Köpenicker Straße 325, 12555 Berlin – Germany
Tel.: +49 30 641670 100 • Fax: +49 30 641670 200 • mrt@microresist.de

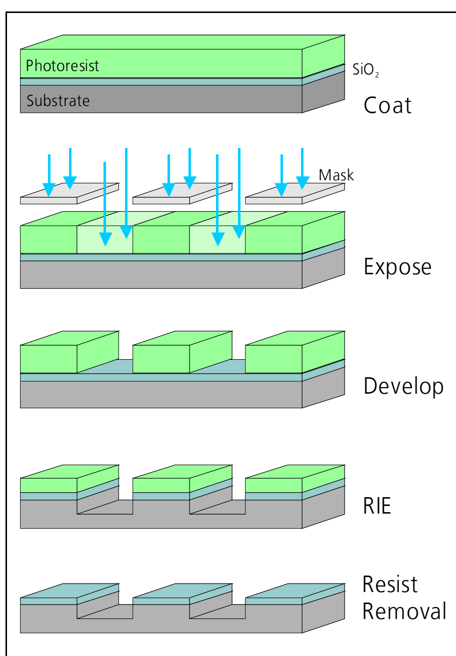
www.microresist.com

Positive Tone Photoresist Series ma-P 1200

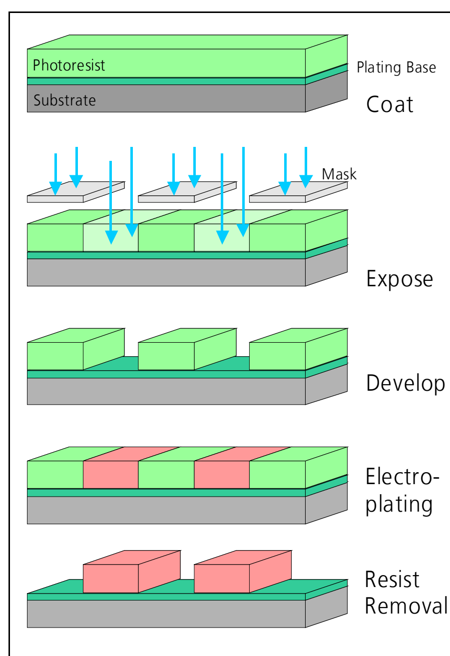
Characteristics

ma-P 1200 is a positive tone photoresist series designed for the use in microelectronics and microsystems technology. The resists are available in a variety of viscosities for film thicknesses of 0.3 – 40 µm in one spin-coating step.well suitable as an etch mask exhibiting high dry and wet etch resistance

- Broadband, g-, h- and i-line exposure
- Very good pattern stability in wet etch processes and acid and alkaline plating baths
- Highly stable in dry etch processes e.g. CHF_3, CF_4, SF_6
- good thermal stability of the resist patterns attainable
- aqueous alkaline development



Process flow for reactive ion etching (RIE)



Process flow for electroplating

Physical properties of the resist solutions

Resist		ma-P 1205	ma-P 1210	ma-P 1215	ma-P 1225	ma-P 1240	ma-P 1275
Film Thickness[1]	[µm]	0.5 ± 0.08	1.0 ± 0.1	1.5 ± 0.1	2.5 ± 0.1	4.0 ± 0.1	7.5 ± 0.2
Dynamic Viscosity[2]	[mPa s]	5 ± 0.3	12 ± 1	22 ± 1	50 ± 3	125 ± 10	460 ± 30
Density[3]	[g cm^{-3}]	1.007 ± 0.002	1.025 ± 0.002	1.036 ± 0.002	1.051 ± 0.002	1.064 ± 0.002	1.080 ± 0.002

[1] Spin coated at 3000 rpm for 30 s   [2] 25°C, 1000 s^{-1} [3] 20 °C

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.

