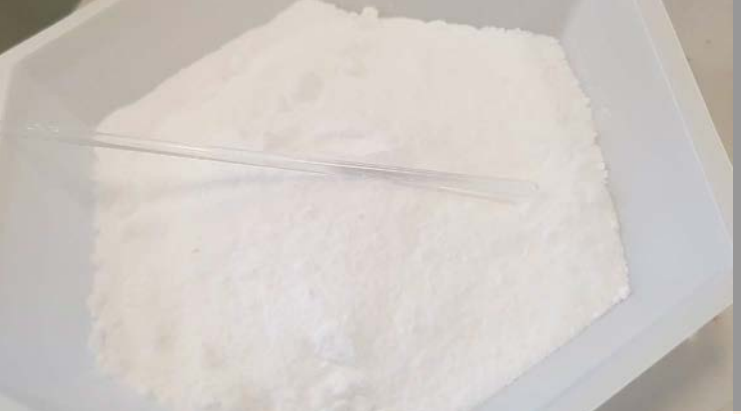

Fraunhofer
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FRAUNHOFER INSTITUTE FOR RELIABILITY
AND MICROINTEGRATION IZM

OPTICAL AND RELIABILITY TESTS

Optical tests

- Beam profile analysis
- Near/far field analysis
- Spectral transmission
- Diameter measurements from 30 µm to 1 mm
- Substrate thickness measurements down to 15 µm
- Refractive index measurements
- Surface roughness analysis via laser scanning microscopy

Reliability tests

- Hardness testing
- Pull testing
- Thermal analysis
- Bending tests of optical fibers and substrates

Further information:
https://www.izm.fraunhofer.de/of

Cover Device for corrosion and etching experiments with different molten salts (Source: Stühff GmbH)

1 Etched optical fibers and glass substrates using molten salts
2 Single-mode fiber before and after etching
3 Profile of an etched glass fiber measured over a distance of 30 mm

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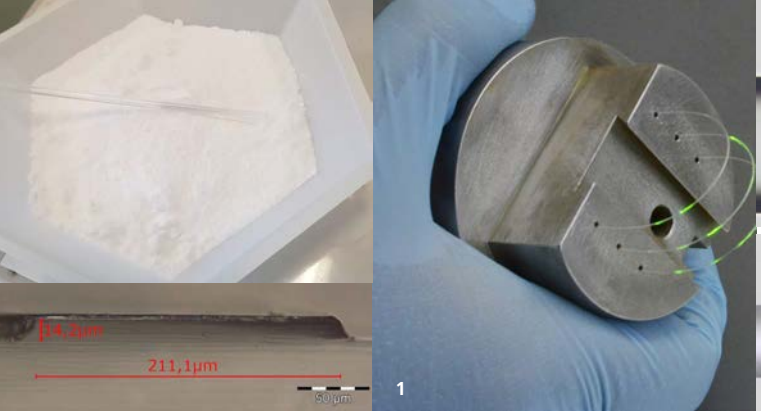
GLASS ETCHING TECHNOLOGY BASED ON MOLTEN SALTS



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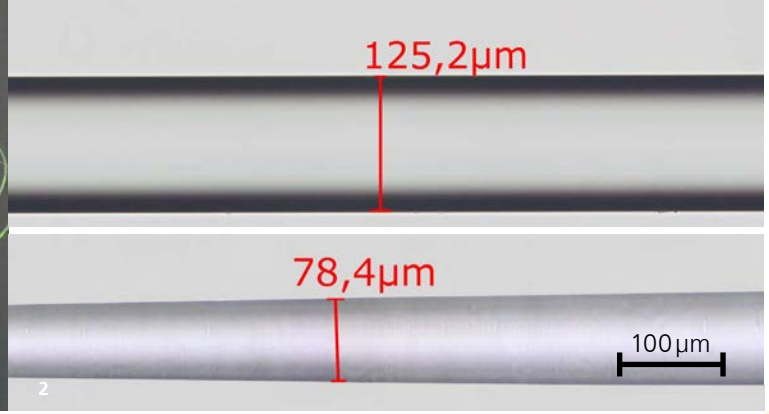

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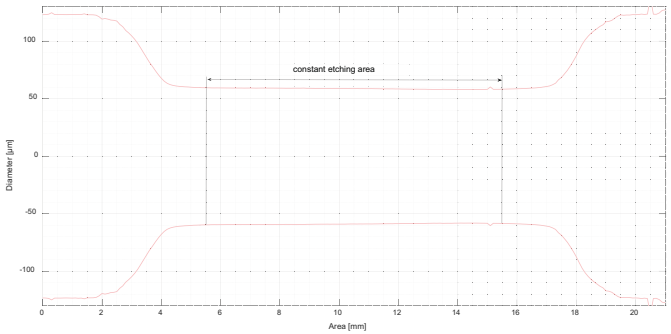

3

APPLICATIONS

Glass is an essential material for photonic industry that has practical advantages over other materials e. g., high optical transparency, excellent homogeneity, thermal insulation and compatible with dopant materials.

In particular, using glass optical fibers, a variety of components can be developed such as:

- Couplers
- Tips
- Bundle probes
- Lensed fibers
- Bottle resonators

Those components have great potential in fields of:

- Data transmission
- Microlaser
- Aerospace
- Healthcare

Anhydrous molten salt etching technology is one-key tool to go beyond the well-known techniques to develop high quality fiber components with the potential of high-volume production.

MOLTEN SALT ETCHING

Fraunhofer IZM is developing an industrial thermal process for the subtractive processing of glass optical fibers. The study of different molten salts as etchants have been investigated. Biconical tapers are successfully produced with high reproducibility.

Molten salt technology can also be extended to etch glass substrates using a mask. Preliminary results show well-defined structures with lower roughness.

Thus the motivation is the substitution of the high toxic hydrofluoric (HF) acid by an etching process based on a thermally activated molten salt. The advantages of molten salts compared to HF are shown in the following table:

Etching with	hydrofluoric acid (state of the art)	molten salt (innovative)
Structuring on the µm scale	Limited	Improved
Reliability	Limited	Substantially higher
Environmental impact	High	Much reduced
Industrial safety	High	Better
Infrastructure/Equipment	Established	In development

In collaboration with the German company Stühff GmbH (www.stuehff-gmbh.de) the innovative molten salt process is transfered to an industrial application.

TECHNICAL DATA

Optical fibers

- Materials: Pure and doped fused silica
- MM- and SM fibers
- Standard diameters from 220 µm to 80 µm
- Reduced diameters down to 35 µm ± 0.5 µm
- Uniform length from 6 mm to 50 mm
- Bent fiber after etching down to 3 mm
- Etch rate up to 0.25 µm/min for pure fused silica
- Shapes: Biconical tapers, wedge tips, lensed fibers, bottle resonators and capillaries

Glass substrates

- Materials: Fused silica, soda-lime, borosilicate and aluminium-silicate glass
- Standard size of 50 × 30 mm^2
- Standard thickness from 10 mm down to 0.1 mm
- Reduced thickness down to 50 µm ± 0.5 µm
- Chemical polishing: Surface roughness reduction from 2 µm to 0.5 nm
- Mask-based Structuring: planar reduction of substrates, square & circular cavities, U-grooves and microchannels