PRODUCT OVERVIEW

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EUV TECH OVERVIEW

- Started in 1997, EUV Tech has pioneered the development of EUV metrology tools:
  - EUV Reflectometer
    - Measures the reflectivity and uniformity of multilayer coatings for EUV lithography mask blanks and absorbers
  - EUV Resist Outgassing Tool
    - Measures the contamination of optics from resist outgassing by using EUV (Extreme Ultraviolet) photon exposure, or alternatively by using electron beam (e-gun) exposure
  - Atomic Hydrogen Cleaner
    - Uses a high temperature filament to create reactive hydrogen radicals that interface with a contaminated sample, effectively "cleaning" the surface of the sample
  - EUV Light source
    - Standalone Laser Plasma High Brightness EUV light source. Light source is configurable to meet customer requirements

  - Other Products/Applications: EUV Photoresist Contrast Curve microtool, EUV Scatterometer

EUV REFLECTOMETER

EUV TECH REFLECTOMETER HIGHLIGHTS

- Installed at customer sites worldwide for over 14 years
- It can measure reflectivity and wavelength properties for the following samples:
  - EUV multilayer blank
  - EUV absorber
  - Post etch EUV masks
  - Black Border
  - Pellicles

EUV REFLECTOMETER – SIDE VIEW

CURRENT **GENERATION EUV REFLECTOMETER**

EUV Tech currently delivers it's 4th generation EUV Reflectometers

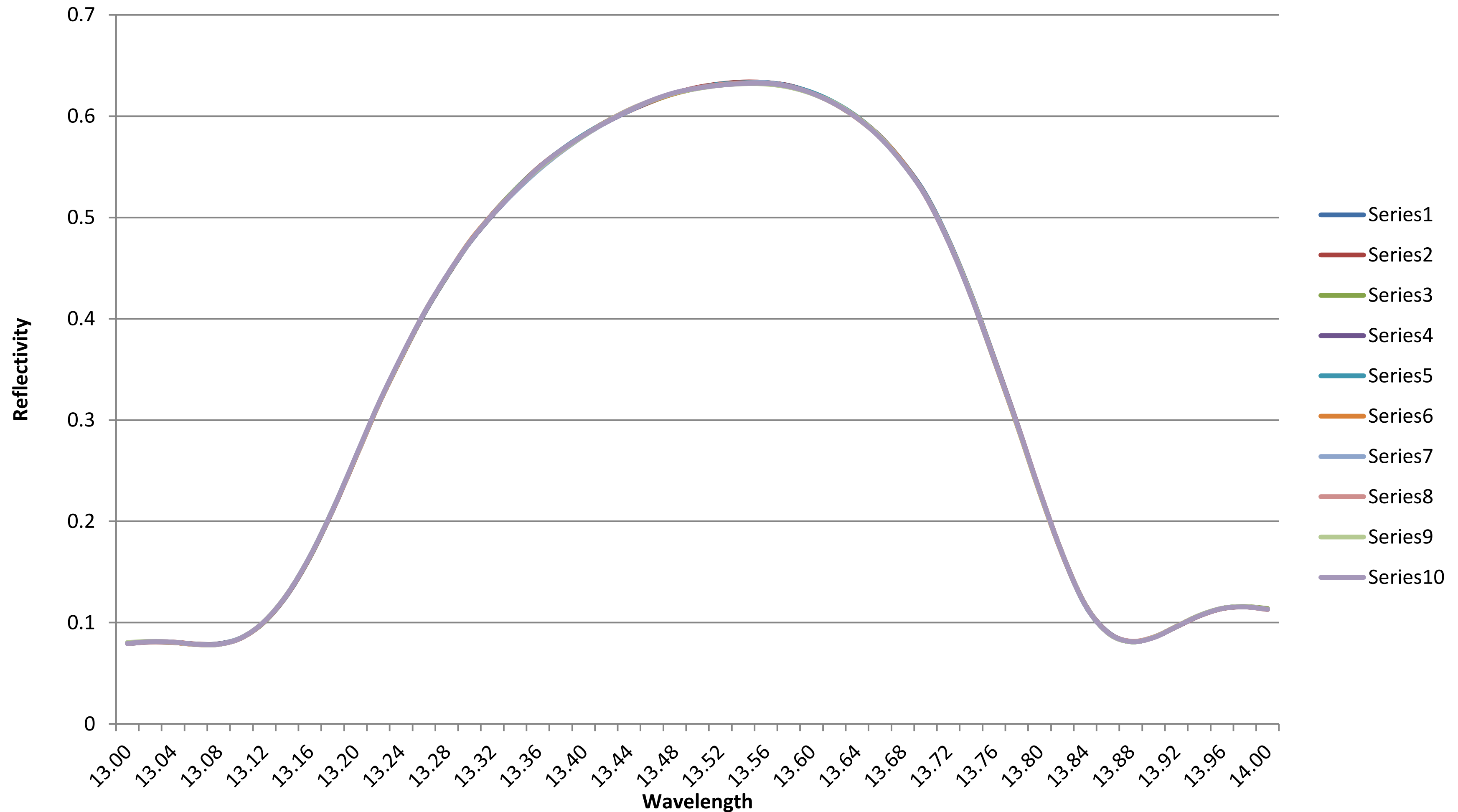
- Additional features of the 4th generation tools:
  - Improved measurement capabilities
  - Updated RSP200 opener
    - Optional Integrated Dual Pod/RSP200 reticle handling system
  - Continued reduction in spot size
  - Field upgradable features
    - Ability to change the angle of incidence from the current 6 degree measurement angle to any fixed angle between 5 and 10 degrees (Not tunable)
    - To the HVM design
    - To 6.x nm region

