

US/SEMATECH EUV Resist Update

Project Overviews

➤ Lawrence Berkeley National Labs

- In operation until February 2006

➤ Albany MET Resist Test Center

- Open to customers
- Contact Klaus Lowack for scheduling (klaus.lowack@sematech.org)

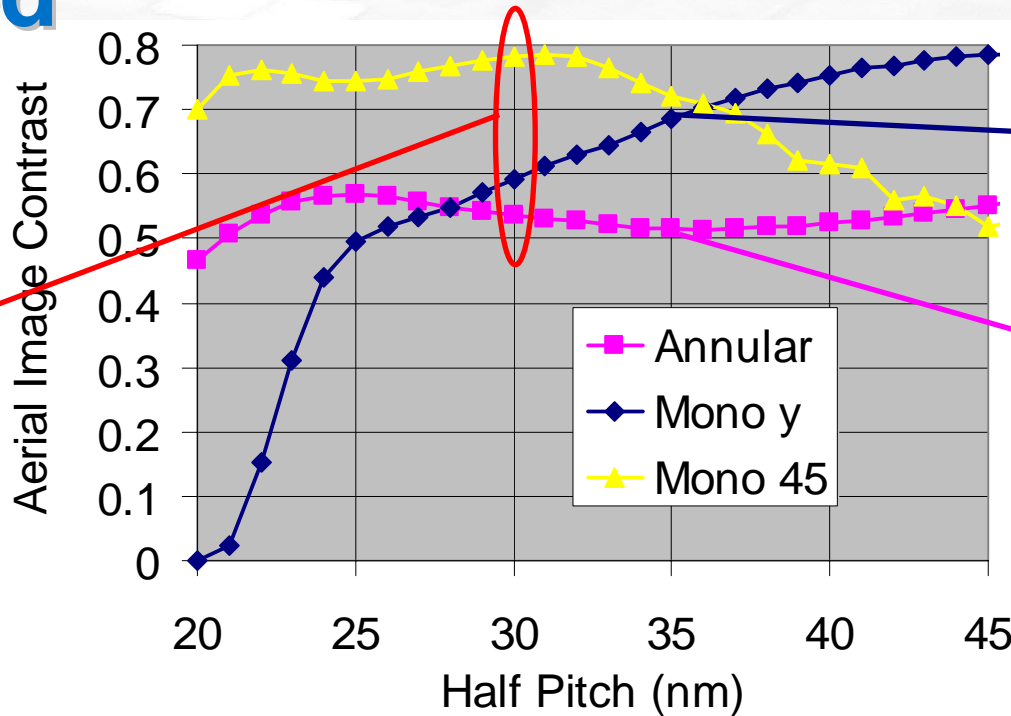
➤ University of Wisconsin resist outgassing

- 28 resists tested to date
- Most passed MET specification



Accelerating the next technology revolution.

