

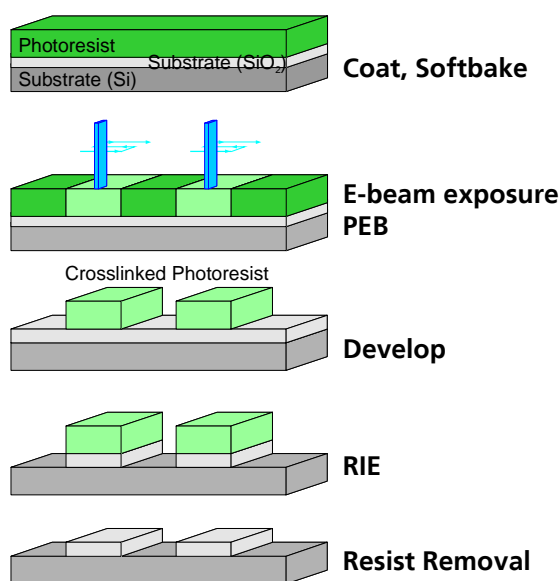
Processing Guidelines

Negative Tone Photoresists mr-EBL 6000

Characteristics

mr-EBL 6000 is a chemically amplified negative tone photoresist for the use in micro- and nanoelectronics.

- Electron beam sensitive
- Well suitable as an etch mask exhibiting high dry and wet etch resistance
- Excellent thermal stability of the resist patterns
- High resolution capability
- Development in organic solvents



Process flow for electronbeam lithography and reactive ion etching (RIE)

Physical properties of the resist solution

Properties		mr-EBL 6000.1	mr-EBL 6000.3	mr-EBL 6000.5
Film thickness ¹	[nm]	100 ± 10	300 ± 25	500 ± 40
Dynamic viscosity ²	[mPa s]	1.3 ± 0.1	2.3 ± 0.1	3.3 ± 0.2
Density	[g cm ⁻³]	1.008 ± 0.002	1.029 ± 0.002	1.038 ± 0.003

¹ Spin coated at 3000 rpm for 30 s ² 25°C, 1000 s⁻¹

Processing

Best patterning results are obtained at temperatures of 20 – 25 °C and a relative humidity of 40 – 46 %. The resist and unexposed resist films have to be processed under yellow light. The guidelines relate to standard processing of resist films spin-coated on silicon or silicon dioxide. The specific process parameters to be applied depend on substrate, application and equipment.

This information is based on our experience and is, to the best of our knowledge, true and accurate. It should inform you about our products and their application processes. We don't guarantee special features of our products or use for a concrete process.

Processing Guidelines

Processing conditions

Resist		mr-EBL 6000.1	mr-EBL 6000.3	mr-EBL 6000.5
Film thickness	[nm]	100	300	500
Substrate preparation		Oven: 200 °C, 30 min for Si and SiO ₂ substrates, oxygen plasma		
Spin coating	[rpm] [s]	3000 30		
Prebake				
Hotplate	[°C] [min]	100 – 120 3	100 – 120 3	100 – 120 3
Exposure dose ¹				
10 keV	[μC cm ⁻²]	2 – 5	2 – 5	2 – 5
20 keV	[μC cm ⁻²]	4 – 6	4 – 6	4 – 6
50 keV	[μC cm ⁻²]	20 – 40	20 – 40	20 – 40
Post exposure bake (PEB)				
Hotplate	[°C] [min]	100 – 120 5	100 – 120 5	100 – 120 5
Development ² mr-Dev 600	[s]	40 ± 10	50 ± 10	60 ± 10

¹ proximity correction is necessary, ² immersion development

Substrate preparation:

The substrates have to be free of impurities and moisture. They should be baked at 200 °C and cooled to room temperature immediately before coating. Alternatively, oxygen or ozone plasma cleaning is recommended.

