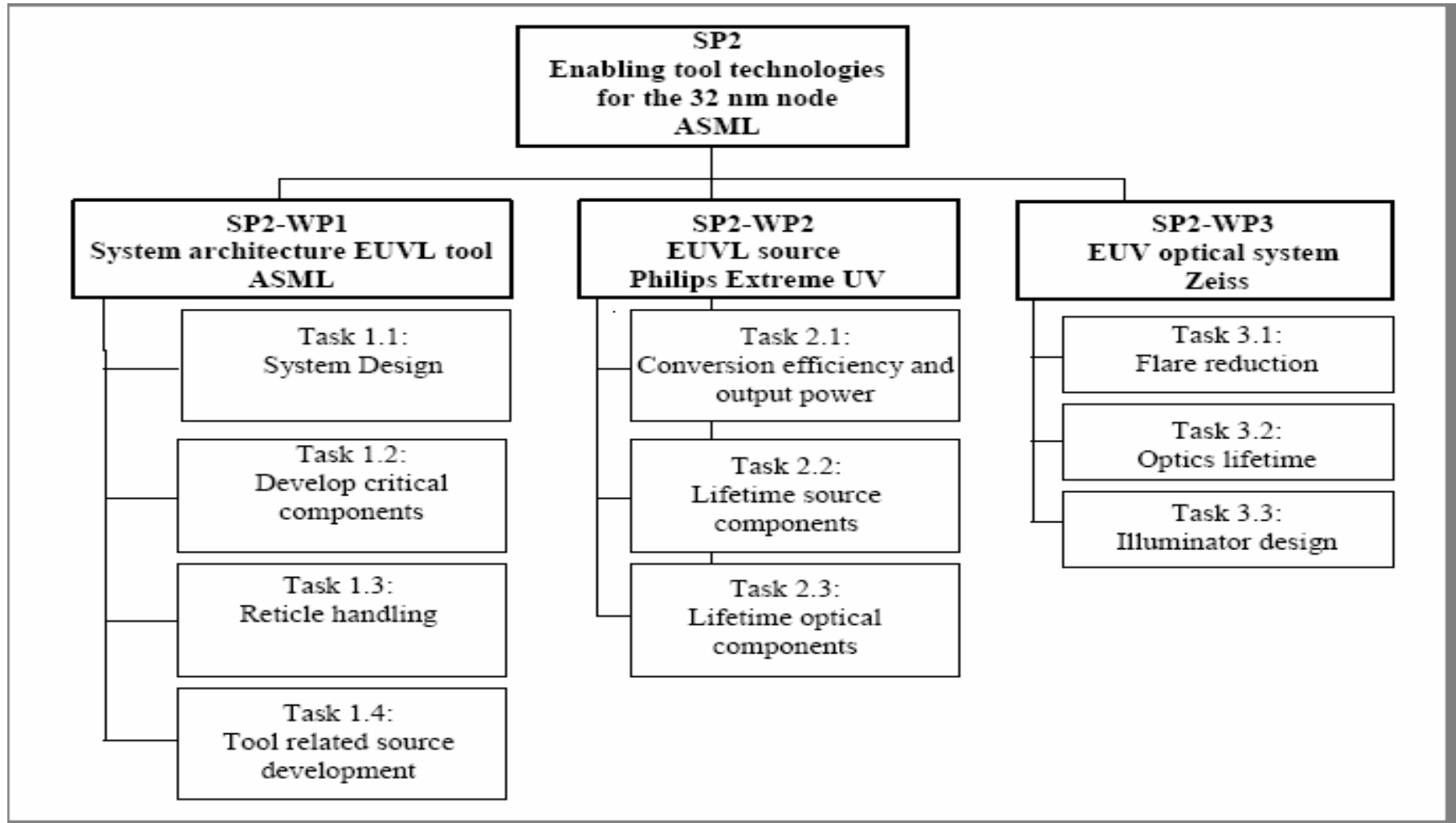


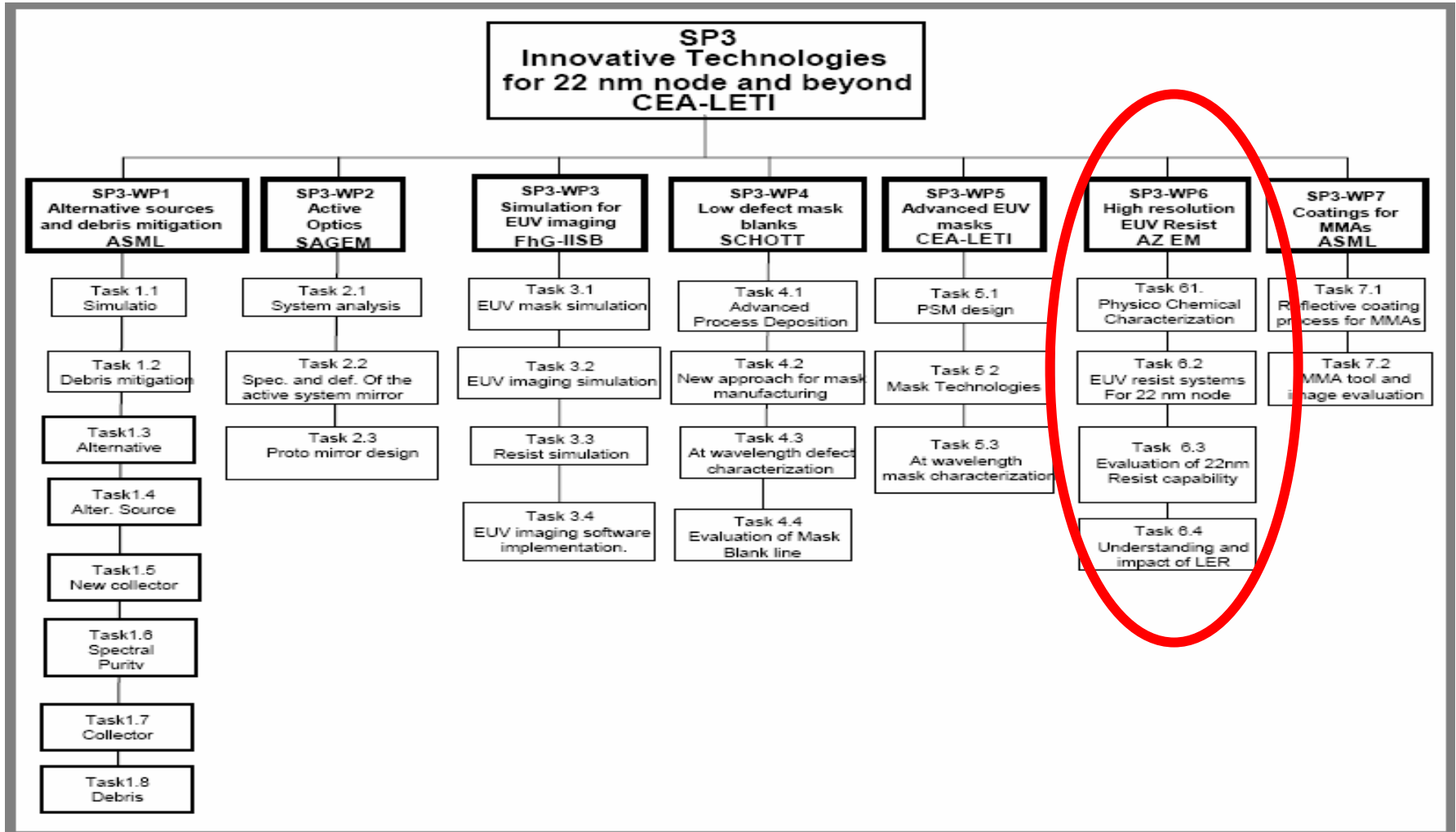


Update from More Moore
Work supported by the EC FP6
Serge Tedesco CEA-LETI

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

A map of Europe is centered on the slide, with several countries highlighted in different colors: the United Kingdom in pink, France in cyan, Germany in light blue, Italy in purple, and Greece in green. Surrounding the map are logos and names of partner institutions:

- UNIVERSITY OF BIRMINGHAM**: Alex Robinson
- imec**: Mieke Goethals
- leti**: Cyril Vannuffel
- CNRS**: Jean-Hervé Tortai
- imel**: Evangelos Gogolides
- TNO**: David Nijkerk
- AZ Electronic Materials**: Karl van Werden
- elettra Synchrotron Light Laboratory**: Michele Bertolo

