Update from More Moore

Work supported by the EC FP6

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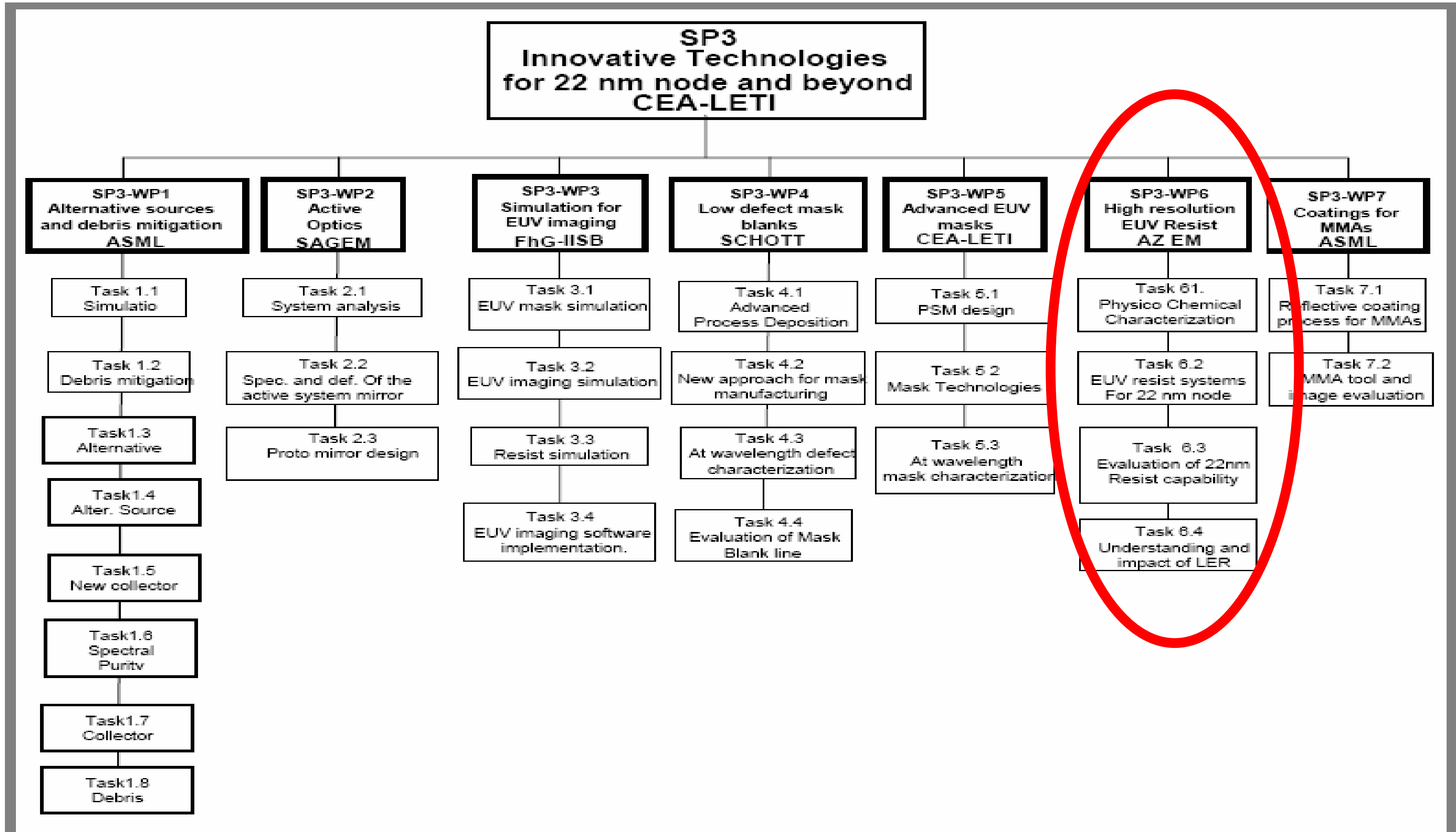
More Moore SP3 structure



