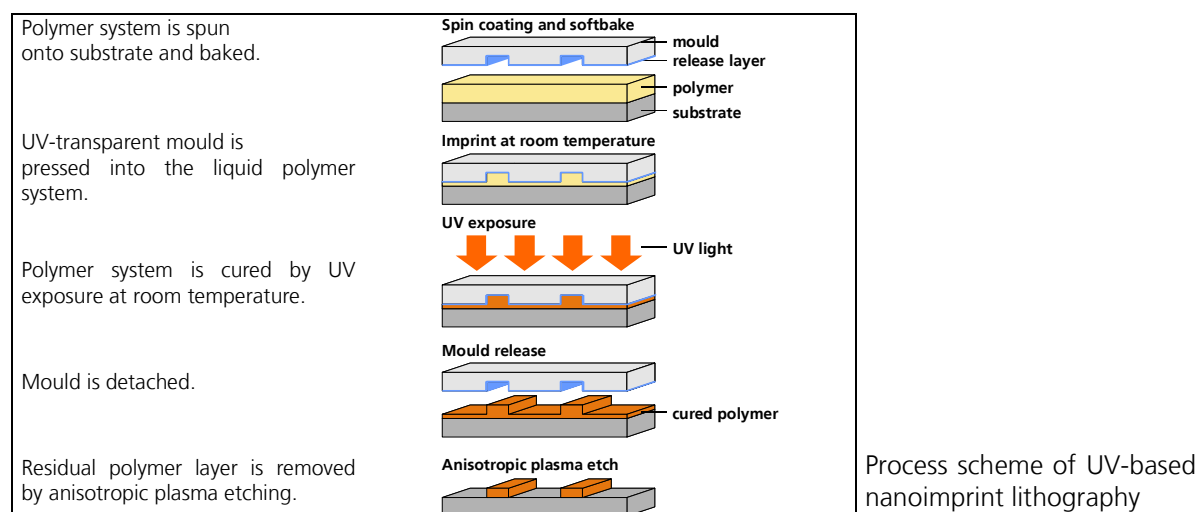


Processing Guidelines

mr-UVCur21 series – UV-curable Polymer for UV-based Nanoimprint Lithography

Characteristics

mr-UVCur21 is a liquid UV-curable polymer system with low viscosity and high curing rate designed for UV-based nanoimprint lithography. It is provided as a ready-to-use solution. Optimum imprint results on Si or SiO₂ substrates are achieved by applying adhesion promoter mr-APS1 before coating mr-UVCur21.



Physical data

	mr-UVCur21-100nm	mr-UVCur21-200nm	mr-UVCur21-300nm
Colour, appearance	colourless, clear	colourless, clear	colourless, clear
Film thickness ¹⁾ [nm]	100 ± 15	200 ± 15	300 ± 20
Density ²⁾ [g cm ⁻³]	0.935 ± 0.005	0.945 ± 0.005	0.955 ± 0.005
Dynamic viscosity ²⁾ [mPa s]	1.7 ± 0.2	1.9 ± 0.2	2.2 ± 0.2
Refractive index n _b ²⁵	1.412 ± 0.002	1.418 ± 0.002	1.422 ± 0.002

¹⁾ Liquid film after spin coating at 3000 rpm for 60 s and subsequent softbake at 80 °C for 1 min

²⁾ 25 °C

Processing

Best patterning results are obtained at temperatures of 20 – 25 °C and a relative humidity of 40 – 46 %.

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

Process step	mr-UVCur21-100nm	mr-UVCur21-200nm	mr-UVCur21-300nm
Substrate preparation	(1) Oven 200 °C, 30 min (2) Adhesion promoter pretreatment (mr-APS1)		
Spin coating ¹⁾	[rpm] [s]	3000 60	
Softbake	Hotplate 60 s at 80 °C		
Film thickness (liquid film) [nm]	100 ± 15	200 ± 15	300 ± 20
Imprinting and UV exposure	Temperature [°C] room temperature		
Pressure ²⁾ [mbar]	> 100		
Exposure dose ³⁾ [mJ/cm ²]	> 700		

¹⁾ Uncovered spin coater

²⁾ Strongly dependent on the pattern density of the mould

³⁾ Referring to a UV intensity integrated in the wavelength range 320–420 nm, curing in vacuum

Substrate preparation

The substrates have to be free of impurities and moisture in order to achieve optimum adhesion. The substrates should be baked at 200 °C and cooled to room temperature immediately before coating. Alternatively, oxygen or ozone plasma cleaning is recommended. For improving the polymer film adhesion to Si or SiO₂ substrates it is advisable to apply an adhesion promoter. We recommend using mr-APS1 (*micro resist technology*). Omnicat (MicroChem Corp., USA) works as an adhesion promoter, too. HMDS (hexamethyl-disilazane) is not suitable.

Coating

Uniform coatings are obtained by spin coating of the liquid polymer in the thickness range indicated in the spin curve. Please select the appropriate spin speed required for the desired film thickness and application. A spin time of 60 s is recommended, since lower film thicknesses and a higher film quality can be achieved compared to 30 s.