MEASUREMENT SPECIFICATIONS

- Specifications have evolved over time

Item	1st Gen SEMATECH (2004)	2nd Gen EIDEC (2009)	3rd Gen (2013/14)	4th Gen (2014/15)
EUV Peak Reflectivity Precision (Rp ~60% abs)	3σ <= 1.5%	3σ <= 0.7%	3σ <= 0.35%	3σ <= 0.30%
EUV Peak Reflectivity Accuracy (Rp ~60% abs)	<= 1.5%	<= 1.0%	<= 0.5%	<= 0.5%
EUV Peak Reflectivity Precision (Rp ~0.3% abs)	N/A	3σ <= 0.05%	3σ <= 0.02%	3σ <= 0.01%
EUV Peak Reflectivity Accuracy (Rp ~0.3% abs)	N/A	<= 0.1%	<= 0.08%	<= 0.07%
EUV Median Wavelength Precision	3σ <= 0.015nm	3σ <= 0.01nm	3σ <= 0.003nm	3σ <= 0.003nm
Average EUV Median Wavelength Accuracy	<= 0.015nm	<= 0.01nm	<= 0.008nm	<= 0.006nm
Spot Size (mm x mm)	5 x 5	3 x 3	2 x 2	1.8 x 1.8

CURRENT GENERATION MEASUREMENT



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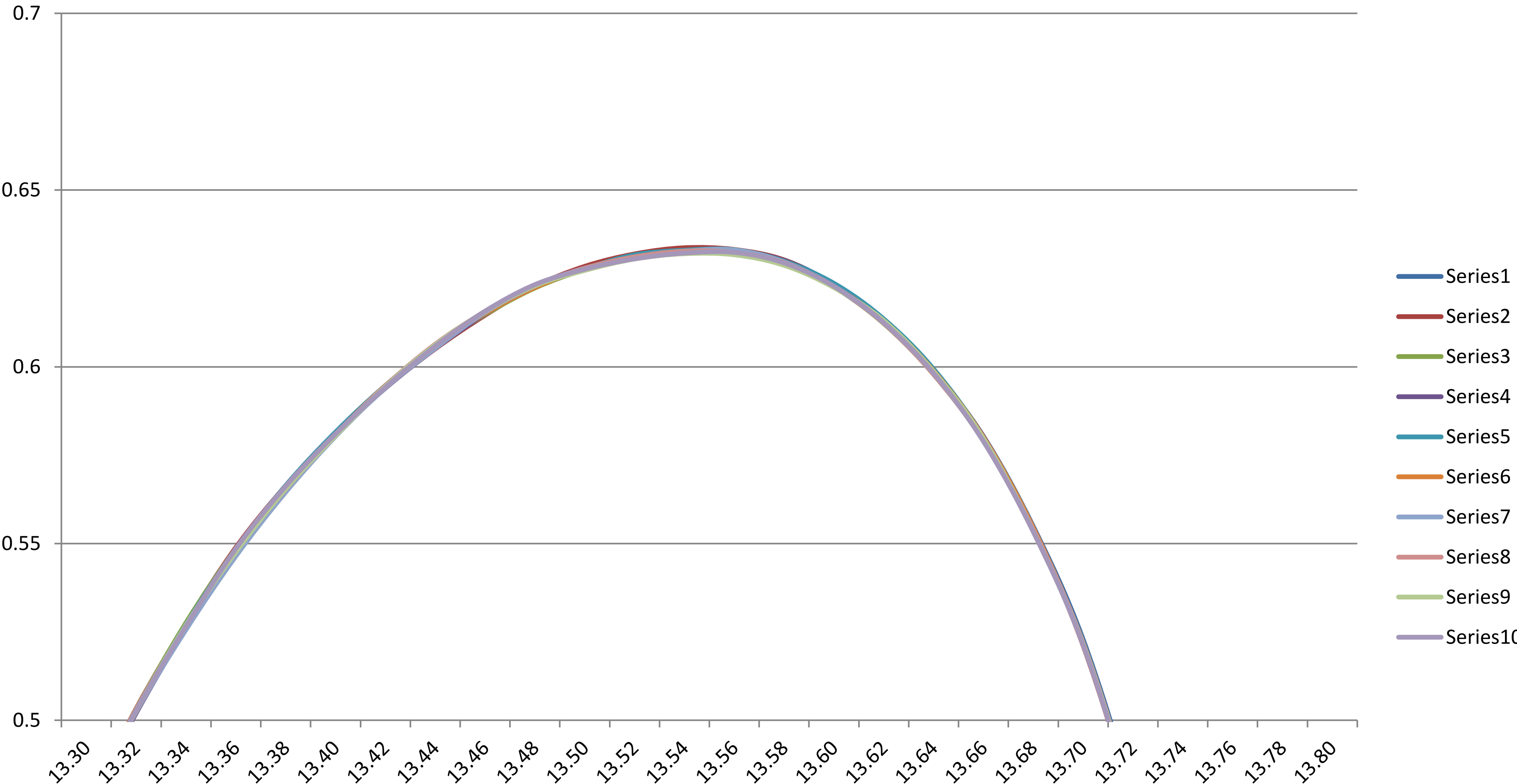
CURRENT GEN MAGNIFIED