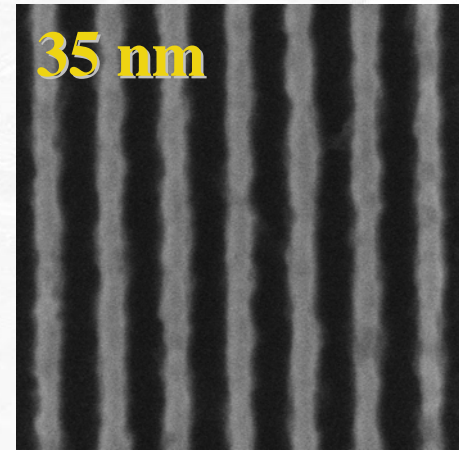
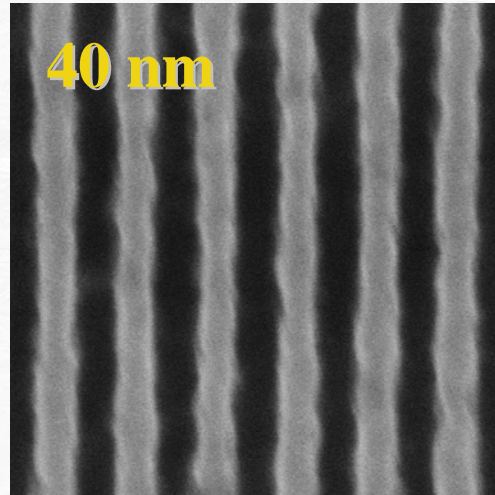
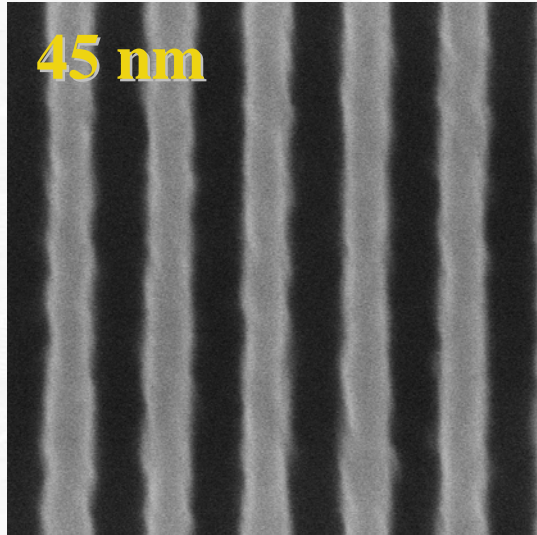
EUV Performance is Currently Resist-Limited



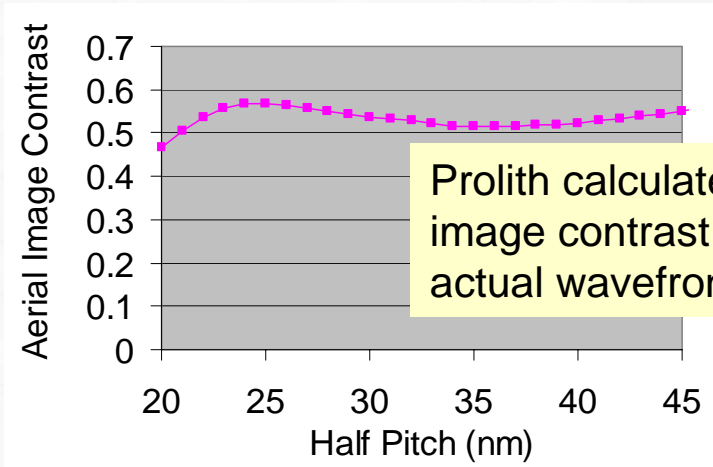
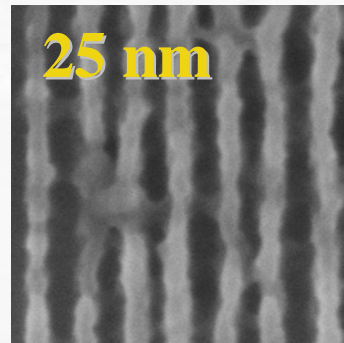
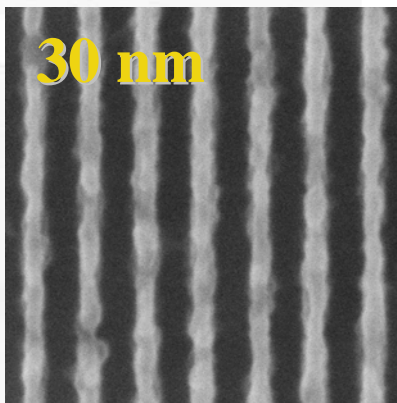
Little difference observed in imaging performance

- Variable pupil fill illuminator enables large changes in aerial-image quality
- Performance at the 30 nm half-pitch level observed to be poor independent of pupil fill
- Resist is playing dominant role in observed through-pitch behavior

Even with best EUV resist, resolution limit determined by resist not aerial image

