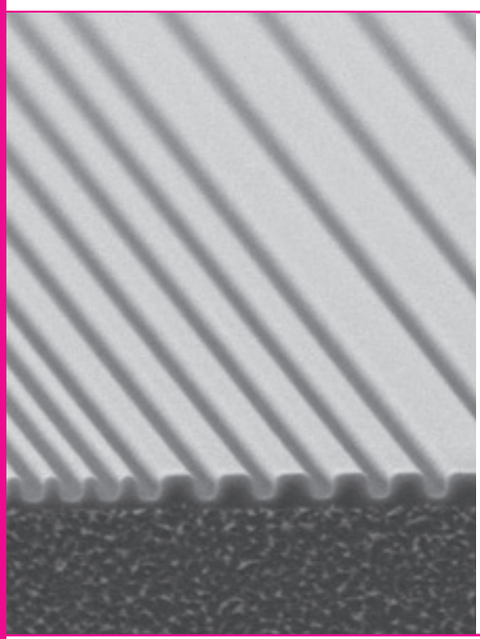
micro resist technology

Resists for Nanoimprint Lithography



Ready-to-use Formulations for Thermal & Photo (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 -

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Imprint Technology	Product	Key Features (T_g = glass transition temperature, Imprint temperature ≈ T_g + 60 K)	Imprint Process: Plate-to-Plate	Imprint Process: Continuous NIL (Roll-to-Roll)	Imprint Process: Step & Repeat NIL	Imprint Process: Subsequent lift-off (after metal deposition or for residue removal): Single layer	Imprint Process: Subsequent lift-off (after metal deposition or for residue removal): Bilayer	Substrate Compatibility: Si, SiO_2, glass	Substrate Compatibility: Metals (e.g. Au, Al)	Substrate Compatibility: Sapphire, Metal oxides	Substrate Compatibility: Plastics (e.g.PET, PEN,PC)	Substrate Compatibility: Multi-layered sub-strate stacks	Substrate Compatibility: Primer	Stamp Compatibility: Hard stamps, opaque (Si, Ni, etc.)	Stamp Compatibility: Hard stamps, trans-parent (SiO_2, glass)	Stamp Compatibility: Ormo-Stamp®[2]	Stamp Compatibility: Soft Stamps (PDMS, PFPE)	Main Applications: LEDs, photonic crystals, quantum dots	Main Applications: Sub wave-legth optical elements (SOE)	Main Applications: Pat-terned sapphire sub-strates (PSS)	Main Applications: Organic elec-tronics (OLED, OPV, OTFT)	Main Applications: Bio appli-cations, Lab-on-chip [3]
Thermal	**mr-I 9000M**	- Thermosetting polymer (T_g = 35 °C) - Fabrication of thermally stable nanostructures, no T_g after imprinting - Outstanding pattern stability in subsequent process steps with thermal load (e.g. RIE)	•••	•			••	•••	••	••	•••		No	•••	•••	•••	•	•••	•••		•••	
	mr-I 7000R[1]	- Thermoplastic polymers - Easy demolding, efficient release force reduction - mr-I 8000R (T_g 105 °C) with higher thermal stability in subsequent processes, e.g. RIE - mr-I 7000R (T_g 55 °C) with lower imprint temperature	•••	•••		•••		•••	•••	••	••		No	•••	•••	•••	•	•••	•••		•••	
	mr-I 8000R[1]		•••	•	•	•••		•••	•••	••			No	•••	•••	••		•••	•••		•••	
	SIPOL	- Thermoplastic polymer (T_g = 63 °C) - High aspect ratio patterns achievable (AR≫3) - Bilayer approach: SIPOL as Si-containing etch mask applied on transfer layer UL1	•••	•••		•••	••	•••	•••	•••	•••		No	•••	•••	•••	•	•••	•••		•••	
	mr-I T85	- Nonpolar thermoplastic polymer for permanent applications (T_g = 85 °C) - High chemical resistance - Superior UV/vis transparency	•••	•				•••					No	•••	•••	••						•••
	mr-I PMMA	- Thermoplastic polymer (T_g = 105 °C) for fundamental imprint investigations (available molecular weights 35 kDa and 75 kDa)	•••			•••		•••	••				No	•••	•••	••						
Combined Thermal and Photo	**mr-NIL 6000E**	- Photo-curable resist (T_g = 1 °C) - Short cycle times due to isothermal imprint process (no cooling step) - Outstanding pattern stability in subsequent process steps with thermal load (e.g. RIE), no T_g after imprinting	•••	•			••	•••	•••	•••	•••		No	•••	•••	•••	••	•••	•••	•••	•••	
Photo, UV (λ ≥ 365 nm)	**mr-NIL210** New	- Photo-curable imprint resist - Excellent compatibility to flexible stamp materials (e.g. PDMS or UV-PDMS KER-4690[4]) - High dry etching stability in challenging etching environments (e.g. sapphire)	•••	•			••	•••	•••	•••	•••	•	Yes (mr-APS1)	••• (comb. with tranparent substrate)	•••	•••	•••	•••	•••	•••	•••	
	mr-UVCur21	- Photo-curable imprint resist - Imprints with hard stamps, fast curing rates - Good dry etching stability	•••	•	••		••	•••	•		•••	•	Yes (mr-APS1)	••• (comb. with transparent substrate)	•••	•••		••	•••		•••	
	mr-XNIL26	- Photocurable imprint resist with excellent stamp release due to intrinsic antisticking characteristics, very low release forces - Excellent wetting characteristics	•••	•	•		••	•••	•••		•••	•••	Yes (mr-APS1)	••• (comb. with transparent substrate)	•••	•••		••	••		•••	
	mr-UVCur26SF New	- Photo-curable resist formulation - Inkjet dispensable at RT due to low viscosity (15 mPas) - Fast curing for continuous imprint processes (roll-to-roll)		•••	•••		••	•••	••		•••	•	Yes (mr-APS1)	••• (comb. with transparent substrate)	•••	•••		••	•••		•••	

