

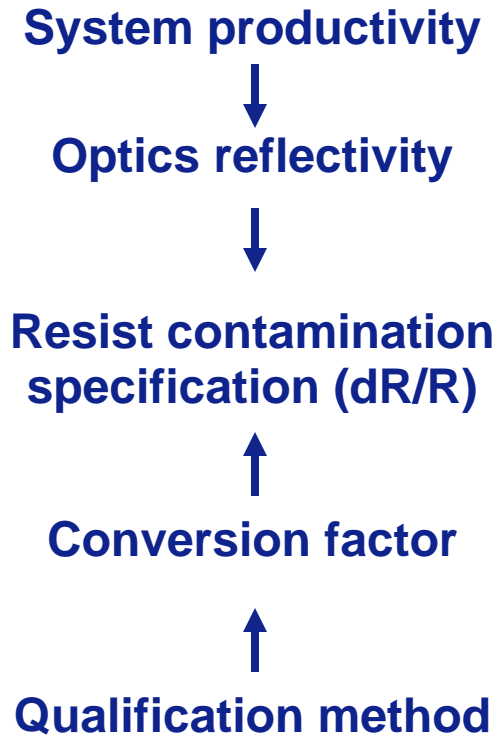


# ASML

**Resist Outgas Testing  
IEUVI TWG**

17 October 2010

# Resist outgas qualification is tied to NXE system performance



- System level performance requires that the mirrors maintain high reflectivity
- Resist outgas, if not managed, could reduce mirror reflectivity
- Outgas requirements have been set to maintain the system performance over > 5 years of expected use
- NXE specification has been correlated to mirror reflectivity
  - $\leq 2\%$  cleanable (carbon);
  - $\leq 0.16\%$  non-cleanable
- Contamination growth has been correlated to dR/R

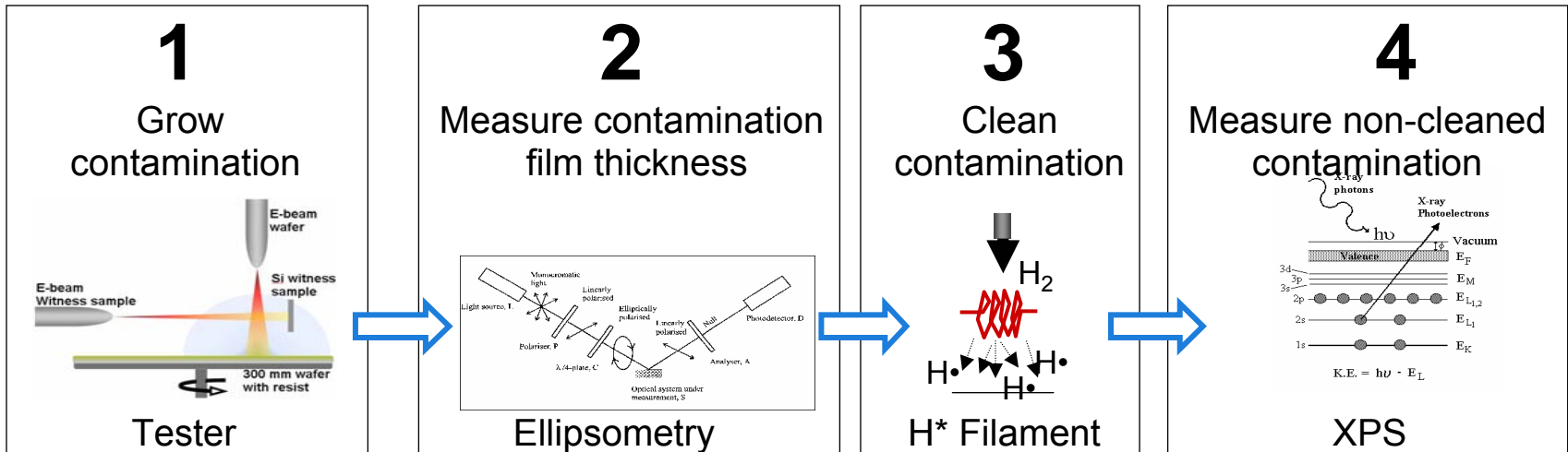
# There are key system specifications for resist outgas testing that must be met

