Negative E-Beam Resists AR-N 7700

AR-N 7700 e-beam resists with steep gradation

High-resolution e-beam resists for the production of integrated circuits

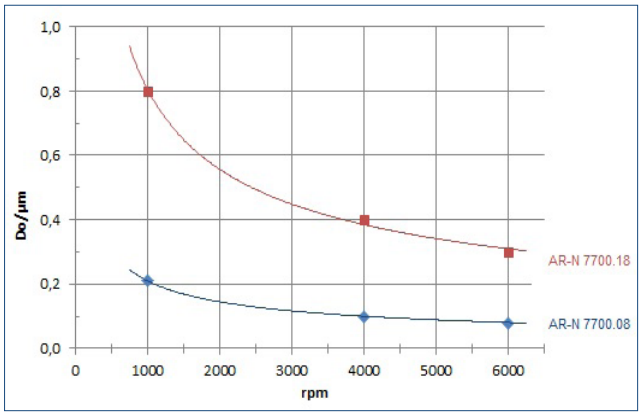
Characterisation

- e-beam, deep UV; chemically enhanced (CAR)
- 7700: high contrast for digital reproduction with excellent sensitivity
- negative-tone with high resolution in the UV range 248-265 nm and 290-330 nm
- plasma etching resistant, temp. stable up to 140 °C
- novolac, acid generator, crosslinking agent
- safer solvent PGMEA

Properties I

Parameter / AR-N	7700.18	7700.08
Solids content (%)	18	8
Viscosity 25 °C (mPas)	4	2
Film thickness/4000 rpm (µm)	0.4	0.1
Resolution best value (nm)	80	
Contrast	5	
Flash point (°C)	42	
Storage 6 month (°C)	8 - 12	

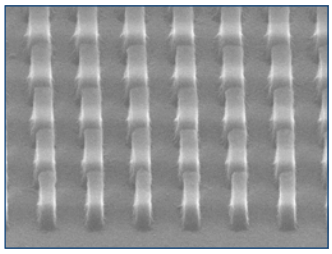
Spin curve



Properties II

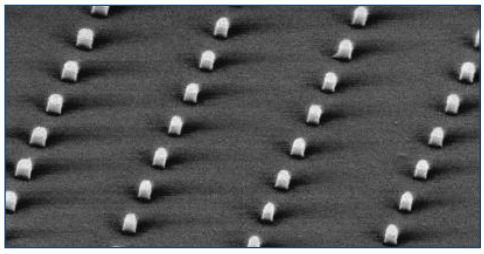
Glass trans. temperature (°C)	102	
Dielectric constant	3.1	
Cauchy coefficients not crosslinked / crosslinked	N_0	1.596/ 1.604
	N_1	77.0 / 85.5
	N_2	65.0 / 56.9
Plasma etching rates (nm/min) (5 Pa, 240-250 V Bias)	Ar-sputtering	8
	O_2	168
	CF_4	38
	80 CF_4 + 16 O_2	89

Structure resolution



AR-N 7700.18
112 x 164 squares, film thickness of 400 nm

Resist structures



AR-N 7700
500-nm dots, written with a dose of 12 µC/cm² (30 kV).

Process parameters

Substrate	Si 4“ waver
Soft bake	85 °C, 90 s, hot plate
Exposure	ZBA 21, 30 kV
Development	AR 300-46, 60 s, 22 °C

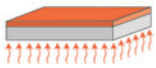
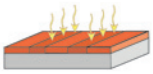
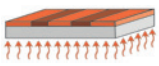
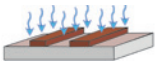
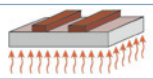
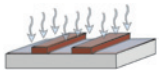
Process chemicals

Adhesion promoter	AR 300-80 new
Developer	AR 300-46, 300-26
Thinner	AR 300-12
Remover	AR 300-73, AR 300-76

Negative E-Beam Resists AR-N 7700

Process conditions

This diagram shows exemplary process steps for AR-N 7700 resists. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, ☞ "Detailed instructions for optimum processing of e-beam resists". For recommendations on waste water treatment and general safety instructions, ☞ "General product information on Allresist e-beam resists".

Coating 	AR-N 7700.18	AR-N 7700.08	
	4000 rpm, 60 s 0.4 µm	4000 rpm, 60 s 0.1 µm	
Sopft bake (± 1 °C) 	85 °C, 2 min hot plate or 85 °C, 30 min convection oven		
E-beam exposure 	ZBA 21, 30 kV		
	E-beam exposure dose (E_0):		
	12 µC/cm²	8 µC/cm²	
UV exposure (optional)	UV exposure dose: (E_0):	for mix & match	
	30 mJ/cm²	24 mJ/cm²	
Crosslinking bake 	105 °C, 2 min hot plate or 100 °C, 60 min convection oven		
Development (21-23 °C ± 0,5 °C) puddle 	AR 300-46 60 s	AR 300-46, 4 : 1 60 s	
Rinse	DI-H_2O, 30 s		
Post-bake (optional) 	120 °C, 1 min hot plate or 120 °C, 25 min convection oven for slightly enhanced plasma etching resistance		
Customer-specific technologies 	Generation of semiconductor properties		
Removal 	AR 300-73 or O_2 plasma ashing		