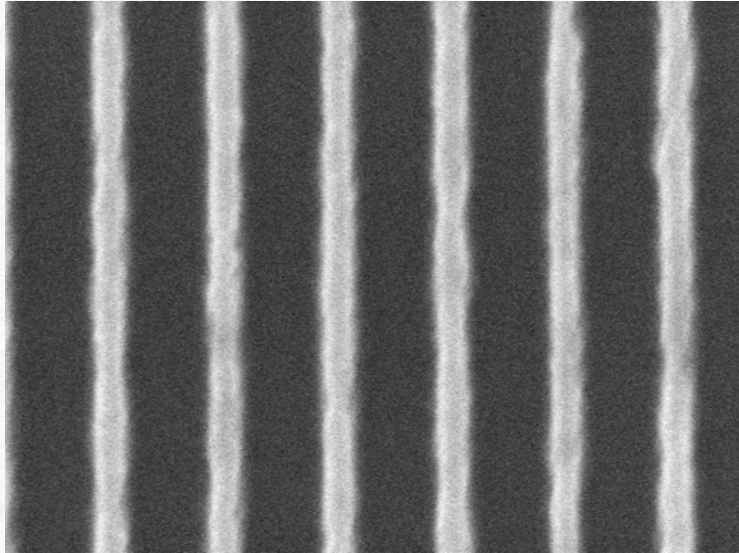


Annular 0.3-0.7

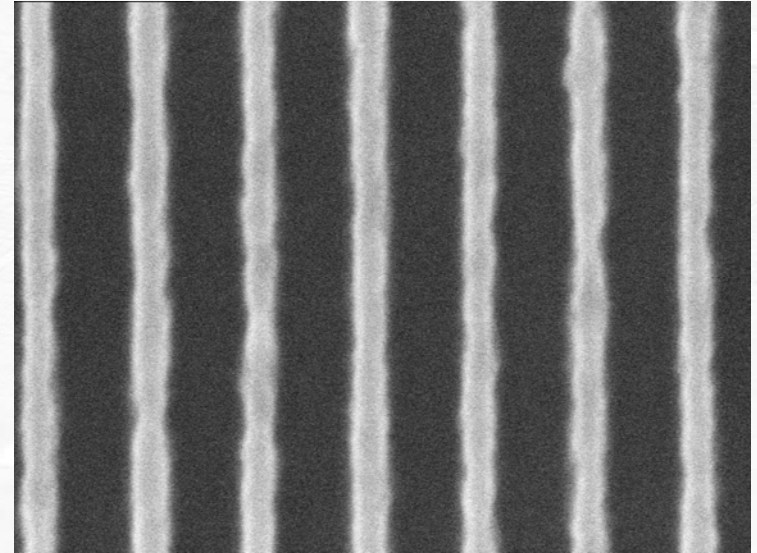


Prolith calculated aerial image contrast using actual wavefront data

Loose-pitch Imaging in KRS with Y Monopole



Coded: 27.5 nm 3:1
Printed CD = 28.3



Coded: 32.5 nm 2:1
printed CD = 27.3



Y monopole enables definitive resist-resolution limit testing

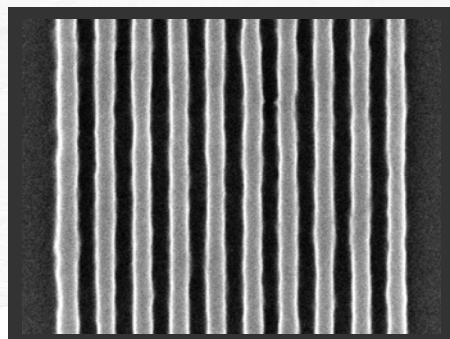