Resist Workpackage objectives

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

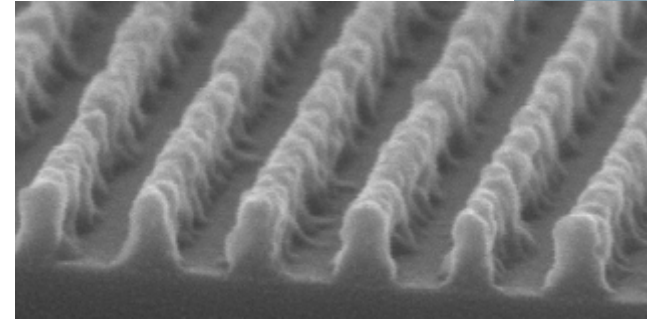
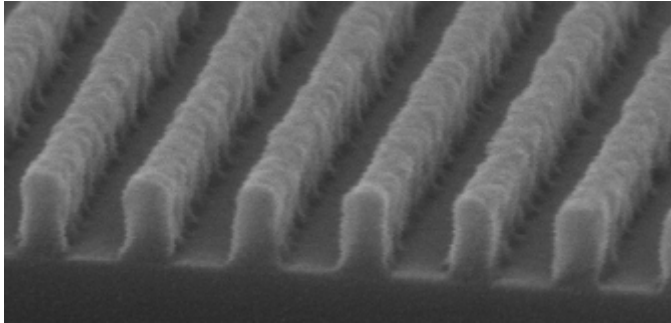
- Development of a new resist platform
- Evaluation, characterization and understanding of the limiting parameters of the new resist platform in terms of resolution and LER
- Understanding of the formation of line edge roughness

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

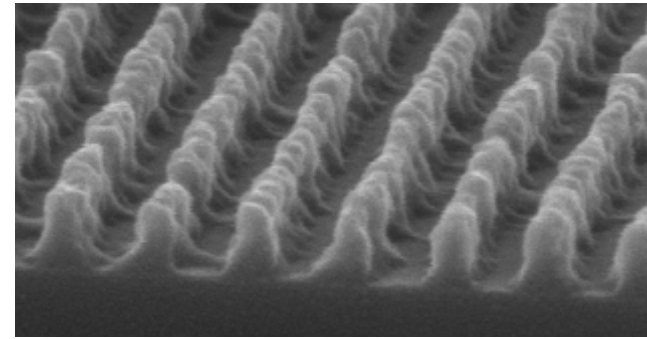
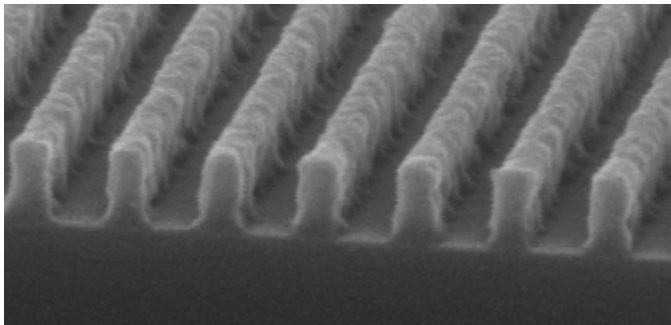


0% flare

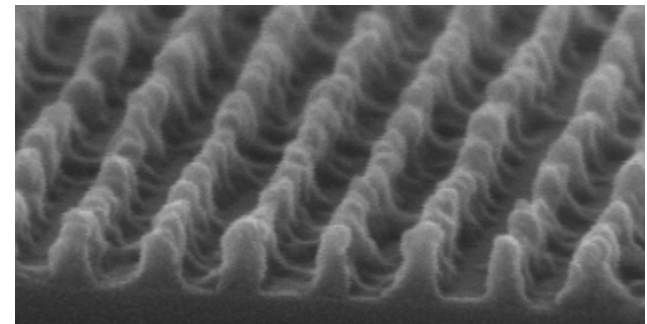
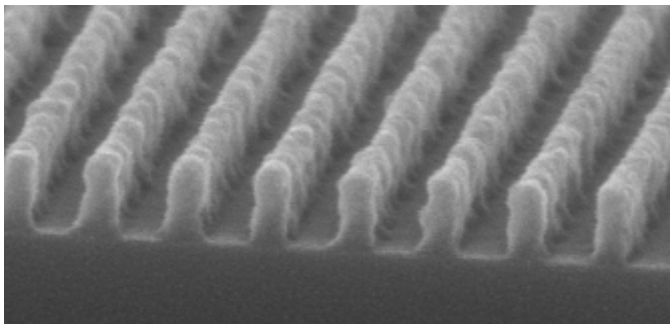
30% flare