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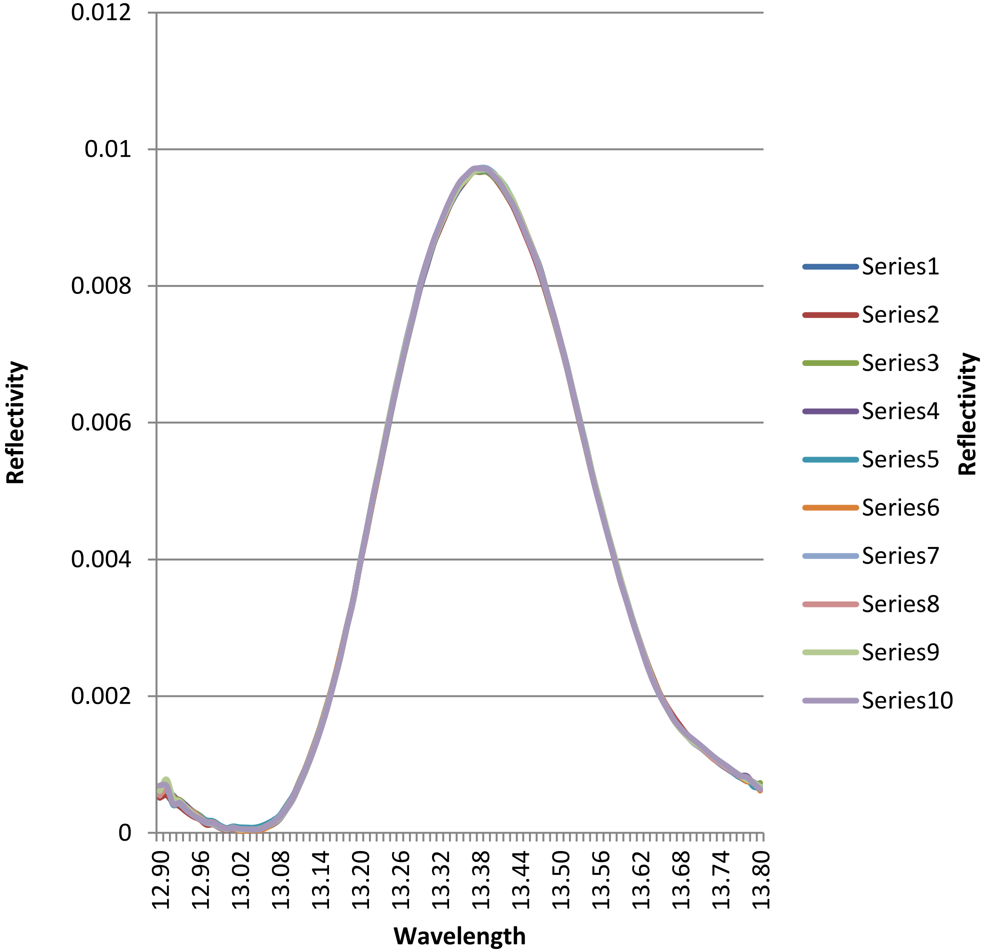