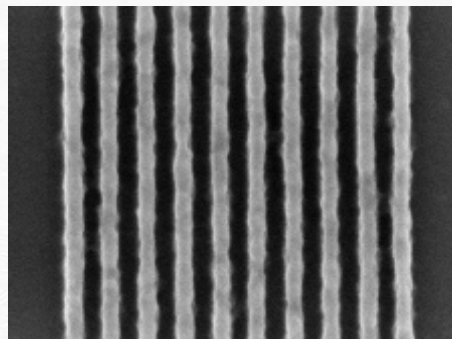
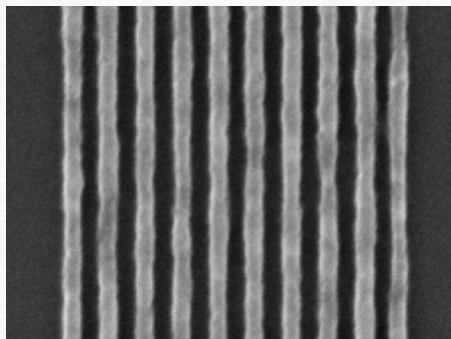
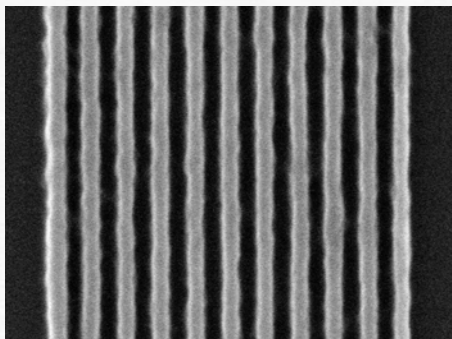
KRS

MET 1K

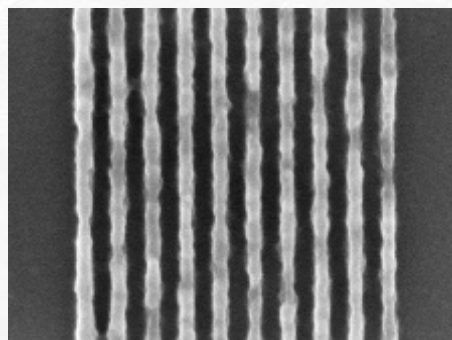
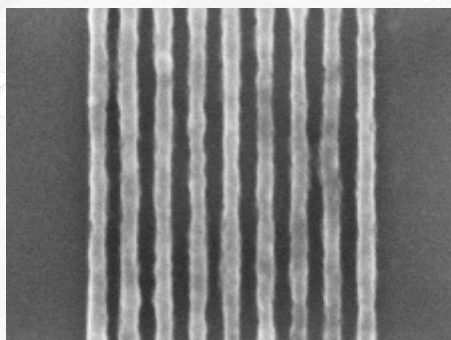
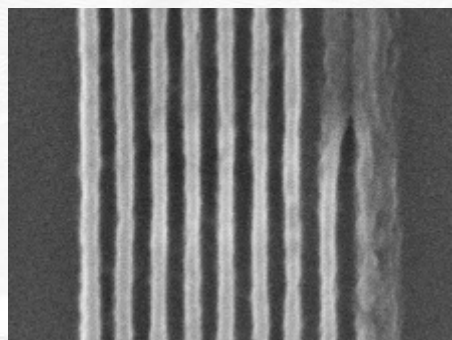
Supplier A

Supplier C

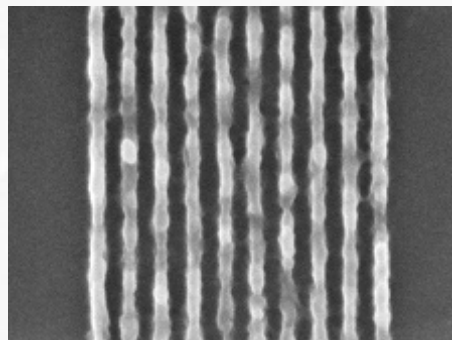
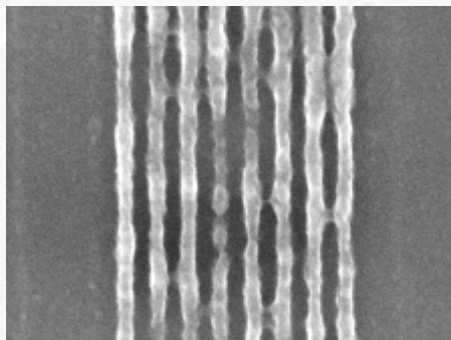
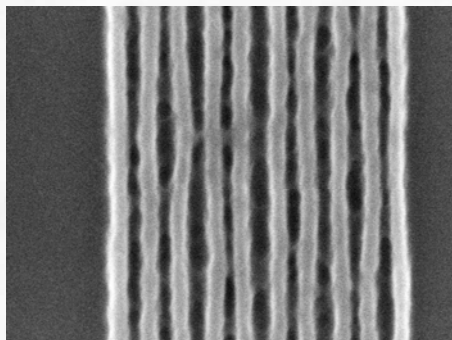
35-nm



