PLEXIGLAS® and EUROPLEX® COC Films for Microfluidic Applications
General information about microfluidics

**Microfluidics**

Microfluidics refers to the behavior, control and handling of fluids that are geometrically limited to a small scale of typically less than one millimeter. It is a multidisciplinary field involving engineering, physics, chemistry, biochemistry, nanotechnology and biotechnology. It has practical applications in the design of systems that process low volumes of fluids in capillaries. Such methods can be used to achieve high-throughput screening. Microfluidics is used in the development of inkjet printheads, DNA chips, lab-on-a-chip technology, micro-propulsion and micro-thermal technologies.

The various applications of such systems rely on passive fluid control using capillary forces. In some applications, external actuation means such as rotary actuators and centrifugal forces are additionally used for a directed transport of the media.

**Fils**

In order to pass the small amount of liquids through microcapillaries, a special surface of the capillaries is required. These surface properties can be achieved with the specially developed PLEXIGLAS® and EUROPLEX® COC films. COC films in particular are characterized by a number of properties such as excellent thermoplastic fluidity; high rigidity, strength and hardness; low density; high transparency; and a high level of resistance to acids and alkalis. Excellent biocompatibility, especially hemocompatibility, must also be emphasized. Our films can be found as the cover film of these chips. They are available in thicknesses between 60 µm and 240 µm.

**Lamination**

All films supplied by us can be laminated in different ways according to customer requirements. It is possible to cover the film without lamination, with one-sided lamination or double-sided lamination. If a lamination is chosen, the blue lamination film marks the top, which is also the smoother side due to the process, whereas the colorless lamination film represents the underside.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Available thicknesses [µm]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLEXIGLAS® Film OF301</td>
<td>80, 200, 375, 500</td>
<td>PMMA polymer-based film. Glossy surfaces on both sides. Double-sided, single-sided or without lamination.</td>
</tr>
<tr>
<td>PLEXIGLAS® Film OF302</td>
<td>175, 250, 375, 500</td>
<td>Impact modified PMMA polymer-based film. Glossy surfaces on both sides. Double-sided, single-sided or without lamination.</td>
</tr>
<tr>
<td>EUROPLEX® COC Film OF304</td>
<td>60, 80, 125, 140, 240</td>
<td>COC-based film. Glossy surface on both sides. Double-sided, single-sided or without lamination.</td>
</tr>
<tr>
<td>EUROPLEX® COC Film OF305</td>
<td>60, 80, 125, 140, 240</td>
<td>COC polymer-based film. Glossy surface on both sides. Higher heat resistant version of the COC film. Double-sided, single-sided or without lamination.</td>
</tr>
</tbody>
</table>

Fig. 1: Available films
Application engineering information on microfluidics

Cutting of PLEXIGLAS® and EUROPLEX® COC film

For die-cutting of PLEXIGLAS® and EUROPLEX® films, certain conditions must be satisfied to obtain good results:

- Use of high-speed punch presses
- Use of dies with sharp, unchipped edges
- Die-cutting of PLEXIGLAS® and EUROPLEX® films at room temperature or higher

A single-sided double bevel is the most suitable geometry for a die-cutting tool in die-cutting of PLEXIGLAS® and EUROPLEX® COC Films.

Three options for punching and cutting the films are described below.

Steel rule dies

Steel rule dies are generally less suitable for die-cutting PLEXIGLAS® and EUROPLEX®, as they result in larger tolerances of up to ± 0.2 mm. However, die-cutting with steel rule dies is a relatively cost-effective option.

Column guided solid tools (solid punching)

Column guided solid tools achieve a precision of ± 0.02 mm. Hydraulic presses are to be preferred here over eccentric presses.

For good results with PLEXIGLAS® and EUROPLEX® films, an accurately designed die clearance is necessary. The die clearance should lie between 0.01 and 0.03 mm; larger die clearances lead to untidy die-cut edges. It is recommended in every case that the die-cutting tool be heated, with the set temperature lying between 60 and 90 °C. The cut edges of PLEXIGLAS® and EUROPLEX® films can also be improved by heating the material to a temperature between
60-70 °C. Special hard coatings on the tool inserts, such as with titanium nitride, have also proven useful. In general, the masking film should remain on PLEXIGLAS® films during die-cutting as this further improves cutting properties.

**Heat contact sealing of PLEXIGLAS® and EUROPLEX® COC film**

Various methods are suitable for connecting the cover film made of PLEXIGLAS® and EUROPLEX® COC to the base layer, e.g. heat contact sealing.