50 nm

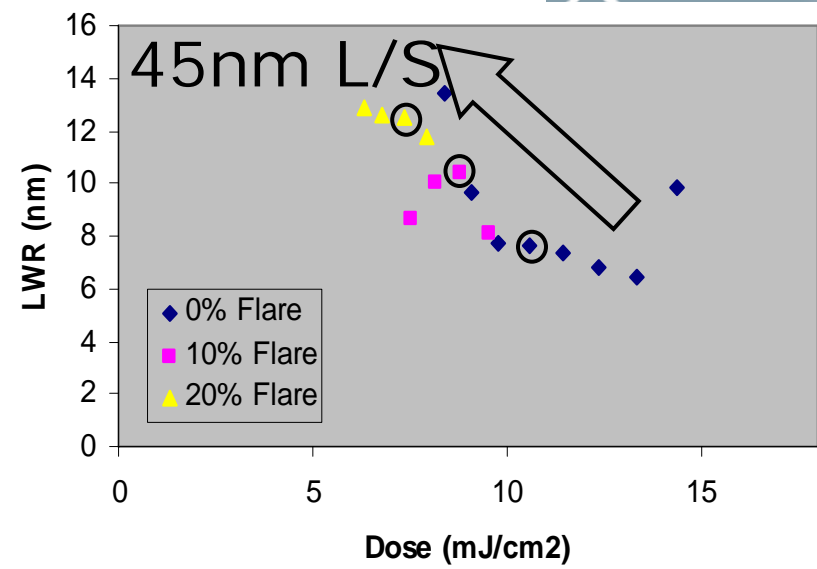
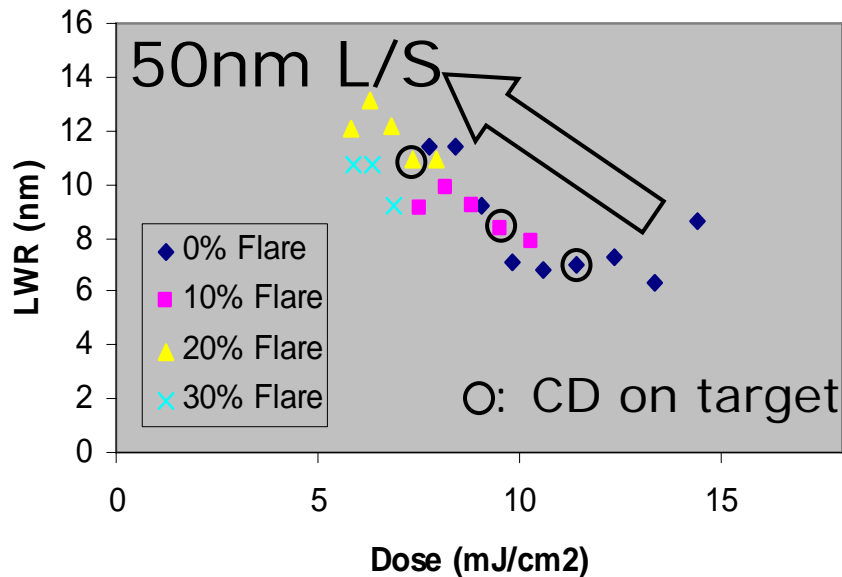


45 nm



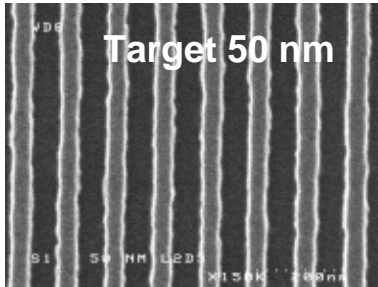
40 nm

Line Width Roughness Resist EUV-30

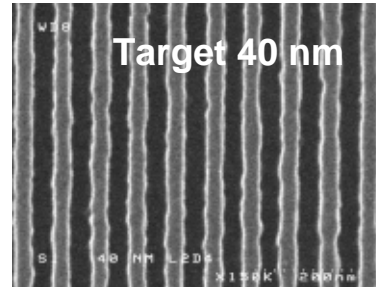


- LWR is increased with increasing flare levels and decreasing dose
- LWR is mainly governed by shot noise statistics and image contrast
- Lowest LWR is achieved at values above the polymer grain size (2-3nm)
- No large LWR improvement should be expected from smaller grain size of molecular resists at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