32.5-nm



30-nm





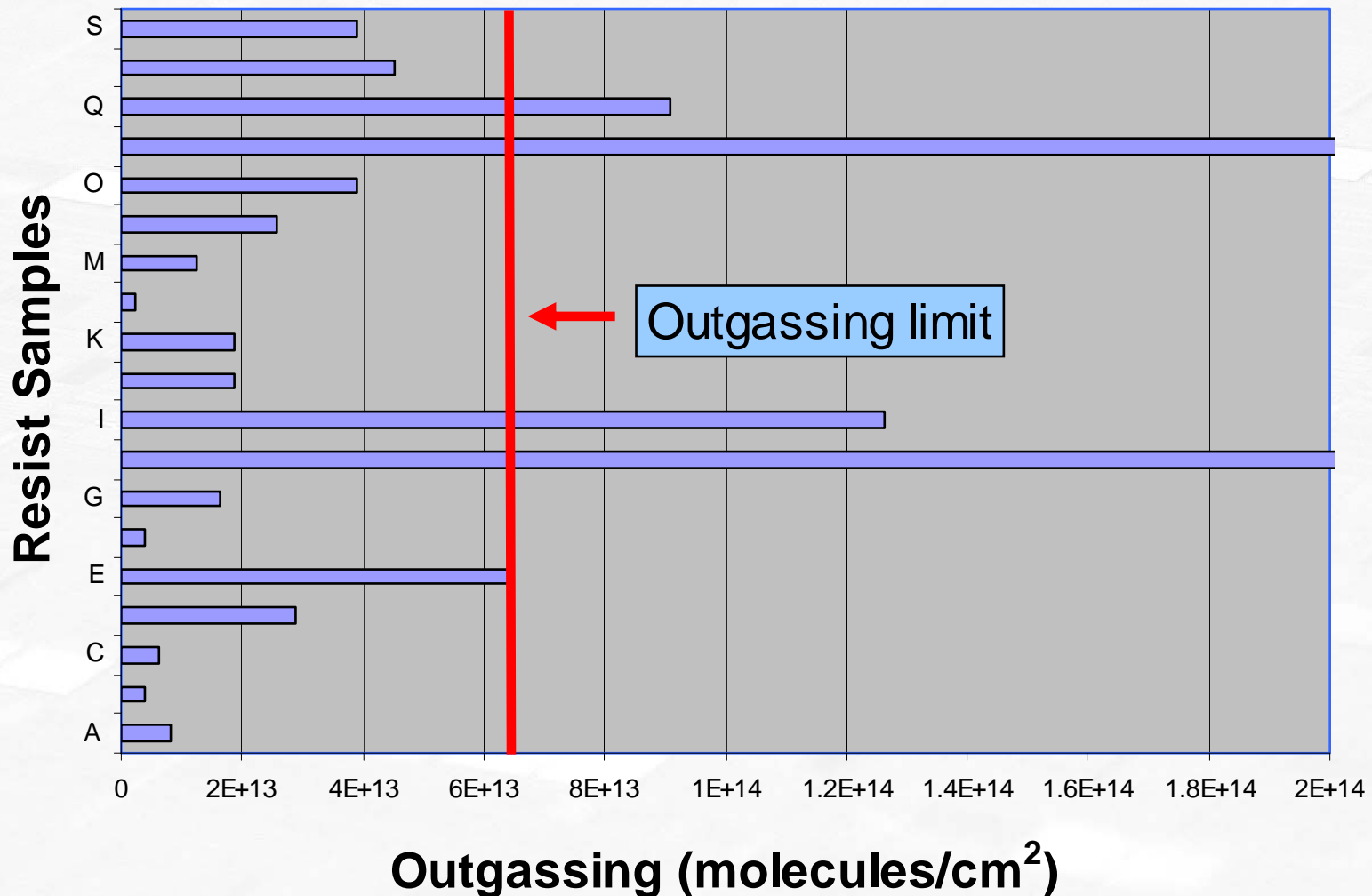
Summary of top-tier chemically-amplified resist performance

