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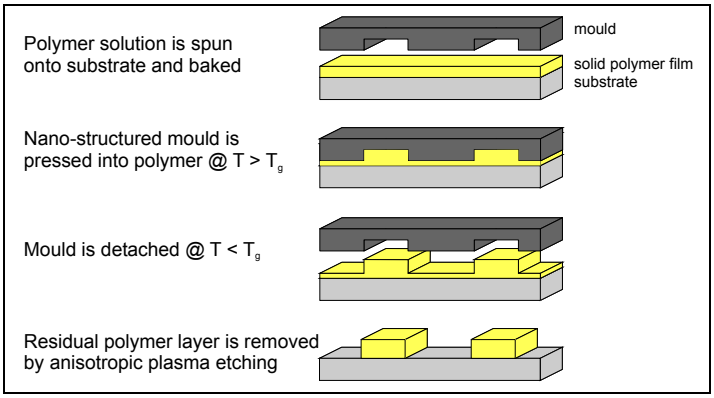
mr-I 7000 Thermoplastic Polymer for Nanoimprint Lithography

Characteristics

mr-I 7000 is a thermoplastic polymer system with a glass transition temperature (T_g) of 60 °C designed for nanoimprint lithography. mr-I 7000 series polymers are provided as ready-to-use solutions for various film thickness and exhibit an excellent plasma etch resistance.



Process scheme of nanoimprint lithography

Physical data of mr-I 7000 solutions

		mr-I 7010	mr-I 7020	mr-I 7030
Appearance/colour		colourless, clear	colourless, clear	colourless, clear
Film thickness[1)]	[nm]	100 ± 15	200 ± 15	300 ± 20
Density[2)]	[g cm^{-3}]	0.975 ± 0.005	0.980 ± 0.005	0.985 ± 0.005
Dynamic viscosity[2)]	[mPa s]	4 ± 1	7 ± 1	10 ± 2
Refractive index n_D^{25}		1.406 ± 0.002	1.408 ± 0.002	1.410± 0.002
Metal ion content	[ppm]	< 2	< 2	< 2

[1)]Spin coated at 3000 rpm for 30 s
[2)]25 °C

Processing

Best patterning results are obtained at temperatures of 20 – 25 °C and a relative humidity of 40 – 46 %. The guidelines relate to standard processing of polymer films spin coated on silicon.

micro resist technology

Processing conditions

		mr-I 7010	mr-I 7020	mr-I 7030
Film thickness	[nm]	100 ± 15	200 ± 15	300 ± 20
Substrate preparation		Oven 200 °C, 30 min		
Spin coating	[rpm] [s]	3000 30		
Bake				
Hotplate	[°C] [min]	140 2		
Oven	[°C] [min]	140 15		
Imprinting				
Temperature	[°C]	125 – 150		
Pressure	[bar]	50		
Time at maximum temperature	[min]	2 – 5		
Release temperature	[°C]	50 – 60		

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.

Coat:

Uniform coatings are obtained by spin coating of the polymer solutions in the thickness range indicated in the spin curves. Please select the appropriate polymer solution and spin speed required for the desired film thickness and application.

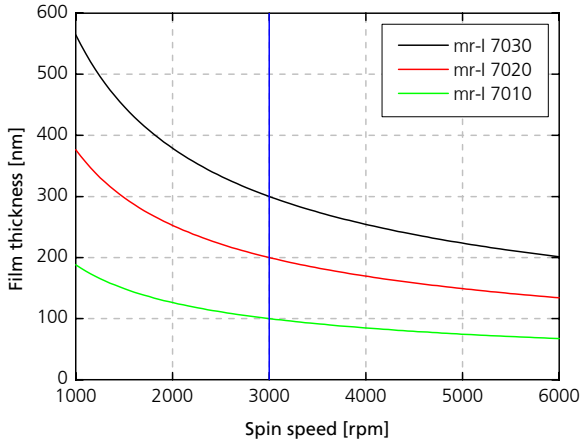


Fig. 1: Spin curves, 30 s spin time

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

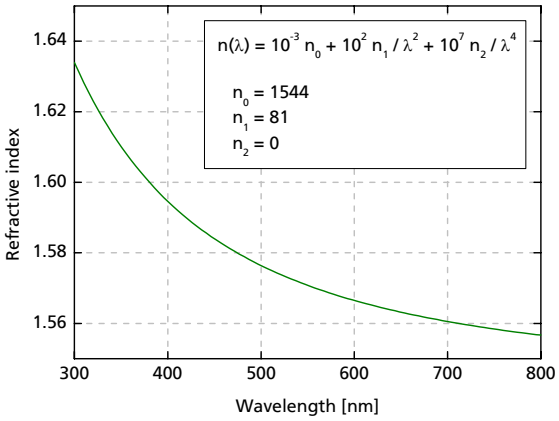


Fig. 2: Refractive index vs. wavelength, Cauchy coefficients of mr-I 7000

Prebake:

The spin coated polymer films are baked at 140 °C for 2 min on a hot plate or for 15 min in a convection oven.

Imprint:

Main factors determining the imprint conditions are the rheological behaviour of the polymer, the mould layout (feature size, density of the patterns etc.), the residual layer thickness to be attained and the imprinting tool. mr-I 7000 can be imprinted in any tool suitable for doing thermal nanoimprint lithography. Commercial nano-imprinters as provided e.g. by EV Group (Austria), Obducat (Sweden), and Suss MicroTec (Germany) may be used.

Imprint conditions

Typically the polymers are heated to 50 – 80 K above T_g and the stamp with nanometer-scale patterns is pressed into the films with a pressure of e.g. 30 – 50 bar to transfer the pattern. After having cooled to a temperature not higher than 5 K above T_g of the polymer, the stamp is released.

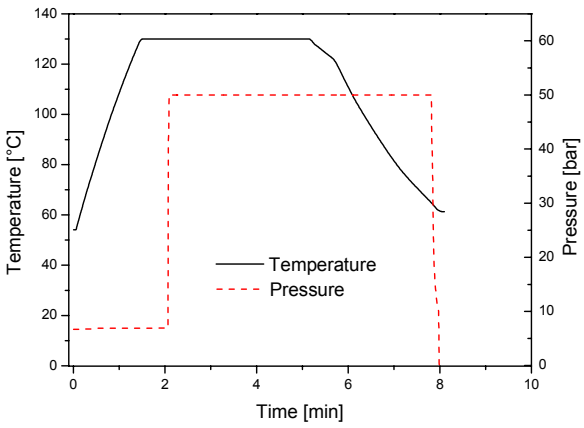


Fig. 3: Example of a process cycle (mr-I 7020, air cooling)

Residual polymer layer removal:

The residual layer remaining in the recessed areas of the polymer film after the imprint is removed by oxygen reactive ion etching (RIE) in order to open the window to the substrate.

Removal:

After the whole process residue-free removal of mr-I 7000 is preferably achieved using organic solvents such as acetone or 1-methoxy-2-propyl acetate (PGMEA). The polymer may also be removed by applying oxygen plasma.

Storage

Storage at temperatures of 15 – 25 °C is recommended. Storage in a refrigerator is not required. Keep mr-I 7000 bottles closed when not in use. Under these conditions, a shelf life of 12 months from the date of manufacture is ensured.

Disposal

Dispose of as halogen free solvent.

Environmental and health protection

mr-I 7000 solutions contain "safe solvents". Ensure that there is adequate ventilation while processing the polymer solution. Avoid contact of the solution with skin and eyes and breathing solvent vapours. Wear suitable protective clothing, safety goggles and gloves.