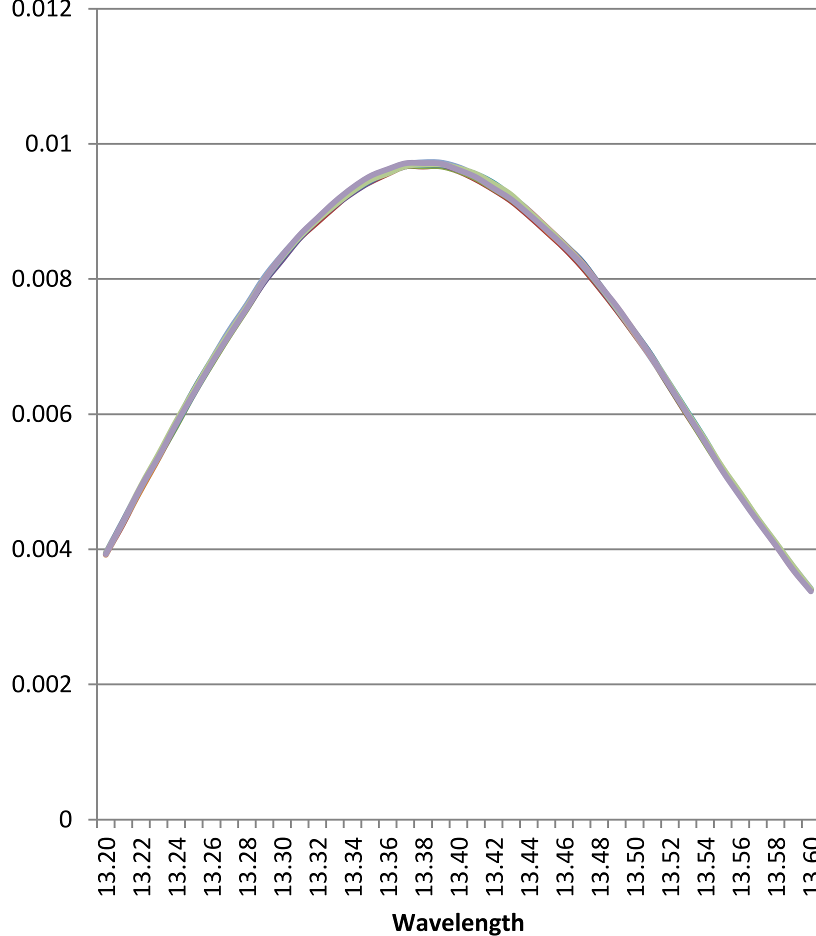
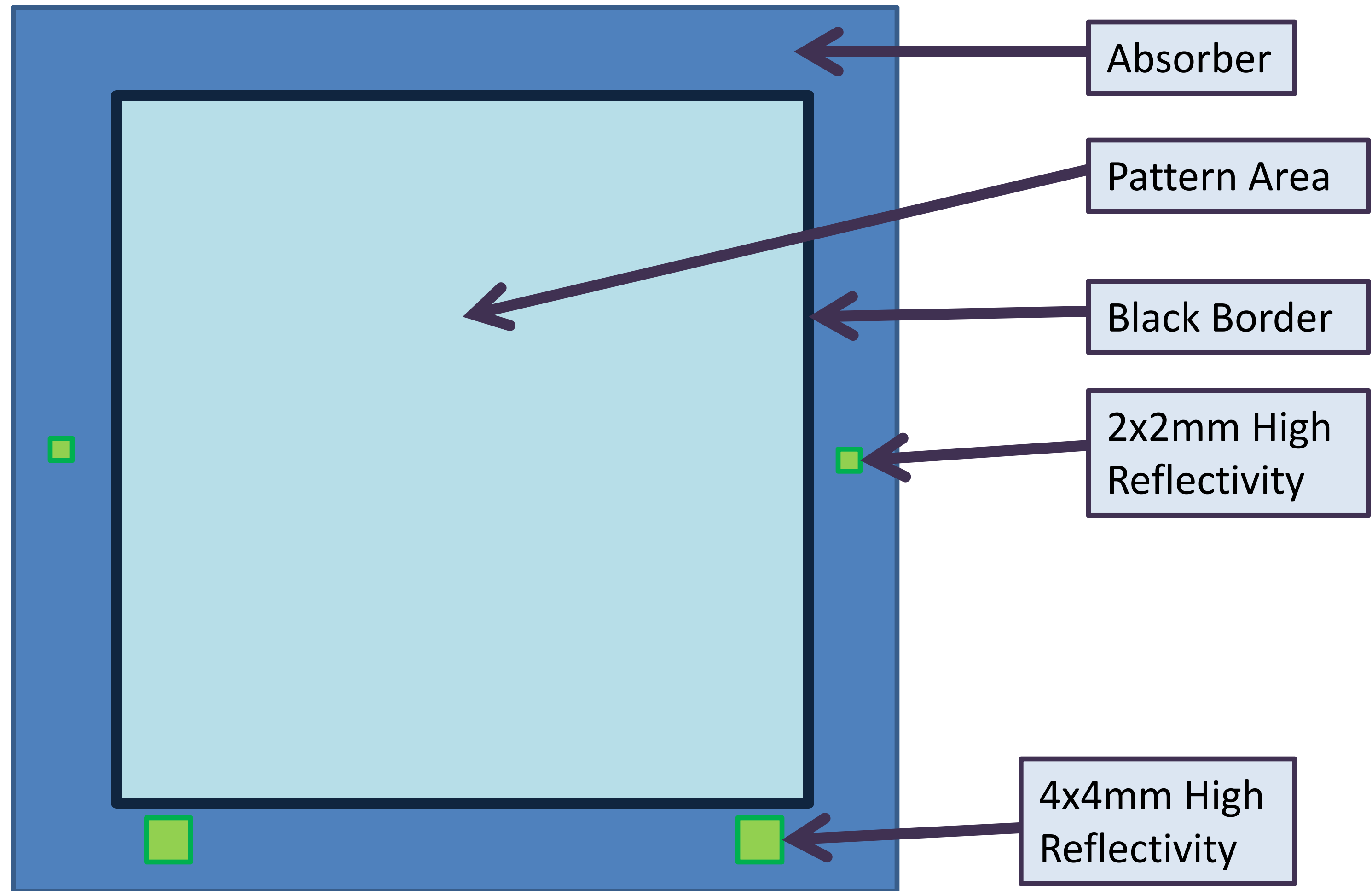
CURRENT GEN ABSORBER