Resist	Speed (mJ/cm ²)	Res.* (nm)	LER (nm)	Failure Mechanism	Intrinsic Bias (nm)
Supplier A	11	35	4.5	Top Loss	4
KRS	19	32.5	3.3	Collapse/ Top Loss	19
MET 1K	21	35	3.6	Top Loss	> 16
Supplier D	21	45	3.0	Collapse	NA
Supplier C	46	35	2.5	Collapse	4

* Resolution defined as smallest observed well-defined half pitch



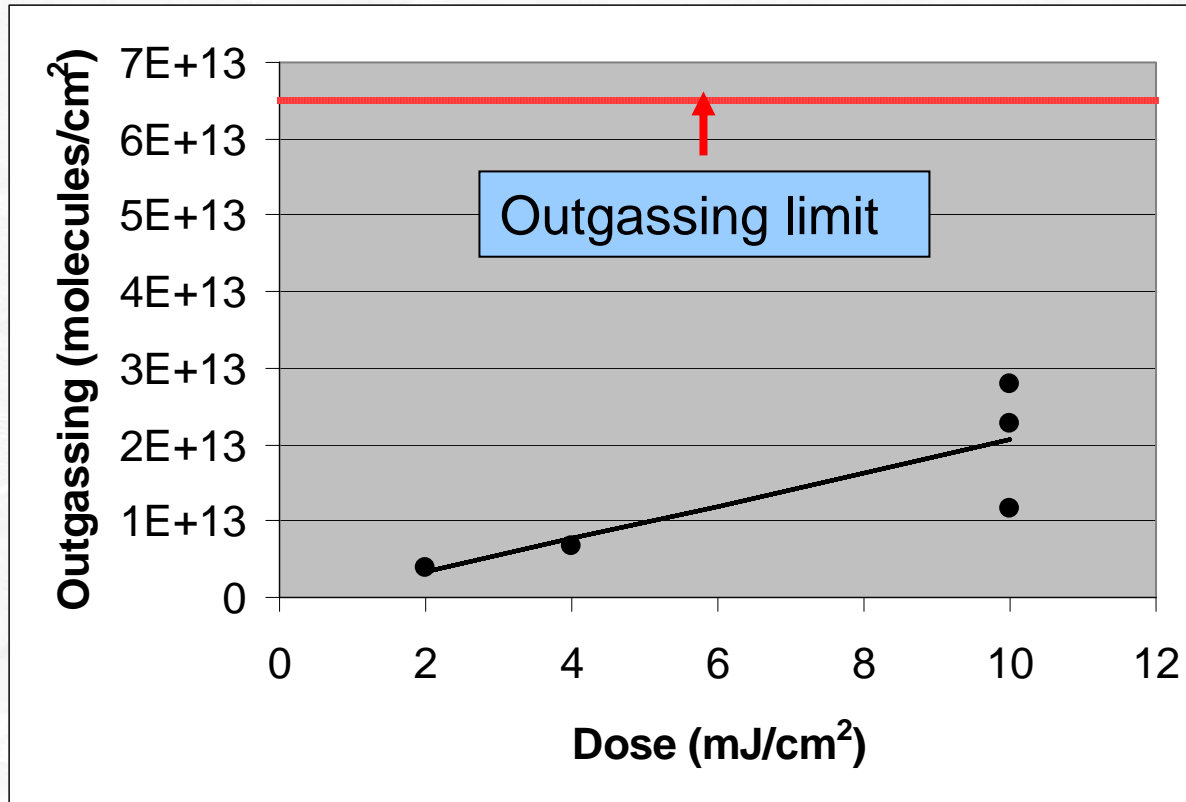
Outgassing Results



Most resists meet the requirement.



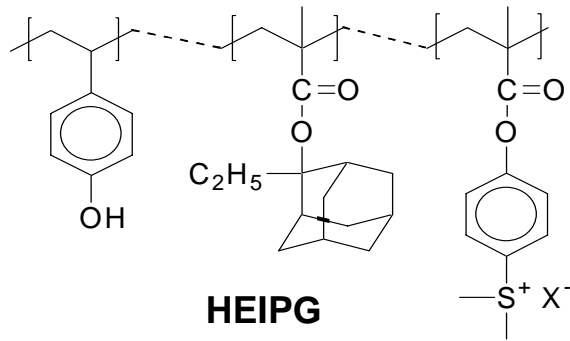
Outgassing versus Exposure Dose



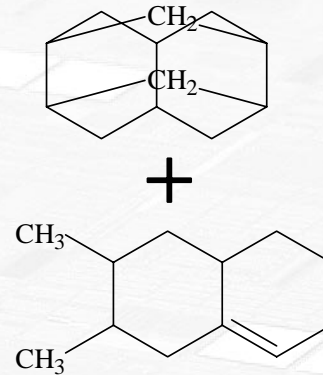
Resist F

- Outgassing increases with increasing dose.
- Repeated measurements at 10mJ/cm² on 3 different days show variation in outgassing.

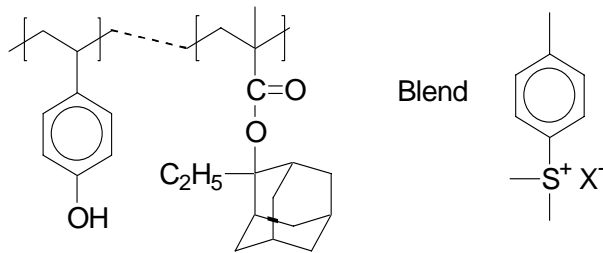
UNCC Resist Outgassing Products



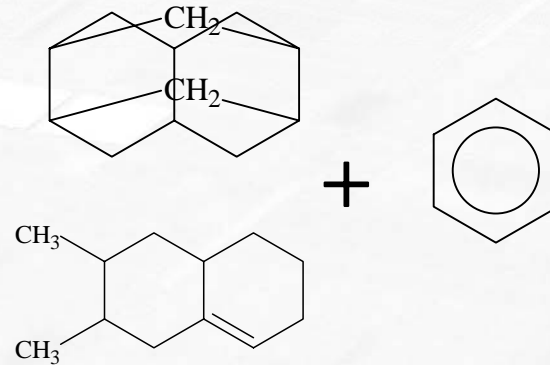
$X^- = \text{Nonaflate}$



No Benzene!



$X^- = \text{Nonaflate}$



- The polymer-bound PAG did not outgas PAG by-products.
- The adamantyl blocking group rearranges into 2 outgassing products.

Conclusions

- MET imaging limited by resist performance
- Outgassing increases with increasing dose for a particular resist.
- Polymer-bound PAGs might provide route for lower outgassing resists.
- Low E_a resists outgas more than high E_a resists.

Future Work

- Continue to provide more cycles of learning for resist suppliers and researchers
- Continue to improve outgassing system repeatability
- Investigate polymer structure influences on outgassing using model polymers
- Improve outgassing methodology so outgassing rates can be compared

Backup Slides

