Update from More Moore

Work supported by the EC FP6

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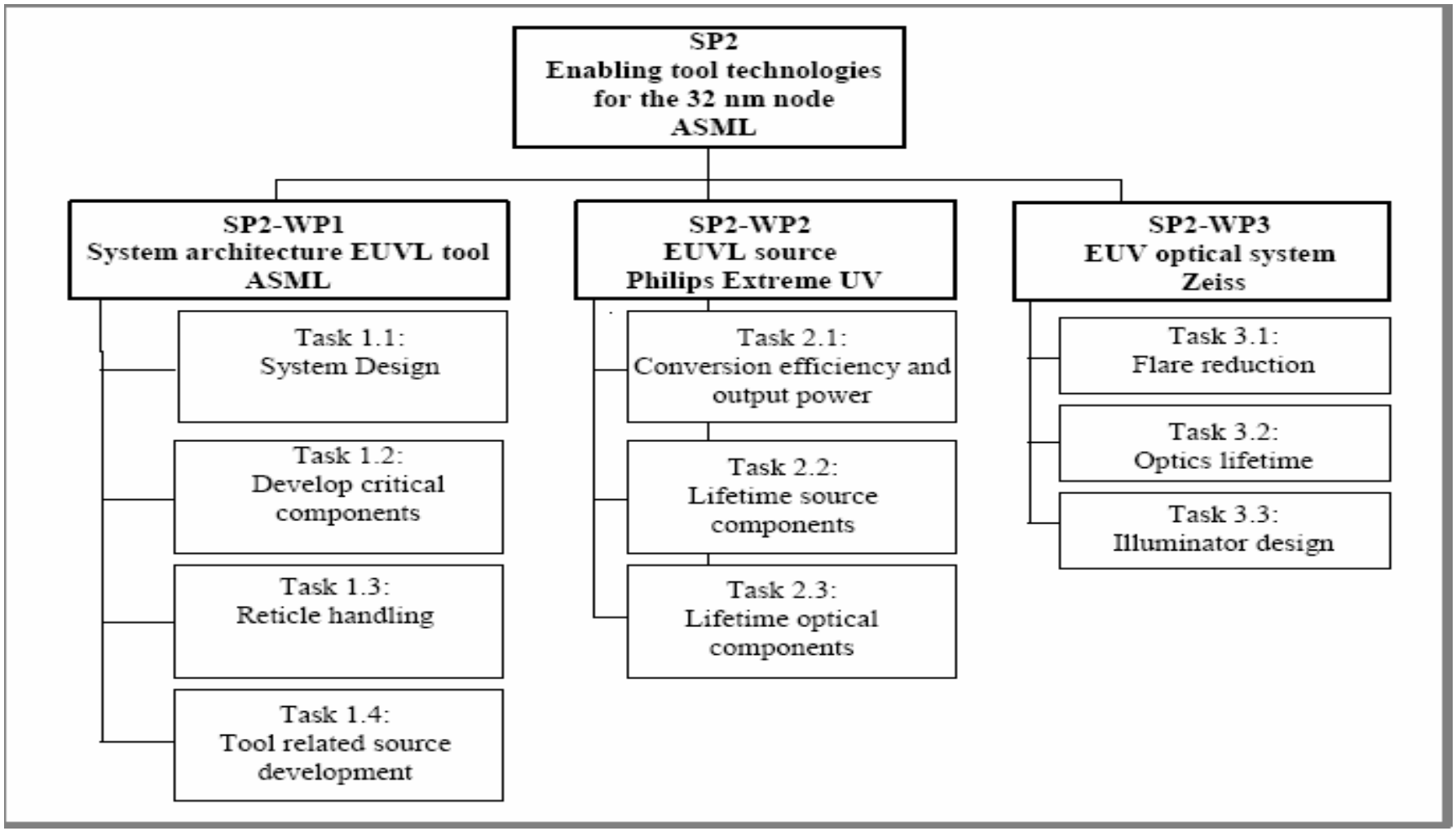
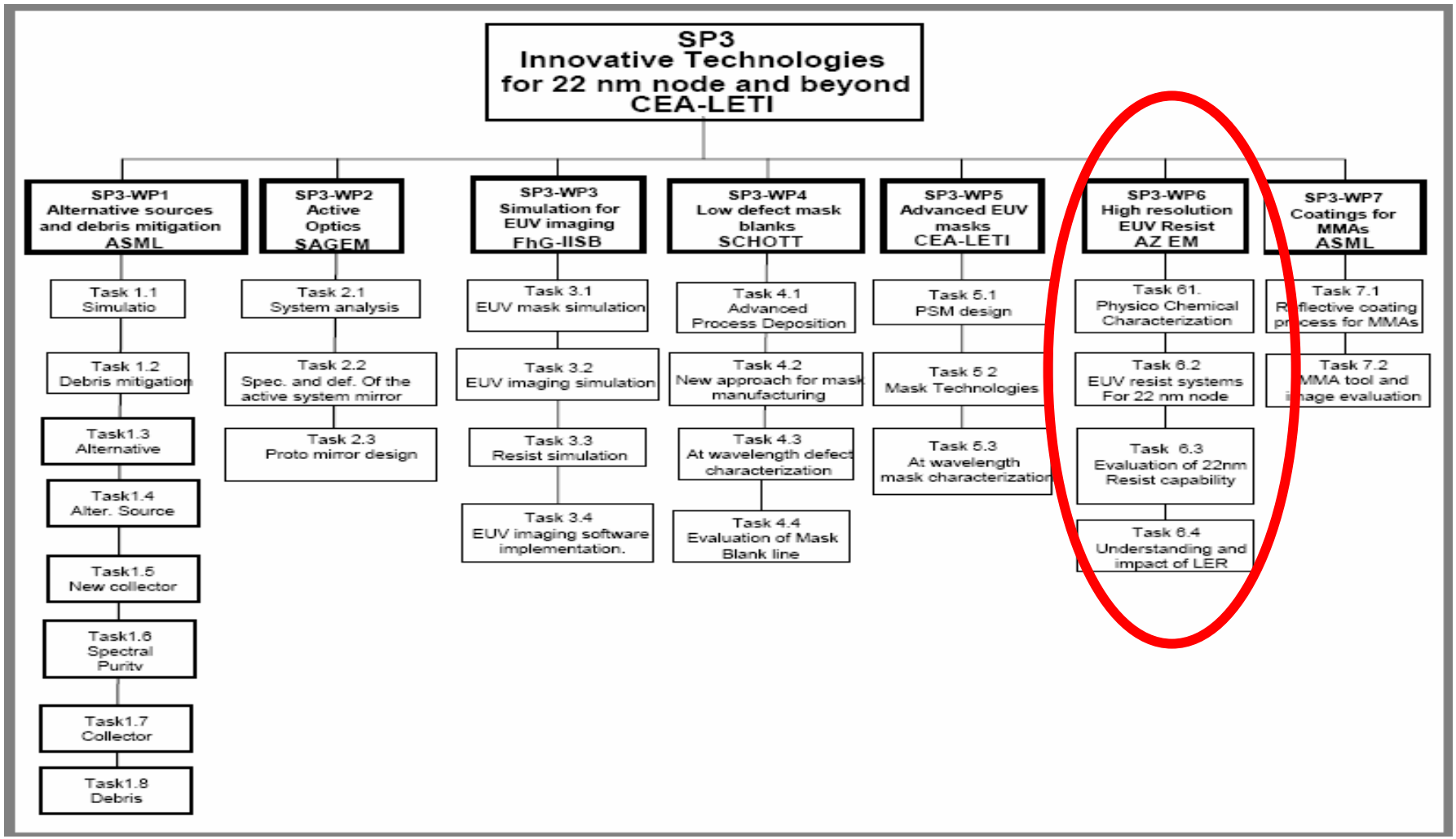
More Moore SP2 structure