CURRENT GENERATION MEASUREMENT

- Current generation tool can measure all areas of the mask



CURRENT GENERATION MEASUREMENT

Location	Peak Reflectivity (abs)	Peak Reflectivity Precision	Peak Wavelength (nm)	Peak Wavelength Precision (nm)
Absorber	1.49%	3σ = 0.009%	13.553	3σ = 0.0009%
Pattern Area	25.89%	3σ = 0.05%	13.556	3σ = 0.0009%
Black Border	0.035%	3σ = 0.0032%	N/A	N/A
2x2mm High Reflectivity Window	61.3%	3σ = 0.15%	13.554	3σ = 0.0006%
4x4mm High Reflectivity Window	61.3%	3σ = 0.10%	13.553	3σ = 0.0006%

HVM REFLECTOMETER

HVM EUV REFLECTOMETER

- In Q3 2015 EUV Tech will complete installation of it's first HVM Reflectometer at a customer site
- HVM Tool is characterized by:
  - Higher throughput
  - Compliance with specific customer particulate adder per pass specifications
  - Absolute reflectivity and wavelength calibration
  - Further Improved measurement capabilities
    - Currently there is standalone tool or synchrotron in the world will match the measurement and cleaniliness capabilities of this tool

SPECIFICATIONS

Item	HVM (2015)
EUV Peak Reflectivity Precision (Rp ~60% abs)	3σ <= 0.07%
EUV Peak Reflectivity Accuracy (Rp ~60% abs)	<= 0.20%
EUV Peak Reflectivity Precision (Rp ~0.5% abs)	3σ <= 0.009%
EUV Peak Reflectivity Accuracy (Rp ~0.5% abs)	<= 0.05%
EUV Median Wavelength Precision	3σ <= 0.002nm
Average EUV Median Wavelength Accuracy	<= 0.005nm

ADDITIONAL SPECIFICATIONS

Item	HVM (2015)
Spot Size	1mm x 1mm
Throughput based on 10 measurement sites (excluding load/unload)	3 masks/hour
Absolute (internal) reflectivity and wavelength calibration	yes
Capability to find pattern location to be measured using fiducials	yes
SEMI S2/S8 and SEMI F47 Certified	yes
Supports messages required by SEMI E5-0706 for SECS-II implementation.	yes

OPTIONAL FEATURES

- Customer specified particulate adder per pass requirements
- Integrated Dual Pod/RSP2000 reticle handling system
- Multi process chamber cluster tool for higher throughput requirements
- SEMI compliant process chamber interface valve with customers existing cluster tool