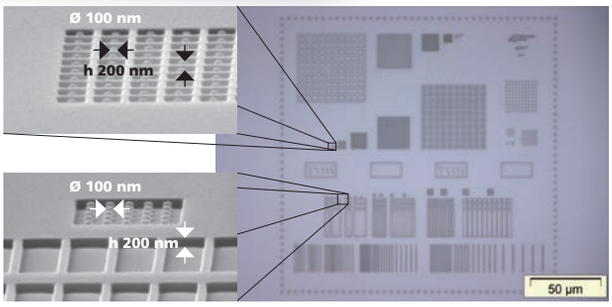
Special designs and innovations	- micro resist technology GmbH provides customized solutions of all the aforementioned products on request, e.g. special designs for non-standard film thickness ranges. Please contact us directly. - micro resist technology GmbH has numerous complementary imprint resist prototypes for different applications which have not been commercialized yet. Please contact us directly with your requirements and your process to get the most suitable product recommendation.

[1] Conventional resist formulations mr-I 7000E and mr-I 8000E without fluorinated components are still available upon request in equal film thickness ranges.
[2] For further information on OrmoStamp® as stamp replication material please refer to separate broschures and webpage www.microresist.com.
[3] See also product group Hybrid Polymers (OrmoComp® etc.). Please refer to seperate brochures.
[4] For further information on UV-PDMS KER-4690 as stamp replication material please refer to separate brochures and webpage www.microresist.com.

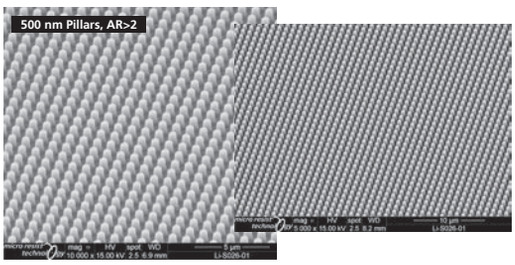
••• excellent •• good • fair

Recent application examples

mr-NIL210



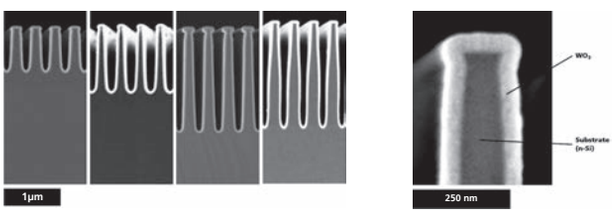
Example 1 Imprint of miscellaneous nano- and micrometer test structures into mr-NIL210 using a UV-PDMS stamp (Shin-Etsu UV-PDMS KER-4690).



Example 2 Large area imprint (50 x 50 mm) of sub micron pillars (500 nm in diameter, 1.12 µm in height) into mr-NIL210 using a UV-PDMS stamp (KER-4690).

mr-UVCur21

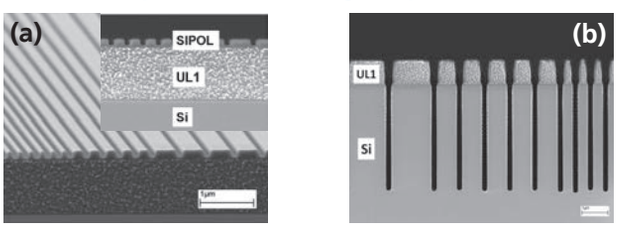
Nanostructuring of photoelectrode surfaces



WO_3 coated photoelectrode surfaces for water splitting fabricated using mr-UVCur21 (images courtesy of M. Schieda and I. Hermann-Geppert, Helmholtz-Zentrum Geesthacht, Germany, and Berkely Lab, USA).

