The experts for photoresists

micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

micro resist technology

The Experts for Photoresists

Innovation | Quality | Service | Know-how

Production of

Positive Tone Photoresists

Negative Tone Photoresists

ORMOCER®s

NanoImprint Resists

IR Baker (Infrared Baker)

Our Service

Microlithographic processing of your substrates

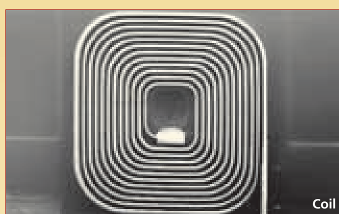
On-site support at your facilities

Technical support

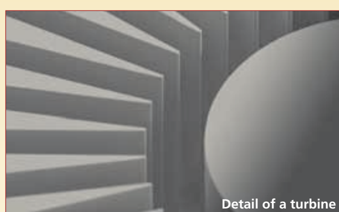
Flexible delivery quantities free of extra charges

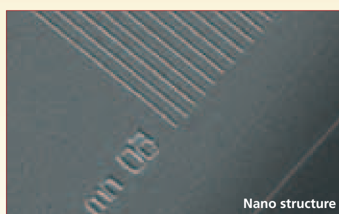
Short delivery times

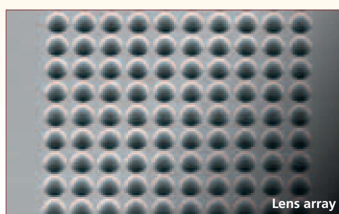
Fast processing of your orders


Coil

Undercutted structure


Detail of a turbine


Nano structure


Lens array

Applications

Micromotors
Microgears
Sensors
Actuators
Printing heads
MR/GMR heads
Ink jet elements
Hard drives
Contact bridges (BUMPS)
Microfluidics
Mikroreaction techniques
Memory chips
Processors and Controllers
RF elements
CD-/DVD-Mastering
Etch and moulding masks
Chips for beamers
Digital cameras
Beamsplitter
Switches and hubs
Scanners
Flexible Displays (OLED)
Communication devices
Nano stamps
Genetic engineering devices
and much more

www.microresist.de

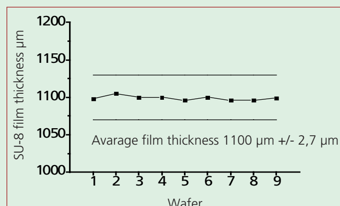
micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

micro resist technology

Profile of our Service

The Experts for Photoresists

Innovation | Quality | Service | Know-how



Highly reproducible film thickness in a series of SU-8 coated wafers

Preparation of a 1000 µm thick resist layer

UV imaging of a 300 µm thick SU-8 layer

UV imaging of a 30 µm thick micro coil

Electroformed Nickel coil - 30 µm

Mikrowave-plasma processor TEPLA 300 SEMI AUTO

Analytical services

- UV/Vis and NIR spectroscopy of solutions and films
- Scanning electron microscopy – characterisation with a magnification of up to 30.000

Photoresist modification

- ORMOCER®s with changed polymerisation initiator
- Customised ORMOCER® solutions (variation of film thickness)
- Customised resist solutions based on epoxy resins (SU-8), e.g. solvent variation
- Dyed photoresist solutions

Lithographic services

- Coating of different substrates (e.g. silicon, glass, ceramics, foils) with photoresists/polymers
  - Spin coating (5 inch)
  - Doctor´s blading (15 cm x 30 cm)
- Preparation of ultra-thick resist films
  - Positive tone photoresists from 1 µm to 80 µm
  - Epoxies (SU-8) from 0.5 µm to 1500 µm
- Innovative bake processes by using of an Infrared baker (4 inch – 6 inch wafer)
- UV lithographic patterning (4 inch wafer)
  - SU-8 films up to 300 µm
  - Positive tone photoresist films up to 30 µm
  - Negative tone photoresist films up to 10 µm

O_2-plasma processing

- Service with microwave-plasma system (TEPLA)
- Removal of photoresists and polymers

Lithographic equipment

- Microwave-plasma processor TEPLA 300 SEMI AUTO
- Coating systems with and without Gyrset up to a substrate size of 5 inch
- Bake systems:
  - Programmable precision hotplates
  - Infrared baker
  - Convection ovens
- Exposure tool maskaligner SUSS MA 56 M
- Film thickness measurement - DEKTAK (profilometer) for films up to 300 µm
- FTP 500 (ellipsometer) for films up to 3 µm
- Nickel electroforming (Ni-sulfamate) of 4-inch wafers – film thickness up to 80 µm

Koepenicker Str. 325 • D-12555 Berlin • Tel.: +49 30 65 76 21 92 • Fax: +49 30 65 76 21 93 • mrt@microresist.de

Negative tone photoresists

Resist	Thickness (3000 rpm)	Developer	Features
ma-N 405 ma-N 415 ma-N 420 ma-N 440 ma-N 490	0.5 µm 1.5 µm 2.0 µm 4.0 µm 7.5 µm	ma-D 331S ma-D 332S ma-D 332S ma-D 332S ma-D 332S	- for lift-off processes λ = 365 nm
ma-N 1405 ma-N 1407 ma-N 1410 ma-N 1420	0.5 µm 0.7 µm 1.0 µm 2.0 µm	ma-D 533S ma-D 533S ma-D 533S ma-D 533S	- for lift-off processes thermally stable up to 170 °C suitable for metal deposition by sputtering λ = 365/405 nm
ma-N 2401 ma-N 2403 ma-N 2405 ma-N 2410	0.10 µm 0.30 µm 0.50 µm 1.00 µm	ma-D 532 ma-D 532 ma-D 532 ma-D 532	- DUV and e-beam resists high plasma etch stability

→ other thicknesses on demand

Positive tone photoresists

Resist	Thickness (3000 rpm)	Developer	Features
ma-P 1205 ma-P 1210 ma-P 1215 ma-P 1225 ma-P 1240	0.5 µm 1.0 µm 1.5 µm 2.5 µm 4.0 µm	ma-D 331 ma-D 331 ma-D 331 ma-D 331 ma-D 331	- Well suitable as an etch mask exhibiting high dry and wet etch resistance λ = 365 nm/ 405 nm/ 436 nm high stability in acid and alkaline plating baths
ma-P 1275 ma-P 1275 ma-P 1275	7.5 µm 30 µm (350 rpm/90 s) 60 µm (double coating)	ma-D 331 ma-D 331 ma-D 331	- high viscosity photoresist with high stability in acid and alkaline plating baths and in wet and dry etch processes specifically designed for electroplating of structures in 3D UV microforming

→ other thicknesses on demand

Koepenicker Str. 325 • D-12555 Berlin • Tel.: +49 30 65 76 21 92 • Fax: +49 30 65 76 21 93 • mrt@microresist.de

micro resist technology

Thermoplastic Polymers for Nanoimprint Lithography

mr-I 7000	Thickness (3000 rpm)	Resolution *	Features
mr-I 7010	100 nm	≤ 50 nm	- T_g 60 °C - Excellent film quality - Imprint temperatures 125 - 150 °C - Imprint pressure 50 bar - Plasma etch resistance superior to PMMA - Etch selectivity to SiO_2 ~ 2 (CHF_3 plasma)
mr-I 7020	200 nm	≤ 50 nm	
mr-I 7030	300 nm	≤ 50 nm	

mr-I 8000	Thickness (3000 rpm)	Resolution *	Features
mr-I 8010	100 nm	≤ 50 nm	- T_g 115 °C - Excellent film quality - Imprint temperatures 170 - 190 °C - Imprint pressure 50 bar - Plasma etch resistance superior to PMMA - Etch selectivity to SiO_2 ~ 2 (CHF_3 plasma)
mr-I 8020	200 nm	≤ 50 nm	
mr-I 8030	300 nm	≤ 50 nm	

mr-I PMMA (35k – 120k)	Thickness (3000 rpm)	Resolution *	Features
mr-I PMMA 35 k [1] 100 nm	100 nm	≤ 50 nm	- T_g 105 °C - Excellent film quality - Imprint temperatures 150 - 180 °C - Imprint pressure 50 bar - Low molecular weights (35k, 75k, 120k) - Suited for fundamental investigations
mr-I PMMA 35 k [1] 200 nm	200 nm	≤ 50 nm	
mr-I PMMA 35 k [1] 300 nm	300 nm	≤ 50 nm	
mr-I PMMA 35 k [1] 400 nm	400 nm	≤ 50 nm	
mr-I PMMA 35 k [1] 500 nm	500 nm	≤ 50 nm	[1] or 75 k or 120 k

* Depending on stamp resolution

Thermoplastic Polymers for Nanoimprint Lithography with Improved Behaviour

mr-I 7000E	Thickness (3000 rpm)	Resolution *	Features
mr-I 7010E mr-I 7020E mr-I 7030E	100 nm 200 nm 300 nm	≤ 50 nm ≤ 50 nm ≤ 50 nm	- Tg 60 °C - Excellent film quality - Imprint temperatures 125 - 150 °C - Imprint pressure 20 - 50 bar - Plasma etch resistance superior to PMMA - Etch selectivity to SiO_2 about 2 (CHF_3 plasma)

mr-I 8000E	Thickness (3000 rpm)	Resolution *	Features
mr-I 8010E mr-I 8020E mr-I 8030E	100 nm 200 nm 300 nm	≤ 50 nm ≤ 50 nm ≤ 50 nm	- Tg 115 °C - Excellent film quality - Imprint temperatures 170 - 190 °C - Imprint pressure 20 - 50 bar - Plasma etch resistance superior to PMMA - Etch selectivity to SiO_2 about 2 (CHF_3 plasma)

* Depending on stamp resolution

Imprint characteristics superior to mr-I 7000 and mr-I 8000

- Lower imprint pressure
- Lower residual layer thickness
- Shorter cycle times due to faster imprint

