Proton beam writing of buried channel waveguides in Foturan glass

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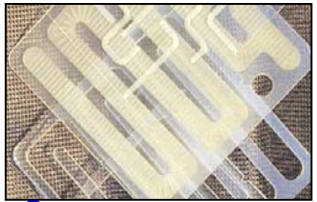
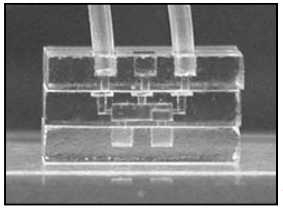
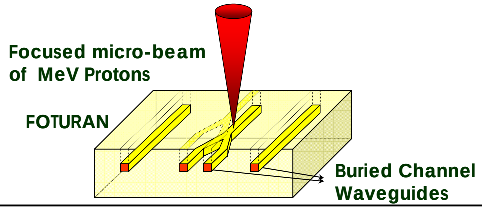
Introduction

- Compatibility → Biomedical applications
- Combines unique glass properties (transparency, hardness, chemical and thermal resistance, etc.) and the prospect to achieve extremely fine structures with tight tolerances and High Aspect Ratio
- Structures <500 nm are now possible. With appropriate heat treatment and processing the resultant mass can be either etched away to provide a true 3-D structure or the resultant structure can be heat treated to become fully ceramicised.
- Applications include micro-fluidic manifolds, precise glass/ceramic diffraction gratings, integrated optical structures for Photonics.



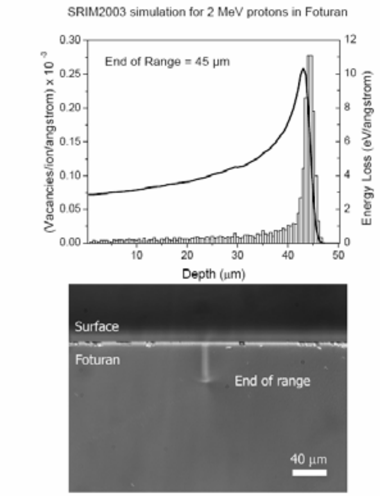


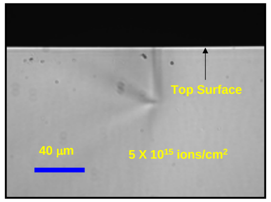


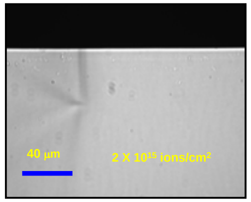
Proton Beam Writing

- Direct-write technique. Focused sub-micron beam of *high energy protons* for writing directly on suitable materials: PMMA, SU-8, Glasses, Polymers etc.
- High Aspect Ratio micro- and nano-structures with *straight* and *smooth* sidewalls (~3 nm roughness).
- Small lateral spread (except at the end of range) → Vertical walls.
- Well defined range: slots & channels with well defined depth.
- Different ion energies → Multi-layered structures.
- 3D capability with high aspect ratio structures > 160.
- 100 nm and below structures possible; 30 nm structures already demonstrated

Fabrication

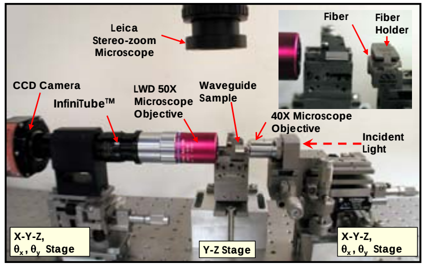


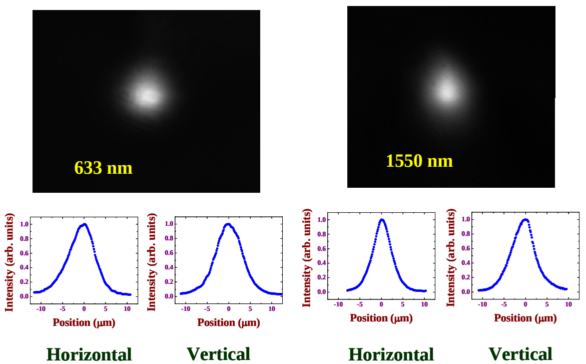




- Seven buried channel waveguides fabricated with fluences ranging from 10^{14} to 10^{16} ions/cm^2
- Single mode waveguides with very good mode profile
- End of range calculated to be ~45 µm using SRIM calculations
- Propagation losses measured using scattering technique: 5.0-12.0 dB/cm
- Refractive Index change (Δn), measured using the propagation-mode near-field technique, was estimated to be ~10^{-3}

Experimental Set Up

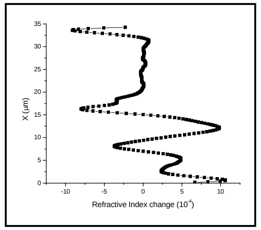


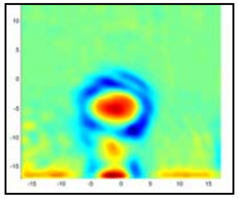


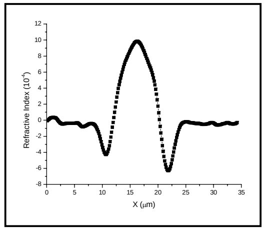
Mode Profile

Characterization

Refractive Index Profile

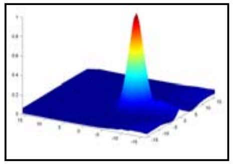


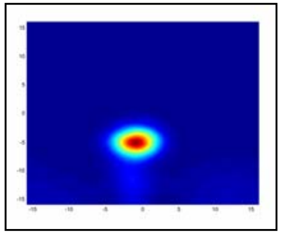




Propagation-Mode Near Field Technique

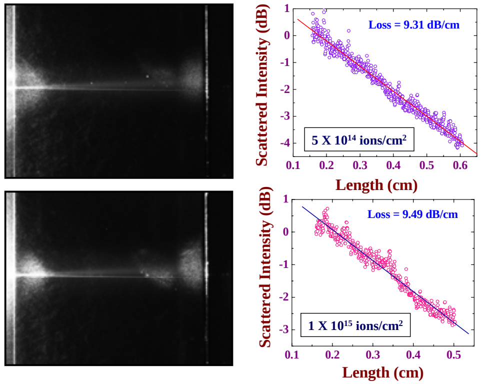
$$\Delta n(x,y)=\sqrt{n_s^2-\frac{\nabla^2 E(x,y)}{k^2.E(x,y)}}-n_s$$

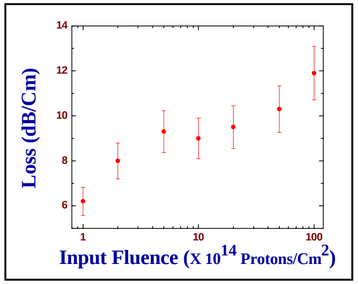




Mode Profile @ 633 nm

Loss Profiles





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