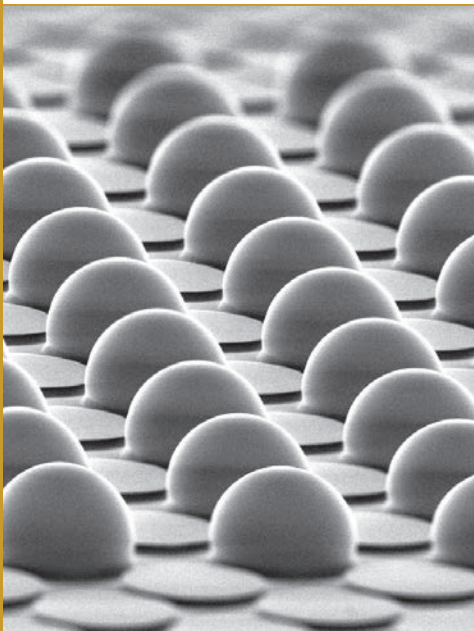


## UV-Curable Hybrid Polymers for Micro Optical Components



- OrmoComp®
- InkOrmo
- OrmoClear®
- OrmoClear®10
- OrmoClear®30
- OrmoCore
- OrmoClad
- OrmoStamp®

### Unique features

- Excellent transparency
- Excellent mechanical properties
- High chemical and physical stability
- Excellent replication fidelity
- Ready-to-use solutions

- Made in Germany -



**micro resist technology GmbH**

Gesellschaft für chemische Materialien spezieller Photoresistsysteme mbH

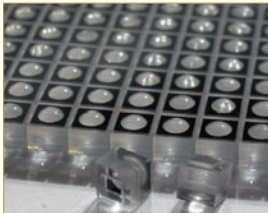
Köpenicker Str. 325  
12555 Berlin  
GERMANY

phone  
fax  
mail  
info

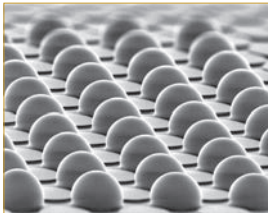
+49 30 64 16 70 100  
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sales@microresist.de  
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Product Overview

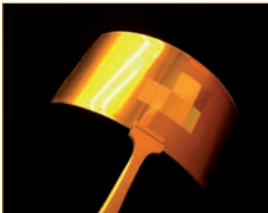
| Material Specifications                                                                                                          | OrmoComp® | InkOrmo | OrmoStamp® | OrmoCore  | OrmoClad  | OrmoClear® | OrmoClear®10 | OrmoClear®30 |
|----------------------------------------------------------------------------------------------------------------------------------|-----------|---------|------------|-----------|-----------|------------|--------------|--------------|
| Liquid material before patterning process                                                                                        |           |         |            |           |           |            |              |              |
| Solvent-free                                                                                                                     | Yes       | No      | Yes        | Yes       | Yes       | Yes        | Yes          | Yes          |
| Viscosity [Pa·s]                                                                                                                 | 2.0 ± 1.0 | *       | 0.4 ± 0.2  | 2.9 ± 0.4 | 2.5 ± 1.0 | 2.9 ± 0.4  | 10 ± 2       | 30 ± 3       |
| Film thickness upon spin coating [µm]                                                                                            |           | **      |            |           |           |            |              |              |
| 3000 rpm                                                                                                                         | 20        |         | 10         | 30        | 30        | 30         | 45           | 100          |
| 6000 - 1000 rpm                                                                                                                  | 10-60     |         | 5 - 35     | 20 - 90   | 20 - 90   | 20 - 95    | 30 - 150     | 50 - 270     |
| Spectral sensitivity photo-curing [nm]                                                                                           | 300 - 410 |         | 300 - 410  | 300 - 390 |           | 300 - 410  |              |              |
| Hybridpolymer after photo-curing (λ = 365 nm) and hardbake (140 - 160°C)                                                         |           |         |            |           |           |            |              |              |
| Volume shrinkage [%]                                                                                                             | 5 - 7     |         | 4 - 6      | 2 - 5     | 2 - 5     | 3 - 5      | < 2          | << 2         |
| Refractive Index (589 nm)                                                                                                        | 1.520     |         | 1.516      | 1.555     | 1.537     | 1.555      | 1.559        | 1.561        |
| CTE (20-100 °C) [ppm/K]                                                                                                          | 60        |         | 105        | 100 - 130 | 100 - 130 | 130        | 130          | 130          |
| dn/dT (589 nm) [10 <sup>-4</sup> /K]                                                                                             | -2.0      |         | -1.5       | -2.2      | -2.7      | -2.1       | -2.3         | -2.3         |
| Young's modulus [GPa]                                                                                                            | ~1        |         | ~0.6       | ~1        | ~0.5      | ~1.2       | ~0.8         | ~0.8         |
| Hardness (by indentation) [MPa]                                                                                                  | ~68       |         | ~36        | ~53       | ~24       | ~60        | ~90          | ~90          |
| * Standard InkOrmo solutions available with viscosity of 7 mPas, 12 mPas, and 18 mPas      ** Inkjet dispensing, no spin coating |           |         |            |           |           |            |              |              |