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Processing conditions

Resist		ma-P 1205	ma-P 1210	ma-P 1215	ma-P 1225	ma-P 1240	ma-P 1275
Film thickness (3000 rpm)	[µm]	0.5	1.0	1.5	2.5	4.0	7.5
Substrate preparation		Oven: 200 °C, 30 min (HMDS for Si und SiO_2 substrates)					
Spin coating	[min^{-1}] [s]	3000 30					
Prebake							
Hotplate	[°C] [s]	100-105 30-60	100-105 60-90	100-105 90-120	100-105 120-180	100-105 240-300	100-105 300-480
Oven	[°C] [min]	105 30	105 30	105 30	105 30-40	105 30-40	105 40-50
Exposure dose[1]	[mJ/cm²]	35 ± 5	45 ± 5	55 ± 5	55 ± 5	110 ± 10	150 ± 10
Development[2] ma-D 331	[s]	10 ± 5	20 ± 5	25 ± 5	40 ± 10	40 ± 10	75 ± 20
mr-D 526/S (2,38% TMAH)	[s]	15 ± 5	25 ± 5	25 ± 5	45 ± 10	50 ± 10	85 ± 20

[1] broadband exposure, intensity measured at λ = 365 nm [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. For improving resist film adhesion to Si and SiO_2 substrates it is advisable to apply an adhesion promoter such as HMDS.

Coating:

Uniform coatings are obtained by spin coating of ma-P 1200 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.

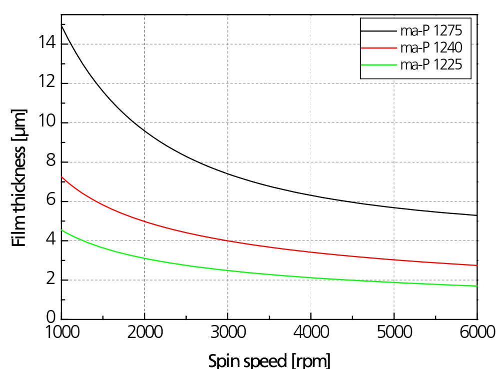

Fig. 1: Spin curves of ma-P 1275, ma-P 1240 and ma-P 1225, 30 s spin time

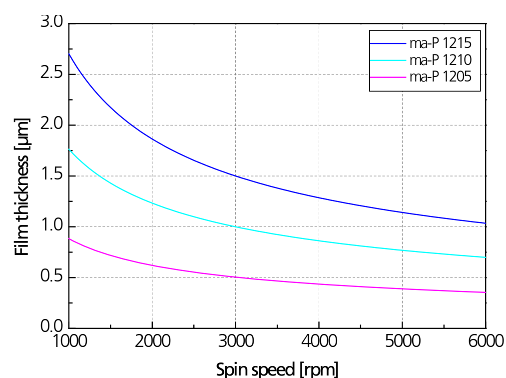

Fig. 2: Spin curves of ma-P 1215, ma-P 1210 and ma-P 1205, 30 s spin time

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The refractive index of the resist film depending on the wavelength and the Cauchy equation are given in Fig. 3. This information is needed for ellipsometric or other optical thickness measurement.

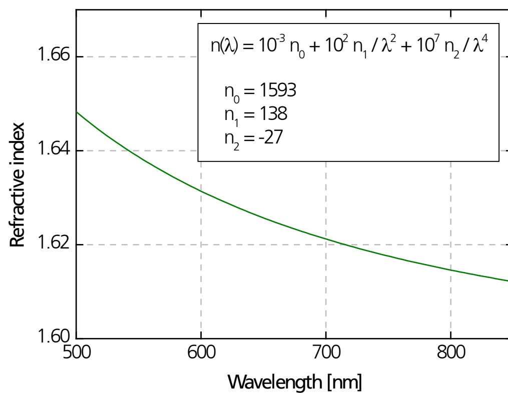

Fig. 3: Refractive index vs. wavelength, Cauchy coefficients of unexposed ma-P 1200

Prebake:

Resist films are baked at 100 – 105 °C on a hotplate or in a convection oven. If required, the etch resistance and thermal stability of the resist can be increased by applying a higher prebake temperature (max. 110 °C) or a longer prebake time. The developing time and the required exposure dose will increase in this case.

Exposure:

The resist is effective for broadband, g-line or i-line exposure.
The resists can also be exposed with UV-LED single wavelength emission, e.g. 390 nm and 410 nm.

