PHOTOINDUCED PERIODIC NANOSTRUCTURES IN GLASS BY FEMTOSECOND PULSES

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The use of ultrashort pulse sources in conjunction with a diffractive element was recently shown as a very promising way to photoinduce permanent periodic nanostructures in glass. Accordingly, high quality and high index modulation structures were written in silica both with UV [1] and IR [2-3] femtosecond (fs) sources. The fs-induced structure can be made very stable at elevated temperatures –where standard UV-written index change would erase. Still, important issues related to the underlying physical process responsible for the fs-induced FBG formation remain unanswered. One of these issues is the role that nonlinear processes such as multi-photon absorption and filamentation are playing in the context of the focusing of a Gaussian beam by a cylindrical lens through a diffractive element. In this presentation, we report the formation of high aspect-ratio nanostructures in silica by the use of the interference of femtosecond pulses in optical fibers. The photoinduced periodic nanostructures are typically less than 250nm width, 800nm height and 50um length formed in a periodic grating over many millimeters long as shown in figure 1.

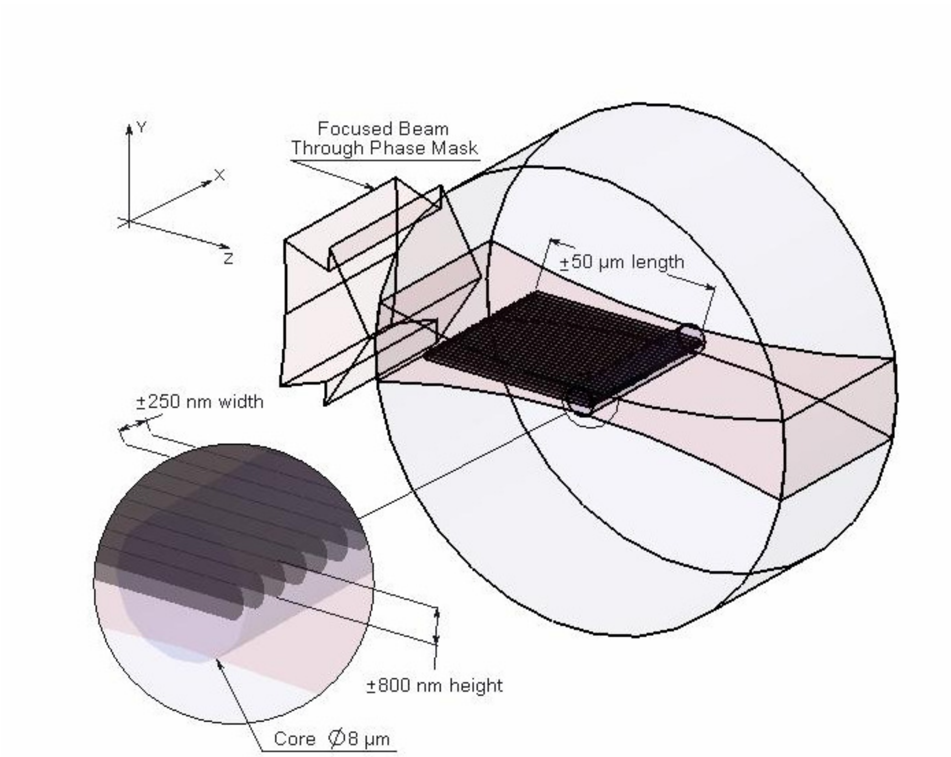

Figure 1: Scheme of the writing conditions and resulting photoinduced nanostructures

We further demonstrate via a high resolution measurement across the transverse plane of the fiber, that the refractive index change is bearing the signature of the filamentation of the femtosecond pulses crossing the fiber as shown in figure 2. We also demonstrate that filamentation process limit the height of the structure to wavelength by high-order solitonic compression and can be tunable from wavelength to many tenth of microns by scanning the beam over the fiber. This phenomenon permit to decrease the nanostructure height to ~300nm and also the structure width to ~75nm by the use of UV femtosecond laser at 266nm. Figure 2 is showing the refractive index profile of the SMF-28 fiber before(left) and after(right) inscription in H_2-free fiber during 60s at 1.4mJ/pulse. One can clearly observe the trace (filament) left by the passage of the fs-pulse across the core and also give a measurement of the nanostructure height to ~800nm FWHM.

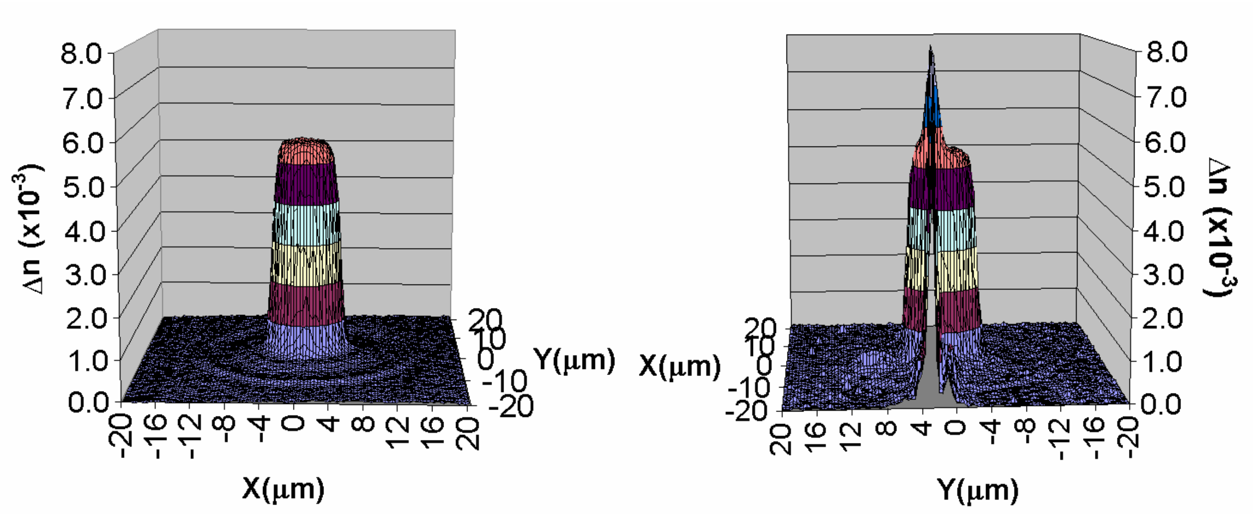

Figure 2: Refractive index profile before(left) and after(right) inscription.

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