UV-Curable Hybrid Polymers for Micro Optical Components

- OrmoComp®
- InkOrmo
- OrmoClear®
- OrmoClear®30
- OrmoClear®FX
- 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 -
**Product Overview**

<table>
<thead>
<tr>
<th>Material Specifications</th>
<th>OrmoComp&lt;sup&gt;a&lt;/sup&gt;</th>
<th>InkOrmo</th>
<th>OrmoClear&lt;sup&gt;a&lt;/sup&gt;</th>
<th>OrmoClear&lt;sup&gt;30&lt;/sup&gt;</th>
<th>OrmoClear&lt;sup&gt;FX&lt;/sup&gt;</th>
<th>OrmoStamp&lt;sup&gt;b&lt;/sup&gt;</th>
<th>OrmoCore</th>
<th>OrmoClad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent-free</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Viscosity [Pa·s]</td>
<td>2.0 ± 0.5</td>
<td>2.9 ± 0.3</td>
<td>30 ± 3</td>
<td>15 ± 0.3</td>
<td>0.4 ± 0.2</td>
<td>2.9 ± 0.4</td>
<td>2.5 ± 1.0</td>
<td>Yes</td>
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<tr>
<td>Film thickness upon spin coating [µm]</td>
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<tr>
<td>3000 rpm</td>
<td>20 - 60</td>
<td>30</td>
<td>100 - 270</td>
<td>20 - 60</td>
<td>10</td>
<td>30 - 90</td>
<td>20 - 90</td>
<td>20 - 90</td>
</tr>
<tr>
<td>Spectral sensitivity photo-curing [nm]</td>
<td>300 - 410</td>
<td>300 - 410</td>
<td>300 - 410</td>
<td>300 - 390</td>
<td>300 - 410</td>
<td>300 - 410</td>
<td>300 - 390</td>
<td>300 - 390</td>
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</tbody>
</table>

Hybridpolymer after photo-curing (λ = 365 nm) and hardbake (140 - 160°C)  
Volume shrinkage [%]  
- OrmoComp®: 5 - 7  
- OrmoClear®: 3 - 5  
- OrmoClear®30: << 2  
- OrmoClear®FX: 3 - 5  
- OrmoStamp®: 4 - 6  
- OrmoCore: 2 - 5  
- OrmoClad: 2 - 5  

Refractive Index (589 nm)  
- OrmoComp®: 1.520  
- OrmoClear®: 1.555  
- OrmoClear®30: 1.561  
- OrmoClear®FX: 1.516  
- OrmoStamp®: 1.555  
- OrmoCore: 1.537  

Abbe number  
- OrmoComp®: 47  
- OrmoClear®: 34  
- OrmoClear®30: 34  
- OrmoClear®FX: 34  
- OrmoStamp®: 51  
- OrmoCore: 33  

dn/dT (589 nm) [10<sup>-4</sup>/K]  
- OrmoComp®: -2.0  
- OrmoClear®: -2.1  
- OrmoClear®30: -2.3  
- OrmoClear®FX: -2.7  
- OrmoStamp®: -1.5  
- OrmoCore: -2.2  
- OrmoClad: -2.7  

CTE (20-100 °C) [ppm/K]  
- OrmoComp®: 60  
- OrmoClear®: 130  
- OrmoClear®30: 130  
- OrmoClear®FX: n.d.  
- OrmoStamp®: 105  
- OrmoCore: 100 - 130  
- OrmoClad: 100 - 130  

Young’s modulus [GPa]  
- OrmoComp®: ~1  
- OrmoClear®: ~1.2  
- OrmoClear®30: ~0.8  
- OrmoClear®FX: n.d.  
- OrmoStamp®: ~0.6  
- OrmoCore: ~1  
- OrmoClad: ~0.5  

Hardness (by indentation) [MPa]  
- OrmoComp®: ~68  
- OrmoClear®: ~60  
- OrmoClear®30: ~90  
- OrmoClear®FX: n.d.  
- OrmoStamp®: ~36  
- OrmoCore: ~53  
- OrmoClad: ~24  

* Standard mOrmo solutions available with viscosity of 7 mPas, 12 mPas, and 18 mPas  
* * Inkjet dispensing, no spin coating

**Main Features and Optical Properties**  
- UV lithography and UV molding  
- Two-photon absorption (TPA) fabrication (OrmoComp<sup>a</sup> 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

**Applications**

**Selection Guide**

<table>
<thead>
<tr>
<th>OrmoComp&lt;sup&gt;a&lt;/sup&gt;</th>
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<th>OrmoClear&lt;sup&gt;a&lt;/sup&gt;</th>
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<th>OrmoCore</th>
<th>OrmoClad</th>
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<tbody>
<tr>
<td>Process Compatibility</td>
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<td>Photolithography (mask-lithography)</td>
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<tr>
<td>UV molding</td>
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<td>Nano-imprinting</td>
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<tr>
<td>Direct laser writing, TPA</td>
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<tr>
<td>Ink-jet dispensing</td>
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<tr>
<td>Roll-to-roll / Roll-to-plate processing</td>
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**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  

**Micro Optical Components**

- Transparent Stamps  
- Optical Waveguides

**Transparent Stamps**

- Replicated OrmoCore<sup>a</sup> microring resonator (Courtesy of TU Dresden)  
- Replicated OrmoComp<sup>a</sup> microlens arrays (Courtesy of PSI, Switzerland)  
- Replicated OrmoClear<sup>a</sup> macrolenses (Courtesy of HZB)

**Optical Waveguides**

- Replicated OrmoComp<sup>a</sup> microlens arrays (Courtesy of FhG IOF, Germany)

**Main Features and Optical Properties**

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**Two-photon absorption (TPA) process (OrmoComp<sup>a</sup> only)**

- Objective polymerization (nano)  
- Hybrid polymer formulas  
- Microresist (www.microresist.com)
OrmoStamp® for Transparent Polymer Working Stamps

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

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

Main Applications - Optical Waveguides
- Single-mode waveguides
- Multi-mode waveguides
- Beam splitters
- Thermo-optical switches
- Microring resonators

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

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Ancillary</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesion Promoter</td>
<td>OrmoPrime®08</td>
<td>- Recommended for various substrates like Si, glass, and quartz</td>
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<td></td>
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<td>- Ready-to-use solution for spin coating</td>
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<td></td>
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<td>- Film thickness 130 nm</td>
</tr>
<tr>
<td>Dilution of Hybrid Polymers *</td>
<td>OrmoThin ma-T 1050</td>
<td>- Dilution for d &gt; 0.5 µm (product-dependent) *</td>
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<tr>
<td></td>
<td></td>
<td>- Dilution for d &lt; 0.5 µm (product-dependent) *</td>
</tr>
<tr>
<td>Developer</td>
<td>OrmoDev</td>
<td>- Removal of uncured material (e.g. after mask lithography was applied)</td>
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<tr>
<td></td>
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<td>- Immersion development</td>
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</tbody>
</table>

*For details of dilution ratios see corresponding processing guidelines

OrmoComp®: DE 30 210 075 433; IR 1 091 982; TW 10030626; OrmoClear®: DE 30 210 075 434; IR 1 091 359; TW 10030628
OrmoStamp®: DE 30 210 075 435; IR 1 092 621; TW 10030629; 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.