- Grease free scanning wafer stage to accommodate a 300 mm wafer and exposure of a full wafer surface
- The system must be equipped with e-beam exposing the witness sample (WS)
  - Cannot get to high enough WS intensity with photons
  - Photons or electrons can be used for the wafer exposure though electrons are more efficient
- The wafer stage and witness sample holder positioned so that primary electrons from either surface will not reach the other
- Cleaning of sample with H radicals is needed and can be part of the tester (best for productivity) or stand-alone
- Ultra clean vacuum required, which is more important than ultra high vacuum
  - Load locks are important to achieve this
- Pumping speed:  $\leq 265$  l/s

| Component                               | Pressure in mbar       |
|---|------------------------|
| N <sub>2</sub>                          | $< 1.0 \cdot 10^{-7}$  |
| O <sub>2</sub>                          | $< 5.0 \cdot 10^{-8}$  |
| H <sub>2</sub> O                        | $< 1.0 \cdot 10^{-7}$  |
| C <sub>x</sub> H <sub>y</sub> (45-100)  | $< 1.0 \cdot 10^{-10}$ |
| C <sub>x</sub> H <sub>y</sub> (101-200) | $< 5.0 \cdot 10^{-11}$ |
| p <sub>total</sub>                      | $< 1.5 \cdot 10^{-7}$  |



# Qualification procedure has four main steps



Besides the resist outgas tester and cleaner the following is needed:

- Resist exposures: Coat and development facilities for 300mm  
Wafers with resist thicknesses <100nms
- Quantification cleanable contamination: ellipsometry
- Quantification non-cleanable contamination: XPS

Note: ToF-SIMS is not needed as XPS is sensitive enough

# Metrology specifications have been defined

## Ellipsometry:

- Measurements on 1" witness samples and 12" wafers
- 2D spectral ellipsometry (preferred wavelength range 300-900nm)
- 150  $\mu\text{m}$  spot size
- 150  $\mu\text{m}$  raster on a 5 x 5  $\text{mm}^2$  area
- Detection limit/accuracy 0.1nm/ $\pm$ 0.1nm

## XPS

- Measurements on 1" witness samples
- Accuracy / detection limit 0.1 %<sub>at</sub>
- Monochromatic Al K <sub>$\alpha$</sub>  radiation source
- Spot size 125  $\mu\text{m}$  x 125  $\mu\text{m}$  or smaller

