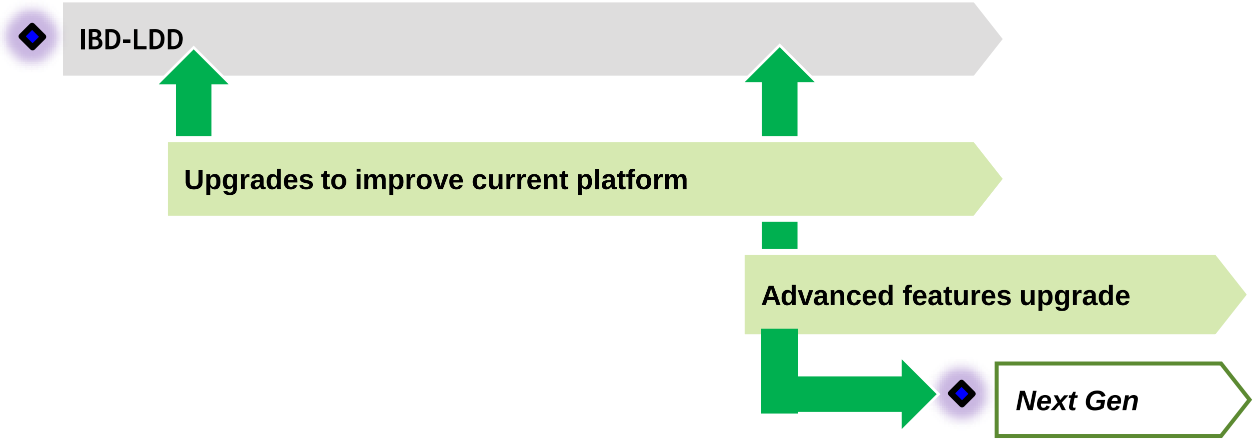
Advantages of Ion Beam Deposition for EUV Masks

Feature	Benefits	Performance
LOW DEPOSITION RATE	Less decoration of defects already present on substrate	**0 at > 50nm**
REMOTE PLASMA	Continuous plasma always-on	
	Substrate isolated from plasma particle generation	
LOW PRESSURE	Less defect decoration	
	Smoother Mo/Si Interfaces	**Reflectivity > 67%**
SINGLE-ENERGY ION BEAM	Control of intermixing at Mo/Si Interfaces	
	CWL Repeatability	**< 0.03 nm (0.2%)**
MULTIPLE MOTION AXES	CWL Uniformity	**< 0.03 nm (0.2%)**
	Material flexibility	**✓ Absorbers Ni, Co, Ru** **✓ Multilayers Ru/Si**

Veeco ML Deposition Product Roadmap

	2001 - 2019	2020	2021	2022	2023	2024 and Beyond
		N7		N5		N3



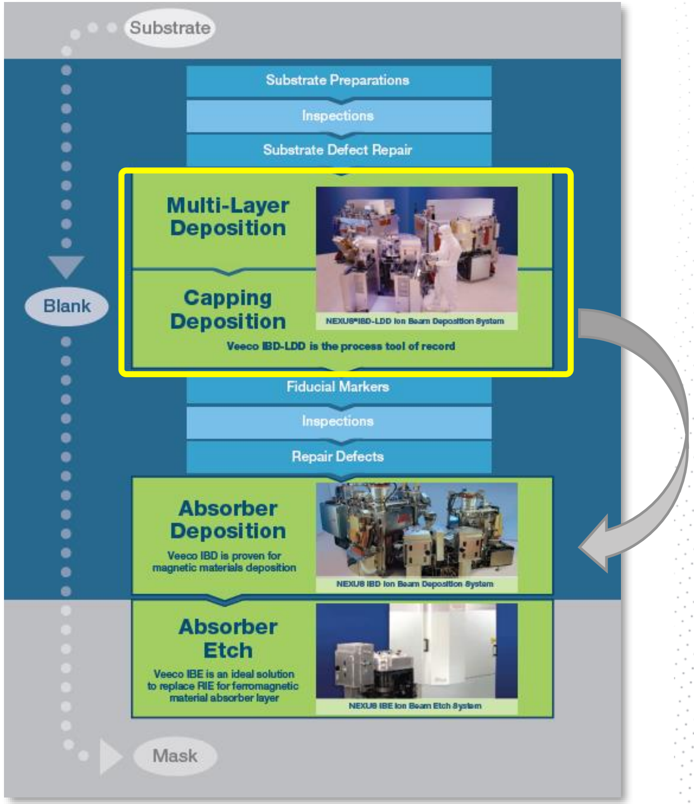


Driving strong roadmap to improve current platform along with next generation activities to support future advanced nodes

Summary

- Veeco Ion Beam Deposition Technology (IBD-LDD) plays an important role in EUVL market value chain
- IBD-LDD qualified for 5nm node
- Actively working on CIPs, N+1 and next generation platform to meet future node requirements
- Continue to leverage Veeco various technologies to study and improve process requirements
    - ○ DLC to for EUV mask blanks capping

EUVL 2022 Workshop Session 3 Paper #31:
Novel Diamond-Like-Carbon Capping Layer for EUV Masks by Antonio Cheeco



Veeco

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