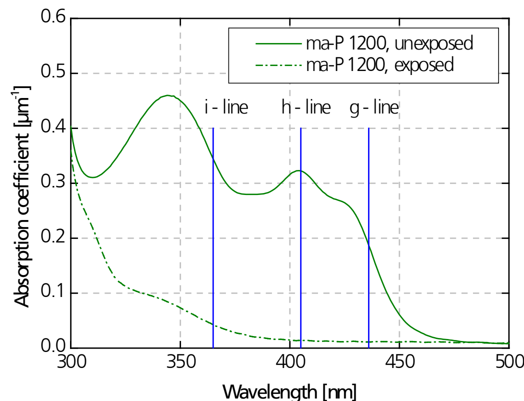

Fig. 4: UV/vis absorption of unexposed and exposed ma-P 1200

Develop:

Ready-to-use developer **ma-D 331** is recommended, or surfactant containing **ma-D 331/S** which can be beneficial e.g. on gold substrates. **ma-D 526/S** is available as metal-ion free developer. Alternatively, 0.26n (2.38%) TMAH developers of other manufacturers can be applied. The temperature of the developer should be 20 – 25 °C. The developed resist films are thoroughly rinsed with deionized water and then dried.

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Hardbake (optional):

If required, the etch resistance and thermal stability of the resist can be further increased. Hardbaking of the developed resist patterns is suggested in an oven at 100 °C – 120 °C for approximately 30 min. A temperature ramp is beneficial in order to reduce pattern reflow.

Removal:

Ready-to-use removers **mr-Rem 500** (free of N-methylpyrrolidon (NMP)), **mr-Rem 700** (free of NMP and of N-ethylpyrrolidon (NEP)) and **ma-R 404/S** (strongly alkaline) are recommended. Acetone, 1-methoxy-2-propyl acetate (PGMEA), or oxygen plasma is also suitable for the residue free removal of the resist.

Storage

Storage at temperatures of 18 – 25 °C is recommended.
Resists 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.
A shelf life of 12 months is ensured for developers and removers.

Disposal

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

Environmental and health protection

ma-P 1200 resist series contains "safe solvents". Ensure that there is adequate ventilation while processing the resists. Avoid contact of the resists with skin and eyes and breathing solvent vapours. Wear suitable protective clothing, safety goggles and gloves.

Equipment

ma-P 1200 resists are compatible with most commercially available photoresist processing equipment.
The data given in these guidelines were obtained using:
- SAWATEC or Suss Delta 6 spin coater
- contact hotplate/ convection oven
- Suss MA56 and MA6 mask aligner
- UV LED exposure tool
- immersion development

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Patterning examples (Resist patterning by mask aligner broadband exposure)

