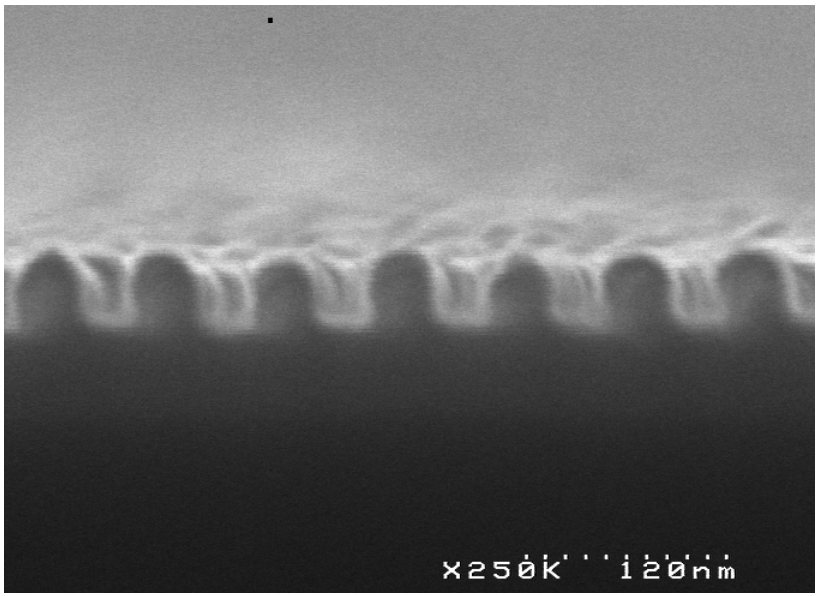
EXTREME ULTRAVIOLET LITHOGRAPHY

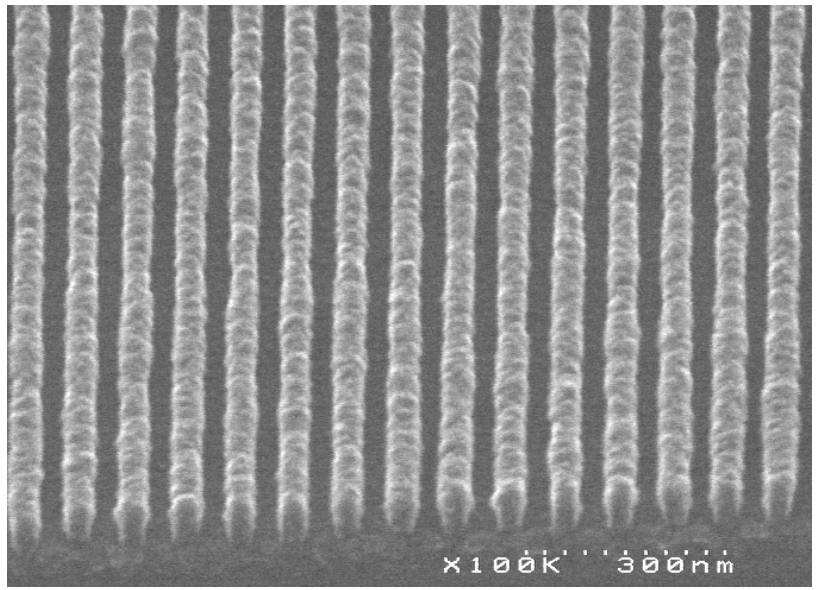
Update from More Moore
Serge Tedesco CEA-LETI

High resolution and low LER EUV resist

Best achieved results on CAR with IL-EUV at PSI

Film thickness 55 nm. Resolution 32.5 nm dense lines.