Koepenicker Str. 325 • D-12555 Berlin • Tel.: +49 30 65 76 21 92 • Fax: +49 30 65 76 21 93 • mrt@microresist.de

micro resist technology

New Curing Polymer for Nanoimprint Lithography

mr-I 9000E	Thickness (3000rpm)	Resolution *	Features
mr-I 9010E mr-I 9020E mr-I 9030E	100 nm 200 nm 300 nm	50 nm 50 nm 50 nm	- T_g 35 °C before curing - Excellent film quality - Nearly isothermal imprint process: • imprint temperature 120 °C • mould release at 100 °C - Curing and increase in T_g to $T_{g,cured}$ during imprint - Imprint pressure 50 bar - Very low residual layer thickness down to 5 nm - Plasma etch resistance comparable to conventional novolak-based photoresists - Attainable smallest feature size at least 50 nm (depending on stamp resolution)

* Depending on stamp resolution

Photochemically Curing Polymers for Thermal Nanoimprint Lithography

mr-NIL 6000	Thickness (3000rpm)	Resolution *	Features
mr-NIL 6000.1 mr-NIL 6000.2 mr-NIL 6000.3	100 nm 200 nm 300 nm	50 nm 50 nm 50 nm	- T_g 40 °C before curing - photochemically curing - Excellent film quality - Imprinting, curing by UV flood exposure and post exposure bake (PEB) during imprinting and mould release **at the same temperature** - Very low residual layer thickness < 10 nm - Excellent pattern transfer fidelity - High plasma etch resistance comparable - Attainable smallest feature size at least 50 nm (depending on stamp resolution)

* Depending on technology

ORMOCER®s – inorganic-organic hybrid polymers

Polymer	Thickness[1] (3000 rpm) (1000 - 5000 rpm)	Refractive index @ 635 nm	Developer Thinner	Features
Ormocore	22 µm 10 µm - 75 µm	1.553	Ormodev Ormothin	- Core material for polymer optical waveguides
Ormoclad	19 µm 10 µm - 89 µm	1.538	Ormodev Ormothin	- Cladding material in planar polymer, optical wave guiding
Ormocomp	32 µm 15 µm - 150 µm	1.520[2]	Ormodev Ormothin	- UV curable polymer for applications in microoptics, e.g. lenses, lens arrays, prisms, optical couplers and connectors

[1] Depending on coating equipment, [2] @ 588 nm

Unique Features

- Solvent-free UV curable viscous liquids
- Thermal stability after curing up to 270 °C
- i-line, broadband exposure
- Patterning by UV lithography, replication technologies and/or rapid prototyping
- Compatible to conventional lithography equipment
- Suitable for datacom and telecom applications

Due to their optical properties ORMOCER®s are excellently suited for new developments in integrated optics, electronics, optoelectronics.

EpoCore and EpoClad – New Materials for Optical Wave Guides in PCB

Polymer	Thickness[1] (1500 rpm) (1000 - 5000 rpm)	Refractive index @ 830 nm	Developer Thinner	Features
EpoCore	50 µm 10 µm - 60 µm	1.58	Ormodev 600	- Core material for planar polymer optical waveguides
EpoClad	70 µm 10 µm - 100 µm	1.57	Ormodev 600	- Cladding material in planar polymer, optical wave guiding

[1] Depending on coating equipment, [2] @ 588 nm

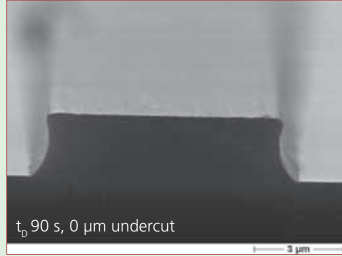
micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

micro resist technology

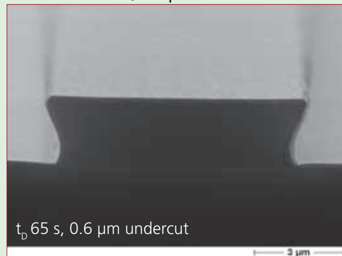
ma-N 400 and ma-N 1400 - Negative Tone Photoresists

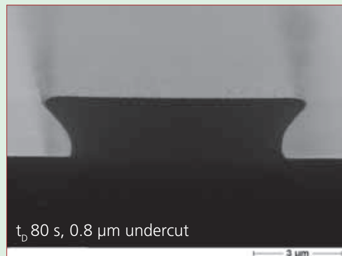
Conventional Pattern Transfer and Single - Layer Lift - Off

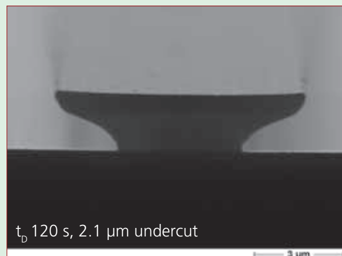
ma-N 400, 2 µm thick



ma-N 1400, 2 µm thick







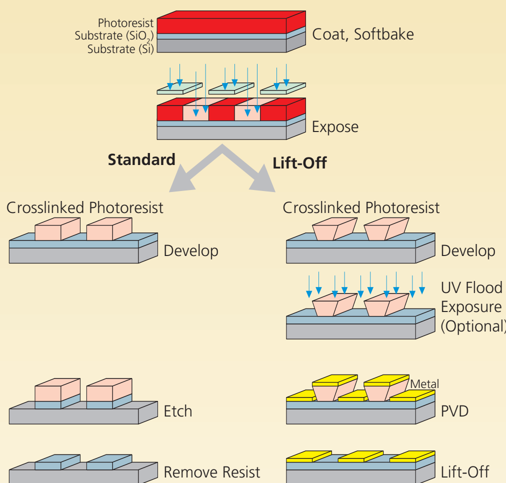
Unique features

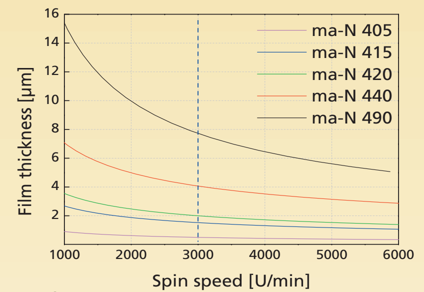
- High wet and dry etch resistance
- Good thermal stability of the resist pattern
- Tunable pattern profil: vertical to undercut
- Aqueous alkaline development
- Easy to remove
- Based on safe solvents
- Resists available in a variety of viscosities

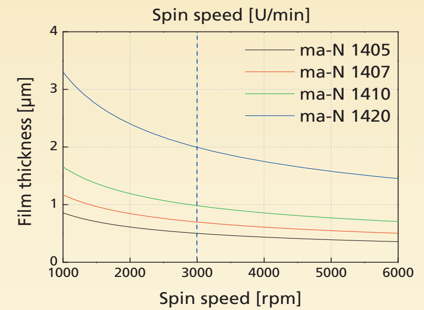
Applications

- Microelectronics and micro systems technology
- Mask for lift-off processes
- Etch mask for semiconductors and metals
- Well suitable for implantation

Standard and Lift-off process flow

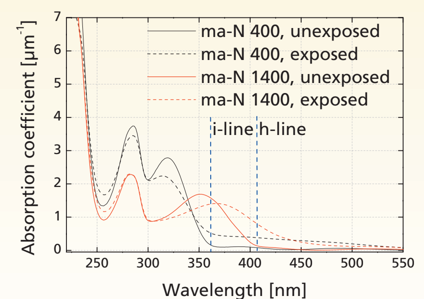






Technical data

Resist	ma-N 400	µm	ma-N 1400	µm
Film thickness	ma-N 405 ma-N 415 ma-N 420 ma-N 440 ma-N 490	0.5 1.5 2.0 4.1 7.5	ma-N 1405 ma-N 1407 ma-N 1410 ma-N 1420	0.5 0.7 1.0 2.0
Spin coating / time	3000 rpm, 30 s			
Spectral sensitivity	300 - 380 nm		300 - 410 nm	
Thermal stability	up to 110 °C, for metal evaporation		up to 160 °C, for metal evaporation and sputtering	



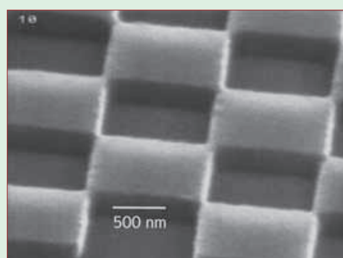
ls.05.11.14.01

micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

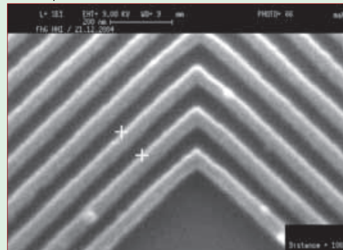
micro resist technology

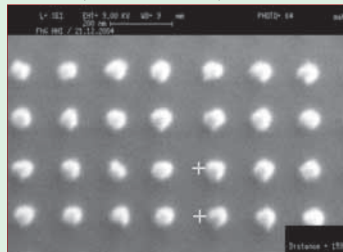
ma-N 2400 — Negative Tone Photoresist Series

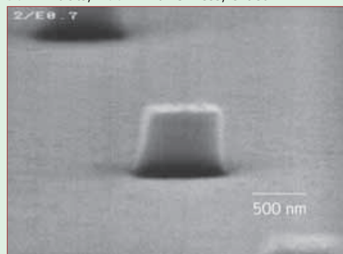
E-Beam and Deep UV Sensitive



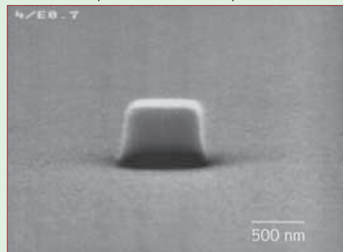
Chess pattern, 300 nm thickness, e-beam


50 nm L&S, 100 nm thickness, e-beam

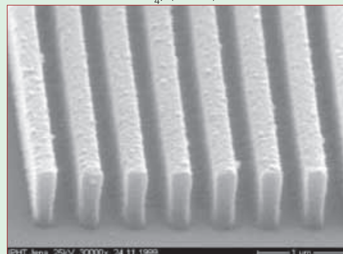

50 nm dots, 100 nm thickness, e-beam



800 nm dots, 750 nm thickness, e-beam



Dot after RIE with CF_4, (60 W)


