Design Guidelines

Customized Fluidic Chip

1. Introduction

The injection molding process described in this document is adapted for the manufacturing of macroscopic parts with a footprint of 25.5mm x 75.5 mm containing microscopic structures like channels, cavities, or pillars with typical dimensions in the range of 50 µm to 500 µm.

If you would like to design a plastics part according to the following design guidelines and need further information or support, please contact: sales@thinxxs.com. To place an order, please contact: sales@thinxxs.com.

2. General design guidelines

2.1. Plastics materials

In general, all kinds of different polymer materials (elastomeric, thermoplastic, and thermosetting material) could be used for injection molding. From this variety of different polymers, the thermoplastic materials listed in the following table may be used for the injection molding process described in this design document.

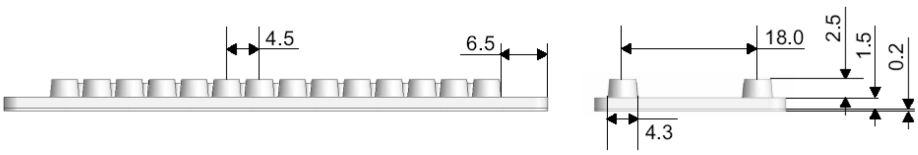
Material	Advantage	Disadvantage
Cycloolefine polymers/ copolymers (COC/COP)	• very good optical transparency in the visible region and in the near UV • low self-fluorescence • good chemical resistance (e.g. against most mineralic acids and alkalis as well as alcohols) • high temperature stability (>100 ℃)	• higher raw material costs • poor chemical resistance for aliphatic and aromatic hydrocarbons • some COC types show tendency to suffer from stress-cracks
Polymethyl-methacrylate (PMMA)	• very good optical transparency in the visible region • good chemical resistance • (e.g. against alkalis and aliphatic hydrocarbons)	• poor chemical resistance for acids • suited for temperatures below 90℃
Polycarbonate (PC)	• very good optical transparency in the visible region • good chemical resistance for some oils and alcohols • good thermal properties between -130 to +130 ℃	• Poor chemical resistance for acids and especially for alkalis
Polypropylene (PP)	• good chemical resistance (against most mineralic acids and alkalis as well as alcohols) • high temperature stability (>100 ℃)	• not preferred as a chip material because of the bending properties due to the softness of the material • opaque • not suited for standard bonding process

If a material different from the ones listed in the table should be used, please contact thinXXS (sales@thinxxs.com) for clarification.

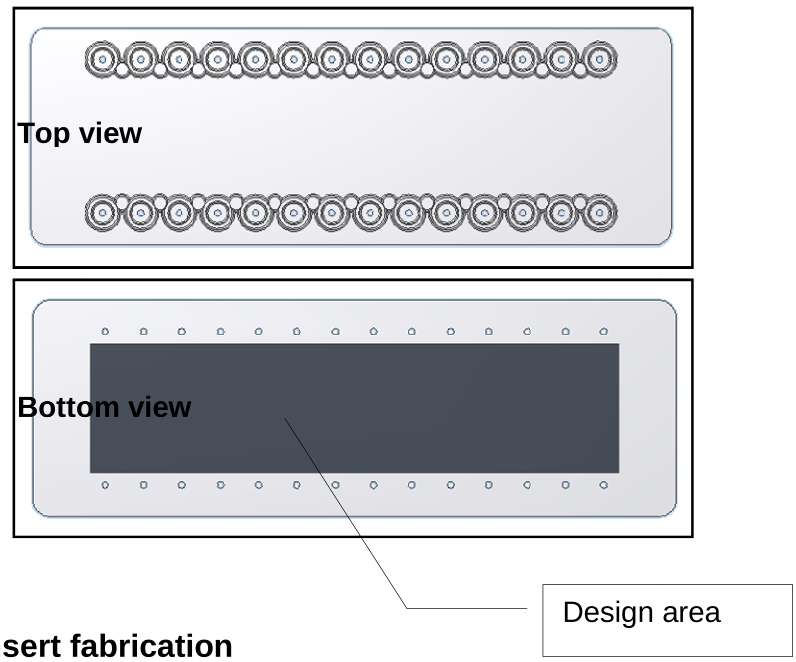
2.2. Outer dimensions

The footprint of the molded parts is based on the microfluidic construction kit. Standard slides have a footprint of 25.5mm x 75.5 mm, which is equivalent to the size of a standard microscopy slide. 28 fluidic access ports are arranged in two lines at the long sides of the slide. Custom channels may be designed in the back of the slide. Not all access ports need to be used for a specific design.

The fluidic ports have a pitch of 4.5mm. This is in accordance with the well spacing of a 384 well microplate.



An area of about 62 mm x 15 mm on the opposite side of the fluidic ports is available for individually designed microfluidic structures.



2.3. Mold insert fabrication

For the design of injection moulded parts it is important to understand that, because of the shrinkage of the plastic material during the molding process, the molded part is not an exact identical negative copy of the mold insert. The design of the molded part has to accommodate the material-specific dimensional changes due to shrinkage.

The shrinkage will be considered during the design of the mold inserts by thinXXS. Since the shrinkage depends on the specific material, the polymer type has to be defined before the mold inserts are designed. A change of the material after the mold inserts have been fabricated could cause deviations from the desired dimensions of the final part.

As a standard, ultra precision milling of nickel alloy is used to fabricate the mould inserts. The ultra precision milling method delivers surfaces with optical quality. The resulting mold inserts are mechanically stable and can be manufactured in a short time.