Coating:

Uniform coatings are obtained by spin coating of mr-EBL 6000 solutions in the thickness range indicated in the spin curves. Please select the appropriate resist type and spin speed required for the desired film thickness and application. The information refers to an open spin-coating system. The film thickness is measured after the prebake process. It is recommended to use a filter when applying the resist to the wafer for spin-coating.

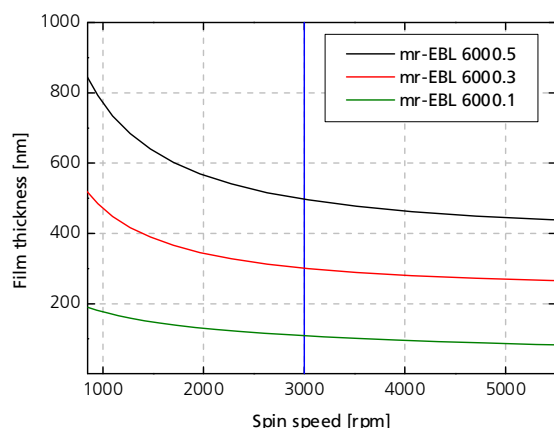


Fig. 1 : Spin curves of mr-EBL 6000, 30 s spin time

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The refractive index of the resist film depending on the wavelength and the Cauchy equation are given in Fig. 2. This information is needed for ellipsometric or other optical thickness measurement.

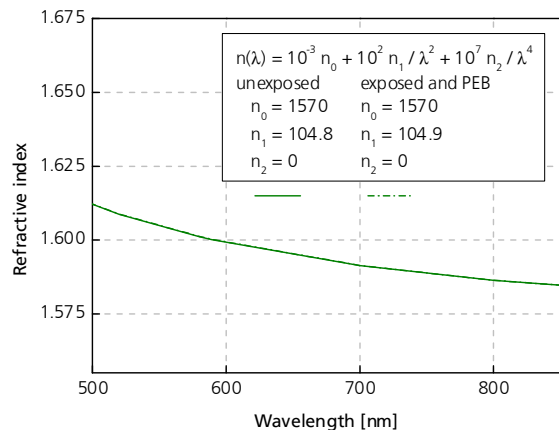


Fig. 2: Refractive index vs. wavelength, Cauchy coefficients of unexposed and exposed and post exposure baked (PEB) mr-EBL 6000

Prebake:

The spin coated resist films are baked at 100 to 120 °C on a hotplate for 3 min.

Exposure:

The resist is effective for e-beam exposure. With higher electron energies the exposure dose shifts to higher doses. For a specific film thickness the generation of smaller features requires higher exposure doses than larger features. The use/ application of proximity correction is necessary. Contrast increases with acceleration voltages.

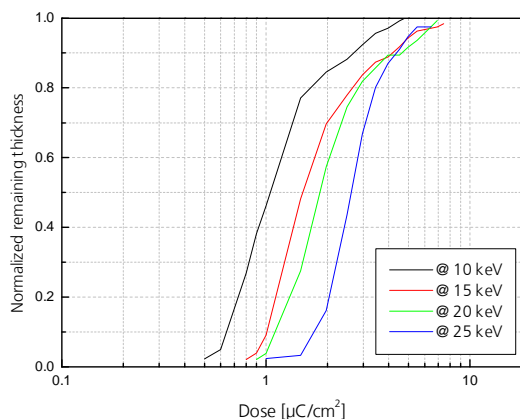


Fig. 3: Sensitivity curves at different electron energies

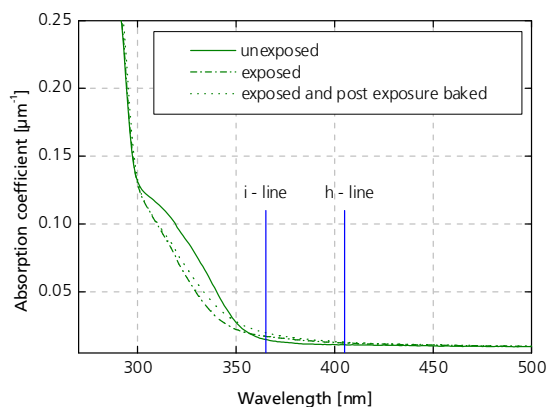


Fig. 4: UV/vis absorption of unexposed, exposed and exposed and post exposure baked mr-EBL 6000

Post exposure bake:

The exposed resist films are baked at 100 – 120 °C on a hotplate for 5 min immediately after exposure.

