

Physical Asymmetry of Defects Induced by Femtosecond Laser Irradiation in Silica

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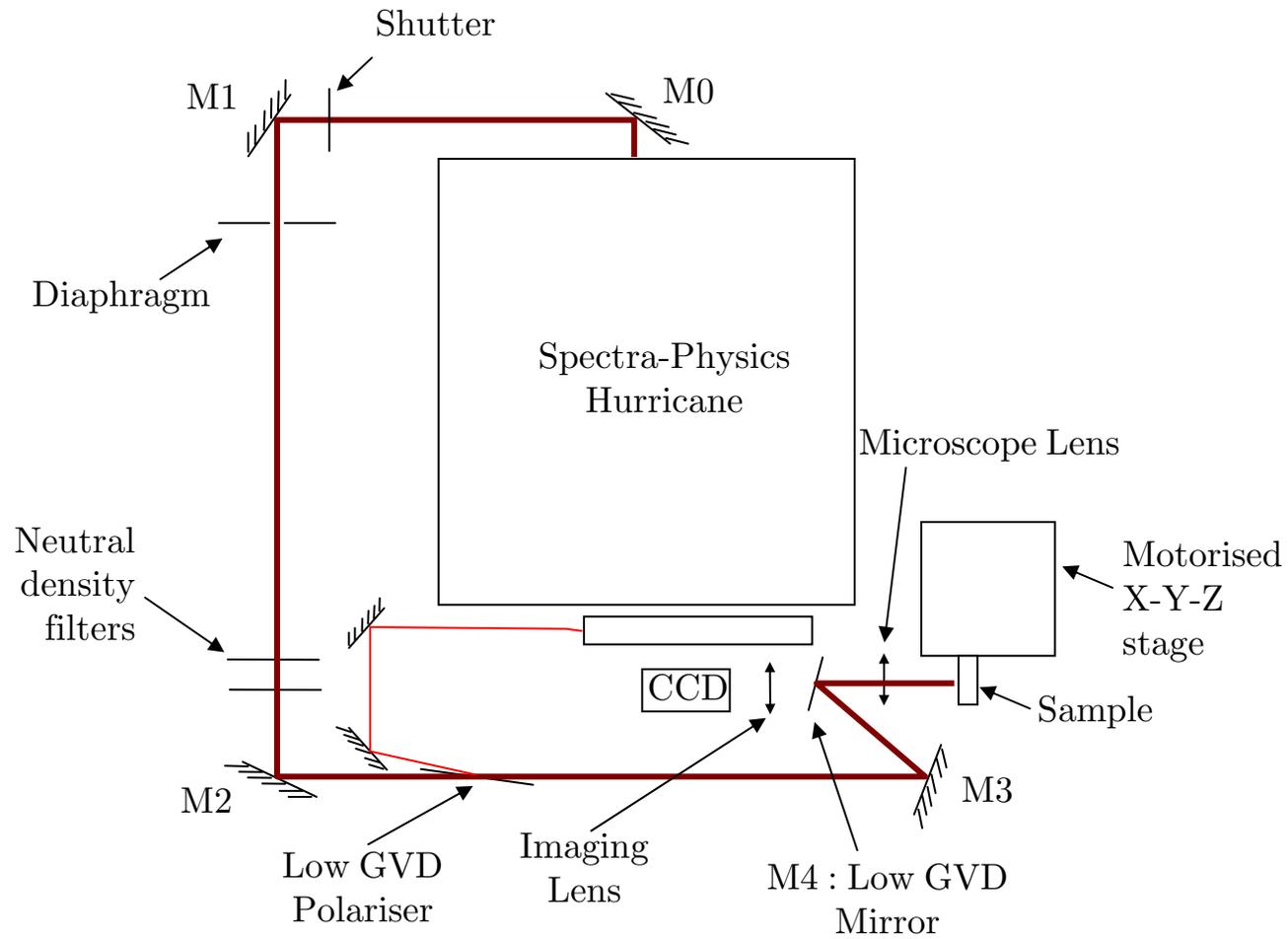
Abstract

We are interested in the study of linear defects induced in silica by femtosecond laser irradiation. Its cross-section, revealed by cleaving the silica sample, presents a granular region at the input and a discontinuous tail.