DELIVERY

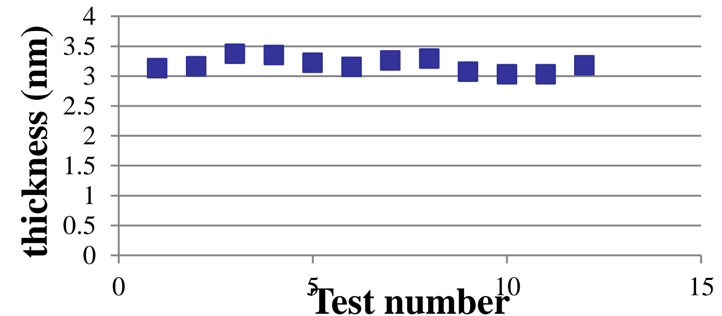
- 4th generation tool
  - Current lead time is 10-14 months ARO for a standard design
  - Tool will meet current requirements until HVM processing comes online

- HVM Tool
  - Current lead time is 30-36 months ARO

RESIST OUTGAS TESTING

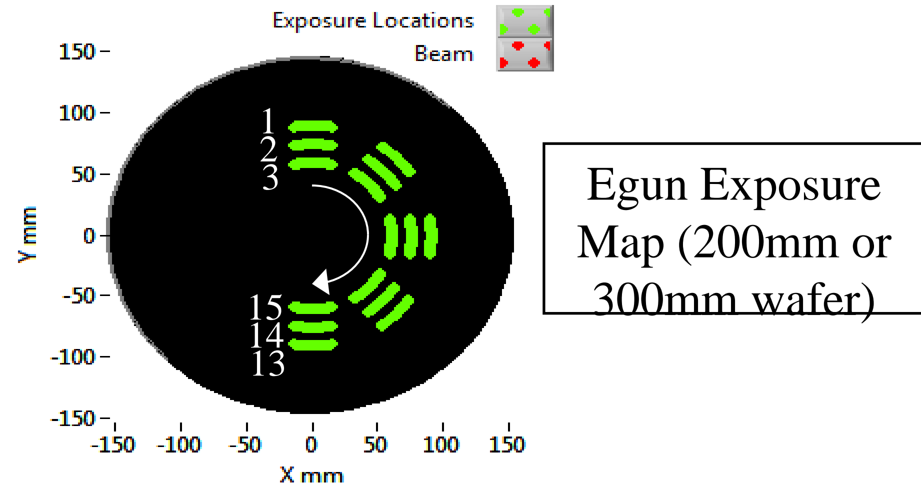
EUV RESIST OUTGASSING TOOL

- Measures the contamination of optics from resist outgassing by using EUV (Extreme Ultraviolet) photon exposure, or alternatively by using electron beam (e-gun) exposure
- EUV Tech has successfully delivered 3 resist out-gassing tools.
- Two tools have been ASML certified
  - Third tool is in the certification process
- High throughput tool – capable of measuring over 1000 samples/year

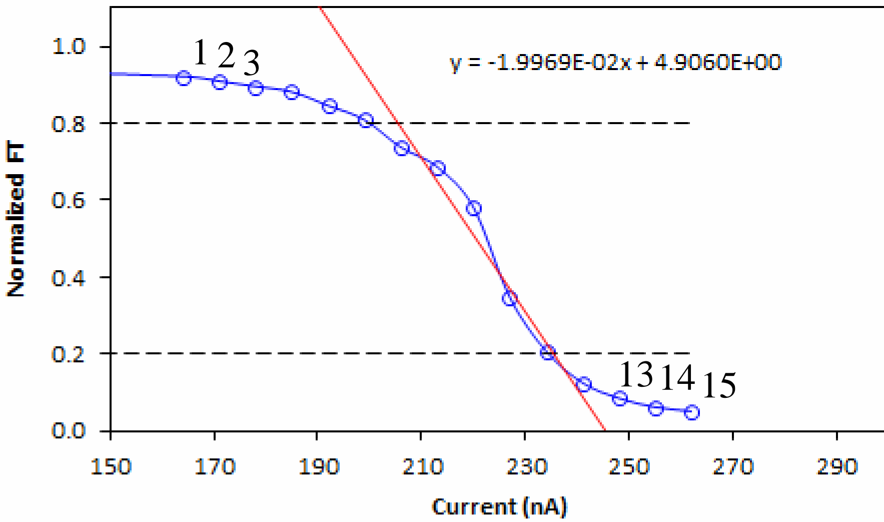


CONTRAST CURVE - EGUN

- Baseline EUV Resist (chemically amplified, positive tone)
- Exposure Time Duration: 15-20 min
- Wafer Thickness Measurement: Ellipsometry (Automated XY Mapping)