250 nm L&S, 800 nm thickness

(Courtesy of FHG - HHI / IPHT Jena)

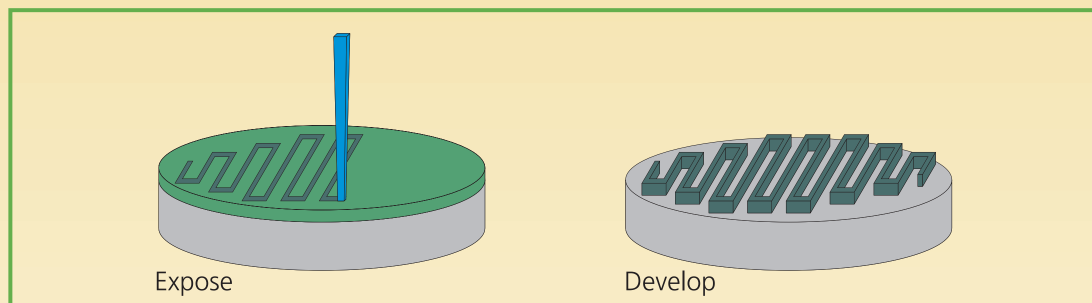
Unique features

- High wet and dry etch resistance
- Good thermal stability
- Excellent pattern resolution - down to 30 nm
- Aqueous alkaline development
- Easy to remove
- Resists available in a variety of viscosities

Applications

- Manufacturing of semiconductor devices
- Use in micro- and nanoelectronics
- Mask for etching, e.g. Si, SiO_2, Si_3N_4 or metals
- Mask for ion implantation
- Stamp fabrication for NIL

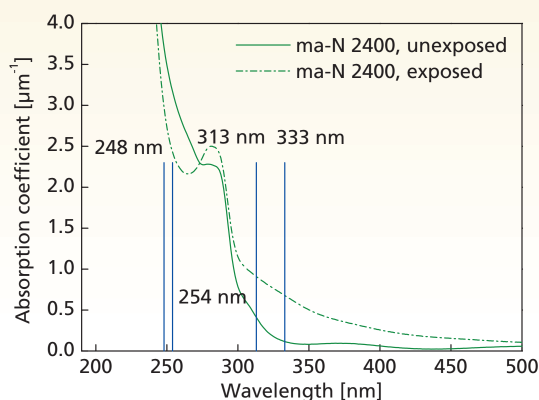
ma-N 2400 is well suited for e-beam exposure

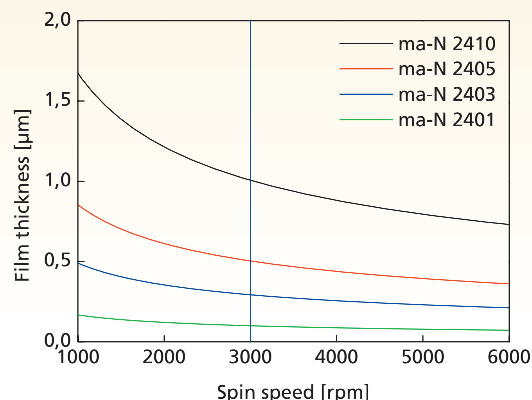


Technical data

Resist			ma-N 2401	ma-N 2403	ma-N 2405	ma-N 2410
Film thickness		nm	100	300	500	1000
Spin coating		rpm/ s	3000/ 30			
Exposure dose - E-beam 20 keV[1]		µC cm^{-2}	120 - 200	170 - 235	170 - 250	-
Exposure dose - E-beam 50 keV[1]		µC cm^{-2}	220 - 350	250 - 350	300 - 350	-
Exposure dose - Deep UV[2]		mJ cm^{-2}	-	260	330	420
Pattern resolution	E-beam	nm	< 50	50	100	150
	Deep UV	nm	-	200	300	500

[1] exposure dose depends on the pattern size/ resolution
[2] broadband exposure, intensity measured at 260nm





micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

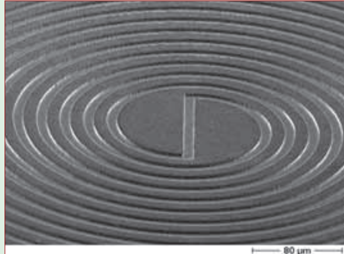
micro resist technology

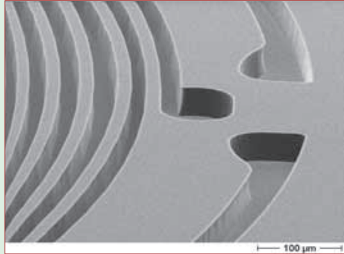
ma-P 1275 - Positive Tone Photoresist

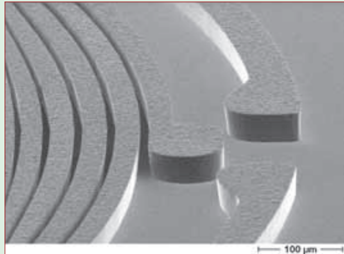
Ultra Thick Resist for UV Lithography

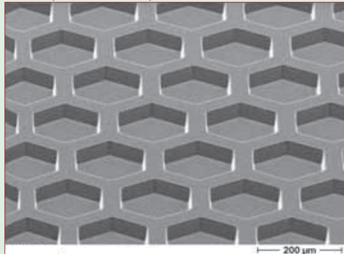
Resist patterning with mask aligner, broadband exposure

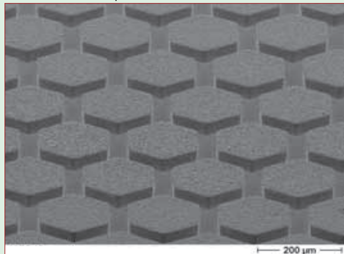
ma-P 1275, 7.5 µm tickness


Electroplated Ni, 5 µm thickness


ma-P 1275, 30 µm thickness


Electroplated Ni, 28 µm thickness


ma-P 1275, 40 µm thickness


Electroplated Ni, 38 µm thickness

Unique features

- Outstanding pattern stability in wet etch processes and acid and alkaline plating baths from pH 1 - 13.5
- Highly stable in dry etch processes e.g. CHF_3, CF_4, SF_6
- Aqueous alkaline development
- Easy to remove
- Side wall angle up to 84°

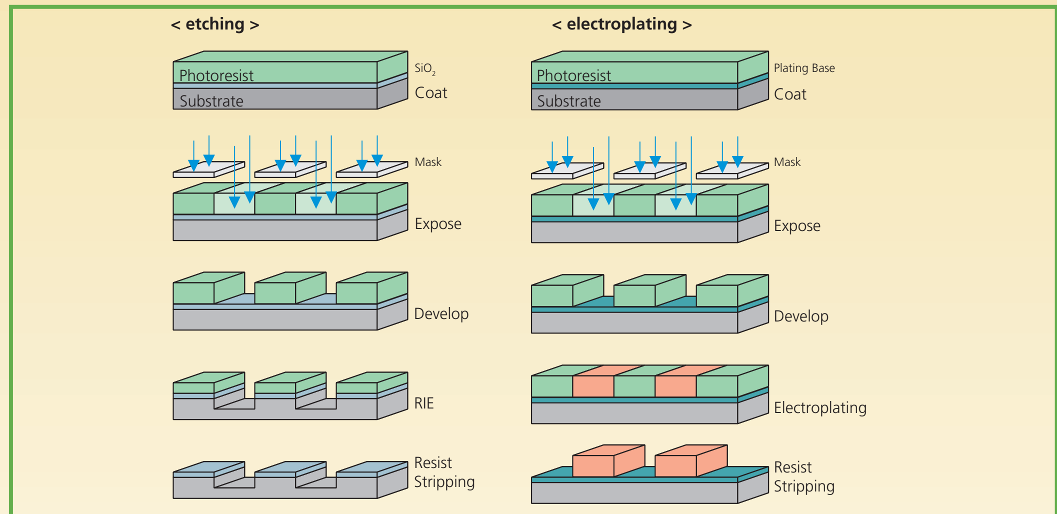
Applications

Moulds for electroplating, e.g.
- Micro optical components
- Micro springs
- Bumping

Mask for etching e.g.
- Si, SiO_2
- Metals
- Semiconductors

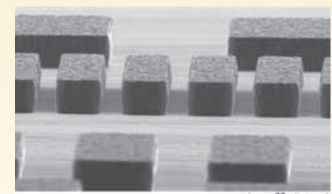
Mask for ion implantation

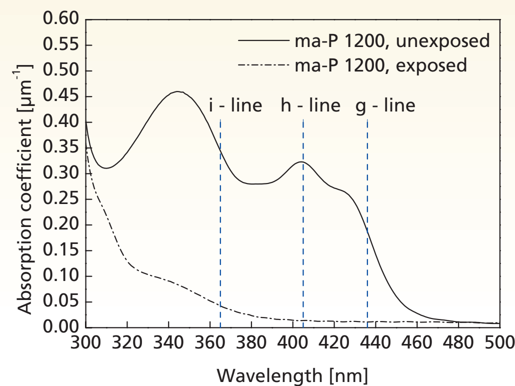
Process flow for

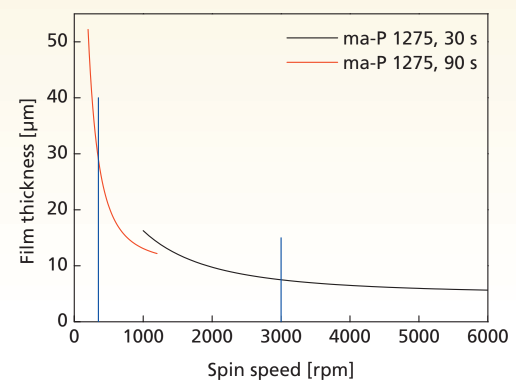


Technical data

Film thickness	µm	7.5	20	30	40
Spin coating	rpm	3000	500	350	250
Spin time	s	30	90	90	90
Aspect ratio		3 - 4	3 - 4	3 - 4	3 - 4