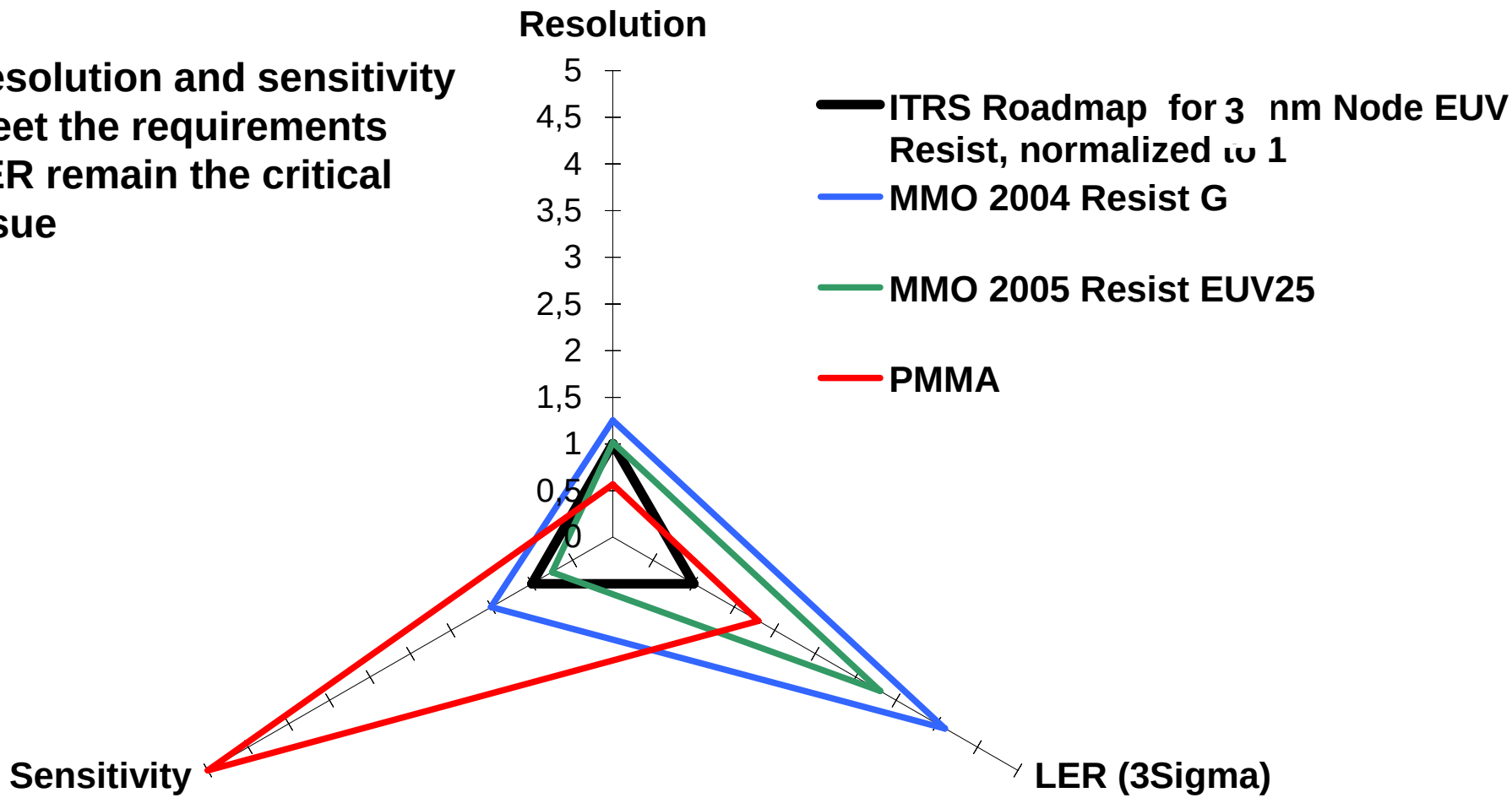




Few improvements achieved in 2005

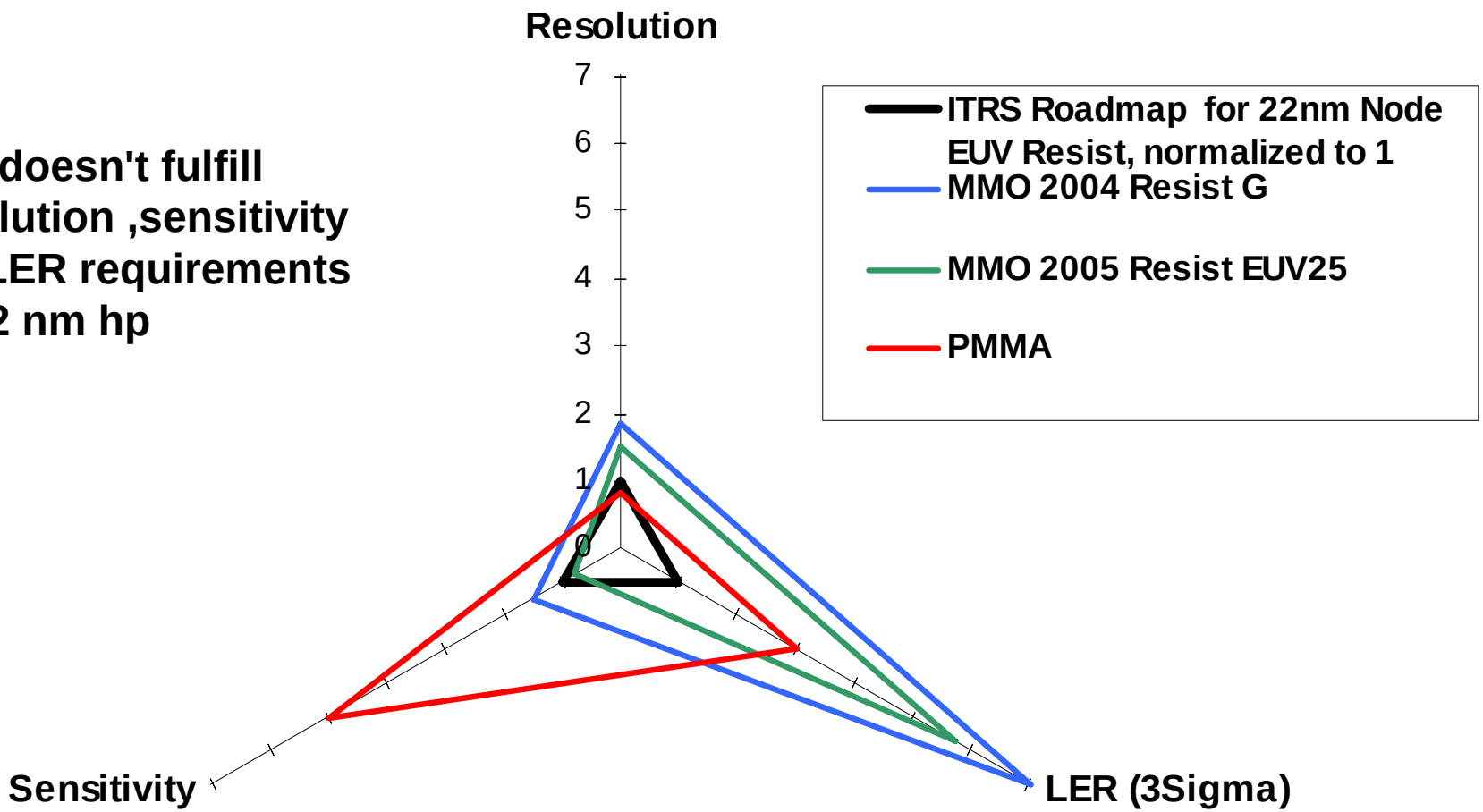
Resist status vs ITRS roadmap for the 32 nm hp

Resolution and sensitivity meet the requirements
LER remain the critical issue



Resist status vs ITRS roadmap for the 22 nm hp

CAR doesn't fulfill Resolution ,sensitivity and LER requirements for 22 nm hp



More Moore orientation for 22 nm hp

Because of the lack of improvement during 2005 the resist has been ranked issue number one for EUV-lithography at the international EUV symposium at San Diego.