More Moore SP3 structure

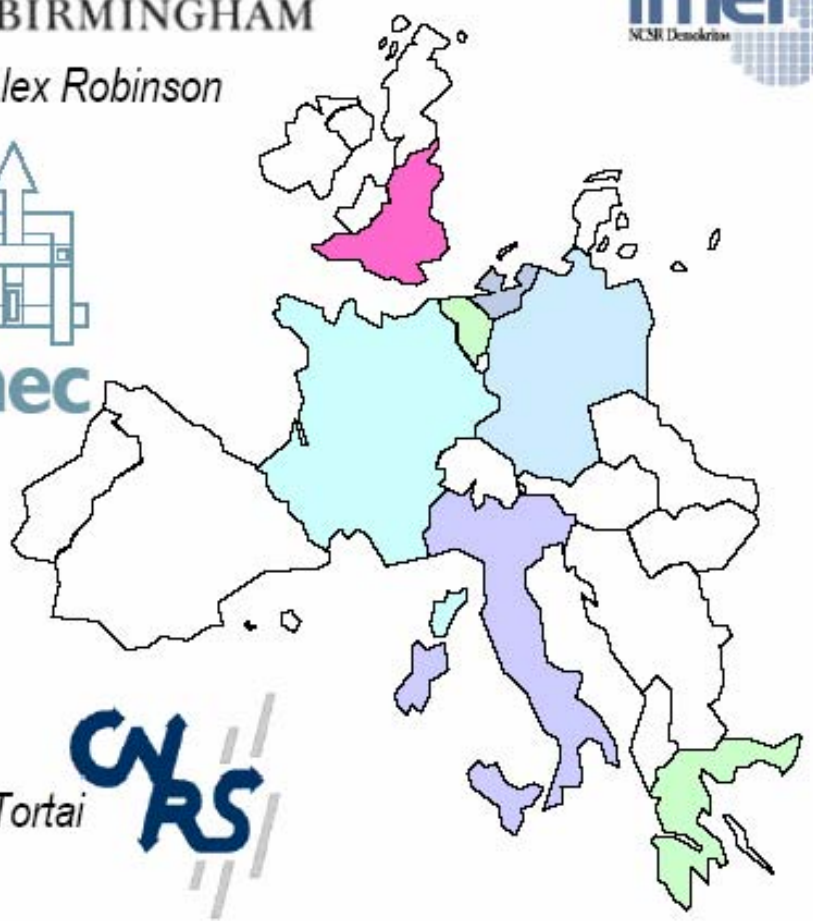


More Moore figures

- 3 years project funded by the European Commission
- Ended 31-12- 2006
- 3 months extension granted to work on Molecular resist

➔Follow up project on resist issues under consideration

More Moore Partners for Resist evaluation



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Resist Workpackage objectives

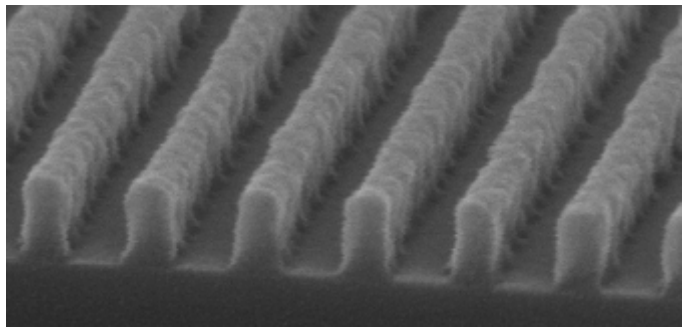
High resolution and low LER EUV resist for the 22nm node

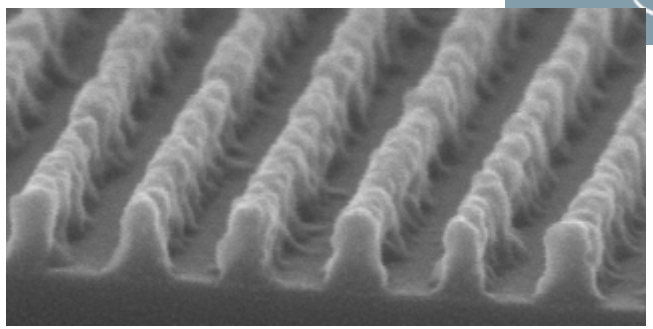
- Development of a new resist platform
- Evaluation, characterization and understanding of the limiting parameters of the new resist platform in terms of resolution and LER
- Understanding of the formation of line edge roughness