Develop:

Ready-to-use developer **mr-Dev 600** is recommended. The temperature of the developer should be 20 – 25 °C. The developed resist films are thoroughly rinsed with isopropanol and then dried.

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Hardbake (optional):

If required, the etch resistance and the thermal stability of the resist can be further increased. Hardbaking of the developed resist patterns is suggested at 100 °C – 140 °C in an oven or on a hotplate for 5 – 15 min.

Removal:

Ready-to-use removers **mr-Rem 660** (NMP based) and **mr-Rem 500** (NMP free) are recommended. This also can be done at temperatures of 40 – 60 °C assisted by ultrasonics. Oxygen plasma is also suitable for the removal of the resist. Please note that the material is strongly cross-linked after the processing and therefore its removal is not easy.

Storage

Storage at temperatures of 18 – 25 °C is recommended. Do not store mr-EBL 6000 in a refrigerator. Resist and unprocessed resist films have to be stored under yellow light. Keep the bottle closed when not in use. Under these conditions a shelf life of 12 months from the date of manufacture is ensured.

Disposal

Unexposed resist: dispose of as halogen free solvent
Exposed resist: dispose of as resist/ old resist

Environmental and health protection

mr-EBL 6000 contains "safe solvents". Ensure that there is adequate ventilation while processing the resist. Avoid contact of the resist with skin and eyes and breathing solvent vapours. Wear suitable protective clothing, safety goggles and gloves.

Equipment

mr-EBL 6000 is compatible with most commercially available photoresist processing equipment. The data given in these guidelines were obtained using:

- Convac spin coater or Suss Delta 6 spin coater without cover
- Contact hotplate
- Leica EBPG 5000plus at 50 keV
- Zeiss SEM LEO 1530 with Raith lithographic capabilities
- Immersion development

Patterning examples (by courtesy of HHI/ Berlin)

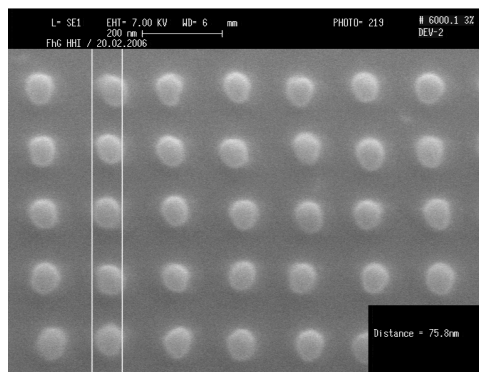


Fig.5: 100 nm thick mr-EBL 6000, 80 nm dots

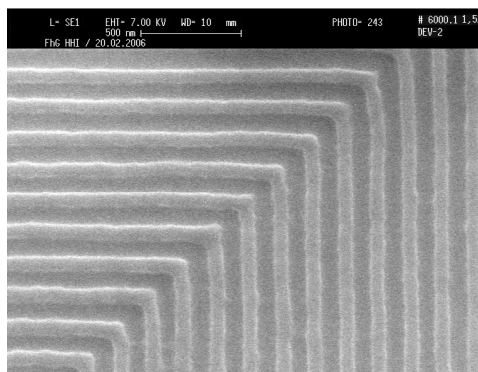


Fig.6: 100 nm thick mr-EBL 6000, 80 nm lines/ spaces

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