Research interests on femtosecond laser interaction with glass

- Refractive index changes and micromachined structures
 - Optical devices
 - Optical waveguide devices
 - Photonic bandgap and classical waveguide hybrid devices
 - Diffractive optics
 - Microfluidic systems (Micromachined structures)
 - Physical aspects of interaction
 - Effect of laser/glass interaction on stress
 - Causes of refractive index changes
 - Influence of material properties and of writing parameters on induced defects
 - Stability of defects

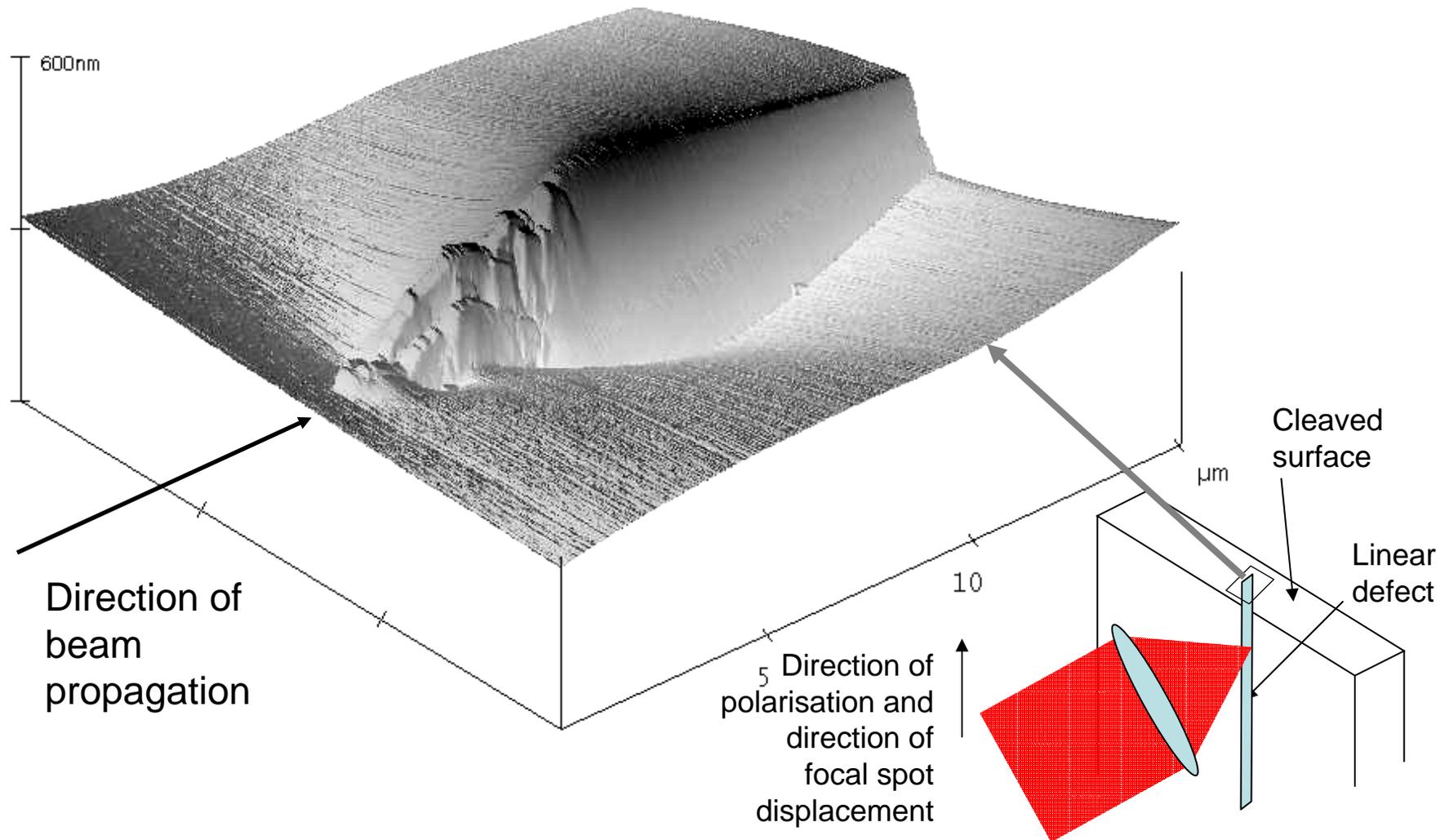
Experimental setup



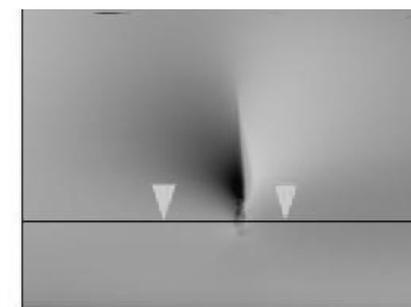
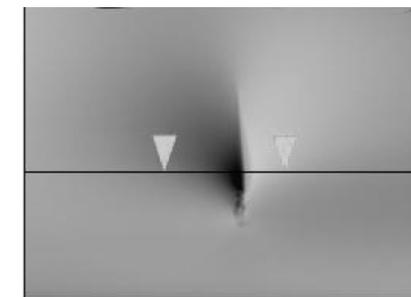
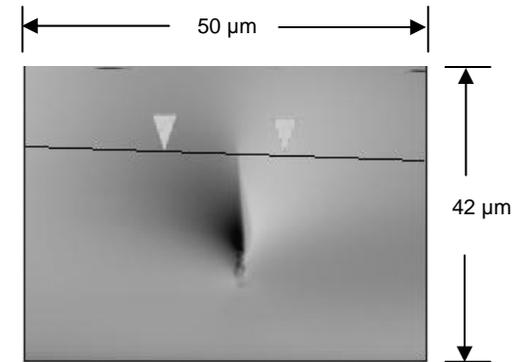
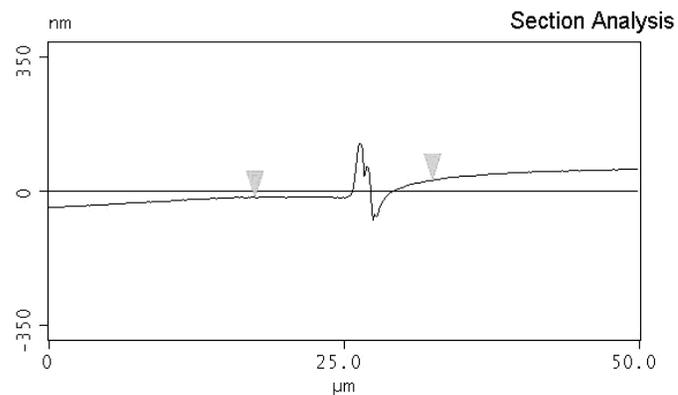
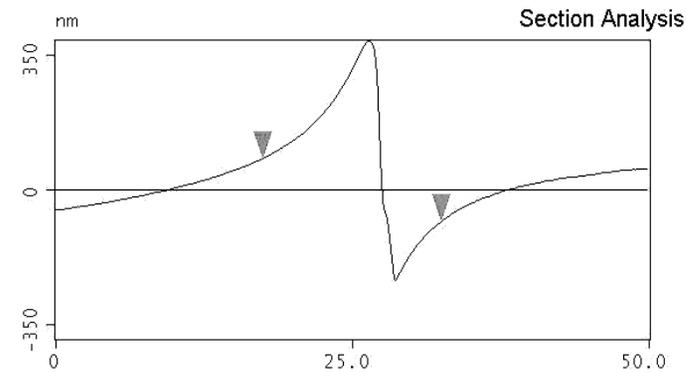
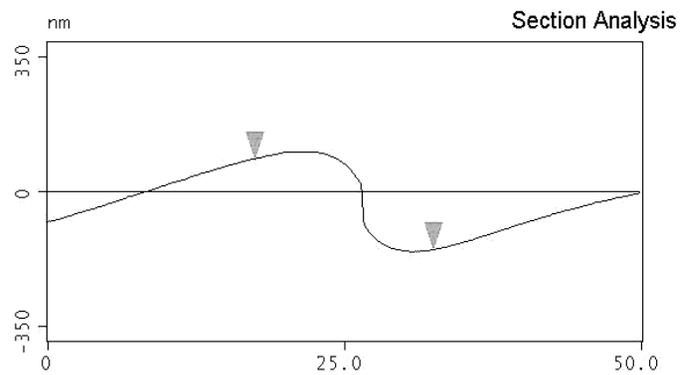
Typical writing parameters

- Central wavelength : 800 nm
- Repetition rate : 1 kHz
- Pulse duration : 160 fs
- Energy/pulse : 0.4 μ J
- N.A. : 0.65
- Writing speed : 1 μ m/s (3.6 mm/hour)
- Depth of waveguide : 150 μ m

Surface topography of a cleaved cross-section of a guide



AFM scans of cross-section



↑
Direction of beam
propagation

●
Direction of
polarisation and
direction of focal
spot displacement

Observations and causes

- Observations
 - Cleaved surface has asymmetry
 - Initial investigation suggests, as noted by Poumellec *et al.* ⁽¹⁾, that both cleaved surfaces are identical
 - Focussing instabilities at the input of the structure
- Possible causes
 - Artefact due to cleaving
 - Stress as a result of asymmetry in wavefront
 - Asymmetric dispersion of the beam
 - Inhomogeneities of the laser front
 - Interference between TE_{00} and TE_{11}
 - Phase matching condition between pump light and third harmonic, as suggested by Poumellec *et al.* ⁽¹⁾

(1) Poumellec, B.; Sudrie, L.; Franco, M.; Prade, B. and Mysyrowicz A. "Femtosecond laser irradiation stress induced in pure silica", *Optics Express*, **11** (9), 1070-1079.