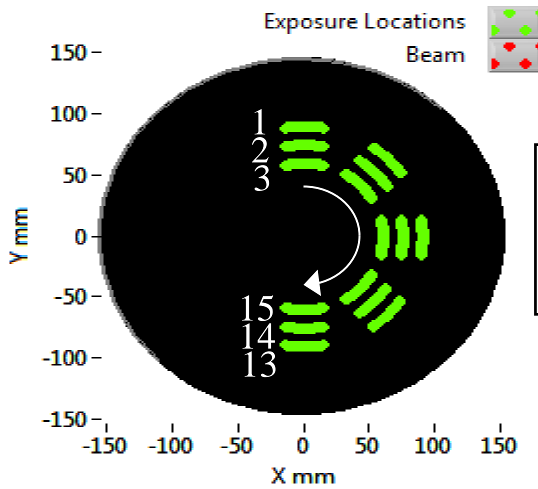


Egun D2C= 245.7nA

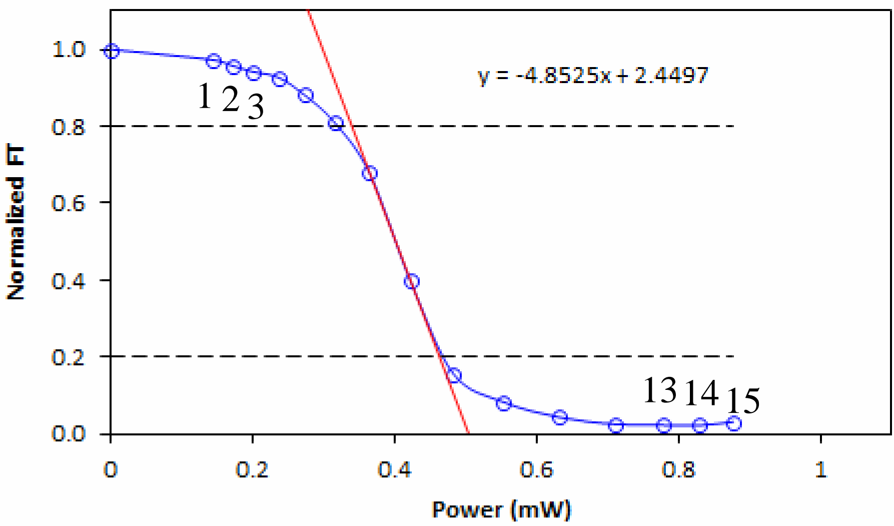


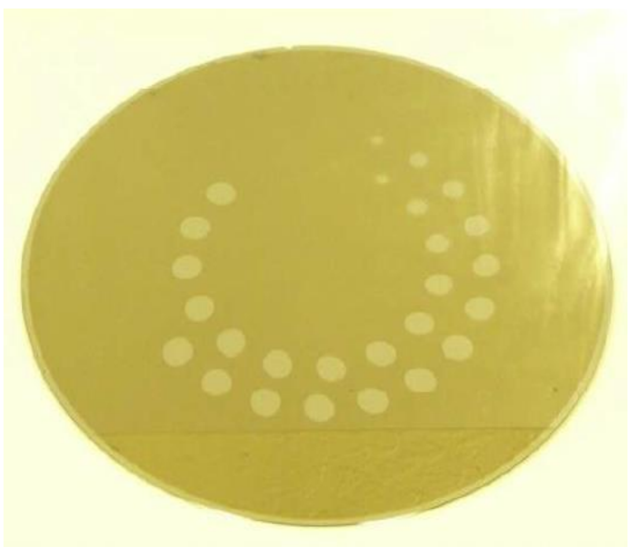
CONTRAST CURVE - EUV

- Baseline EUV Resist (chemically amplified, positive tone)
- Exposure Time Duration: 15-20 min
- Wafer Thickness Measurement: Ellipsometry (Automated XY Mapping)



EUV Exposure Map (200mm or 300mm wafer)