Cuboid Ni structures, 17 µm thickness





b.06.01.30.02

micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

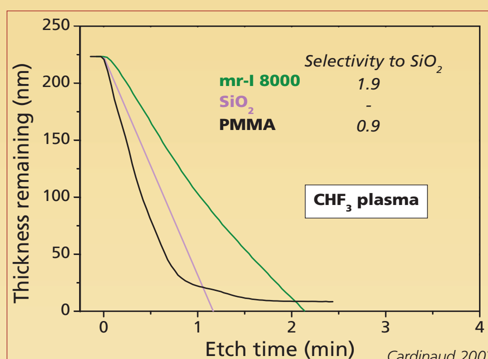
micro resist technology

Thermoplastic Polymers for Nanoimprint Lithography

mr-I 7000, mr-I 8000 and mr-I PMMA - Special Polymers for NIL

Unique features and Applications

- Excellent film quality
- Plasma etch resistance superior to PMMA
- Application as etch mask (single layer process)
- Attainable smallest feature size at least 50 nm (depending on stamp resolution)
- Safe solvents



mr-I 7000

- T_g 60 °C
- Etch selectivity to SiO_2 about 2 (CHF_3 plasma)
- Imprint temperatures 110 - 140 °C
- Standard ready-to-use solutions

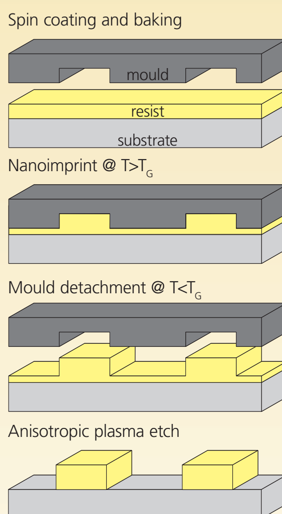
Type	Film thickness
mr-I 7010	100 nm
mr-I 7020	200 nm
mr-I 7030	300 nm

mr-I 8000

- T_g 115 °C
- Etch selectivity to SiO_2 about 2 (CHF_3 plasma)
- Imprint temperatures 160 - 190 °C
- Standard ready-to-use solutions

Type	Film thickness
mr-I 8010	100 nm
mr-I 8020	200 nm
mr-I 8030	300 nm

NIL process scheme

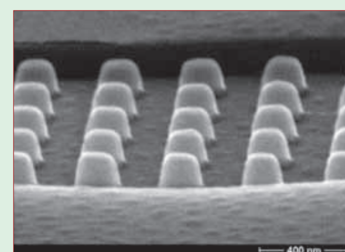


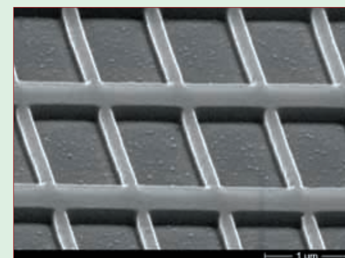
mr-I PMMA

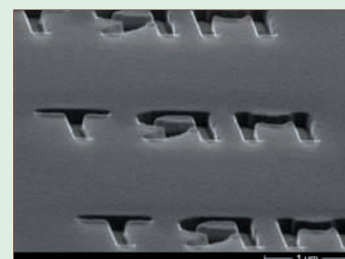
- T_g 105 °C
- Suited for fundamental investigations
- Imprint temperatures 150 - 180 °C
- Standard ready-to-use solutions
- Different molecular weights (35 k, 75 k, 120 k)

Type	Film thickness
mr-I PMMA 35k[1)] 100 nm	100 nm
mr-I PMMA 35k[1)] 200 nm	200 nm
mr-I PMMA 35k[1)] 300 nm	300 nm
mr-I PMMA 35k[1)] 400 nm	400 nm
mr-I PMMA 35k[1)] 500 nm	500 nm

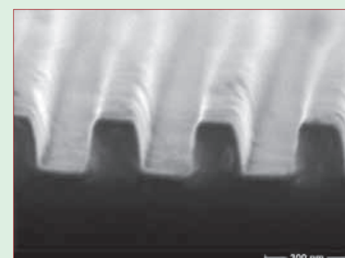
[1)] or 75k or 120k


200 nm dots in mr-I 8000


Imprinted structures in 300 nm thick mr-I 8000, mimimum width: 200 nm


Initials of *micro resist technology* in mr-I 8000

Test structure in mr-I 7000, 200 nm lines

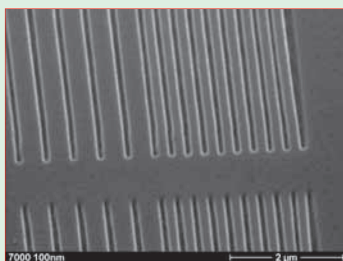

100 nm trenches in mr-I 7000

micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

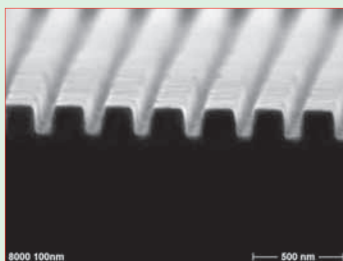
New Products by **micro resist technology**

Thermoplastic Polymers for Nanoimprint Lithography

mr-I 7000E, mr-I 8000E Thermoplastics with Improved Imprinting Behaviour



100 nm trenches, pitch 300 and 500 nm,
Film thickness: 200 nm
Imprint: 130 °C, 3 min, 50 bar
Complete filling of stamp cavities
Residual layer thickness < 10 nm



100 nm trenches, pitch 300 nm,
Film thickness: 200 nm
Imprint: 190 °C, 3 min, 50 bar
Complete filling of stamp cavities
Residual layer thickness < 10 nm

Unique features

- Excellent film quality
- Plasma etch resistance superior to PMMA
- Attainable smallest feature size at least 50 nm (depending on stamp resolution)
- Safe solvents

Imprint characteristics superior to mr-I 7000 and mr-I 8000 polymers

- ✓ Lower imprint pressure
- ✓ Lower residual layer thickness
- ✓ Shorter cycle times due to faster imprint

Imprint conditions

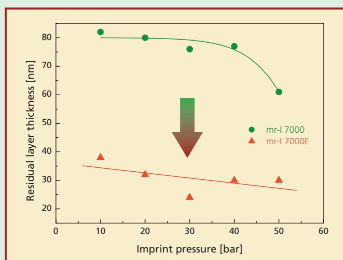
mr-I 7000E

- T_g 60 °C
- Imprint temperatures 125 - 150 °C
- Imprint pressure 20 - 50 bar
- Etch selectivity to SiO_2 about 2 (CHF_3 plasma)
- Ready-to-use solutions for 100 nm, 200 nm, 300 nm film thickness (3000 rpm)

mr-I 8000E

- T_g 115 °C
- Imprint temperatures 170 - 190 °C
- Imprint pressure 20 - 50 bar
- Etch selectivity to SiO_2 about 2 (CHF_3 plasma)
- Ready-to-use solutions for 100 nm, 200 nm, 300 nm film thickness (3000 rpm)

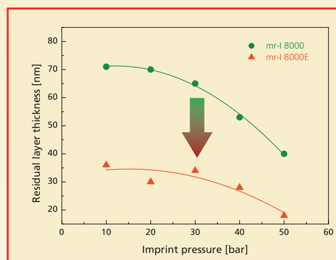
Lower residual layer thickness under gentle imprint conditions



mr-I 7000 vs. mr-I 7000E

Residual layer thickness as a function of imprint pressure

Film thickness: 200 nm
Imprint: 10 s @ 100 °C
Incomplete filling of stamp cavities

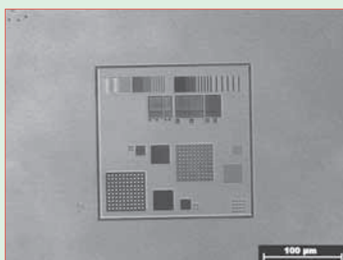


mr-I 8000 vs. mr-I 8000E

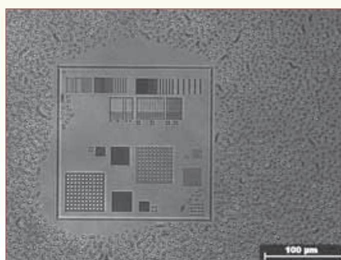
Residual layer thickness as a function of imprint pressure

Film thickness: 200 nm
Imprint: 10 s @ 160 °C
Incomplete filling of stamp cavities

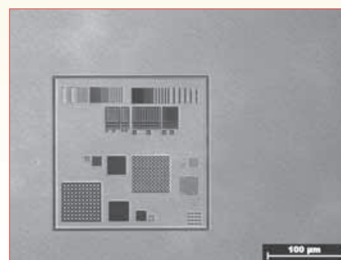
Defect-free imprints at lower pressure



mr-I 7000
130 °C, 3 min,
50 bar
no defects



mr-I 7000
130 °C, 3 min,
20 bar
insufficient polymer flow



mr-I 7000E
130 °C, 3 min,
20 bar
no defects

micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

micro resist technology

Curing Polymers for Thermal Nanoimprint Lithography

mr-I 9000 and mr-L 6000.5 for NIL

Unique features

- Excellent film quality
- Plasma etch resistance superior to PMMA
- Outstanding thermal stability
- Safe solvents

Applications

- Etch mask (single layer process)
- Low cost stamp fabrication
- Permanent applications