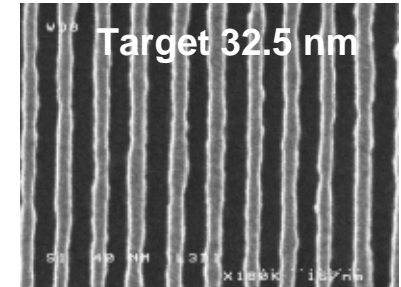
Best results with resist developed inside the More Moore project



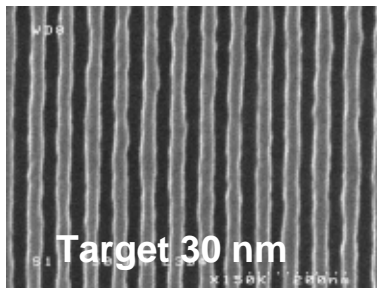
CD= 44.2 ± 2.1 LER= 4.1 ± 0.7
dose on resist 13mJ/cm²



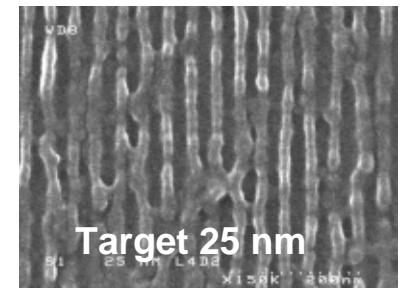
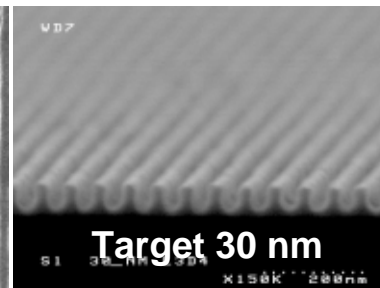
CD= 39.3 ± 1.3 LER= 4.5 ± 0.9
dose on resist 14mJ/cm²