SIPOL

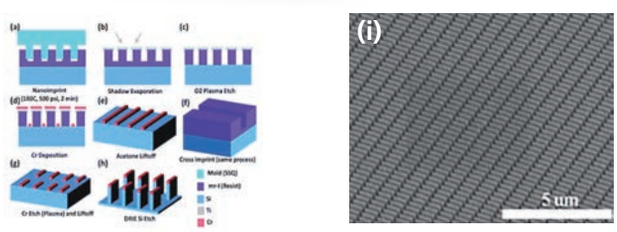
Pattern amplification for high aspect ratio



a) L/S imprinted into SIPOL resist (top layer) on top of organic transfer layer UL1 (dappled), inlay: cross sectional view of a); b) Imprint of a) transferred into Si using a Bosch process resulting in an aspect ratio of ca. 20.

mr-I 8000R

Silicon Nanowalls for Lithium Ion Batteries

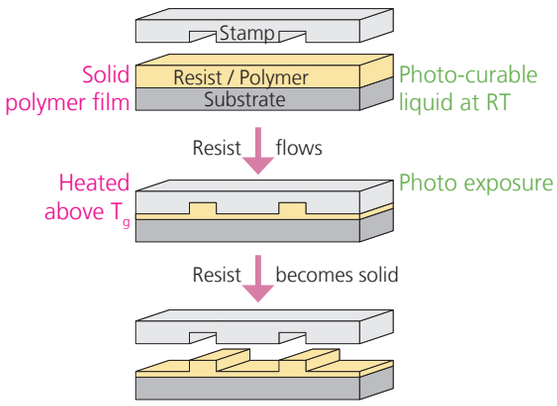


a)-h) Two dimensional imprint process for the fabrication of Si nanowalls for Lithium Ion Batteries using mr-I 8000R as thermoplastic NIL resist; i) SEM image of the fabricated 200 nm Si nanowall array (J. Wan *et al.,* J Mater Chem A 2 2014 6051).

Imprint process

Thermal NIL
Thermoplastics and Thermosets

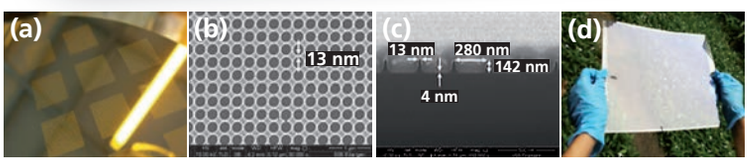
Photo-NIL (UV-NIL)
Photo-curable resists



Future Innovations

Alternative coating and imprint technologies

Inkjet dispensing, gravure & spray coating, etc.

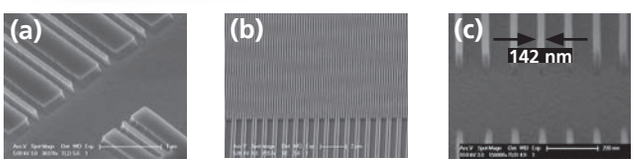


a) Resist dots of inkjet dispensed mr-UVCur26SF at RT onto 6 inch Si wafer; b) S&R imprinted nanoapertures using mr-UVCur26SF; c) Cross-sectional view of the imprinted nanoaptertures of b), residual layer thickness minimization to 4 nm by inkjet deposition of an effectual amount of resist, (all courtesy of M.Rumler, FhG IISB, Germany); d) imprinted antireflection moth-eye pattern on PC using inkjet dispensed mr-UVCur26SF (courtesy of IMRE, Singapore).

Product	Viscosity (@ RT)	Resist Characteristics
mr-UVCur21SF	31 mPas	Solvent free formulation of mr-UVCur21 featuring equal material characteristics
mr-UVCur26SF	16 mPas	Inkjet-dispensable at RT, high plasma etch stability, recommended for R2R-NIL
mr-XNIL26SF	147 mPas	Solvent-free formulation of mr-XNIL26, low release forces after imprint

Bilayer applications

Lift-off and aspect ratio amplification



a) L&S pattern after break through etch of resist and 100 nm UL3 using oxygen plasma; b) evaporated metal lines after lift-off of UL3 using DI H_2O at RT; c) 40 nm metal lines after lift-off of UL3 (courtesy of B. Vratzov, Nanotechnology & Devices, NT&D, Germany).

	UL1 series	UL3 series (experimental)
Application	Bilayer for high AR and lift-off	Bilayer for high AR and lift-off
Film thickness	300, 500, 1000 nm	50 – 2000 nm
Solvent compatibility	PGMEA, acetone, etc.	PGMEA, acetone, etc.
Resist compatibility	Excellent	Excellent
Neutral wet lift-off	Ethanol, IPA	DI H_2O
Dry etching	O_2 (100% organic)	O_2 (100% organic)
Etch performance	High dry etching stability	High dry etching stability