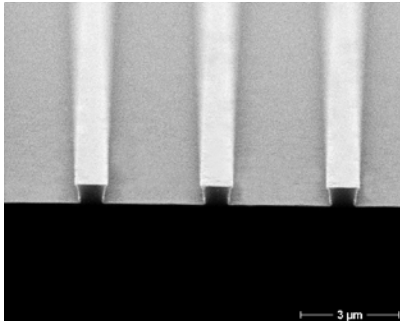


Fig. 5: 0.5 µm ma-P 1205, 1 µm lines, 3 µm spaces

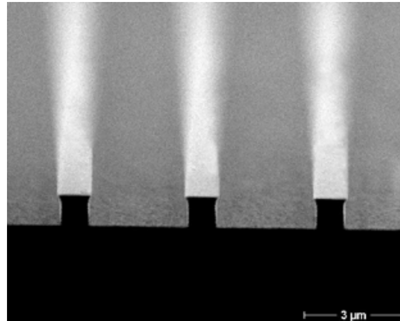


Fig. 6: 1 µm ma-P 1210, 1 µm lines, 3 µm spaces

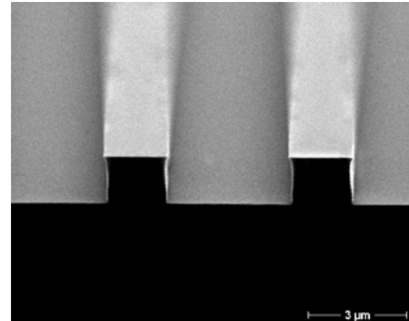


Fig. 7: 1.5 µm, ma-P 1215, 2 µm lines, 4 µm spaces

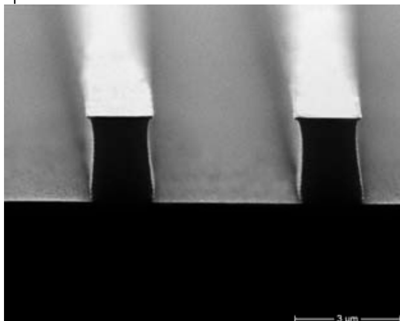


Fig. 8: 2.5 µm ma-P 1225, 2 µm lines, 4 µm spaces

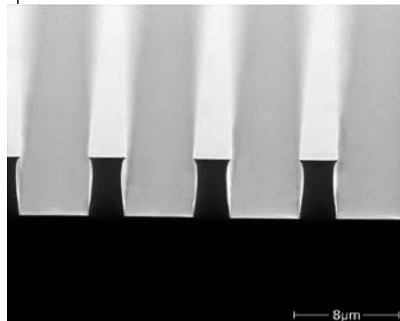


Fig. 9: 4 µm ma-P 1240, 3 µm lines, 5 µm spaces

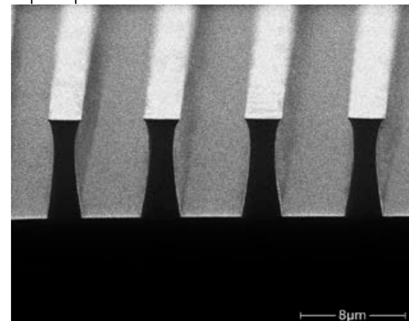
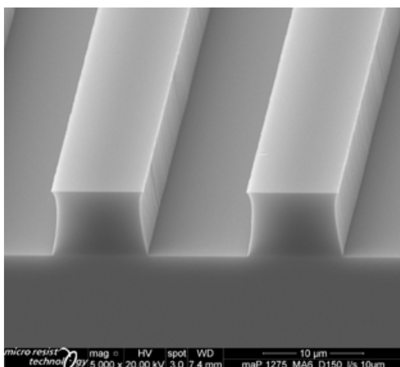
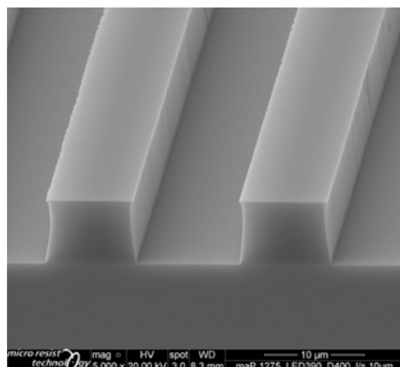


Fig. 10: 7.5 µm ma-P 1275, 3 µm lines, 5 µm spaces

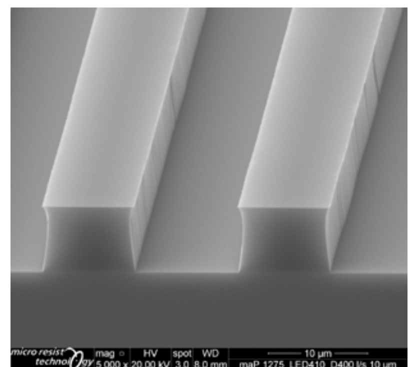
Comparison Mask Aligner and UV LED exposure



7.5 µm ma-P 1275, 10 µm L/S
Mask Aligner, broadband
D(365nm) = 150 mJ/cm², D(405nm) = 100 mJ/cm², D(436nm) = 100 mJ/cm²



7.5 µm ma-P 1275, 10 µm L/S
UV LED @ 390 nm, D = 400 mJ/cm²



7.5 µm ma-P 1275, 10 µm L/S
UV LED @ 410 nm, D = 400 mJ/cm²

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