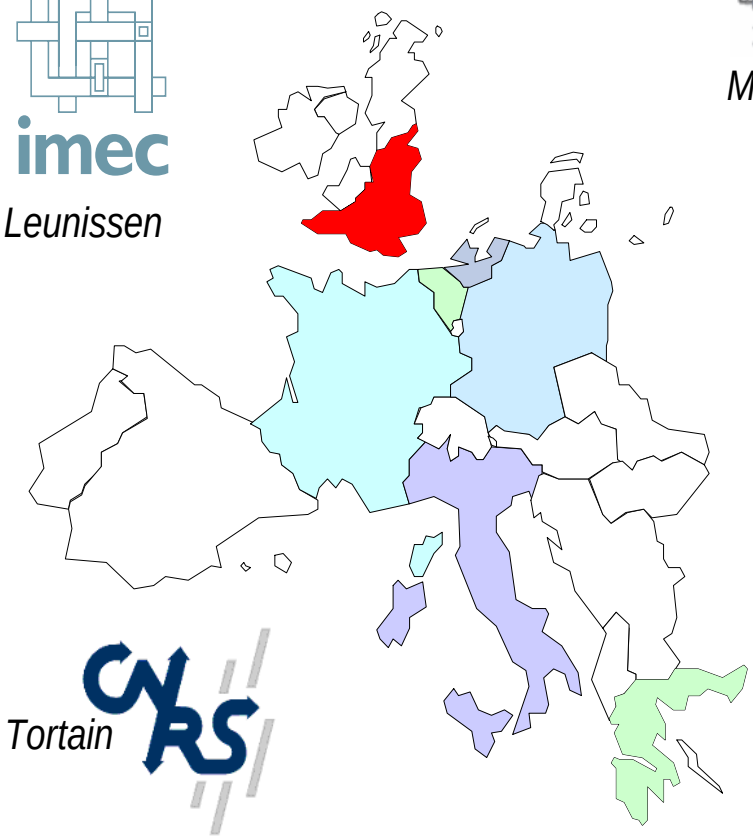
As a consequence the decision to reinforce the resist activity in more Moore has been decided.
The orientation is to study alternative to CAR by looking at new resist platform.

two new specific tasks have been introduced one will be carried out by IMEL and the other by introducing a new partner the University of Birmingham

IMEL Demokritos will work on molecular resists based on polycarbocycle derivatives: material optimization and lithographic evaluation.

University of Birmingham is involved to develop and optimise new molecular photoresists based on Fullerenes and Triphenylenes.

More Moore Partners for Resist evaluation



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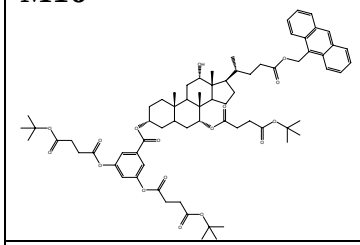
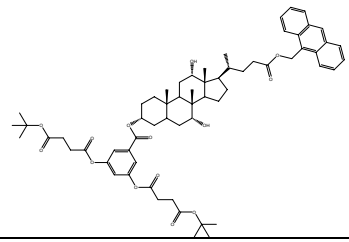
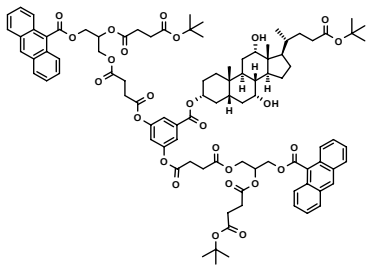
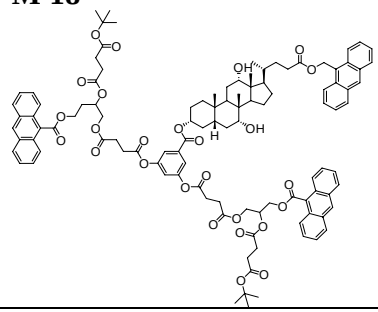
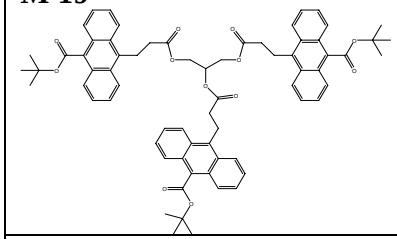
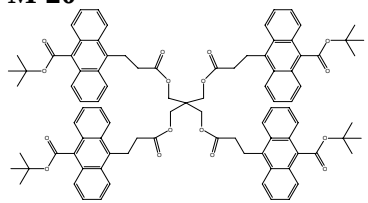
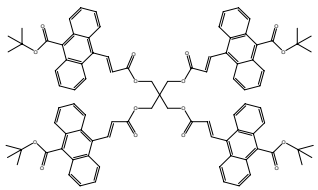
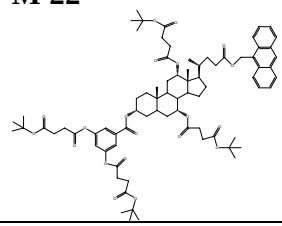
Newly-synthesized Polycarbocycles, under Evaluation as components of Molecular Resists