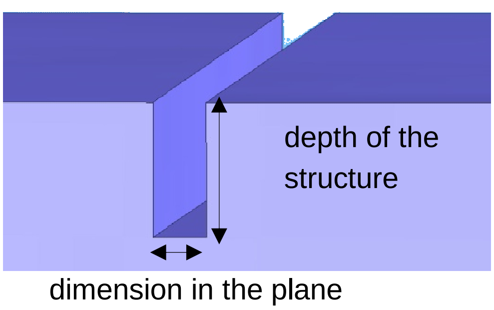
The design rules (dimensions, features, etc.) are based on this fabrication method. If the milling process and the design rules, respectively, are not sufficient to meet the requirements, other techniques may also be used. In this case, please contact sales@thinxxs.com for further information. For information regarding achievable tolerances please contact sales@thinxxs.com

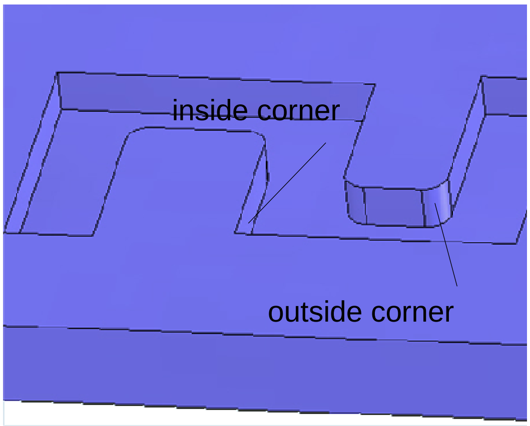
2.4. Feature Size

Microfluidic chips are typically composed of a set of different basic structures in order to realize the desired functionality and the basic microfluidic operations (e.g., mixing, separation, transport, splitting, etc.), respectively. In the following, some basic microfluidic structures are listed:

- Channels
- Chambers / Cavities
- Pillars

Only structures going into the base area are possible. To be able to remove the molded parts from the mold, the planes perpendicular to the parting plane have to be chamfered by ideally 3° (draft angle), in a way that the structures taper. To guarantee a homogeneous filling of the cavity in the molding tool, the dimensions of the micro structures should be as uniform as possible.

	• Minimum dimension in the plane (width) = 50 µm • Aspect ratio (depth/ width) ≤ 1.5:1 • Maximum depth of a structure 0.5 mm • surfaces with optical quality (Ra = 20 nm at the channel bottom only)

	• Minimum radius at inside corners in the plane = 0.03 mm. • Minimum radius at outside corners in the plane = 0.15 mm. • Minimum distance between two structures = 0.3 mm • Stepped structures are possible • Undercuts are not possible

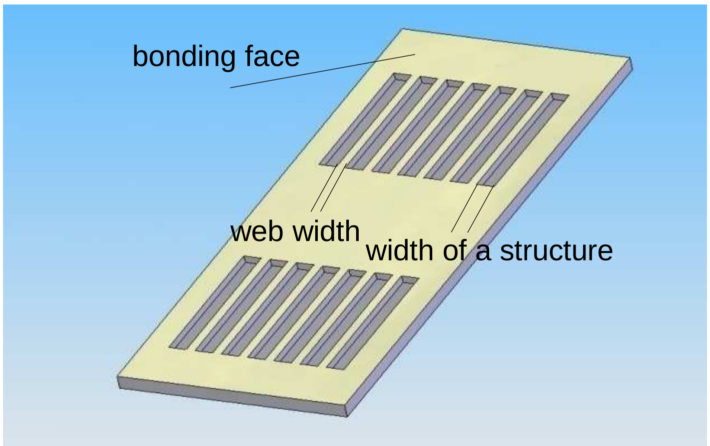
If you would like to design / fabricate structures not complying with the design rules, please contact sales@thinxxs.com for clarification. **Please also observe requirements for bonding as described later.**

2.5. Sealing of channels

In many cases the molded parts need to be covered in order to realise closed channel structures. The different technologies described below are available to mount a cover foil to the molded parts.

- Diffusion bonding
- Laser welding
- Thermal bonding
- Adhesive bonding
- Use of sealing layers made from elastomers

As a standard, we use diffusion bonding to cover the plastics parts. Foil and slide are made from the same polymer. To be able to use this process, the design has to comply with the rules described below.



Design rules for diffusion bonding

- The surface area of the face to be covered (bonding face) must be at least 60 % of the base area (overall length x overall width) of the part. No structures may stick out of the bonding face of the moulded part.
- Minimum web width = 0.8 mm
- Minimum depth of a structure = 50 µm
- Maximum width of a structure must not exceed 100 x depth. Preferred is that the width does not exceed = 2 mm, depending on the length.

The standard process is the manufacturing of moulded parts form COC and covering these parts with the corresponding COC cover foil. The foils have a typical thickness of approximately 140µm.

The following foils are also available for bonding according to this standard process:

- For parts made from COP: Foil thickness approximately 190 µm.
- For parts made from PMMA: Foil thicknesses between 100-300µm.
- For parts made from PC: Foil thicknesses between 100-200µm.

If you would like to use a different bonding technique, other material combinations or foil thicknesses, please contact sales@thinxxs.com for clarification.

2.6. CAD import/export formats

thinXXS uses Autodesk Inventor (http://www.autodesk.com) for 3D CAD/CAM. This software supports industry-standard data transfer for importing and exporting design and drawing information. Customers using other 3D CAD/CAM systems can deliver DWG, DXF™, Pro/E®, SAT, IGES, and STEP files for direct import.

If you would like to provide 2D drawing using DXF formats, please contact sales@thinxxs.com for clarification and we will translate your specifications in a 3D model at low extra costs.