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Special Glasses

Glass for Microtechnolgy

- Glass for bonding with Silicon (e.g. Borofloat, Pyrex)
  - heat expansion similar to silicon

- Photoetchable glass (e.g. Foturan)
  - Microstructures with high aspect ratio

- Quartz-glass (e.g. Herasil, Suprasil)
  - Optical transmission in the u.v. spectra

- Thin glass (e.g z.B. AF45, D263)
  - Lids and membranes

- Glass with special properties (e.g dot. Li-Borosilicate-glass)
  - Structurable with laser and bondable with si

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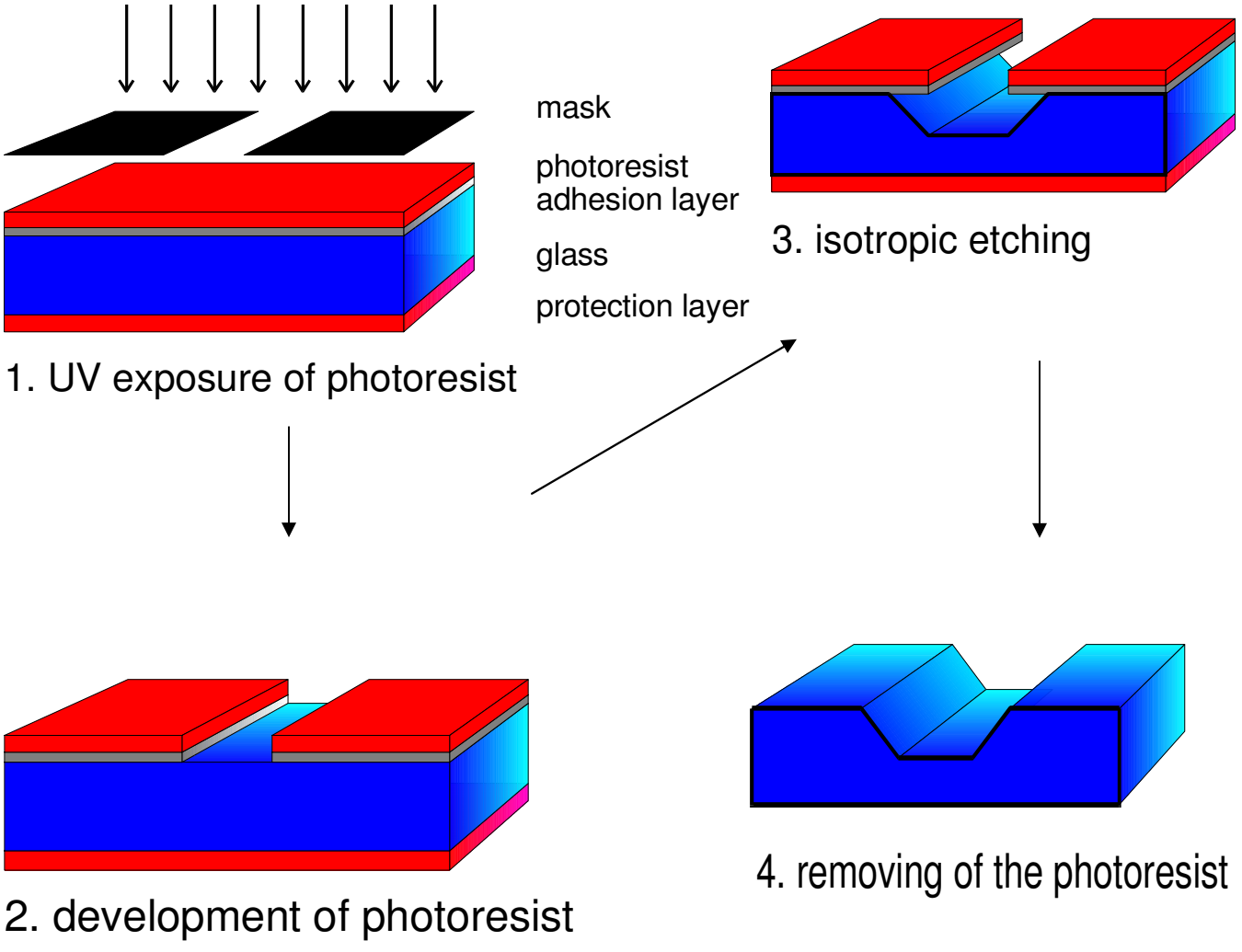
mikroglas