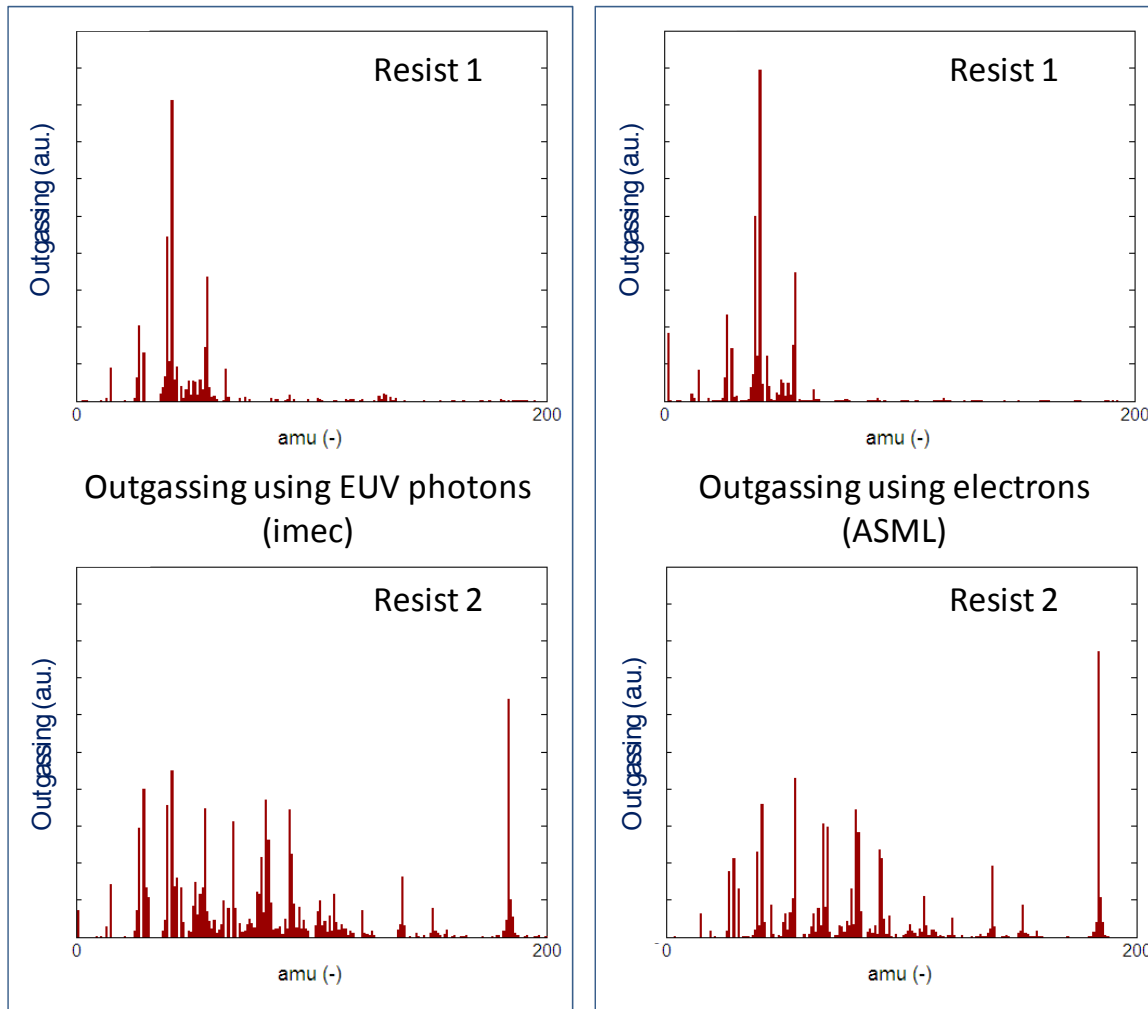


# Summary

- To retain scanner optics reflectivity, resist outgas must be managed
- Resist outgas testing with witness sample is needed to confirm compliance with specs
  - Tester needs to be ultra-clean
  - Electrons or electrons + photons are needed for exposure
  - Ellipsometry + XPS is needed for contamination thickness and material content measurements
- Witness sample resist outgas test capability is needed now to support resist optimization for use for early production EUVL

# Backup

# Resist outgassing from photons and electrons is similar



**Fingerprints  
show good  
resemblance**

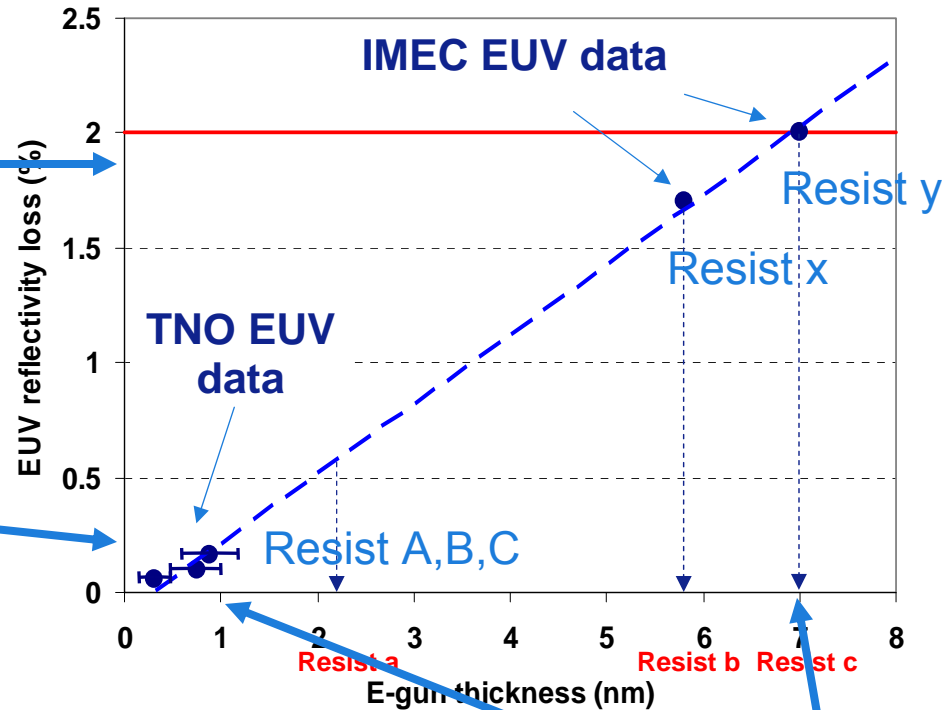
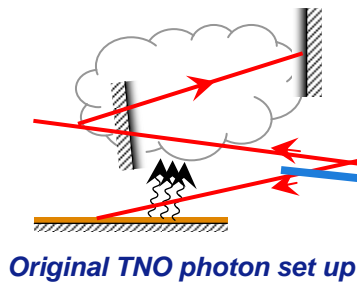
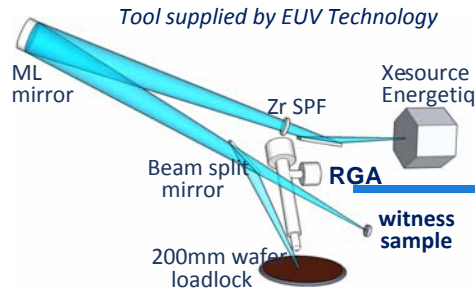
**Spie 7636-69**



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# E-gun grown contamination has been correlated to EUVL grown contamination



Resists tested with 2 procedures:  
 EUV and e-beam  
 Different resists tested to obtain full range