Effect of contrast demodulation <flare>on resist profiles in resist EUV-38

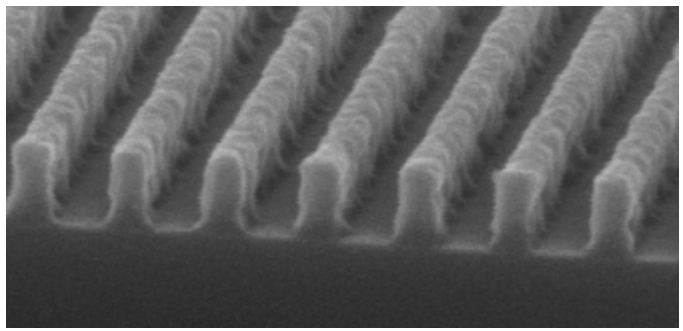
0% flare

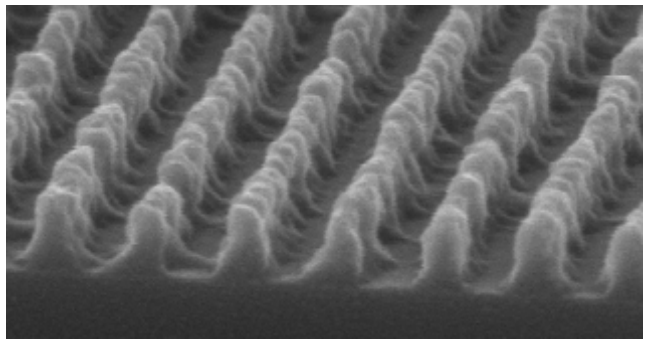
30% flare



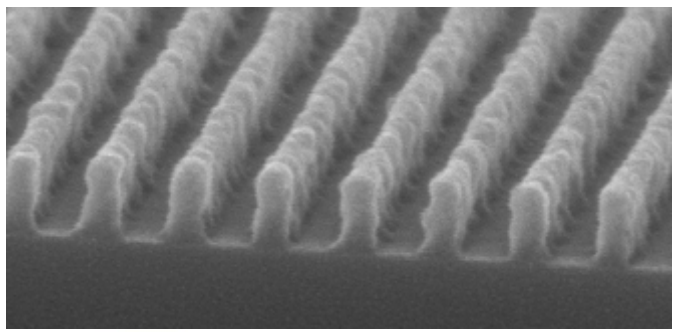


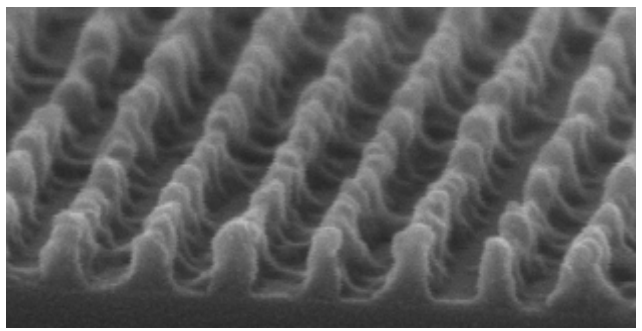
50 nm





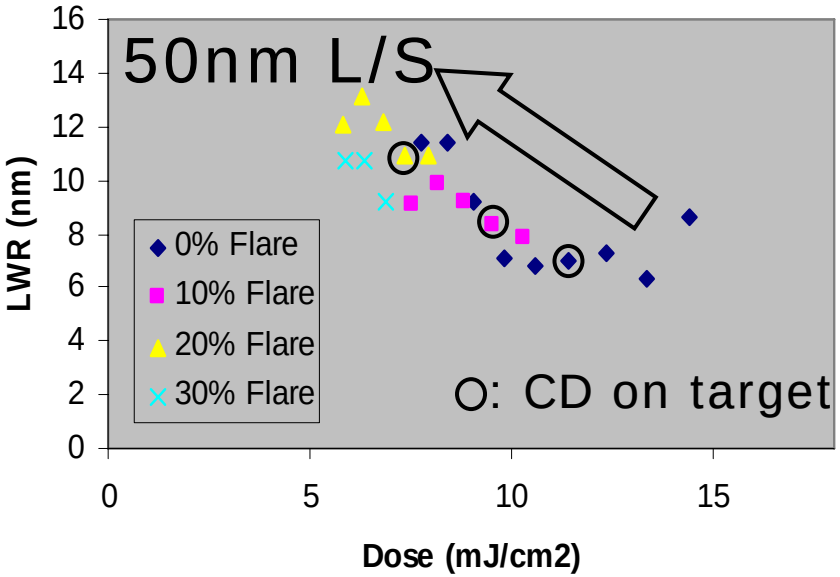
45 nm

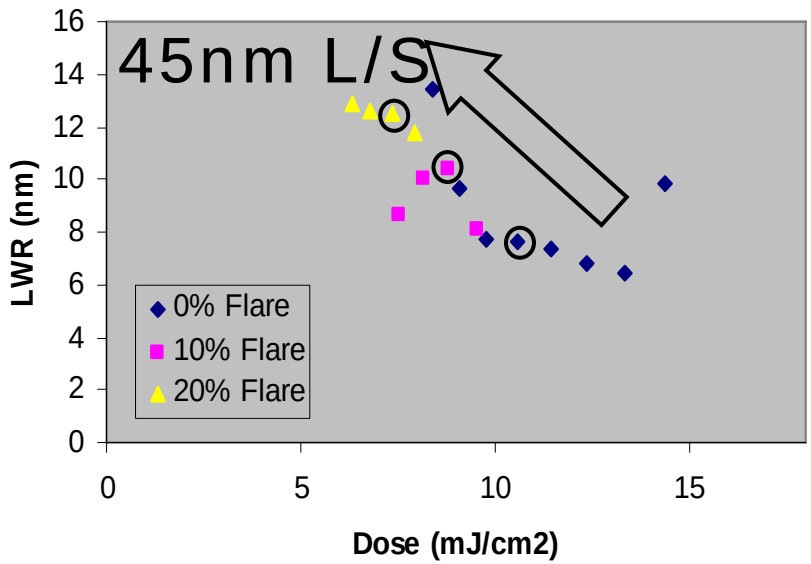




40 nm

Line Width Roughness
Resist EUV-30

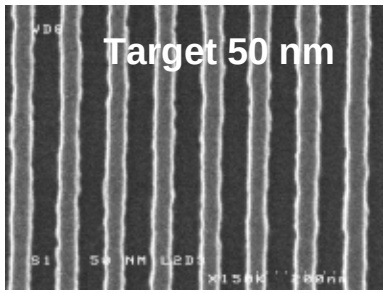




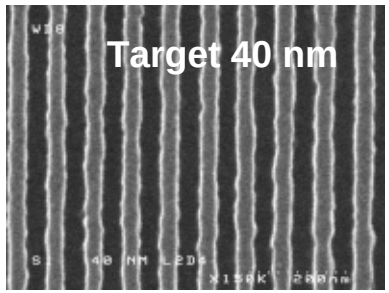
- LWR is increased with increasing flare levels and decreasing dose