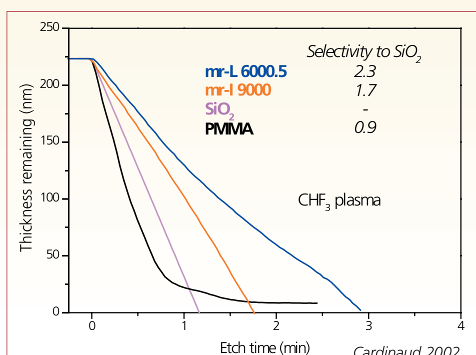
mr-I 9000

- T_g 65 °C
- **Thermal curing during imprint**
- Attainable smallest pattern size at least 50 nm (depending on stamp resolution)
- Etch selectivity to SiO_2 about 2 (CHF_3 plasma)
- Imprint temperatures 120 - 160 °C
- Standard ready-to-use solutions

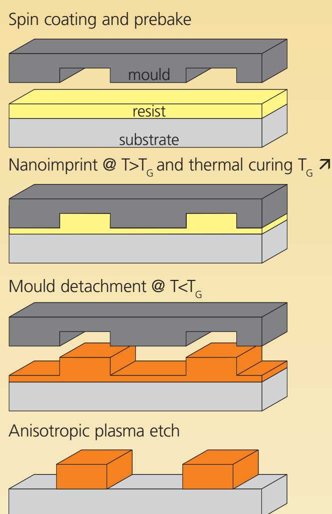
Type	Film thickness
mr-I 9010	100 nm
mr-I 9020	200 nm
mr-I 9030	300 nm

mr-L 6000.5

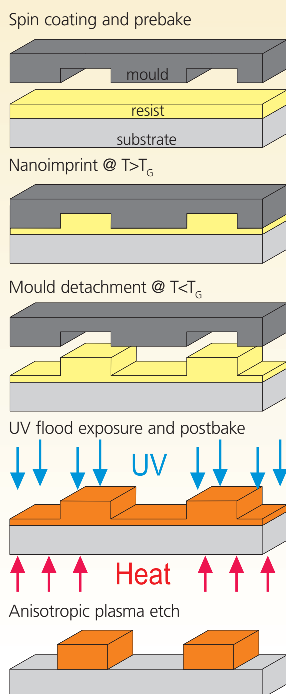
- T_g 35 °C
- **Curing after imprint by UV flood exposure and heat**
- Etch selectivity to SiO_2 > 2 (CHF_3 plasma)
- Attainable smallest pattern size at least 200 nm
- Imprint temperatures 80 - 120 °C
- Standard ready-to-use solution for 500 nm



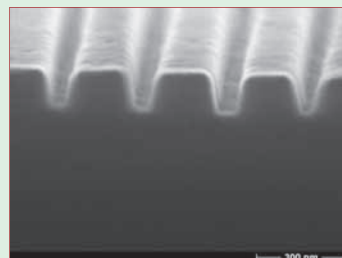
NIL process scheme for mr-I 9000

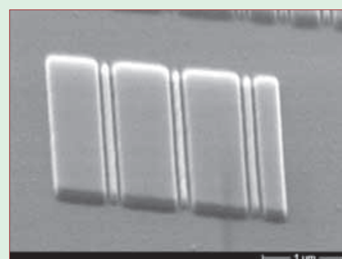


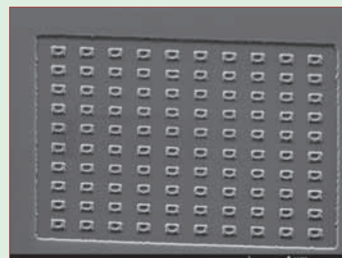
NIL process scheme for mr-L 6000.5

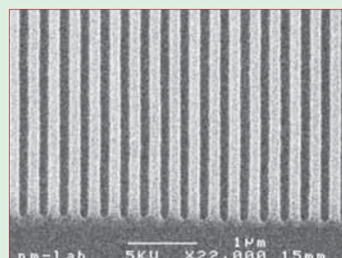


200 nm lines in mr-I 9000


100 nm trenches in mr-I 9000


70 nm lines and 50 nm trenches in 300 nm thick mr-I 9000


200 nm rings in mr-I 9000



100 nm lines & spaces imprinted in 300 nm thick mr-L 6000XP (P. Carlberg 2002)

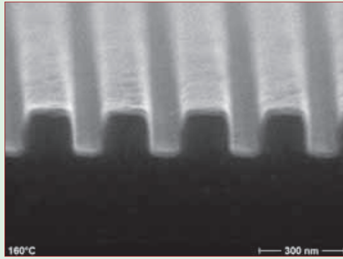
25.01.05 - ls

micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

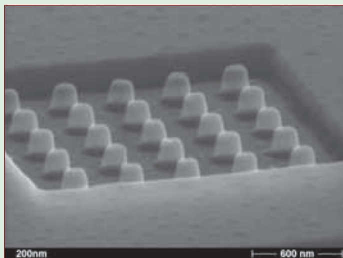
micro resist technology

Curing Polymer for Thermal Nanoimprint Lithography

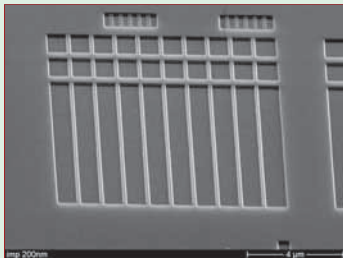
mr-I 9000E - Advanced thermoset for pattern transfer



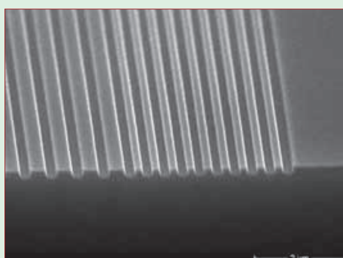
100 nm trenches, 300 nm pitch



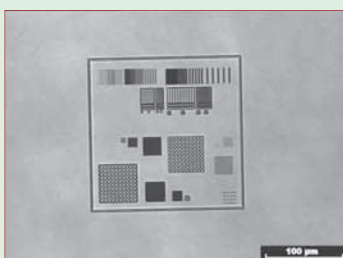
200 nm dots



200 nm lines



200 nm trenches



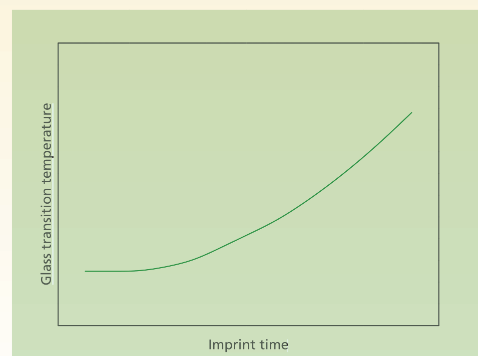
Uniform filling of patterns with different size (100 nm to 2 µm)

b.06.01.06.01

- Imprinting at moderate temperature and generating patterns with good thermal stability
- Applying nearly isothermal conditions

Unique features

- Excellent film quality
- T_g 35 °C before curing
- Nearly isothermal imprint process:
  - Imprint temperature 120 °C
  - Mould release at 100 °C
- ***Curing*** and increase in T_g to $T_{g,cured}$ ***during imprint***
- Imprint pressure 50 bar
- Very low residual layer thickness down to 5 nm
- Excellent pattern transfer fidelity
- Plasma etch resistance comparable to conventional novolak-based photoresists
- Attainable smallest feature size at least 50 nm (depending on mould resolution)
- Ready-to-use solutions
- Safe solvents



Increase in T_g during imprinting

Applications

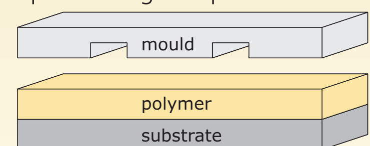
- Coating of various substrate materials, e.g. Si, SiO_2, Al
- Mask for ***pattern transfer*** processes
- Dry and wet etching
- Single and multilayer systems

Type	Thickness[1]
mr-I 9010E	100 nm
mr-I 9020E	200 nm
mr-I 9030E	300 nm

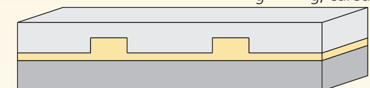
[1] 3000 rpm, 30 s

NIL process - mr-I 9000E

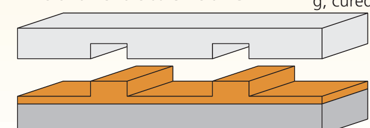
Spin coating and prebake



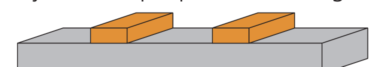
Nanoimprinting @ $T > T_g$ and thermal curing, $T_g \rightarrow T_{g,\ cured}$



Mould is detached @ $T < T_{g,\ cured}$



Residual polymer layer is removed by anisotropic plasma etching

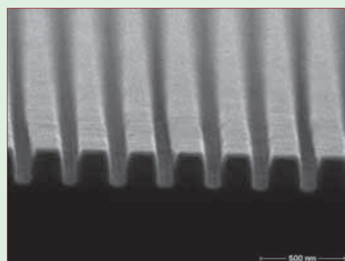


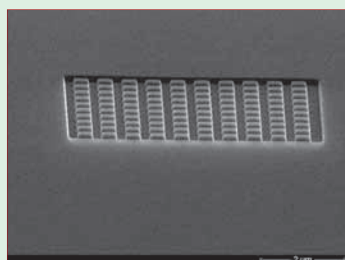
micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

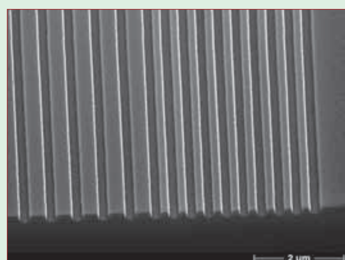
micro resist technology

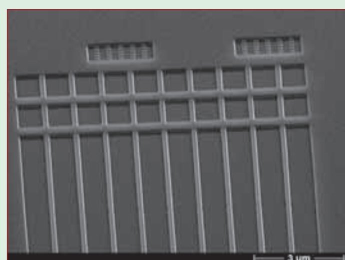
Photochemically Curing Resist for Thermal Nanoimprint Lithography

