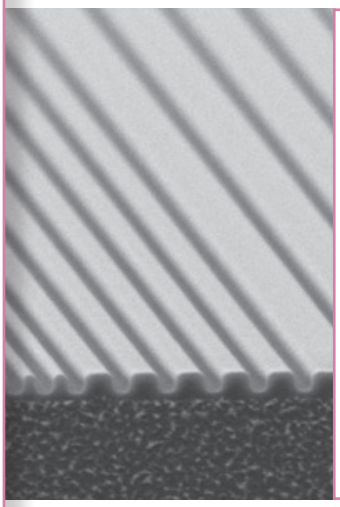
Materials for Nanoimprint Lithography

micro resist technology

Gesellschaft für chemische Materialien spezieller Photoresistsysteme mbH

Materials for Nanoimprint Lithography



Broad Portfolio of Ready-to-use Materials for
Thermal & UV Nanoimprint Lithography (NIL)

- Coating of various substrates with excellent film quality (Si, SiO_2, glass, Al, Al_2O_3, plastics)
- Excellent pattern replication fidelity using various mold materials (Si, SiO_2, Ni, OrmoStamp®)
- Superior mold release properties
- Numerous application areas (pattern transfer using dry etch processes, permanent applications)
- Customized solutions and resist formulations designed for industrial high throughput processes
- Safe solvents specified for industrial requirements
- Guaranteed product quality and processing reproducibility
- Manufacturing according to ISO 9001 and ISO 14001

- Made in Germany -

micro resist technology GmbH
Köpenicker Str. 325
12555 Berlin
GERMANY

phone +49 30 64 16 70 100
fax +49 30 64 16 70 200
mail sales@microresist.de
info www.microresist.com

www.microresist.com

NIL Material Specifications

Product Series	Film Thickness Ready-to-use Solutions (@ 3000 rpm)	Material Specifications (glass transition temperature T_g)	Imprint Condition (Imprint temperature T_i, release temperature T_r)	Ancillaries
Thermal Nanoimprint Lithography				
mr-I 7000R [1]	100 nm 200 nm 300 nm	Thermoplastic T_g = 55 °C	T_i = 120 - 140 °C T_r = 30 - 50 °C	Thinner ma-T 1050
mr-I 8000R [1]	100 nm 200 nm 300 nm	Thermoplastic T_g = 105 °C	T_i = 150 - 180 °C T_r = 80 - 100 °C	Thinner ma-T 1050
mr-I T85	300 nm 1.0 µm 5.0 µm	Thermoplastic T_g = 85 °C	T_i = 130 - 150 °C T_r = 60 - 80 °C	-
SIPOL New	60 nm 100 nm 200 nm	Thermoplastic T_g = 63 °C	T_i = 120 °C T_r = 30 - 50 °C	Transfer layer UL1 Thinner ma-T 1050
mr-I 9000M	100 nm 200 nm 300 nm 500 nm 1.0 µm	Thermoset T_g = 35 °C (before curing)	T_i = T_r = 90 - 140 °C	Thinner ma-T 1045
UV Nanoimprint Lithography				
mr-UVCur06	240 nm (solvent-free)	UV-curable monomers, indifferent towards atmospheric oxygen	T_i = T_r = room temperature (20 °C) UV exposure dose > 400 mJ cm^{-2} (@ 365 nm)	Adhesion promoter mr-APS1 Thinner mr-T 1070
mr-UVCur21	100 nm 200 nm 300 nm	UV-curable monomers ($\eta_{25°C}$ = 33 mPa s after softbake)		
mr-UVCur21SF	1.6 µm (solvent-free)	UV-curable monomers ($\eta_{25°C}$ = 33 mPa s)		
Combined Thermal and UV Nanoimprint Lithography				
mr-NIL 6000E	100 nm 200 nm 300 nm	UV-curable resin T_g = 1 °C (before UV curing)	1. T_i = 65 - 70 °C 2. UV exposure dose 350 mJ cm^{-2} (@ 365 nm) 3. T_r = 65 - 70 °C	Thinner ma-T 1045
Available on Request				
Special Designs and Customized Formulations	Thickness range from sub-100 nm up to several µm	• NIL process condition, imprint and pattern transfer performance depend on the specific material. • Resist modifications for alternative coating technologies are provided upon request (e.g. gravure printing). • For fundamental NIL investigations our PMMA resist formulations are recommended. Low molecular weights of 35 kDa and 75 kDa guarantee appropriate replication properties.		

[1] mr-I 7000R and mr-I 8000R are fluoro-modified for improved mold release behavior. Conventional resist formulations mr-I 7000E and mr-I 8000E without fluorinated components are still available in the thickness ranges indicated above.

