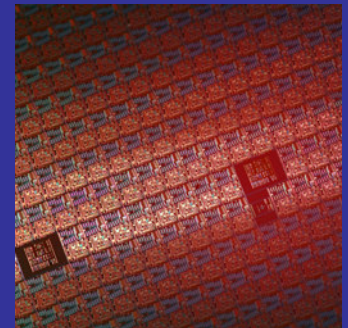




Accelerating the next technology revolution

SEMATECH Policy on EUV Resist Outgassing



Kevin Orvek, Intel / SEMATECH

SEMATECH Viewpoint: Resist Outgassing



- It's Showtime for EUVL
 - We have about 2 to 3 years to enable EUVL Pilot Lines for at least two of our member companies.
 - If EUVL fails to work in these pilot lines then the future is bleak for EUVL.
- We need to concentrate on high risk items
 - Resources are limited
- For ~ five years, the industry has been testing EUVL resist outgassing levels out of concern for potential contamination of exposure tool optics.
 - Has anyone seen a problem with resist? – NO
- Do we really want to transform the high risk RLS triangle for EUV resist into a pyramid that includes ultra-low outgassing requirements?

Discussion – Current Scanners



- No data exists to date implicating resist outgassing in any tool optical contamination
- No data exists showing resist contamination significantly contributes to witness plate contamination above residual chamber organic contributions at current small-field and full-field power levels
- All tests to date indicate residual hydrocarbons are the dominant source of contamination at current power levels
- No justification has been shown for continuing resist outgas testing of any kind for small-field and current full-field low power scanners
- Significant resources are required to judge which resists should be tested, to arrange for testing, to perform the tests, and to report the results

SEMATECH is discontinuing resist outgas testing for our MET tools with conventional PAG resists.

Discussion – Future Scanners



- Future scanners will need to improve orders of magnitude in residual organics before resist outgassing should be considered as any significant threat.
- Future scanners will have in-situ carbon cleaning techniques; the presence of such capability should be fully comprehended in any budget analysis of allowable hydrocarbons from all sources.
- If in situ cleaning is successful on future scanners, then resist outgassing is not of concern.
- Scanner suppliers need to convince customers of the need for any resist outgassing limits with careful hydrocarbon budget analysis.

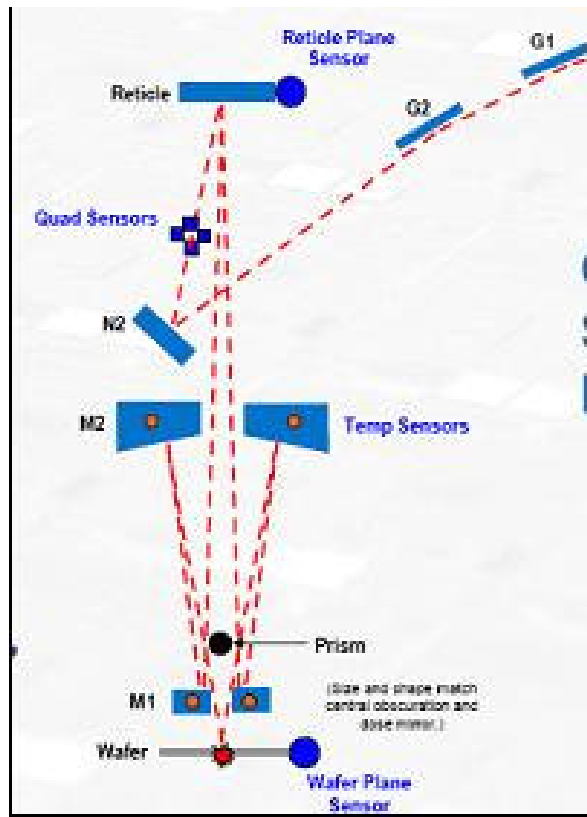


Backup Slides

Counting Molecules Approach: How Intel/SEMATECH Specification was Determined



MET primary mirror M2 assumed to be the optic at greatest risk from resist outgas products (only optical lens surface with a direct line-of-sight to the resist).



2003/2004 /2005 Spec

- M2s 'permitted' to acquire 1 monolayer of carbon after 3 years (about 0.3% reflectivity loss)
- Usage: 64 fields/wafer, 30 wafers/week, 48 weeks/year, 3 years.
- Surface impingement: 100% of all outgas molecules hit M2.
- Surface sticking probability: 100% of all molecules that hit stick to M2.
- Molecular disassociation: Each molecule that sticks generates 10 carbon atoms.

2006 – current Spec

- Same
- 64 fields/wafer, 36 wafers/week, 40 weeks/year, 3 years.
- 20% of all outgas molecules hit M2.
- 85% of all molecules that hit stick to M2.
- Each molecule that sticks generates 5 carbon atoms.