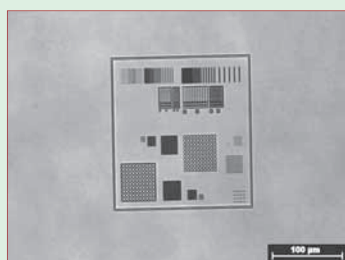
mr-NIL 6000 — High performance resist for pattern transfer and permanent applications


100 nm trenches, 300 nm pitch


200 nm dots


200 nm trenches


200 nm lines


Uniform filling of patterns with different size (100 nm to 2 µm)

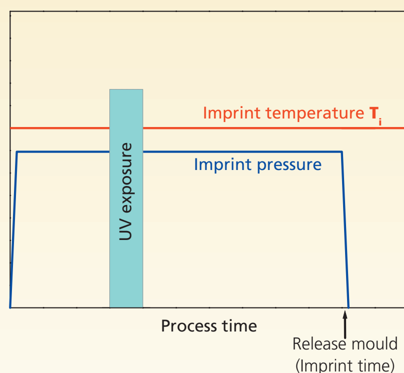
ls.06.03.27.01

mr-NIL 6000 — tailored material for thermal nanoimprinting and photochemically curing as simultaneous process for the manufacturing of ultra fine structures

- Solid resist film after spin coating
- Imprinting at moderate temperature
- Isothermal imprint process

Unique features

- Excellent film quality
- T_g 40 °C before curing
- Imprinting, curing by UV flood exposure and post exposure bake (PEB) during imprinting and mould release ***at the same temperature***
- Very low residual layer thickness < 10 nm
- Excellent pattern transfer fidelity
- Plasma etch resistance comparable to conventional novolak-based photoresists
- Ready-to-use solutions
- Safe solvents



Type	Thickness[1]
mr-NIL 6000.1	100 nm
mr-NIL 6000.2	200 nm
mr-NIL 6000.3	300 nm

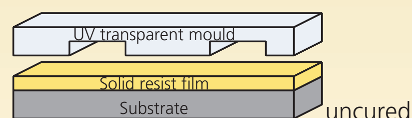
[1] spin coating @ 3000 rpm, 30 s

Applications

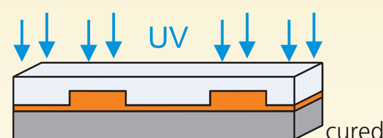
- Coating of various substrate materials, e.g. Si, SiO_2, Al
- Mask for ***pattern transfer*** processes
- Dry and wet etching
- Single and multilayer systems
- Permanent structures e.g. in microfluidics, optics

Process

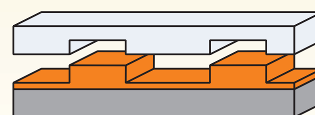
Spin coating and prebake



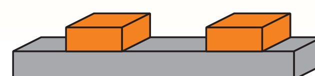
Nanoimprint @ $T_i > T_g$, UV flood exposure and post exposure bake



Mould detachment @ T_i



Anisotropic plasma etch

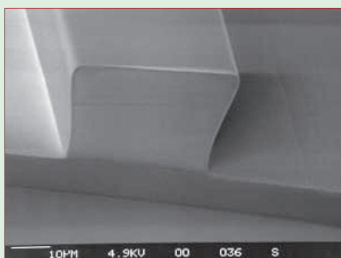


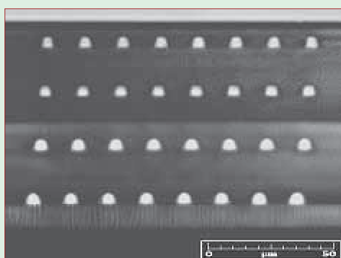
micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

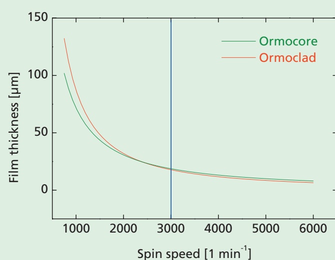
micro resist technology

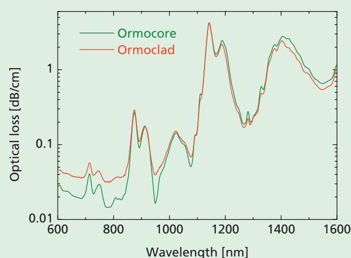
Ormocore and Ormoclad

ORMOCER® System for Planar Optical Waveguides


Undercladding/ core of a multimode wave guide on silicon - ACREO/ Sweden


Multilayer optical fan out FHG - IOF/ Jena - Germany





Unique features

Photo patterning inorganic-organic hybrid polymers

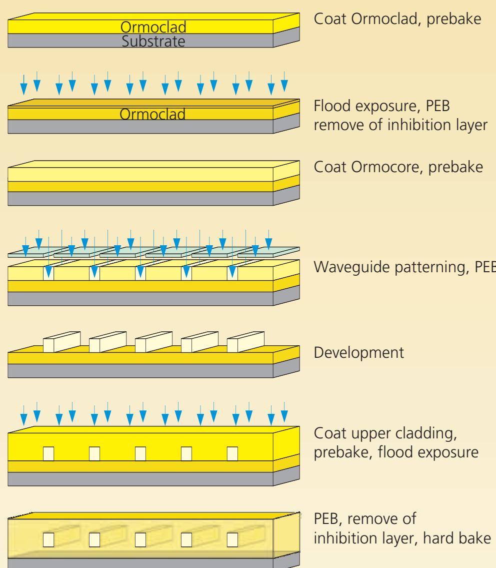
- UV patterning (lithography/ moulding)
- Exposure: i-line, broadband
- Tunable refractive index (core/ clad)
- Low optical loss at datacom wavelengths
- Thermally stable up to 270 °C
- 6 months shelf life

Applications

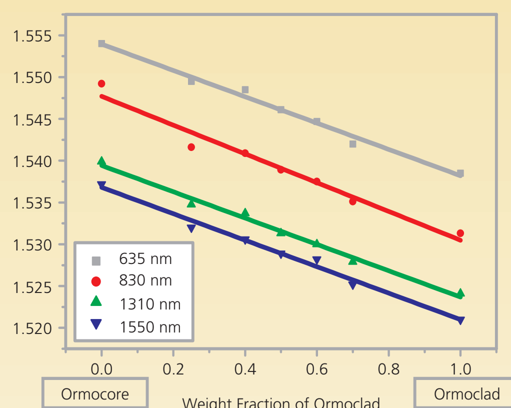
For manufacture of

- Multimode wave guides
- Singlemode wave guides
- Beam splitters
- Thermooptical switches

Process flow for optical wave guides



Refractive index tuning



Optical loss (α)

Ormocore	Ormoclad
< 0.1 dB cm^{-1} @ 633 nm	≤ 0.1 dB cm^{-1} @ 633 nm
0.23 dB cm^{-1} @ 1310 nm	0.26 dB cm^{-1} @ 1310 nm
0.5 - 0.6 dB cm^{-1} @ 1550 nm	0.48 dB cm^{-1} @ 1550 nm

Technical data

Properties of the cured materials	Ormocore	Ormoclad
Thermal stability	Weight loss < 5 % up to 270 °C (5 K min^{-1})	
Film quality	Good planarisation properties	
Thermal behaviour	duromeric	
Water absorption	< 0.5 %	
CTE (20 - 100 °C)	100 - 130 ppm K^{-1}	
Rms roughness	2 - 4 nm	
Shrinkage (during curing)	2 - 5 Vol.-%	
Refractive index @ 635 nm	1.553	1.534

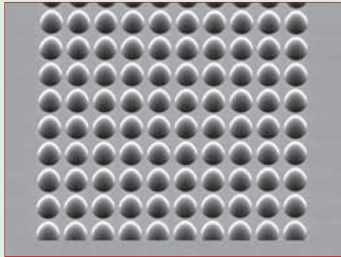
® Registered trademark of the Fraunhofergesellschaft zur Förderung der angewandten Forschung in Deutschland e.V.

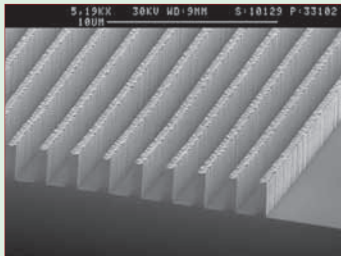
micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

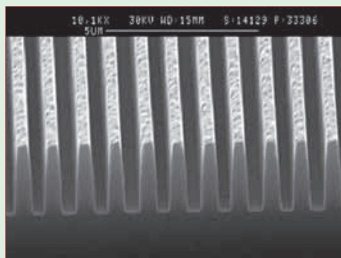
micro resist technology

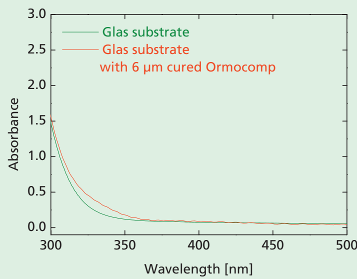
Ormocomp — UV Curable Hybrid Polymer for Moulding

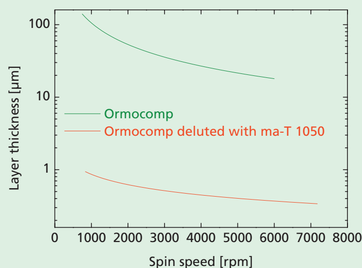
ORMOCER® for Microoptical Components Produced by UV moulding


Replicated 10x10 micro lens array
FHG -IOF Jena/ Germany


Optical grating
FSU - Jena/ Germany


Optical grating
FHG -IOF Jena/ Germany





Unique features

Ormocomp - UV curable material for imprinting

- UV patterning (lithography/ moulding)
- Exposure: i-line, broadband
- Fast curing
- Shrink during curing 5 - 7 Vol.%
- Thermally stable up to 270 °C
- 6 months shelf life
- Solvent free