EXTREME ULTRAVIOLET LITHOGRAPHY

More Moore Partners for Resist evaluation

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More Moore figures

- 3 years project funded by the European Commission
- Ended 31-03- 2007

➔No European follow up project on EUV resist issues at this time

EXTREME ULTRAVIOLET LITHOGRAPHY

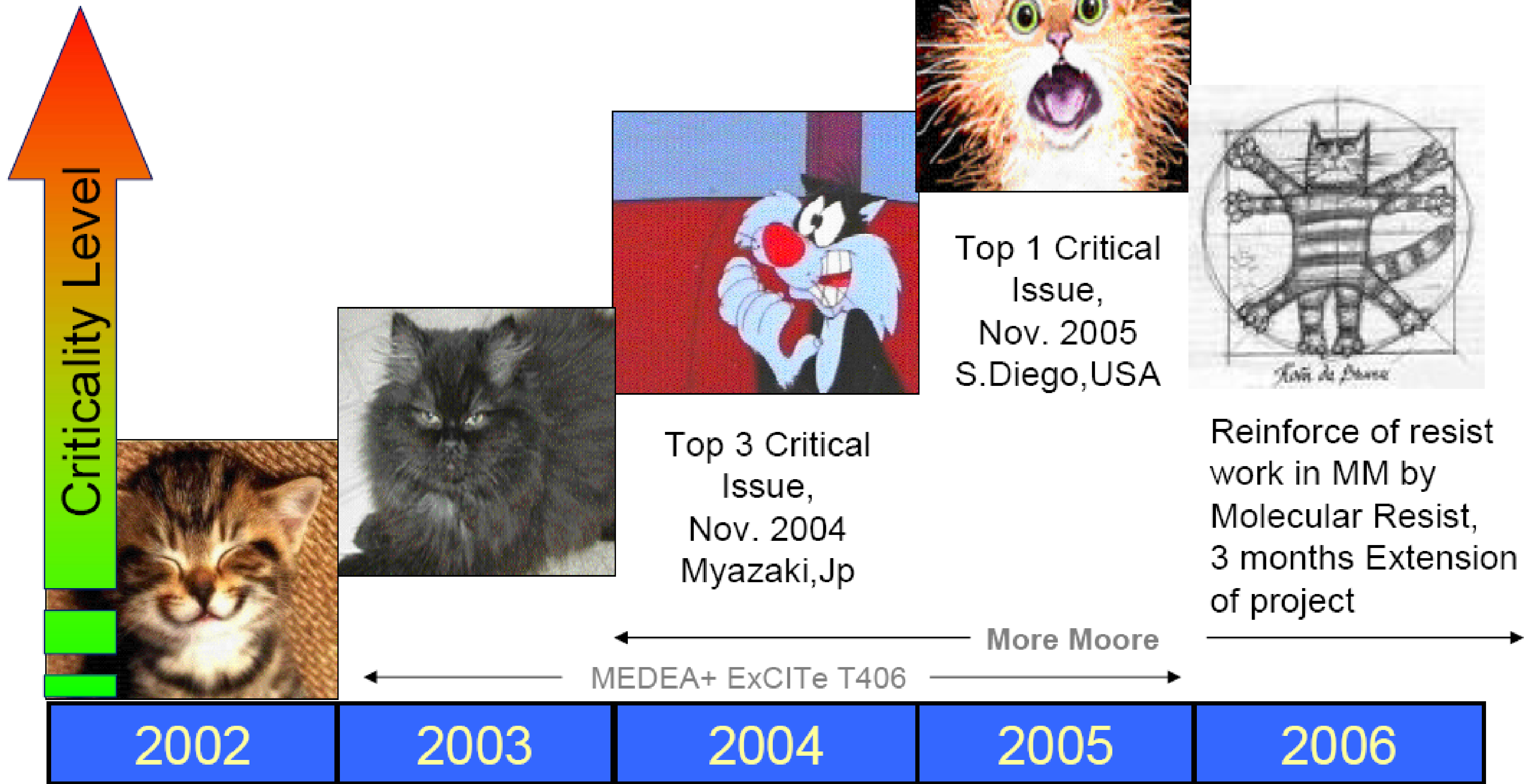
Resist Workpackage objectives

- The resist part of the More Moore project addressed the 22nm node:
  - **–resolution 22 nm dense lines**
  - **–line etch roughness, LER 1.2 nm (3 sigma)**
  - **–Sensitivity <15 mJ/cm^2**