CD= 27.8 ± 2 LER= 3.4 ± 0.9
dose on resist 16mJ/cm²



CD= 32.7 ± 1.6 LER= 4.9 ± 1.2
dose on resist 19mJ/cm²

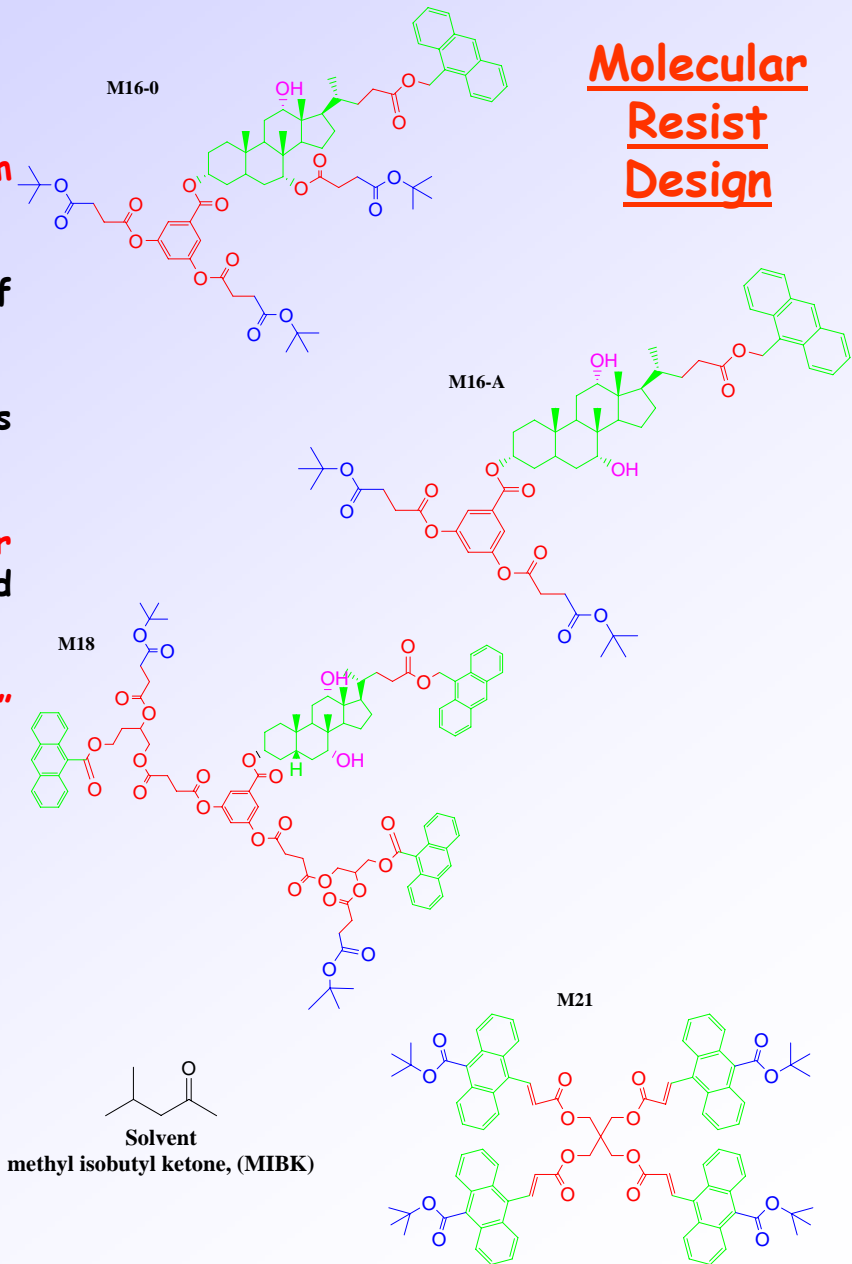


dose on resist 24 mJ/cm²

Development of molecular resists based on especially designed polycarbocycles

- 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)

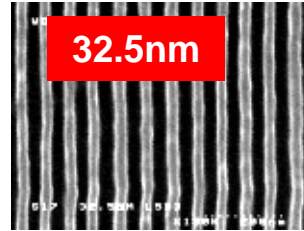


Molecular Resist Design

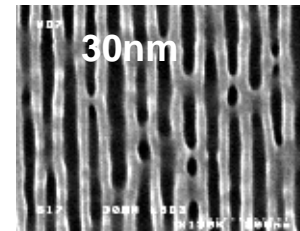
M17-20 formulation batch c

PEB 40°C
PAB 100

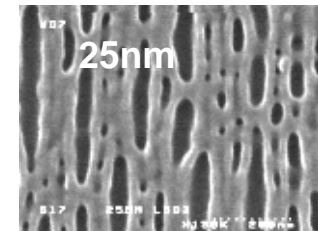
CD 50nm
LER 5-6nm



90mJ/cm²



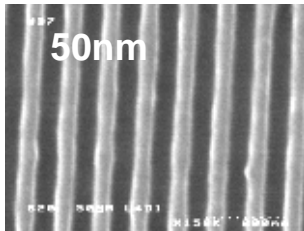
30nm



25nm

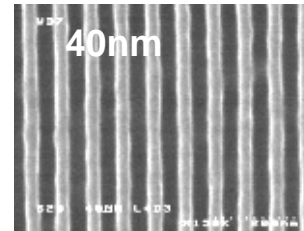
M17-30 formulation batch c

PEB 40°C
PAB 100



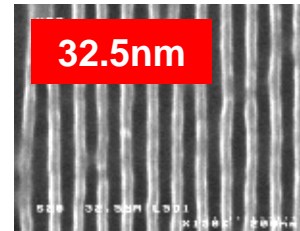
50nm

LER 3.6nm
53 mJ/cm²



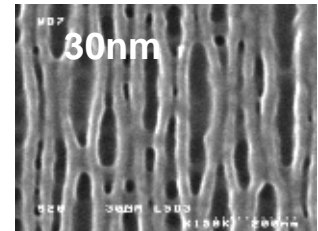
40nm

62 mJ/cm²



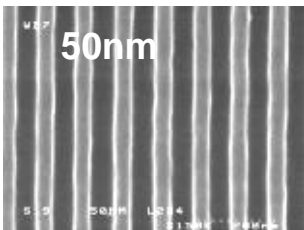
32.5nm

78 mJ/cm²



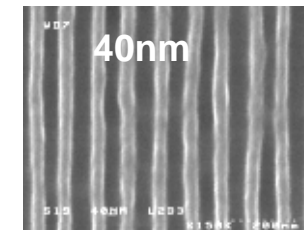
30nm

PEB 50°C
PAB 100



50nm

LER 2.5nm
31mJ/cm²



40nm

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