M16 	**M16-A** 
M 17 	**M 18** 
M 19 	**M 20** 
M 21 	**M 22** 

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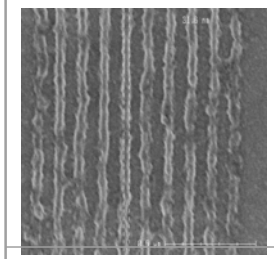
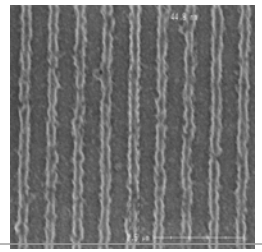
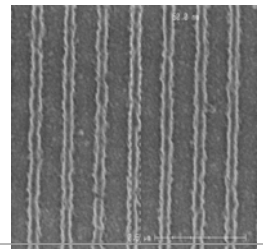
Lithographic Results at EUV (Evaluation at Sandia and Sematech North)



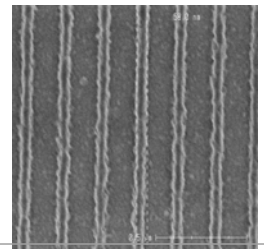
20 nm



25 nm

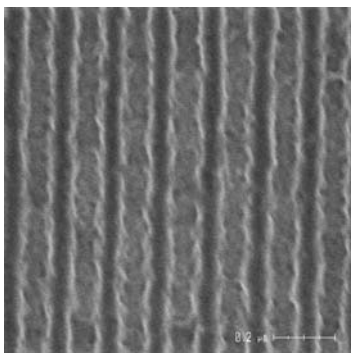


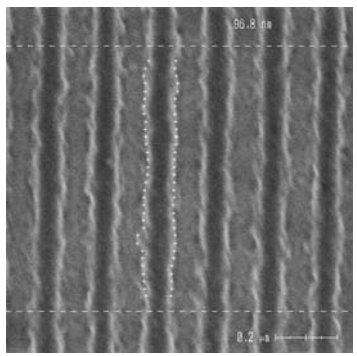
30 nm

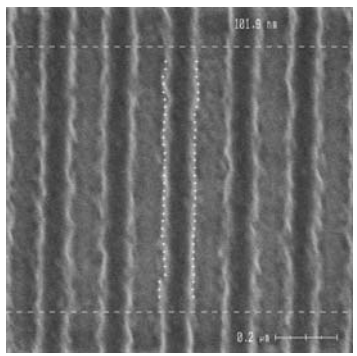


35 nm

Sub 40nm lithographic features obtained under EUV exposure (at Sematech North) for the M21-based resist formulations . Dose: 48 mJ/cm^2