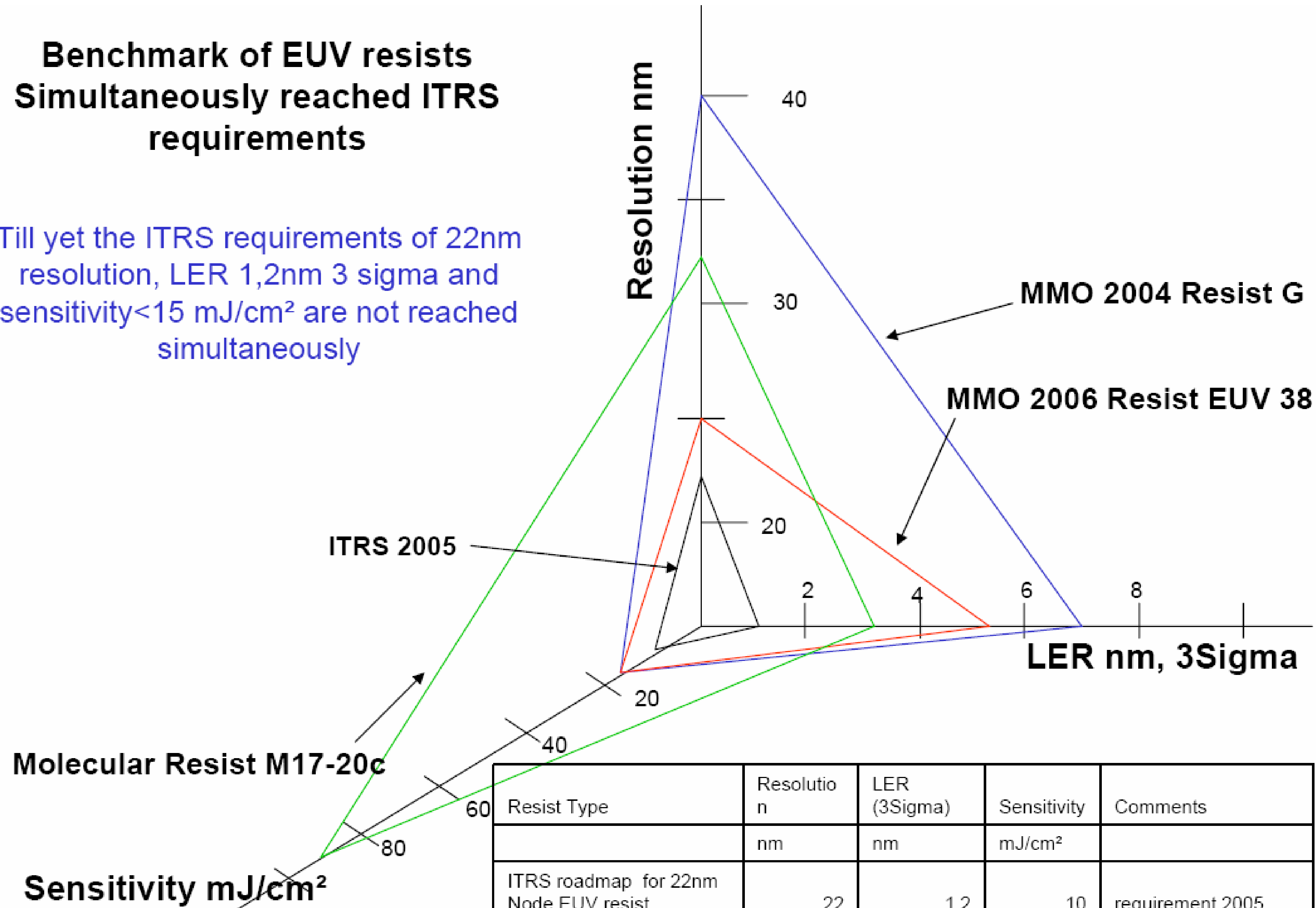
In More Moore objective was broken down to the following tasks:

- Physicochemical characterisation of photo resists. Developing the necessary characterisation tools and techniques allowing, to understand the physic of CAR and the impact of thin film.
- EUV resist systems for the 22 nm node, to propose formulation of EUV resist fulfilling the requirements of the EUV lithography.
- Evaluation of the 22 nm node capability (resolution limit) of existing and novel resist systems
- Line Edge Roughness. Simulate the resist performance and LER formation, propose LER quantification methods, and try to understand Line Edge Roughness and the impact on devices