- LWR is mainly governed by shot noise statistics and image contrast
- Lowest LWR is achieved at values above the polymer grain size (2-3nm)
- No large LWR improvement should be expected from smaller grain size of molecular resists at these image contrast and dose levels
  - There may be improvement due to better material homogeneity

Polymer resists

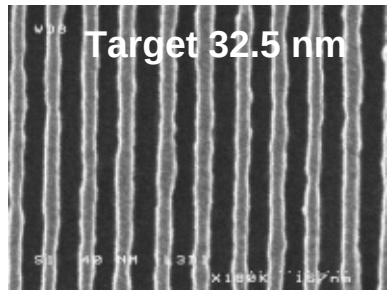
Best results with resist developed inside the More Moore project



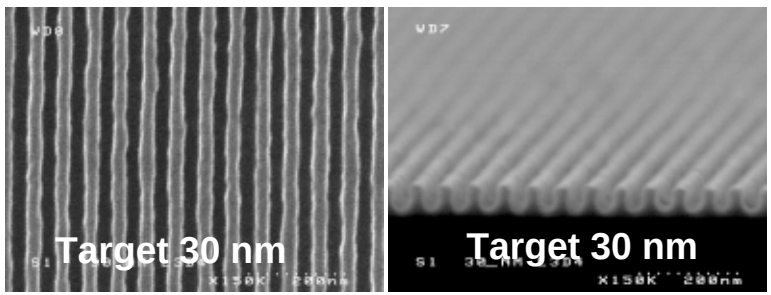
CD=**44.2**±2.1 LER=**4.1**±0.7
dose on resist 13mJ/cm^2