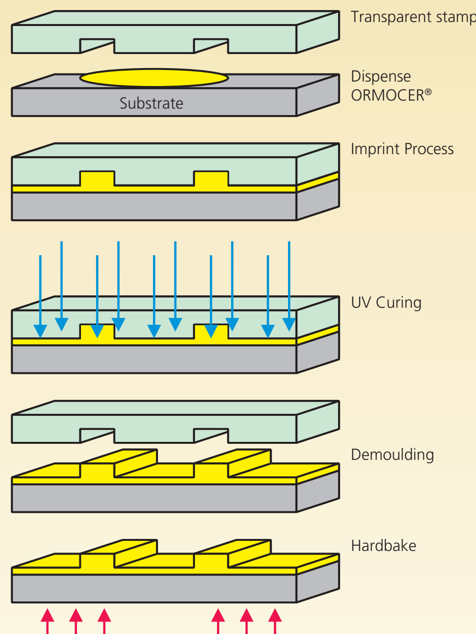
Applications

For manufacture of

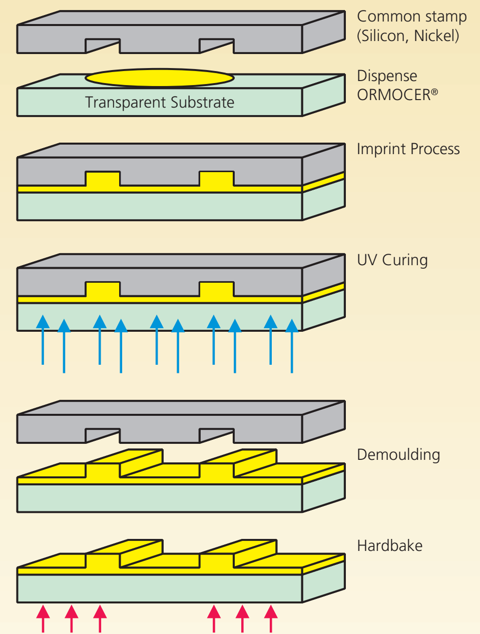
- Moulded gratings
- Micro lenses
- Micro lens arrays
- Optical couplers and connectors
- Prisms

Process flow UV moulding

< transparent stamp >



< common stamp >



Technical data

Properties of the cured materials	Ormocomp
Thermal stability	Weight loss < 5 % up to 270 °C (5 K min^{-1})
Film quality	Good planarisation properties
Thermal behaviour	durometric
Water absorption	< 0.5 %
CTE (20 - 100 °C)	100 - 130 ppm K^{-1}
rms roughness	2 - 4 nm
Shrinkage (during curing)	5 - 7 Vol.-%
Refractive index @ 635 nm	1.518

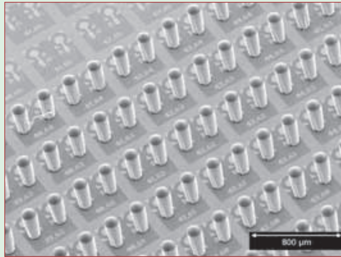
® Registered trademark of the Fraunhofergesellschaft zur Förderung der angewandten Forschung in Deutschland e.V.

micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

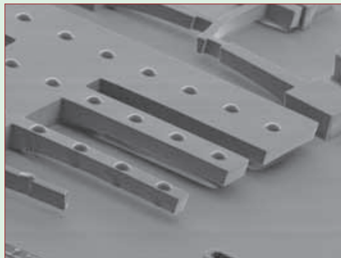
micro resist technology

ORMOCER®s — Ormocore & Ormocomp for Microoptics

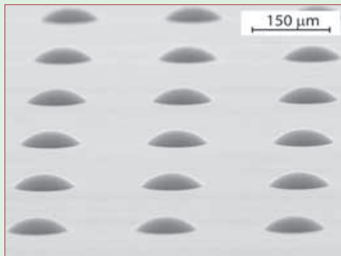
Materials and Technology for Innovative Microoptical Applications



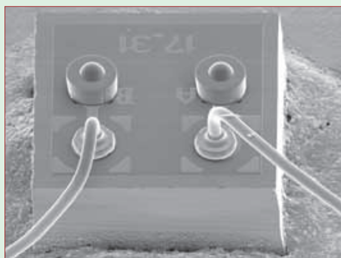
SEM of replicated sol-gel refractive microlenses on a VCSEL wafer substrate (Courtesy of Avalon)



Replicated ORMOCER® cantilever beams with microlenses. Lenght: 1mm, height: 50 μm, gap under the beams: 30μm (CSEM)



SEM of replicated microlenses in sol-gel material (CSEM)



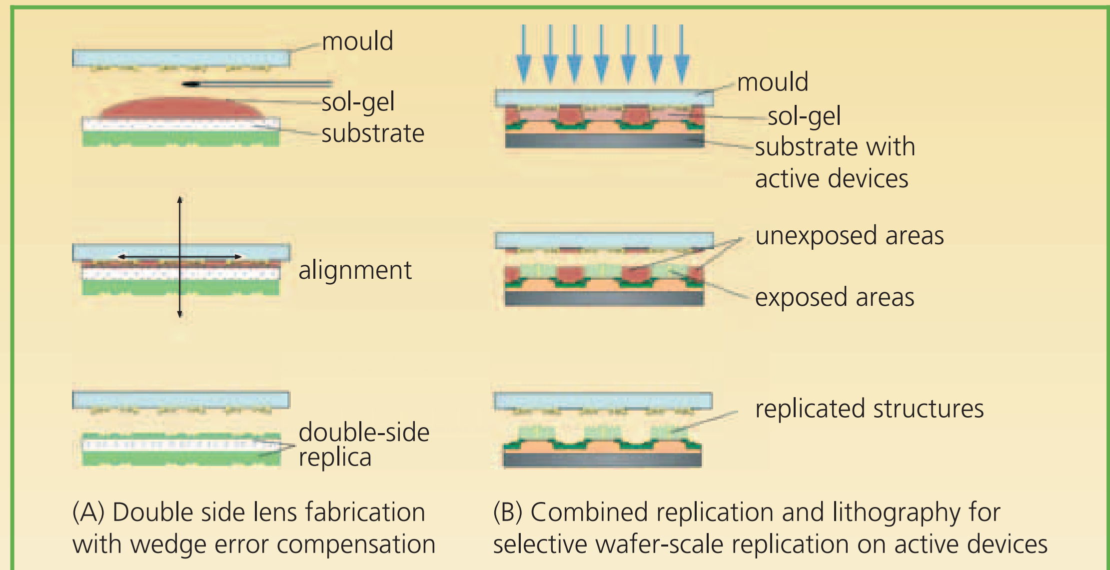
Packaged replicated sol-gel lens on a VCSEL chip (CSEM/Avalon)

Material

- UV patterning
- Thermally stable up to 270 °C
- Fast curing
- Solvent free

Technology

- Very high resolution to sub 200 nm linewidth
- Binary and continous profile
- Positioning and mechanical alignment features in one mold
- Single elements or wafer scale



(A) Double side lens fabrication with wedge error compensation

(B) Combined replication and lithography for selective wafer-scale replication on active devices

Physical properties

Ormocore	Ormocomp
n @ 635 nm: 1.553 n @ 800 nm: 1.543	n @ 635 nm: 1.518 n @ 800 nm: 1.513
Exposure dose: 300 - 1000 mJ cm^{-2} at 350 nm - UV 300 source recommended	
CTE: 100 - 130 ppm K^{-1}	
Shrinkage 3 - 5 %	Shrinkage 5 - 7 %
Highly transparent up to 400 nm and at datacom wavelenghts	Highly transparent up to 400 nm
Thermal behavior: stable up to 270 °C	

Applications

- Microoptical components and microsystems, optical sensors and measurement systems, telecom and datacom, displays and optical sensors and instruments

CSEM SA
Badenerstrasse 569
P.O. BOX
CH-8048 Zuerich
Telephon +41 1 497 1411
Fax +41 1 497 1400
www.csem.ch

csem
technologies for innovation

- We gratefully acknowledge all contributions of our partner: CSEM.

® Registered trademark of the Fraunhofergesellschaft zur Förderung der angewandten Forschung in Deutschland e.V.

ls.05.09.08.01

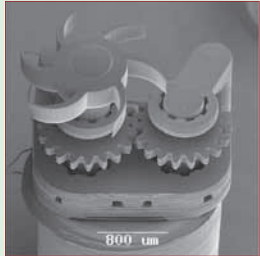
micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

micro resist technology

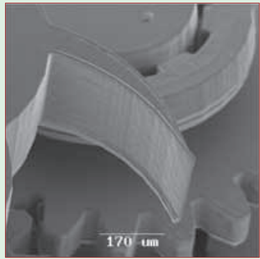
The μ-stereo Lithography Setup

Layer-by-Layer 3D micro patterning with ORMOCER®s

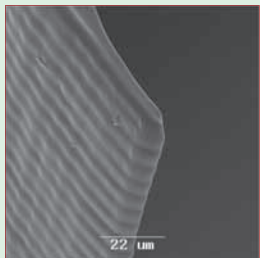
micro mechanical demonstrators, developed within the PRONTO project:



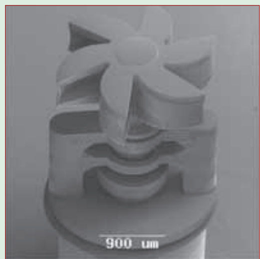
Windmill for fluidic media with a gearwheel connection



