PLEXIGLAS®

GUIDELINES FOR WORKSHOP PRACTICE

PLEXIGLAS® and EUROPLEX®
COC Films for Microfluidic Applications

POLYVANTIS

Films for microfluidic applications

Microfluidic

Microfluidic refers to the behavior, control and handling of fluids that are confined to geometries with diameters of less than one millimeter. It is a multidisciplinary field involving engineering, physics, chemistry, biochemistry, nanotechnology and biotechnology. Microfluidic is a crucial factor to consider when designing systems that process low volumes of fluids in capillaries. These systems can be used to achieve high-throughput screening and are essential 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 – such as rotary actuators and centrifugal forces – is additionally used for a directed transport of the media.

Films

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. They are available in thicknesses between 60 µm and 240 µm.

Masking films

Masking films are typically applied on both sides but can be adapted per customer's needs. It is possible to obtain the film without a masking film or applied on one or both sides.

Application engineering information

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 (Figure 1).

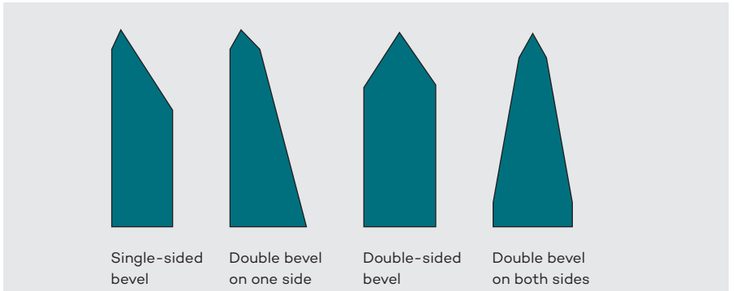

Figure 1: Different geometries for cutting tools.

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.

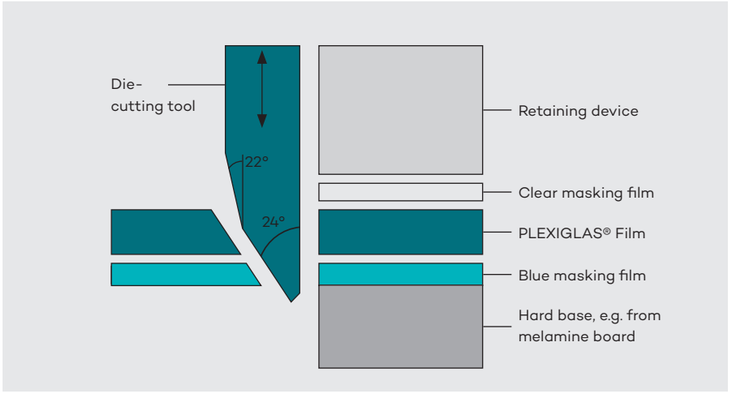

Figure 2: Setup for a die-cutting unit.

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 is 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 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® PMMA 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 table 2.

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 films. 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 due to molecular and interfacial friction. Despite the very different glass transition temperatures (T_g) of EUROPLEX® COC film 0F304 and 0F305, ultrasonic sealing is suitable for joining these two materials 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 table 3.

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 common sterilization methods for EUROPLEX® COC films.

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 are exemplarily and may differ for the process you are using.

Table 1: Available PLEXIGLAS® and EUROPLEX® films for microfluidic applications.

Product name	Available thicknesses [µm]	Remarks
PLEXIGLAS® Film 0F301	80, 200, 375, 500	PMMA-based film. Glossy surfaces on both sides.
PLEXIGLAS® Film 0F302	175, 250, 375, 500	Impact modified PMMA-based film. Glossy surfaces on both sides.
EUROPLEX® COC Film 0F304	60, 80, 125, 140, 240	COC-based film. Glossy surface on both sides.
EUROPLEX® COC Film 0F305	60, 80, 125, 140, 240	COC-based film. Glossy surface on both sides.

Table 2: Glass transition and heat contact sealing temperatures of PLEXIGLAS® and EUROPLEX® films.

Sealing film	Glass transition temperature (T_g)	Sealing temperature
PLEXIGLAS® Film 0F301	Approx. 110 °C	Approx. 140 °C to 150 °C
PLEXIGLAS® Film 0F302	Approx. 111 °C	Approx. 150 °C to 160 °C
EUROPLEX® COC Film 0F304	Approx. 78 °C	Approx. 110 °C to 120 °C
EUROPLEX® COC Film 0F305	Approx. 142 °C	Approx. 180 °C to 190 °C

Table 3: Standard settings for laser sealing of EUROPLEX® films.

Material	Feed rate [mm/s]	Power [W]
EUROPLEX® COC Film 0F305	33.3	100
EUROPLEX® COC Film 0F304	20	100

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