Development recommendations

optimal | suitable

Developer	AR 300-26	AR 300-35	AR 300-40
AR-N 7700.18 ; 7700.08	2 : 1 ; 1 : 3	undil. up to 3 : 1	300-46 undil. ; 300-46, 4 : 1

Negative E-Beam Resists AR-N 7700

Processing instructions

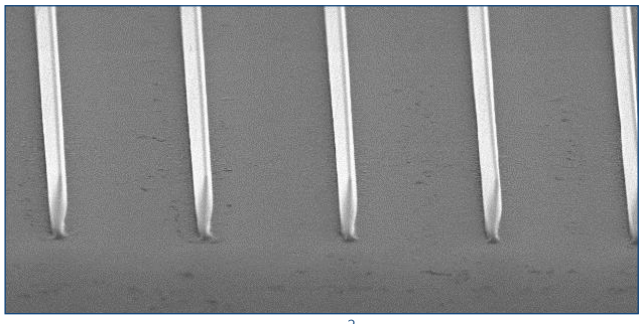
These resists are predestined for e-beam exposure, but also suitable for UV exposure. During e-beam exposure, the resist works in a negative mode. The exposure dose mainly depends on the acceleration voltage, the substrate and the film thickness. The resist also work in a negative mode after deep UV exposure if the image-wise exposure is performed at a wavelength of 248-265 and 290-330 nm. A bake step is mandatory after exposure (e-beam/UV) to induce the required crosslinking.

Contrast and development rate strongly depend on the tempering. Recommended is a temperature of 105 °C (hot plate, 2 min), with possible variation of ± 5°C. Higher crosslinking temperatures require stronger developers. Contrast and development rate can be influenced to a large degree if developer strength and tempering temperature are coordinated accordingly. The general rule is: the weaker the developer, the higher is the contrast and the lower the development rate. The development time ideally is about 60 s (30 … 120 s) at 21 – 23 °C. Shorter times for complete development will attack the crosslinked structures.

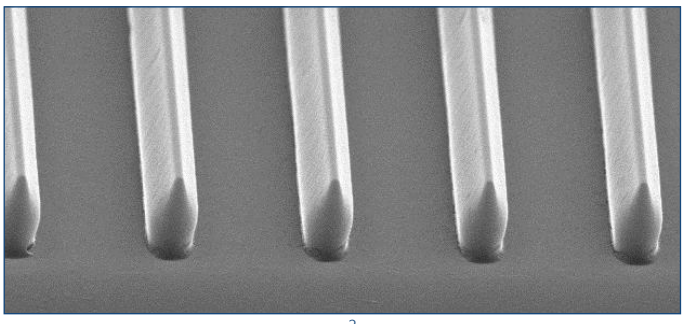
Proximity effect

If electrons are used for the irradiation of resist films, always a certain amount of scattered radiation will occur, either as forward scattering due to an interaction with the resist material or as backscattering from the substrate (wafer). This phenomenon is called proximity effect and results in undesirable changes of the structures. The proximity effect is significantly more pronounced if sensitive resists (CAR) as compared to e.g. PMMA resists are used.

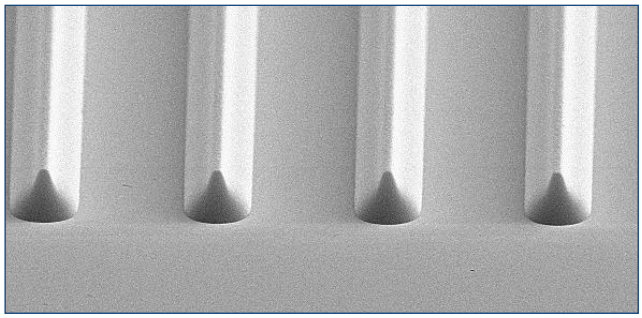
In the following example, AR-N 7700.18 was applied by spin coating to yield a film thickness of 1100 nm, tempered (85 °C, 2 min, hot plate) and irradiated with different doses (20 kV). The crosslinking bake was carried out at 105 °C, 3 min on a hot plate. After development (AR 300-46 undil., 2 min), the following structures were obtained. Clearly visible is an increased widening of the 250-nm bars with higher exposure doses.



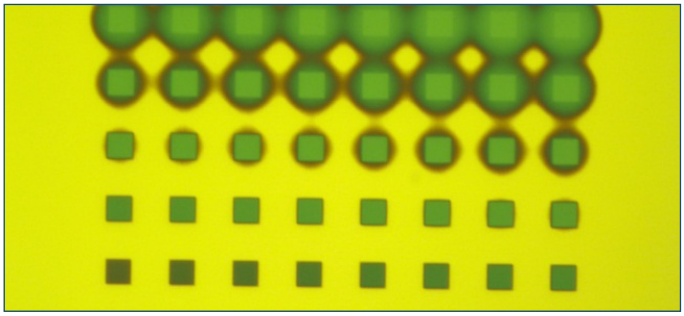
AR-N 7700.18 dose 19.5 µC/cm^2



AR-N 7700.18 dose 37.0 µC/cm^2



AR-N 7700.18 dose 63.5 µC/cm^2



Dose sequence of AR-N 7700.08 : Squares were written with a dose of 1.0 – 90 µC/cm^2. The proximity effect at higher doses is quite apparent.