Fabrication of microstructures with glass



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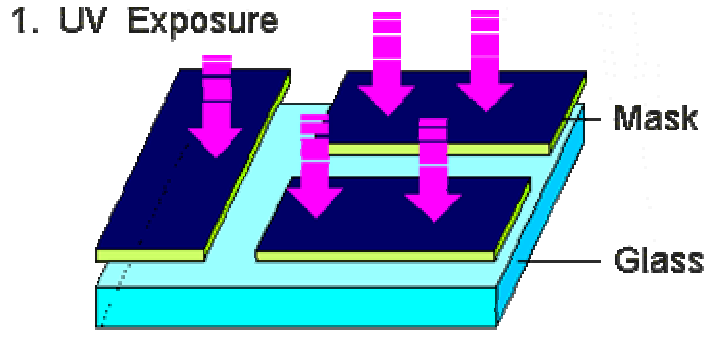
What is the Foturan?

FOTURAN is a photosensitive glass, the main material ***mikroglas*** works with.
It allows the fabrication of complicated and high precision components by direct illumination, crystallization and etching processes. This material combines the unique glass properties (transparency, hardness, chemical and thermal resistance, etc.) and the opportunity to achieve very fine structures with tight tolerances and high aspect ratio (hole depth/hole width). Smallest structures of 25 µm are possible with a roughness of 1 µm. The unique properties of these materials make them useful for many applications in micro technology.

Fabrication of microstructures with FOTURAN®



In the exposure step, FOTURAN glass is exposed to ultraviolet light at a wavelength between 290 - 330 nm. It is possible to illuminate material thicknesses of up to 2 mm. An energy density of approximately 20 Joule/cm² is sufficient to structurize a 1 mm thick FOTURAN plate.

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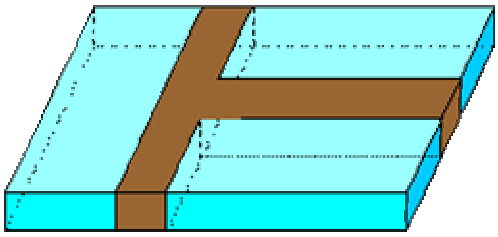
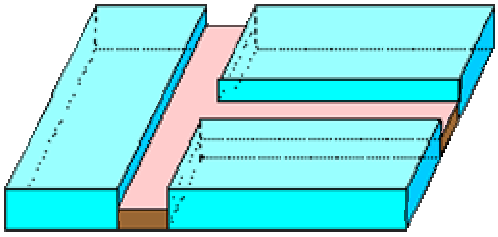
2. Crystallization



With the UV exposure step silver atoms are formed in the illuminated areas. During the heat treatment between 500° and 600°C the glass crystallizes around these silver atoms.

3. Anisotropic Etching



The crystalline regions, when etched with a 10% solution of hydrofluoric acid at room temperature, have an etching rate up to 20 times higher than that of the vitreous regions. If wet chemical etching is supported by ultrasonic etching or by spray-etching, the resulting structures display a large aspect ratio.

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Material properties of Foturan

Mechanical Properties	Glass	Glass ceramic (brown)
Young's modulus [10^3 N/mm²]	78	88
Poisson's ratio	0,22	0,19
Knopp hardness [N/mm²]	4600	5200
Modulus of rapture [N/mm²]	60	150
Density [g/cm³]	2,37	2,41

Thermal properties	Glass	Glass ceramic (brown)
Thermal expansion $a_{20\text{-}300}$[10^{-6}/K]	8,6	10,5
Thermal conductivity 20°C [W/mK]	1,35	2,73
Specific heat 25°C [J/gK]	0,88	0,92
Transformation temperature [°C]	465	-
Max. safe processing temperature [°C]	450	750

Electrical properties	Glass	Glass ceramic (brown)
Electrical conductivity 25°C [Ohm*cm]	$8{,}1*10^{12}$	$5{,}6*10^{16}$
Electrical conductivity 200°C [Ohm*cm]	$1{,}3*10^{7}$	$4{,}3*10^{7}$
Dielectric constant 1 MHz, 20°C	6,5	5,7
Loss factor tan d 1 MHz, 20°C [$*10^{-4}$]	65	25