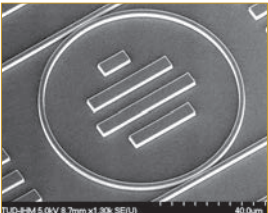
Microlenses on glass  
(Courtesy of FhG IOF, Germany)



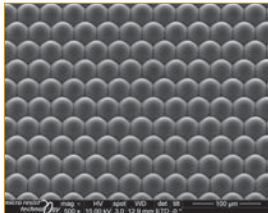
InkOrmo lenses on OrmoComp®  
pedestals - diameter of 100 µm  
(Courtesy of EPFL/LMIS1, Switzerland)



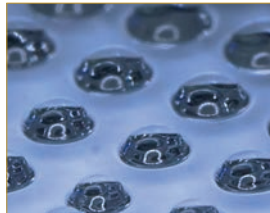
Flexible OrmoStamp® on nickel  
backplate  
(Courtesy of PSI, Switzerland)



Replicated OrmoCore  
microring resonator  
(Courtesy of TU Dresden)



Replicated OrmoComp®  
microlens arrays



Replicated OrmoClear®  
macrolenses (Courtesy of HZB)

Applications

Micro Optical Components

Transparent Stamps

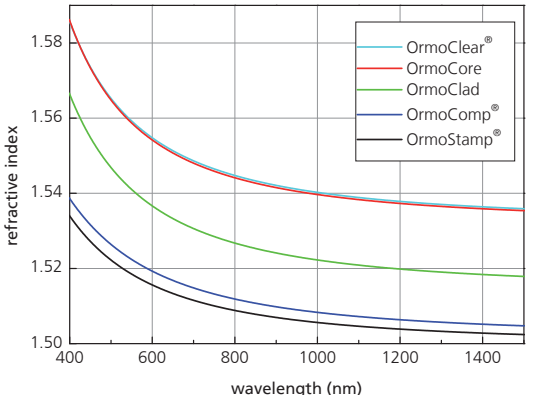
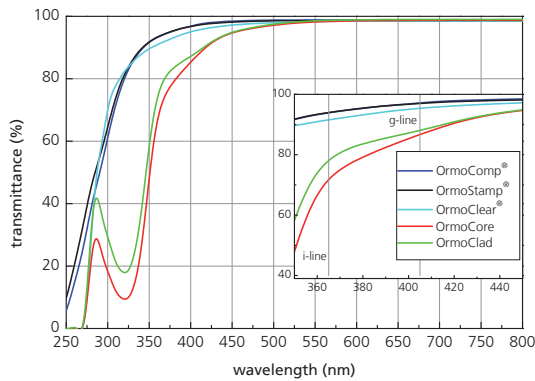
Optical Waveguides