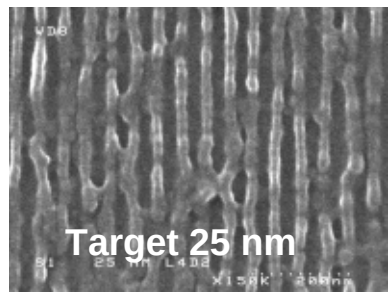
CD=**39.3**±1.3 LER=**4.5**±0.9
dose on resist 14mJ/cm^2



CD=**27.8**±2 LER=**3.4**±0.9
dose on resist 16mJ/cm^2



CD=**32.7**±1.6 LER=**4.9**±1.2
dose on resist 19mJ/cm^2



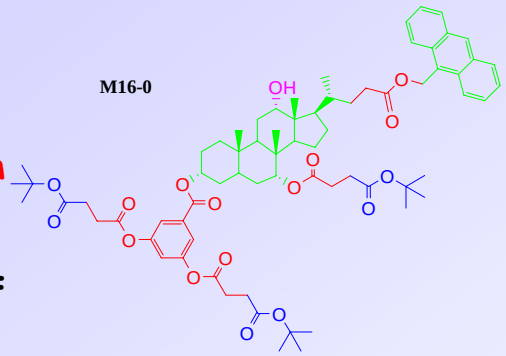
dose on resist 24 mJ/cm^2

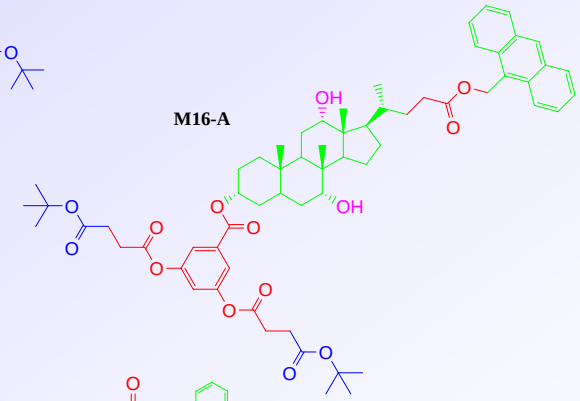
Development of molecular resists based on especially designed polycarbocycles

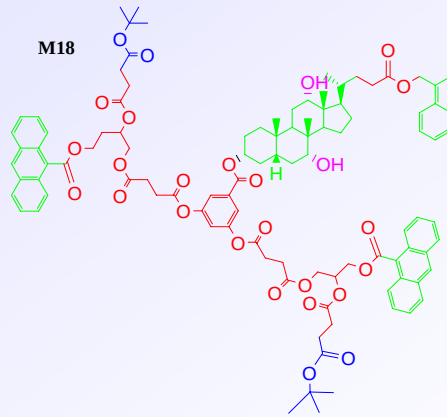
Molecular Resist Design

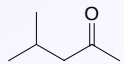
- Development of resists with potential for sub 45 nm patterning.
- Attachment of several functional groups on a core of high etch resistance.
- Selection of polycarbocycles and primarily anthracene as etch resistant cores.
- Combination of one or more anthryl-moieties with other polycarbocycles, such as adamantane and steroids (mixed derivatives).
- Formulation of "chemically amplified molecular resists" (with suitable PAGs) based on the new polycarbocycles.