The cover film is bonded to the base layer under heat, pressure and time on the contact surface. Temperature parameters can be found in the table. (Fig. 6).

**Solvent-based sealing of EUROPLEX® COC film**

EUROPLEX® COC film is soluble in non-polar organic solvents such as toluene, cyclohexane, methylcyclohexane, decalin, xylene and chloroform. This means that EUROPLEX® COC can be sealed with such solvents.

With increasing polarity, moderately polar solvents such as THF are less effective for EUROPLEX® COC film. Polar solvents such as acetone do not dissolve EUROPLEX® COC films and are therefore not suitable for solvent sealing.

**Ultrasonic sealing of EUROPLEX® COC film**

Ultrasonic sealing is a process that is ideally suited for joining EUROPLEX® COC film because of its high modulus of elasticity and the resulting low attenuation. Sealing is achieved by means of high-frequency mechanical vibration typically in the range of 20 to 35 kHz, which leads to heating between the components by molecular and interfacial friction. Despite the very different glass transition temperatures (Tg) of EUROPLEX® OF304 and OF305, ultrasonic sealing is suitable for joining these two plastics together.

**Laser sealing of EUROPLEX® COC film**

Laser welding is also suitable for joining EUROPLEX® COC film.

A thulium fiber laser with a wavelength of 1960 nm should be used. In addition, pyrometer monitoring should be used to ensure constant weld quality. The approximate parameters can be found in the table (Fig. 7).

**Sterilizing EUROPLEX® COC films**

EUROPLEX® COC films are relatively stable against gamma and beta radiation and can therefore be easily sterilized using electron-beam processing. This does not affect mechanical properties such as tensile strength. It must be noted, however, that a slight change in color (yellowing) occurs immediately after irradiation; this will fade away shortly thereafter. Below you can see the common sterilization methods for EUROPLEX® COC film.

**Gamma, electron radiation**
- Maintains the mechanical properties
- No influence on transparency
- Temporary color change

**Steam**
- Maintains the mechanical properties
- Minimal influence on transparency and color

**Ethylene oxide**
- No effect

**Hydrogen peroxide**
- No effect

Please note that all parameters and recommendations may differ from the process you are using.
<table>
<thead>
<tr>
<th>Sealing film</th>
<th>Glass transition temperature (Tg)</th>
<th>Sealing temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLEXIGLAS® Film OF301</td>
<td>Approx. 110 °C</td>
<td>Approx. 140 °C bis 150 °C</td>
</tr>
<tr>
<td>PLEXIGLAS® Film OF302</td>
<td>Approx. 111 °C</td>
<td>Approx. 150 °C bis 160 °C</td>
</tr>
<tr>
<td>EUROPLEX® COC Film OF304</td>
<td>Approx. 78 °C</td>
<td>Approx. 110 °C bis 120 °C</td>
</tr>
<tr>
<td>EUROPLEX® COC Film OF305</td>
<td>Approx. 142 °C</td>
<td>Approx. 180 °C bis 190 °C</td>
</tr>
</tbody>
</table>

Fig. 6: Heat contact sealing of PLEXIGLAS® and EUROPLEX® COC film

<table>
<thead>
<tr>
<th>Material</th>
<th>Feed rate [mm/s]</th>
<th>Power [W]</th>
</tr>
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<tbody>
<tr>
<td>TOPAS 5013</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>EUROPLEX® COC Film OF305</td>
<td>33.3</td>
<td>100</td>
</tr>
<tr>
<td>EUROPLEX® COC Film OF304</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

Fig. 7: Laser sealing of EUROPLEX® COC film
United Nations Sustainable Development Goals: How PLEXIGLAS® supports sustainable action

The United Nations’ 2030 Agenda for Sustainable Development aims to shape global economic progress in a socially just manner and within the Earth’s environmental limits. At the heart of this agenda are 17 Sustainable Development Goals (SDG). These goals are to be achieved by 2030 through the joint efforts of states, companies and civil society. We at Röhm GmbH are also contributing toward this necessary change – through both our PLEXIGLAS® products and our company’s sustainability strategy.

Find out which SDGs are particularly relevant for us and how PLEXIGLAS® supports sustainable action at www.plexiglas.de/eco.

Röhm GmbH
Acrylic Products
Riedbahnstraße 70
64331 Weiterstadt
Germany
www.plexiglas.de
www.roehm.com

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