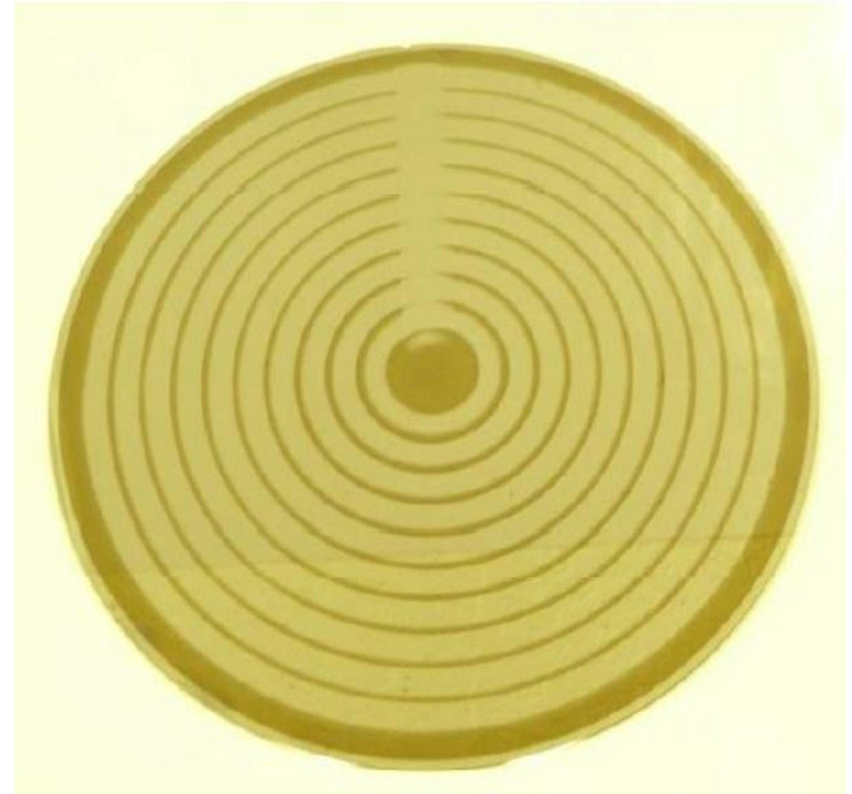




CONTINUOUS EXPOSURE

EUV Exposure

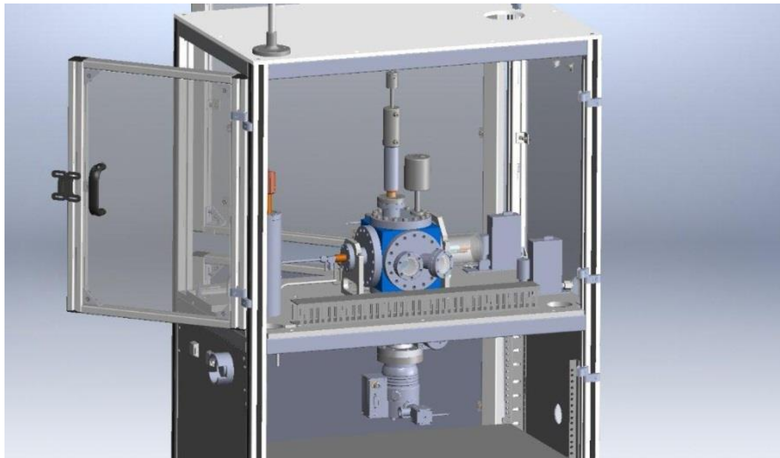
E-Gun Exposure

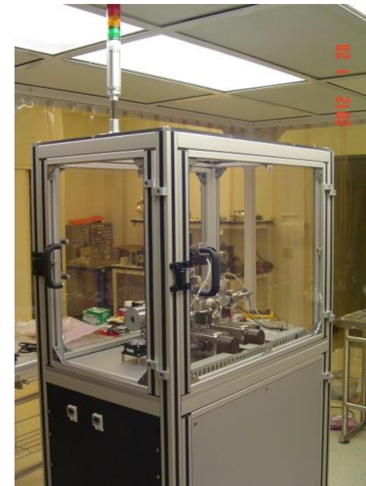


Exposure 80% of 200 mm wafer in 30 mins

EUV HYDROGEN RADICAL CLEANER

- Streamlined witness sample transfer process between resist outgassing tool and hydrogen cleaner
- Cleaning rate ~ 3 nm/hour
- Small footprint 36” x 24”
- Controlled and interlocked N2 and H2 flow





ROADMAP

EUV TECH ROAD MAP

- EUV Resist Exposure Tool (Q1 2015)
  - Generate contrast curves: ~ 1mm spot size
  - For transmission FTIR measurements: ~5mm x 5mm
  - For other analytic techniques: ~10mm x 10mm
- Stand-alone EUV Scatterometer (Q3 2015)
  - For high accuracy characterization of mask roughness
- HVM Reflectometer (Q3 2015)
  - High precision.
  - Absolute (internal) reflectivity and wavelength calibration.
  - Capability to find pattern location to be measured using fiducials

THANK YOU!