Chemical properties	Glass	Glass ceramic (brown)
Water resistance DIN/ISO 719 [(µg) Na_2O/g]	468	1300
Acid resistance DIN 12116 [mg/dm²]	0,4	0,9
Alkali resistance DIN/ISO 695 [mg/dm²]	96	250

Optical properties	Glass	Glass ceramic (brown)
Refractive Index 546,1 nm, 25°C	1,515	-
Transmission Spectra [nm]	see graphic	

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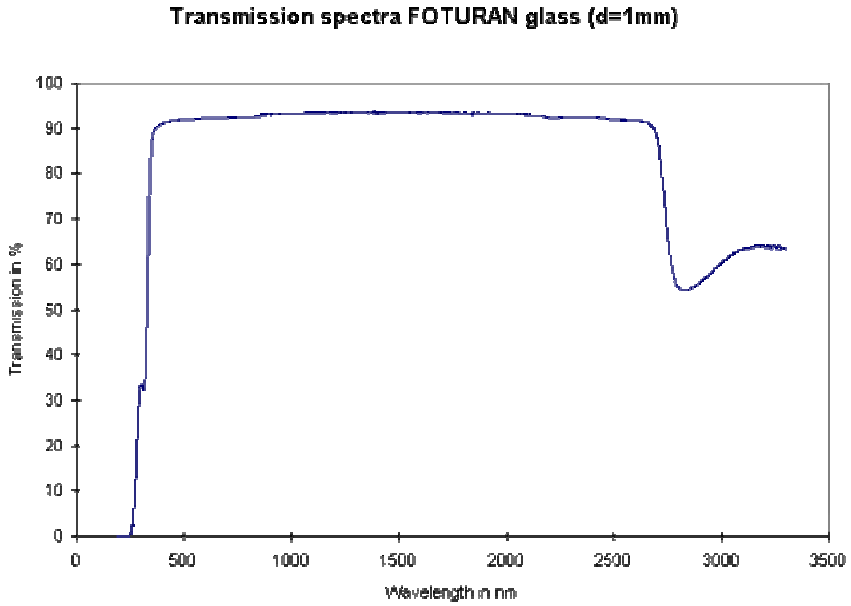
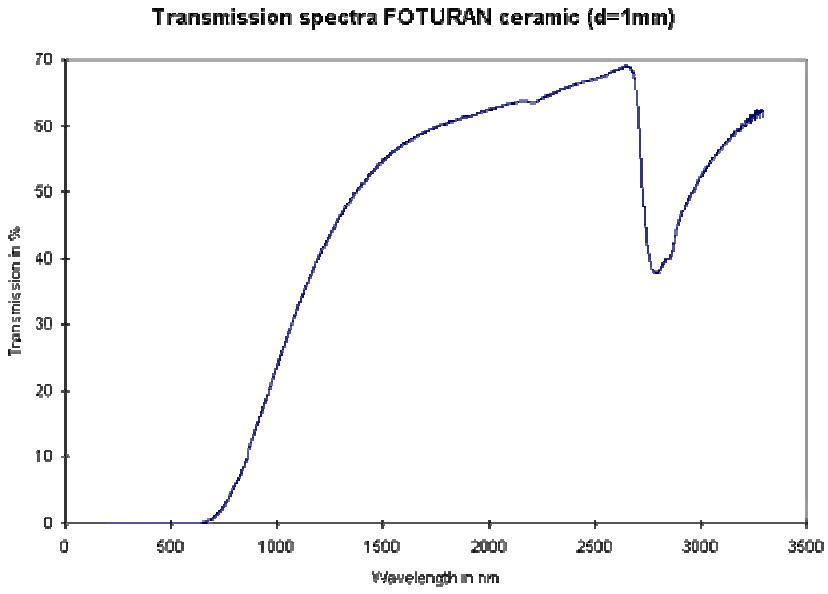
Optical properties of Foturan





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Comparison to other materials

Material to compare	Advantages of glass
Metal	- Better corrosion resistance - Higher electrical isolation - Hardness - Lower thermal conductivity - Better biocompatibility - Transparency
Silicon	- Variety in forms and sizes - Considerably higher breaking strength - Less expensive to adapt - Better biocompatibility - Transparency - Chemical resistance
Ceramic materials	- Transparency - Easier structurization - Simpler bonding
Plastics	- Better mechanical hardness - Better temperature resistance - Chemically more stable - Better electric resistance - Better optical quality - Less expensive prototyping