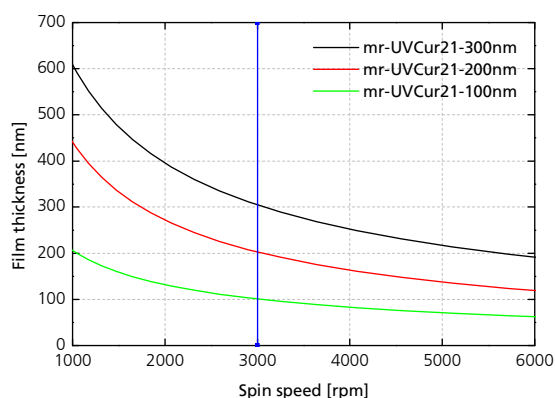


Fig. 1: Spin curve, 60 s spin time (liquid film after spin coating and softbake)

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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.

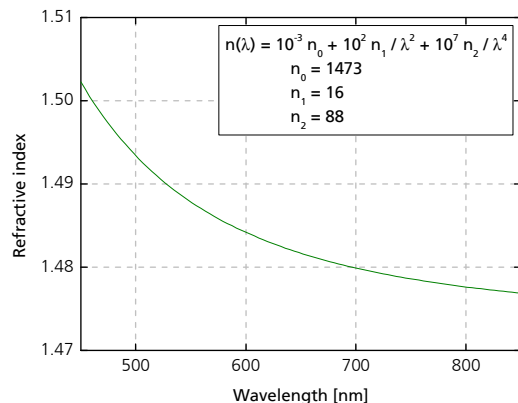


Fig. 2: Refractive indices vs. wavelength, Cauchy coefficients of liquid mr-UVCur21 after spin coating and subsequent softbake

Softbake

The spin coated films are baked at 80 °C for 60 s on a hot plate before UV exposure. This step is necessary to evaporate residual solvent.

Dilution of mr-UVCur21

mr-UVCur21-300nm or mr-UVCur21-200nm can be diluted using the diluent mr-T 1070 to achieve lower film thicknesses than indicated in their spin curves. The processing steps for the diluted versions are the same as for the original solution (substrate preparation, coating, imprinting).

Mass ratios	mr-UVCur21-300nm / mr-T 1070			
	1.0 / 0	1.0 / 0.35	1.0 / 1.3	1.0 / 2.4
Spin coating ¹⁾	3000			
[rpm]	60			
[s]	60 s at 80 °C			
Softbake on hotplate	60 s at 80 °C			
Film thickness (liquid film)	300	200	100	60
[nm]				

¹⁾ Uncovered spin coater

Mass ratios	mr-UVCur21-200nm / mr-T 1070		
	1.0 / 0	1.0 / 0.70	1.0 / 1.5
Spin coating ¹⁾	3000		
[rpm]	60		
[s]	60 s at 80 °C		
Softbake on hotplate	60 s at 80 °C		
Film thickness (liquid film)	200	100	60
[nm]			

¹⁾ Uncovered spin coater

Imprint and UV exposure

Main factors determining the imprint conditions are the viscosity of the polymer system, the mould layout (feature size, density of the patterns etc.), the residual layer thickness to be attained and the imprinting tool. mr-UVCur21 can be imprinted in any tool suitable for doing UV-based nanoimprint lithography.

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Commercial nano-imprinters as provided e.g. by EV Group (Austria), Obducat (Sweden), and Suss MicroTec (Germany) may be used.

Mould

It is highly recommended to treat the UV-transparent mould with a release agent like F₁₃-OTCS or other ones before using it for nanoimprinting. F₁₃-OTCS (trichloro-(1H,1H,2H,2H-perfluorooctyl)-silane, CAS number [78560-45-9]) is commercially available from many suppliers of laboratory chemicals.

Imprint conditions

After softbaking the mould with nanometer-scale patterns is pressed into the films with a pressure of > 100 mbar to transfer the pattern. The imprint pressure and time necessary to get complete filling of the mould cavities depends on the pattern density and pattern width. Since mr-UVCur21 has a very low viscosity, the time necessary to build up the imprint pressure is sufficient to completely fill the patterns.

UV exposure

The polymer has to be exposed to UV light for curing. Sufficient curing is attained at doses of approximately 700 mJ/cm² (curing under vacuum) using broad band UV light (320 – 420 nm). Applying higher doses or broader UV wavelength ranges do not affect the imprint quality or the properties of the cured polymer. Exposure applying a smaller UV range of e.g. 350 – 400 nm or applying the 365 nm line works as well, but will require higher doses. The degree of shrinkage of mr-UVCur21 during the UV exposure is approximately 3 – 4 % (linear shrinkage). Reproducible exposure conditions will lead to reproducible shrinkage values. After UV exposure the mould is detached.

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-UVCur21 is preferably achieved applying oxygen plasma. Since mr-UVCur21 does not contain any inorganic components like silicon, no residues are left on the substrate after plasma treatment with pure oxygen.

Storage

Storage at temperatures of 15 – 25 °C is recommended. Storage in a refrigerator is not required. mr-UVCur21 is light-sensitive and should not be exposed to direct daylight. mr-UVCur21 bottles have to be handled under yellow light. Keep the 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

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.

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