NIL Material Performance

Key Features	Product Series
Thermal Nanoimprint Lithography	
• Thermoplastics with excellent flow behavior • Low imprint pressure • High uniformity of the residual layer thickness • Easy demolding, efficient release force reduction[1] • High plasma etch resistance comparable to Novolak-based resists	**mr-I 7000R** **mr-I 8000R**
• Nonpolar thermoplastic with high chemical resistance • Excellent flow behavior, superior UV/vis transparency • High plasma etch resistance	**mr-I T85**
• Excellent polymer flow and easy demolding[2] • Bilayer resist system: SIPOL as etch barrier (Si-containing hard mask) for transfer layer UL1 • Significant amplification of imprinted aspect ratios by pattern transfer into the substrate (Fig. 3)	**SIPOL** New
• Thermosetting polymer for outstanding pattern stability and for demanding imprint designs • No reflow in subsequent process steps with thermal load • Mold release at imprint temperature possible (no cooling step) • High plasma etch resistance comparable to Novolak-based resists	**mr-I 9000M**
UV Nanoimprint Lithography	
• Vacuum-stable resist films (>10 mbar) • Short imprint cycle times: - Fast filling of mold cavities due to low viscosity - Low UV doses, fast polymerization rates • Pattern resolution down to 10 nm (mr-UVCur21)[3] • Compatibility to different UV exposure systems (Hg, LED) • High uniformity of the residual layer thickness • Excellent plasma etch resistance[3]	**mr-UVCur06** **mr-UVCur21** **mr-UVCur21SF**
Combined Thermal and UV Nanoimprint Lithography	
• Solid resist film after spin coating • Short imprint cycle times due to isothermal NIL process (no cooling step) • High uniformity of the residual layer thickness • High plasma etch resistance comparable to Novolak-based resists	**mr-NIL 6000E**
As for all *micro resist technology* products: • Excellent film quality on various substrates • Guaranteed product quality and reproducibility • Manufacturing according to ISO 9001 and ISO 14001 • Safe solvents specified for industrial requirements	**Special Designs and Customized Formulations**

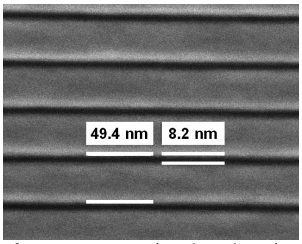


Fig.1 8 nm trenches imprinted in mr-I 7000R using a 4-inch OrmoStamp® replica mold[1]

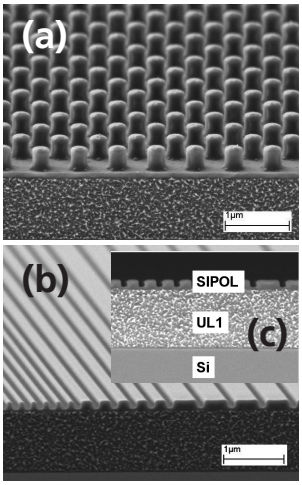


Fig.2 Nanoimprinted SIPOL resist (top layer) onto organic transfer layer UL1: (a) pillars (stamp design Courtesy of Eulitha AG), (b)/(c) L/S patterns[2]

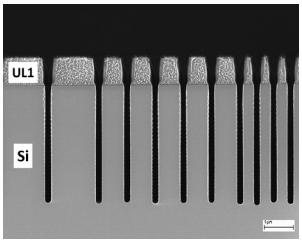


Fig.3 Imprint of aperiodic line grating transferred into Si by dry etching resulting in an aspect ratio (AR) of ca. 20.

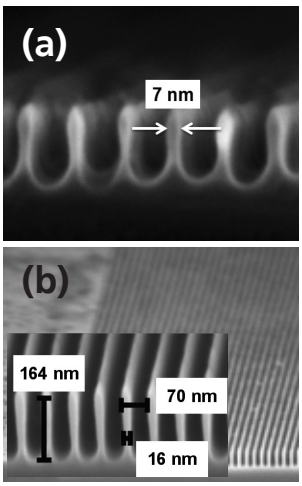


Fig.4 Si grating after dry etching of a nanoimprinted mr-UVCur21 resist: (a) 7 nm linewidth, 35 nm height; (b) 16 nm linewidth, 164 nm height, AR > 5 [3]

www.microresist.com

[1] H Atasoy, M Vogler, T Haatainen, A Schleunitz, D Jarzabek, H Schift, F Reuther, G Gruetzner, Z Rymuza Microel Eng 88 2011 1902
[2] M Messerschmidt, A Schleunitz, C Spreu, T Werner, M Vogler, F Reuther, A Bertz, H Schift, G Grützner Microel Eng 98 2012 107
[3] C Peroz, S Dhuey, M Cornet, M Vogler, D Olynick, S Cabrini Nanotechnol 23 2012 015305