Underestimation of *Resist* as Critical Issue in EUVL



Courtesy of K. Van Verden and P. Zandbergen

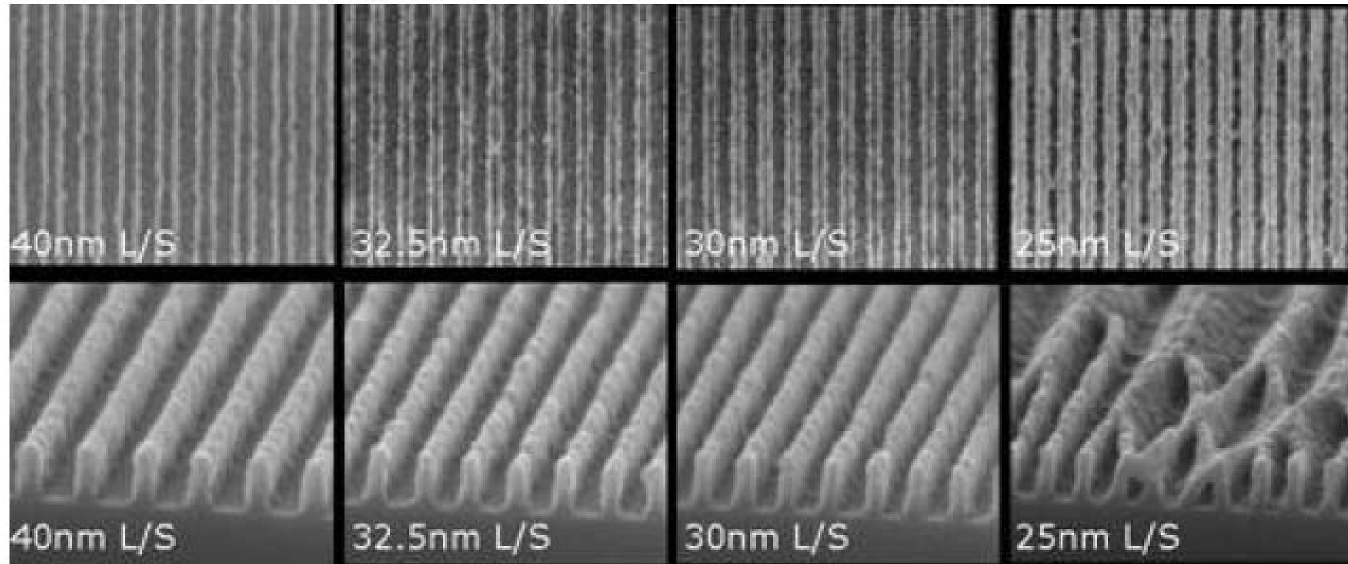


Resist Type	Resolution	LER (3Sigma)	Sensitivity	Comments
	nm	nm	mJ/cm²	
ITRS roadmap for 22nm Node EUV resist	22	1,2	10	requirement 2005
MMO 2004 Resist G	40	7	15	CAR best achievment
MMO 2006 Resist EUV38	25	5,1	15	CAR best achievment
Molecular Resist M17-20c	32,5	3,3	91	Polycarbocycle

EXTREME ULTRAVIOLET LITHOGRAPHY

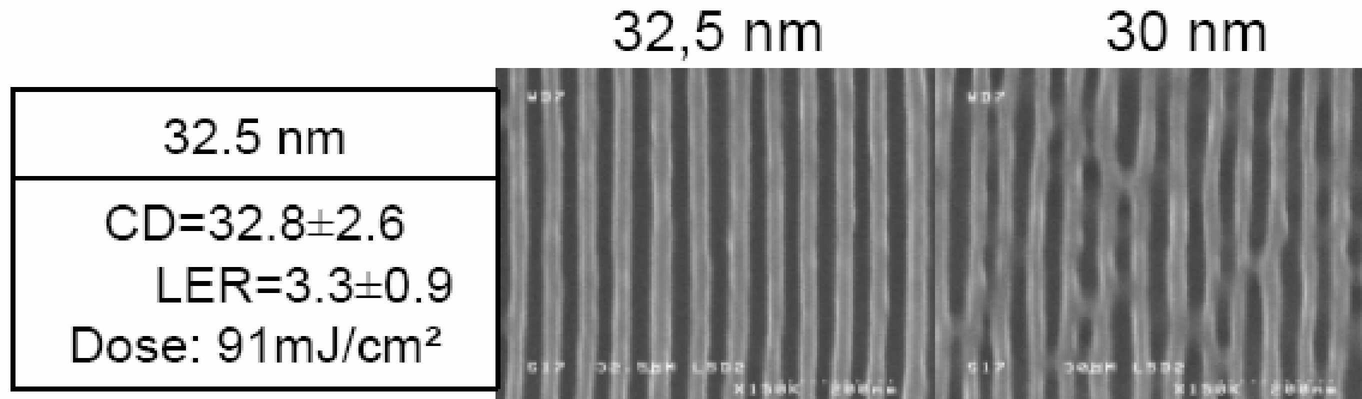
Main achievement on CAR

The classical polymer CAR hits 2006/07 the 25 nm resolution barrier, which was shown with samples from resist vendors at PSI.



Top-down (top) and X-sectional SEM (bottom) pictures of 40nm L/S down to 25nm L/S in the current state of the art resist EUV-38.

Main achievement on molecular resist



sample J19	M17-30c (PAB 50°)
L2D4 resist dose **31** mJ/cm²	50 nm dense lines CD=49.1±1.9 **LER=2.7**±0.5

The molecular resist formulation M17-20C, positive working and based on polycarbocycle chemistry platform, resolved lines of 32,5nm with LER of 3.3nm.
Sensitivity is still too low but potential of improvement is given

Conclusion

The ITRS requirements are not simultaneously fulfilled, but potential for improvements is given.

➢ The most important results were:

- The understanding of LER was supported by computer simulation
- Photoresists with small polymer chains and small acid diffusion give low LER, like molecular resist chemistry.
- EUV resist gives evidence of a high dose regime where LER is controlled by resist properties and a low dose regime where LER is controlled by shot noise.
- High flare conditions of commercial EUV tools results in an increase of LWR, decrease in exposure latitude and degradation of the resist profiles.