- GREEN for etch resistance (polycarbocycles: antracences, steroids)
- BLUE for imaging (tert-butyl-esters)
- RED for linking, molecular stability, physicochemical properties (usually ether or ester links or phenyls)
- PINK for polarity, solubility, sticking (usually OH groups)

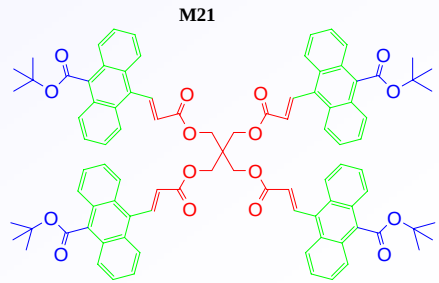








Solvent
methyl isobutyl ketone, (MIBK)

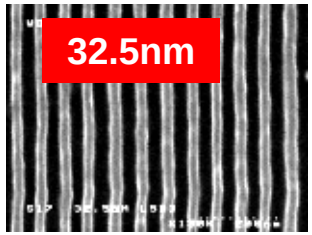


Molecular resist

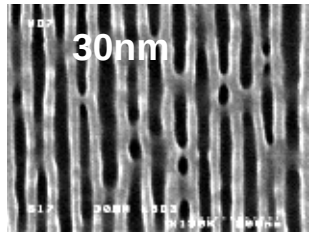
M17-20 formulation batch c

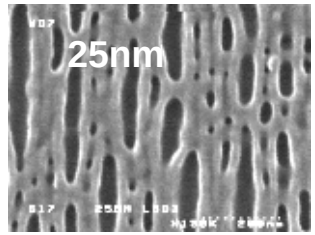
PEB 40°C
PAB 100

CD 50nm
LER 5-6nm



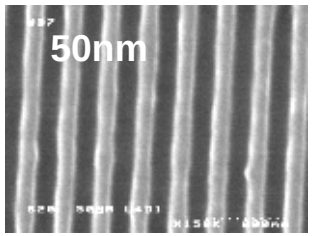
90mJ/cm²



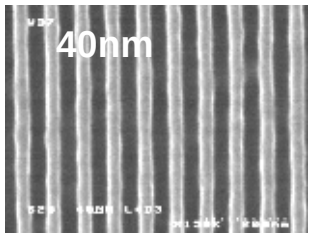


M17-30 formulation batch c

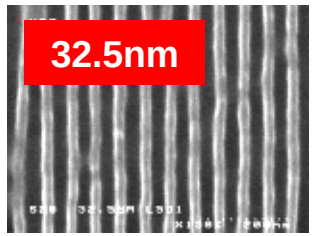
PEB 40°C
PAB 100



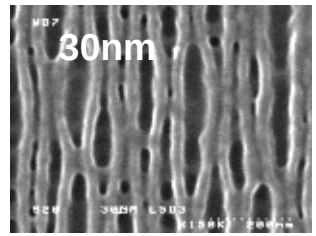
LER 3.6nm
53 mJ/cm²



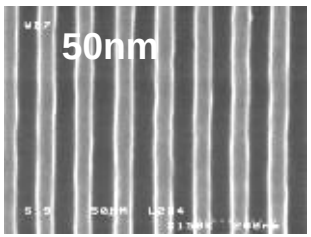
62 mJ/cm²



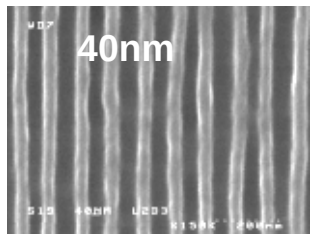
78 mJ/cm²



PEB 50°C
PAB 100



LER 2.5nm
31mJ/cm²



28 mJ/cm²

M17-30
- **40°C PEB: better resolution than 50°C**
- **50°C PEB: better roughness than 40°C**
- **Better sensitivity and better LER than for M17-20**
- **resolution slightly worse than for M17-20**

Conclusion

- **Polymeric resists**
  - Best resolution obtained: 30nm dense lines
  - 25nm dense lines printed but with pattern collapse
  - LER 4-5nm
  - Clear improvement this year in resolution but not in LER
- **Molecular glass resists**
  - Work started in More Moore in 2006
  - Best result achieved :
    - Best resolution obtained: 32.5 nm dense lines
    - 30 and 25nm dense lines printed but with pattern collapse
    - LER down to 2.5 nm on 50 nm dense lines: clear progress
- **Most important issues ?**
  - CD have improved significantly but more is needed to achieve 22 nm
  - LER still need improvement but clear progress made on molecular resist: 2.5 nm
  - Work has been focused on LER and resolution little improvement on sensitivity