

The influence of chemical composition on Line Edge Roughness values in 193nm resists



E. Ismailova
C. Chochos
C. Brochon
C. A. Serra
G. Hadziioannou



R. Tiron
C. Sourd
P.
Bandelier
J. Foucher



O. Soppera
H. Ridaoui



D. Perret
C. Brault

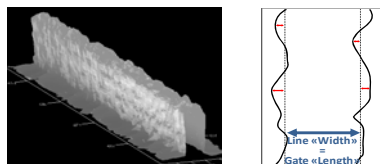


The increasing performance of the integrated circuits produced by the constant reduction of their dimensions. The "Line Edge Roughness" has been introduced in 2001 with progressive miniaturization of the components in the microelectronic industry. This microlithography pattern roughness limits the possibility to control accurately the length of the transistor gate increasing, thus, it's leaking currents.

The aim of our research is to understand the physical chemical mechanisms inducing the LER and optimize the synthesis and formulation of the photosensitive resists.

Definition

Line Edge Roughness (LER) & Line Width Roughness (LWR)
3σ deviation of an edge from a line fit to that edge

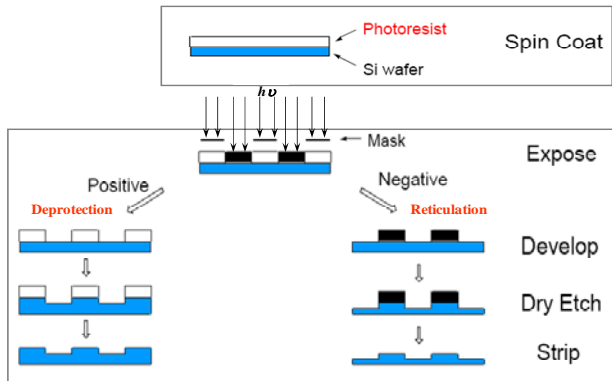


Approach

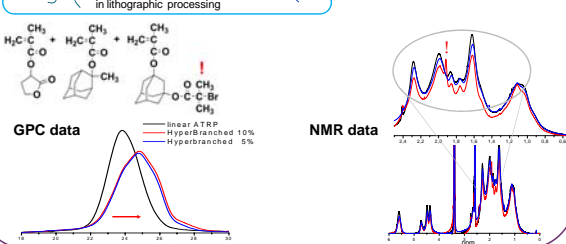
- Synthesis and characterization of resins
- Lithography of the model resist
 - understanding of the relationship between material - properties - process
- Lithography of new model resist
 - new resist formulation with branched cleavable macromolecules

Photolithography

Creating the patterns in Semiconductor Chip Manufacture

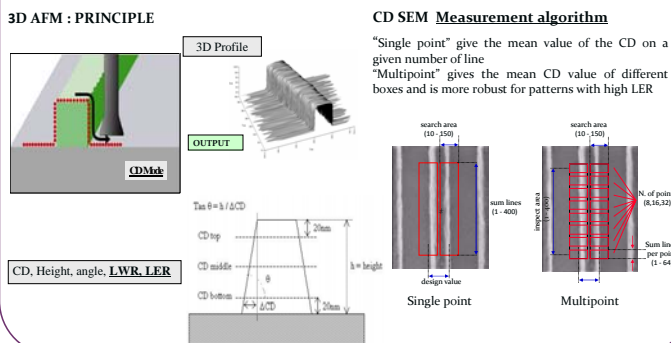


Polymers Synthesis



LER and LWR measurements

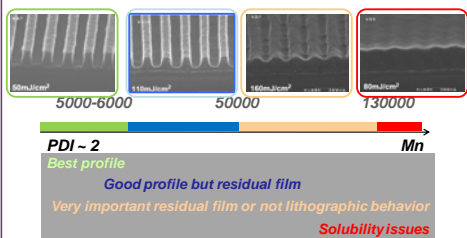
Two techniques in order to measure resist's LWR and LER
CD-SEM and AFM 3D



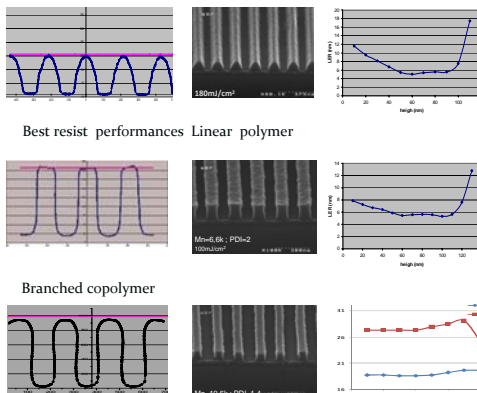
Results

Lithographic performance

Ref. resist commercial formulation RHEM

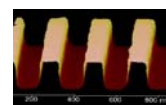


Degradation of the profile with Mn increasing



3D AFM measurements:

Sidewall Roughness Measurement



Resist	Average 3σ LER values
Ref.	5-6 nm
Linear	5-6 nm
Branched	18-19 nm

Request the processing optimization

Conclusion

- We have demonstrated the impact of the polymer molecular weight and the polydispersity on the lithographic performances
 - linear polymers with low Mn and intermediate PDI showed similar LER performances with the commercial photoresists
- New branched polymer architectures have been tested for the first time in the microlithography
 - branched resists present lithographic sensitivity and the capability to 100 nm patterning