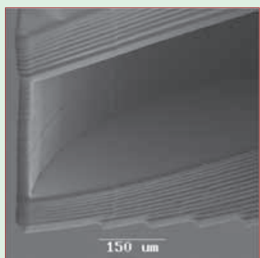
Detail view of a windmill sail



Detail view of the 10 μm layers of a windmill sail



Windmill with cavities



Detail view of the windmill cavity

ls.06.03.07.01

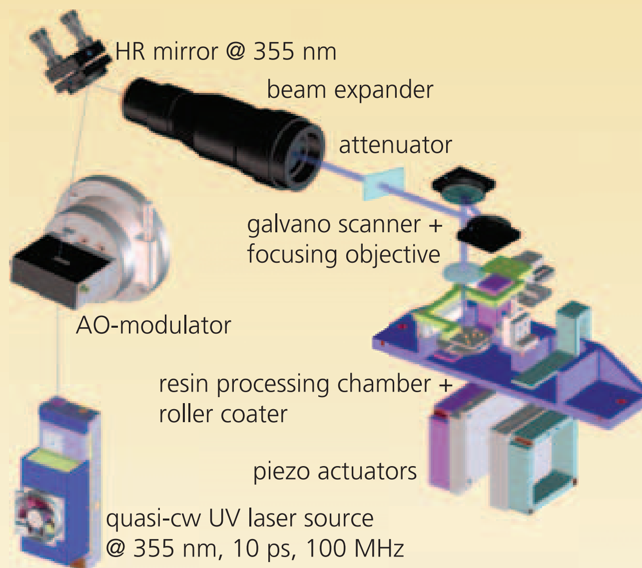
Unique features

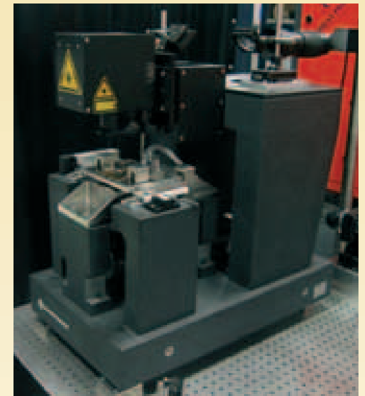
- Laser: 355 nm, 20 mW, 100 Mhz
- Scanner: 100 mm focal distance, scanning area 50 x 50 mm
- Resolution: < 10 μm vertical 5 μm lateral
- Positioning with piezo actuators

Applications

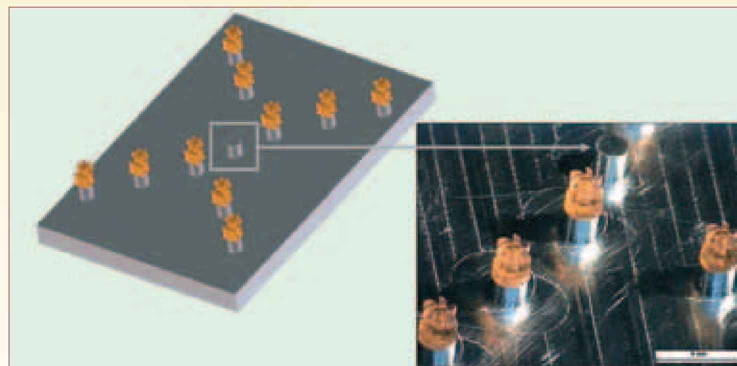
- Micro mechanical systems
- Micro sensors
- Micro fluidics
- Medicine and bio applications

Principle Setup

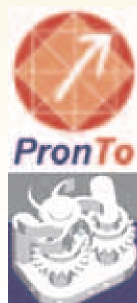




Photograph of the μ-stereo lithography setup



Substrate with 10 windmills built simultaneously



LZH LASER ZENTRUM HANNOVER e.V.

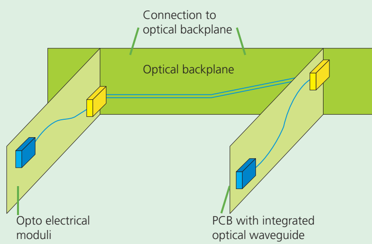
® Registered trademark of the Fraunhofergesellschaft zur Förderung der angewandten Forschung in Deutschland e.V.

micro resist technology GmbH
Koepenicker Straße 325
12555 Berlin-Koepenick
Germany
Telephone +49 30 65762192
Fax +49 30 65762193
E-Mail mrt@microresist.de
www.microresist.de

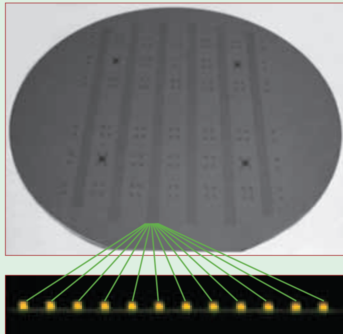
New Products by **micro resist technology**

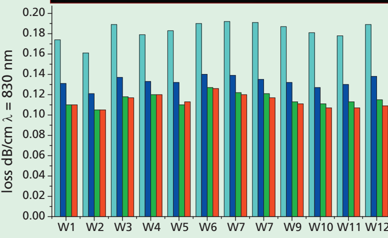
EpoCore & EpoClad - New Materials for Optical Wave Guides in PCB

For New Generation Interconnection Technology (NegIT)



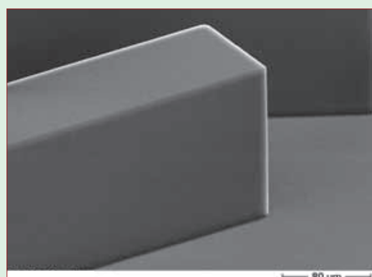
New Generation Interconnection Technology (NegIT)





after:
- Lamination 185 °C 23.5 kp/cm^2
- Reflow 3 x 230 °C
- TCT 100 x -40/125 °C
- TCT 204 x -40/125 °C

Low optical loss @ λ = 830 nm after standard tests: 0.1 dB/cm



Waveguide with smooth surface and vertical sidewalls

No microcracks on critical spots

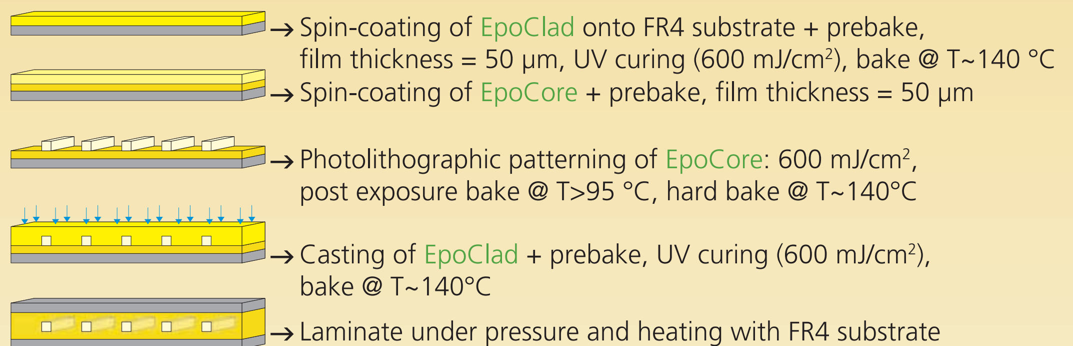
ls.06.02.07.01

Unique features

- Standard Lithography and PCB technology processing
- UV patterning of core and cladding
- High transmittance @ 850 nm
- High heat and pressure resistance
- Tunable refractive index (core/cladding)

Applications

- Optical waveguides
- Etch mask
- Casting moulding
- Biosensors (multifunctional systems)
- UV resist



→ Spin-coating of EpoClad onto FR4 substrate + prebake, film thickness = 50 µm, UV curing (600 mJ/cm^2), bake @ T~140 °C

→ Spin-coating of EpoCore + prebake, film thickness = 50 µm

→ Photolithographic patterning of EpoCore: 600 mJ/cm^2, post exposure bake @ T>95 °C, hard bake @ T~140°C

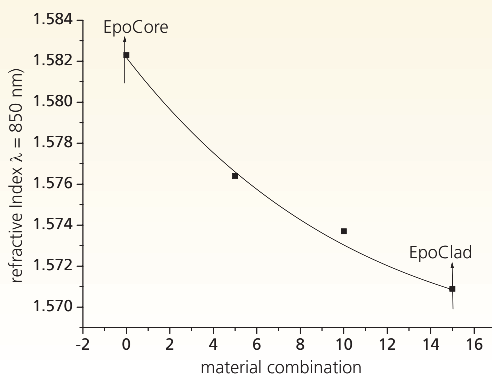
→ Casting of EpoClad + prebake, UV curing (600 mJ/cm^2), bake @ T~140°C

→ Laminate under pressure and heating with FR4 substrate

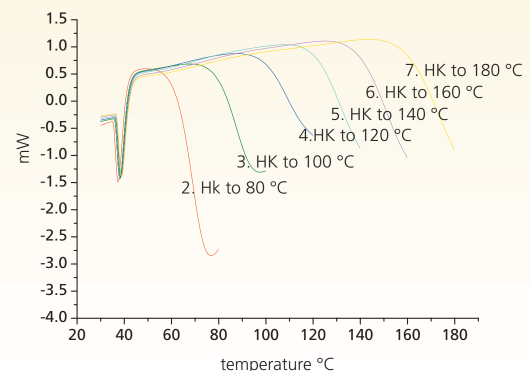
Technical data

Resin typ	Epoxy duromer
Waveguide	Refractive index @ λ = 830 nm: EpoCore 1.58, EpoClad 1.57
Glass transition temperature	> 180 °C
Substrate	Standard FR4 (10x10 cm, 8 inch)
Lamination	Standard temperature > 185 °C, pressure 23 kp/cm^2
Standard tests	Reflow: 3 x 15 s @ T = 230 °C; TCT: 240 x -40 °C / +120 °C
Optical loss	~0.2 dB/cm @ λ = 850 nm

- Fabrication with conventional equipment (UV lithography and PCB)
- High thermal stability (> 230 °C), high glass transition temperature (> 180 °C)
- Excellent stability of embedded, laminated waveguides after reflow and TCT tests



Refractive index tuning by copolymerisation



EpoCore, DSC-curve after repeated measurements with different final temperatures

We gratefully acknowledge all contributions of our partners. BMBF Förderkennzeichen NeGIT 16SV 1819

micro resist technology GmbH

Koepenicker Straße 325, Haus 211
12555 Berlin
Germany

Tel.: +49 30 65 76 21 92
Fax: +49 30 65 76 21 93
Email: mrt@microresist.de

www.microresist.de