micro resist technology

JENA IPHT

Nanometer Patterning using ma-N 2400 Series DUV Negative Photoresist and Electron Beam Lithography

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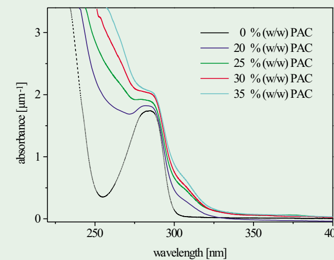
Abstract

The continual rapid growth of the information and communication technologies demands the development of more sophisticated lithographie tools and the search for new high performance resist materials.
Results of nanometer patterning by means of electron beam lithography using ma-N 2400 series photoresist are presented. The ma-N 2400 series is a DUV sensitive negative tone photoresist composed of a phenolic resin (novolak) as polymeric binder and a bisazide as photoactive compound (PAC) dissolved in safer solvents. This resist works without chemical amplification consequently its processing does not comprise any critical steps.
The resist is developed in aqueous-alkaline developers.
80 nm patterns with excellent steep side walls are achieved. The resist offers good wet and plasma etch resistance.

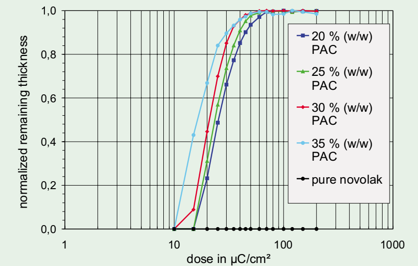
Resist Process

ma-N 2400 series resist	Chemically amplified resist
Spin coating	Spin coating
Prebake	Prebake
Exposure	Exposure
	Post exposure bake
No further steps	Critical steps: • time delay between exposure and post exposure bake • bake conditions
Development	Development

Sensitivity optimizing



UV/vis spectra of resist films with various PAC contents

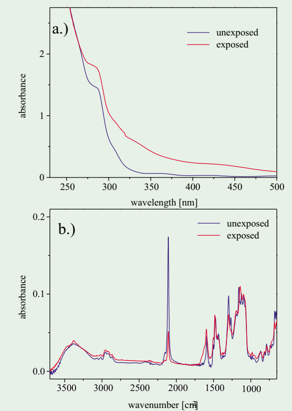


Exposure characteristics of the resist films of various PAC contents
film thickness 0.8 µm, Developer MIF 726, 120 sec

- Pure novolak does not show any crosslinking.
- The exposure sensitivity increases with increasing PAC amount.
- The resist contrast increases with increasing PAC amount.
- The degree of photolysis of the acido groups (vibrational band 2106 cm^{-2}) to achieve stable (sufficiently crosslinked) patterns is decreased with increasing PAC amount.

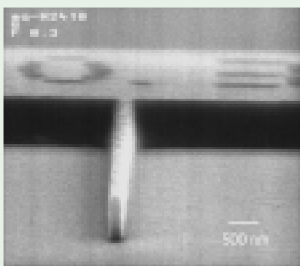
Degree of photolysis by e-beam exposure with 120 $\mu C/cm^2$ for various PAC amounts

PAC amount [%]	Degree of photolysis [%]
20	93
25	80
30	73
35	70

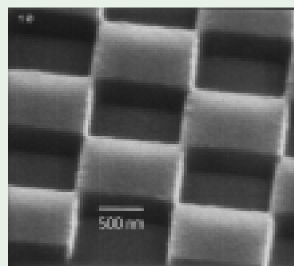


a.) UV/vis spectra and b.) IR sprectra of unexposed and exposed resist films with 35 % (w/w) PAC

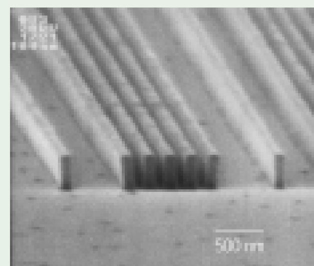
Resist patterns



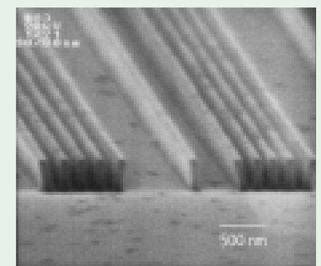
Single line of **0.25 µm width**
film thickness 0.8 µm,
exposure dose 120 $\mu C/cm^2$ (ZBA 23, 20 kV),
developer MIF 726, 120 sec



Chess pattern
film thickness 0.3 µm,
exposure dose 120 $\mu C/cm^2$, (ZBA 23, 20 kV),
developer MIF 726, 60 sec



Single line/ lines and spaces of **100 nm** (on the left) and of **90 nm** (on the right) **width**
film thickness 0.35 µm,
exposure dose 101 $\mu C/cm^2$ (LION LV1, 20 kV),
developer MIF 726, 30 sec



Single line/ lines and spaces of **90 nm** (on the left) and of **80 nm** (on the right) **width**
film thickness 0.35 µm,
exposure dose 101 $\mu C/cm^2$ (LION LV1, 20 kV),
developer MIF 726, 30 sec

Conclusions

- ma-N 2400 resist series is easily - no critical steps, a wide process latitude.
- The exposure doses range from 60 to 120 $\mu C/cm^2$.
- Developing times can be varied in a wide range wiithout loss of pattern width and height.
- 80 nm are obtained at film thickness of 0.3 µm.
- Aspect ratio > 3.

Acknowledgement

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