Micro Optical Components

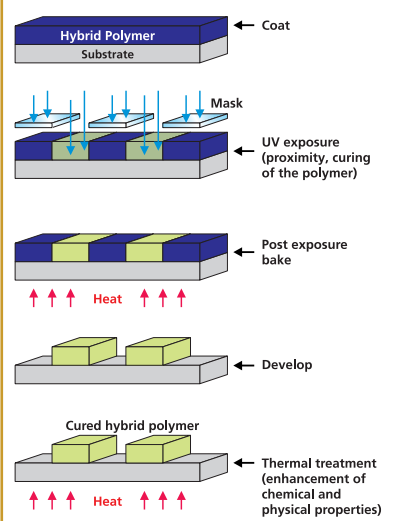
| Selection Guide                                     | OrmoComp® | InkOrmo | OrmoStamp® | OrmoCore | OrmoClad | OrmoClear® | OrmoClear®10 | OrmoClear®30 |
|-----------------------------------------------------|-----------|---------|------------|----------|----------|------------|--------------|--------------|
| Process Compatibility                               |           |         |            |          |          |            |              |              |
| Photolithography (mask-lithography)                 | •         |         | •          | •        | •        | •          | •            | •            |
| UV molding                                          | •         |         | •          | •        | •        | •          | •            | •            |
| (Nano-)imprinting                                   | •         |         | •          | •        | •        | •          | •            | •            |
| Direct laser writing, TPA                           | •         |         |            |          |          |            |              |              |
| Ink-jet dispensing                                  |           | ••      |            |          |          |            |              |              |
| Roll-to-roll / Roll-to-plate processing             | •         |         | •          |          |          |            |              |              |
| Preferred Applications                              |           |         |            |          |          |            |              |              |
| Microlenses, gratings, prisms, DOEs                 | •         | •       |            |          |          | •          | •            | •            |
| Waveguiding                                         |           |         |            | ••       | ••       | •          | •            | •            |
| Bio applications, lab-on-chip, microfluidics        | ••        |         |            |          |          | •          | •            | •            |
| Replication with hard molds (quartz, Ni etc.)       | •         | •       | •          | •        | •        | •          | •            | •            |
| Replication with PDMS molds (no oxygen sensitivity) | •         |         | •          |          |          |            |              |              |
| Working stamp fabrication (e.g. for NIL)            |           |         | ••         |          |          |            |              |              |
| Material Compatibility                              |           |         |            |          |          |            |              |              |
| Si and SiO <sub>2</sub> substrates                  | •         | •       | •          | •        | •        | •          | •            | •            |
| Plastic substrates                                  | •         |         | •          |          |          |            |              |              |

Main Features and Optical Properties

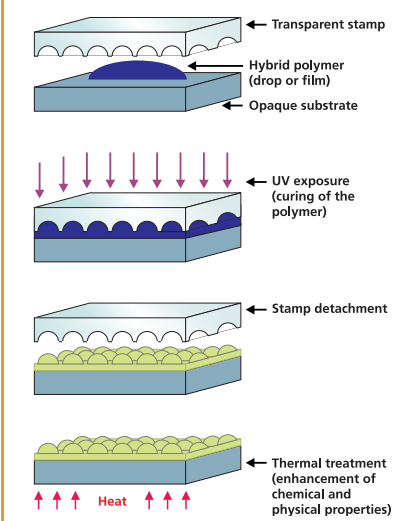
- UV lithography and UV molding
- Two-photon absorption (TPA) fabrication (OrmoComp® only)
- High resolution down to 100 nm feature size
- Highly transparent for VIS and near UV down to 350 nm
- High thermal stability up to 300 °C (short term), 270 °C (long term)
- High mechanical stability



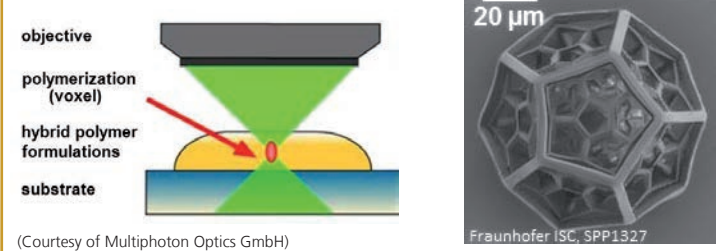
Process flow UV lithography



Process flow imprint lithography

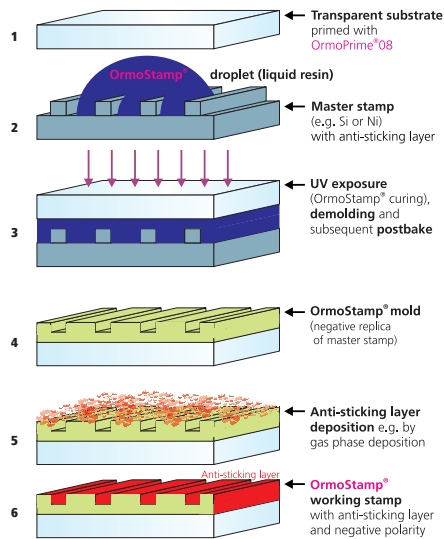


Two-photon absorption (TPA) process (OrmoComp® only)