M17-based material
80/90/100nm (1:1)
Dose: 10.5mJ/cm^2

(EUV SematechNorth)

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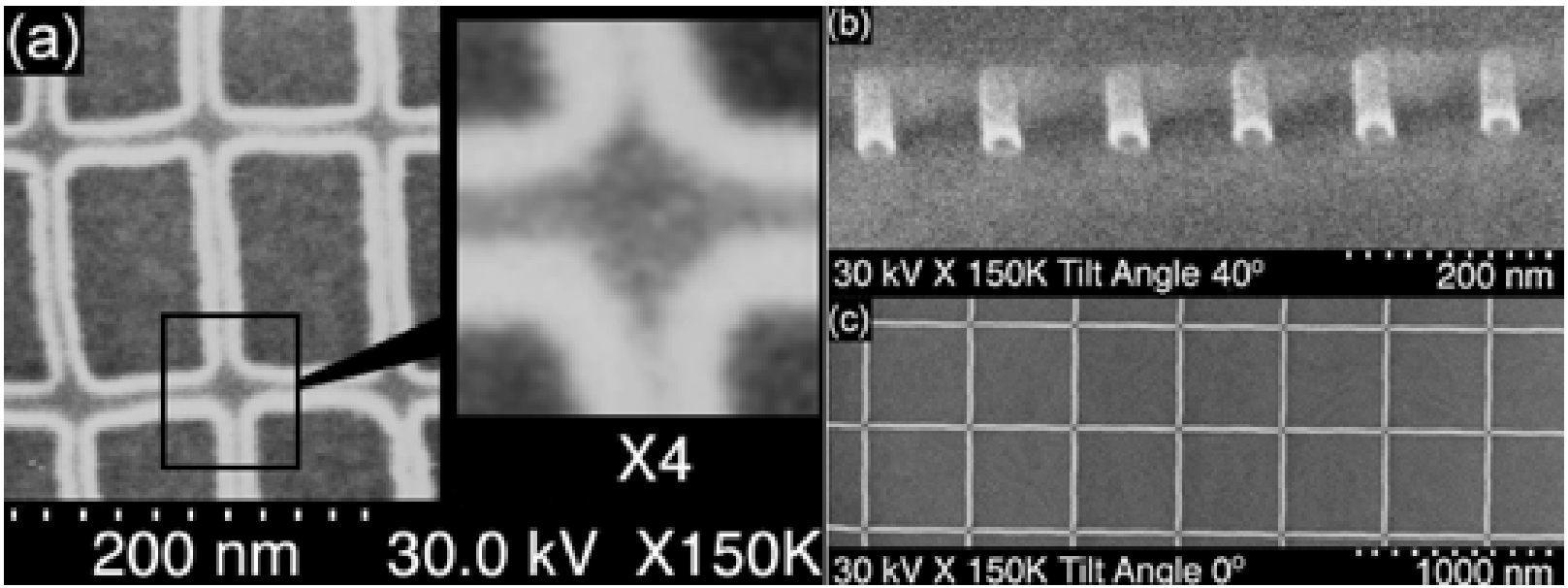
Fullerene and Triphenylene Patterning

UNIVERSITY OF BIRMINGHAM

NPRL

Both the fullerene derivatives (a) and the triphenylenes (b & c) are capable of sub 20 nm patterning.