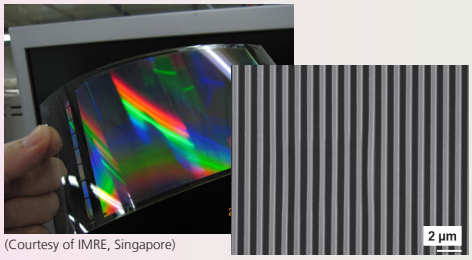
NIL Material Selection Guide

Materials recommended [1]	mr-I 7000R	mr-I 8000R	mr-I T85	mr-I 9000M	SIPOL	mr-UVCur06	mr-UVCur21	mr-UVCur21SF	Hybrid polymer product group [2]	mr-NIL 6000E	Special Designs and customized formulations	OrmoStamp® [2]
NIL Process	Thermal NIL					UV-NIL				Combined thermal and UV-NIL	Various	Transparent working stamp
Etch mask	•	•	•	•	•	•	•			•	•	
Pattern transfer applications												
LEDs, photonic crystals, quantum dots	•	•		•	•	•	•			•	•	
Sub wavelength optical elements (SOE, polarizer)	•	•		•	•	•	•			•		
Patterned sapphire substrates (PSS)				•	•					•		
Organic electronics (OLED, OPV, OTFT)	•	•		•	•	•	•	•		•	•	
Aspect ratio >> 3					••		•					
Permanent Applications												
Imprintable polymer with optical functionality, DOEs			•						••		•	
Organic electronics (OLED, OPV, OTFT)									•			
Bio applications, lab-on-chip			•						•			
Mold replication												•
Compatibility												
Si and SiO_2 substrates	•	•	•	•	•	•	•	•	•	•	•	•
Al_2O_3 (sapphire) substrate	•	•		•	•	•	•	•		•	•	
Plastic substrates	•			•	•		•	•	•	•	•	•
Inkjet dispensing								•			•	
Roll-to-roll processing	•							•	•		•	

[1] For selected publications about various applications please go to the nanoimprint material section of micro resist technology's webpage www.microresist.com.
[2] For the hybrid polymers and OrmoStamp® please refer to separate brochures.

Future mrt-innovations coming up soon

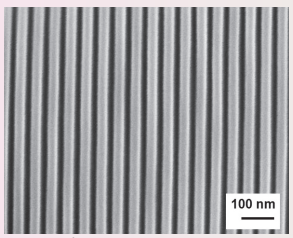
UV resist materials for Roll-to-Roll NIL and inkjet dispensing at room temperature on plastic substrates



(Courtesy of IMRE, Singapore)

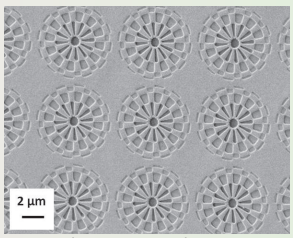
500 nm lines and trenches of an inkjet dispensed resist imprinted onto polycarbonate plastic, UV-Roll-to-Roll process at room temperature, 395 nm LED exposure, imprint speed 5 m min^{-1}, aspect ratio 3, bare Ni mold

Resist materials imprintable without an antisticking layer on the mold



(Courtesy of PSI, Switzerland)

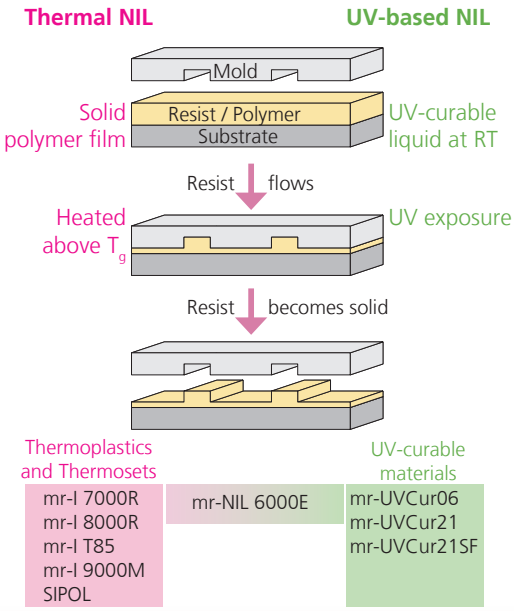
15 nm trenches, 50 nm bars imprinted in experimental resist, pattern depth 50 nm, glass substrate coated with primer. Si mold provided by Eulitha AG



(Courtesy of Catalan Institute of Nanotechnology, Spain)

R2R imprint on PET foil with experimental resist

NIL process



www.microresist.com

© micro resist technology GmbH | 18 September 2012
OrmoStamp®: DE 30 210 075 435; IR 1 092 621; TW 100030629 (application)