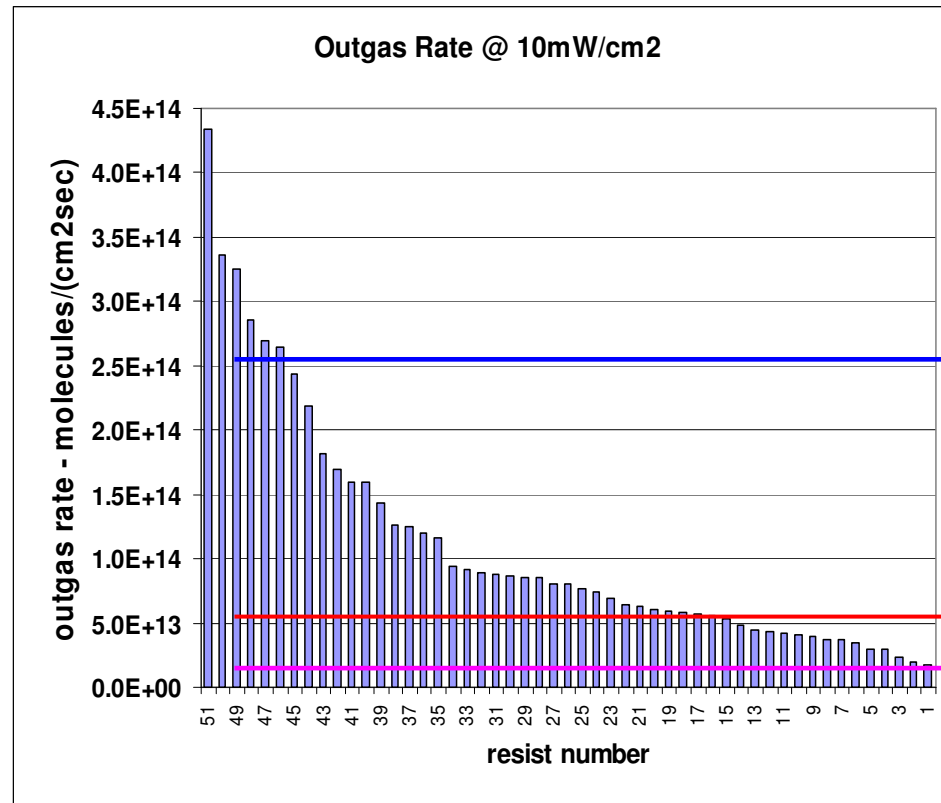
$\leq 6.5E+13$ molecules/cm²

$\leq 6.5E+14$ molecules/cm²

SEMATECH/Intel Approach



- Still very conservative assumptions in current resist outgas spec level.
- Yet most resists tested in 2007 passed SEMATECH/Intel outgassing limit.



SEMATECH spec converted to rate based upon 10 mW/cm² power level of Alpha/Beta tools

SEMATECH 2007 spec

ASML original spec

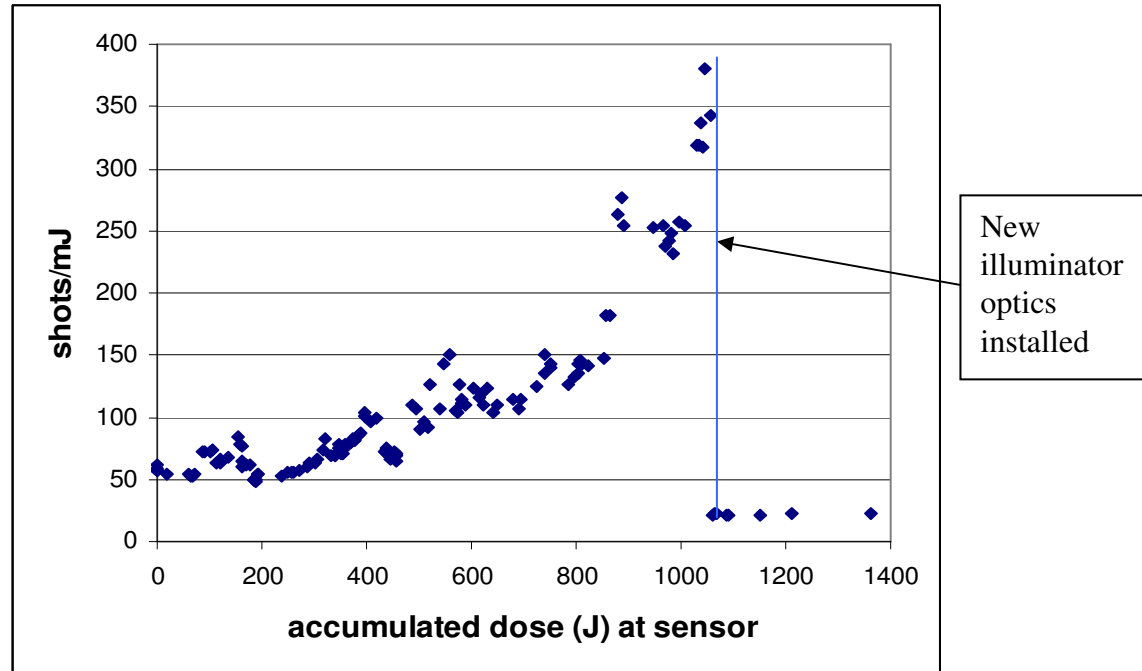
Nikon original spec

- 119 tested out of 224+ used on MET tools in 2007, 51 commercial shown
- Sometimes we allowed resists on MET tools even if they failed our spec.
- How have we done on protecting the MET tools?

Optics Contamination on SEMATECH's MET Tool



- SEMATECH has swapped illuminator mirror optics twice due to contamination
- With each swap, total system power has been restored to \geq original value
 - Intel has experienced same response
- No sign of significant accumulation of carbon on MET primary optics



Shots required per 1 mJ of dose as a function of accumulated dose

It looks like Sandia was correct in 2002; cause is residual organics