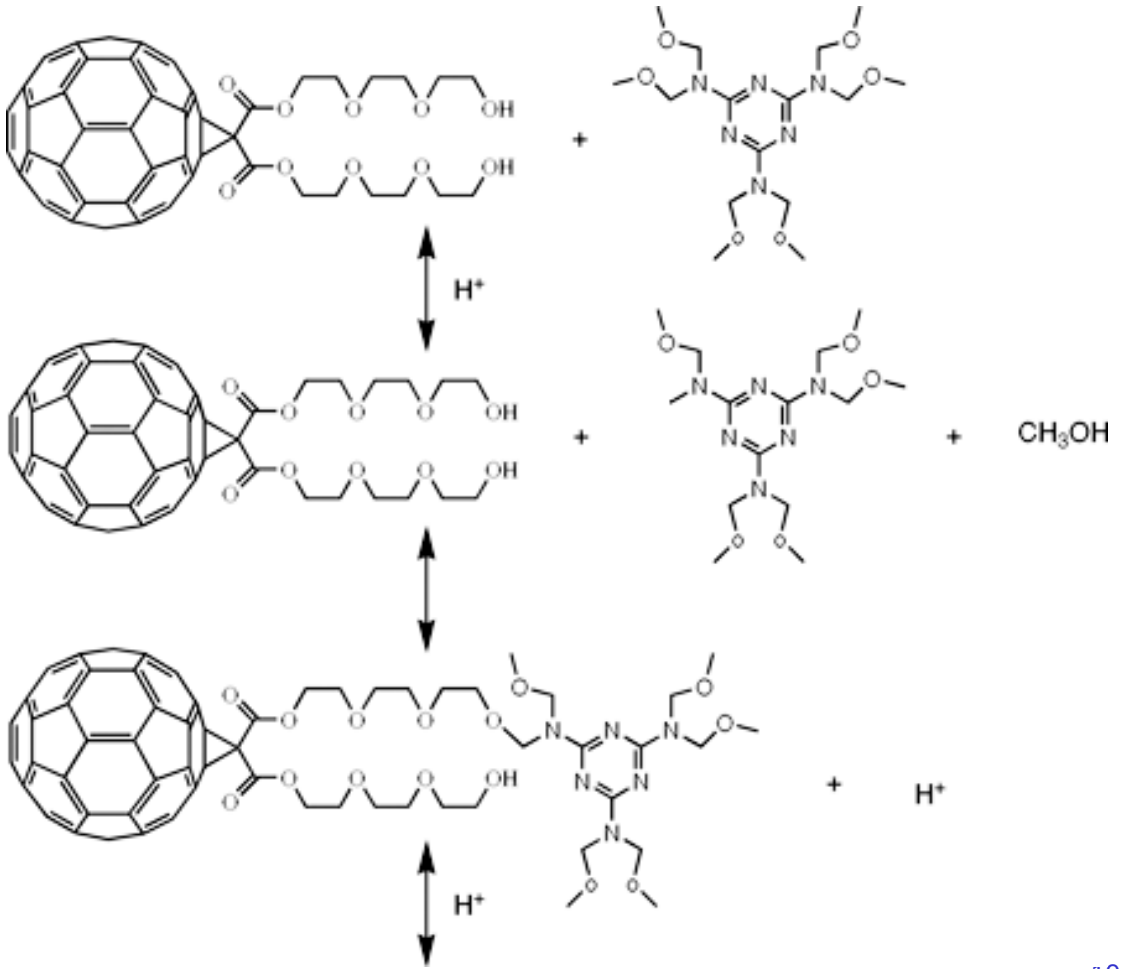
Chemical Amplification with HMMM and PAG

UNIVERSITY OF BIRMINGHAM

NPRL

Initially we used hexamethylmethoxy melamine crosslinker and triphenylsulfonium triflate photoacid generator to amplifiy the sensitivity.

Significant sensitivity improvements were seen (for instance from 650 to 7.5 μC/cm^2.)



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Conclusions

- 32.5 nm resolution was reached by CAR resist which give hope that CAR could be pushed for the 32 nm hp but LER is still a critical issue.
- But we don’t expect CAR could reached resolution, sensitivity and LER for the 22nm node.
- Research on „New“ resist has been introduced in More Moore

Roads to the 22 nm ?

- CAR improvement :
  - **Polymer matrix type, Mw decreasing**
  - **PAG /Quencher concentration and type**
  - **….**
- LER could be improved through process resist smoothing:
  - **Surface conditioning**
  - **CO2 supercritical**
  - **Etching**
  - **….**
- Molecular resist with added CA functionalities
- Copolymer self assembled resist
- …..