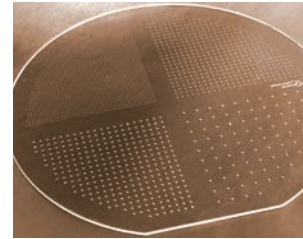
## OrmoStamp® for Transparent Polymer Working Stamps

### Process flow for working stamp fabrication



### Main Applications - Stamp Fabrication

- Transparent working stamp fabrication
- (Nano)Imprint processes
- Cost efficient alternative to quartz stamps



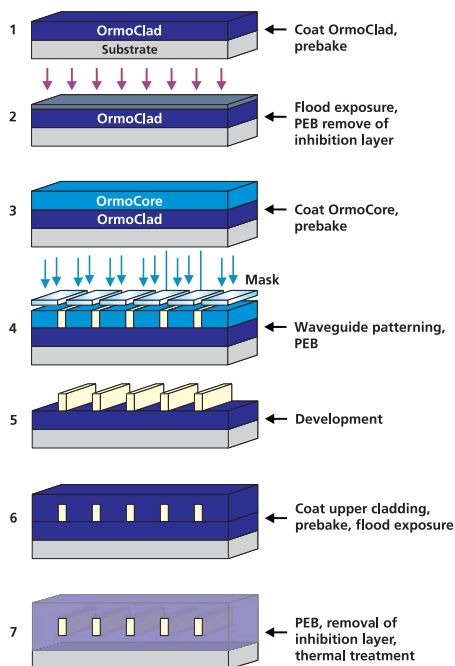
Large area replication of OrmoStamp® using 6 inch glass substrate

### Main Features - Stamp Fabrication

- For UV-based and thermal imprinting
- Highly transparent for near UV and visible light
- Excellent pattern replication
- High mechanical stability
- Thermal stability up to 270 °C (short term)
- Enhanced anti-adhesive properties for low release forces

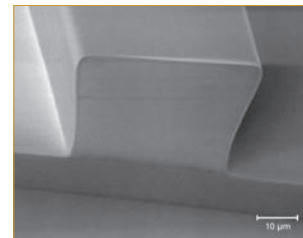
## OrmoCore and OrmoClad for Optical Waveguide Fabrication

### Process flow for waveguide fabrication



### Main Applications - Optical Waveguides

- Single-mode waveguides
- Multi-mode waveguides
- Beam splitters
- Thermo-optical switches
- Microring resonators



Undercladding/ core of a multimode waveguide on silicon (Courtesy of ACREO)

### Main Features - Optical Waveguides

- UV lithography and UV moulding
- Low optical loss at datacom wavelengths
- Tunable refractive index (Core/Clad ratios)
- High resolution down to 100 nm feature size
- Thermal stability up to 270 °C (short term)
- High mechanical stability

## Ancillaries

| Purpose                       | Ancillary             | Features                                                                                                                               |
|-------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Adhesion Promoter             | OrmoPrime®08          | - Recommended for various substrates like Si, glass, and quartz<br>- Ready-to-use solution for spin coating<br>- Film thickness 130 nm |
| Dilution of Hybrid Polymers * | OrmoThin<br>ma-T 1050 | Dilution for $d > 0.5 \mu\text{m}$ (product-dependent) *<br>Dilution for $d < 0.5 \mu\text{m}$ (product-dependent) *                   |
| Developer                     | OrmoDev               | - Removal of uncured material (e.g. after mask lithography was applied)<br>- Immersion development                                     |

\*For details of dilution ratios see corresponding processing guidelines

OrmoComp®: DE 30 210 075 433; IR 1 091 982 ; TW 100030626; OrmoClear®: DE 30 210 075 434; IR 1 091 359 ; TW 100030628

OrmoStamp®: DE 30 210 075 435; IR 1 092 621 ; TW 100030629; OrmoPrime®: DE 30 210 075 436

Hybrid polymers based on ORMOCER®s for micro-optics licensed by the Fraunhofergesellschaft zur Förderung der Angewandten Forschung in Deutschland e.V.