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Surface Functionalization of Glass Using Femtosecond Laser-Induced Plasma

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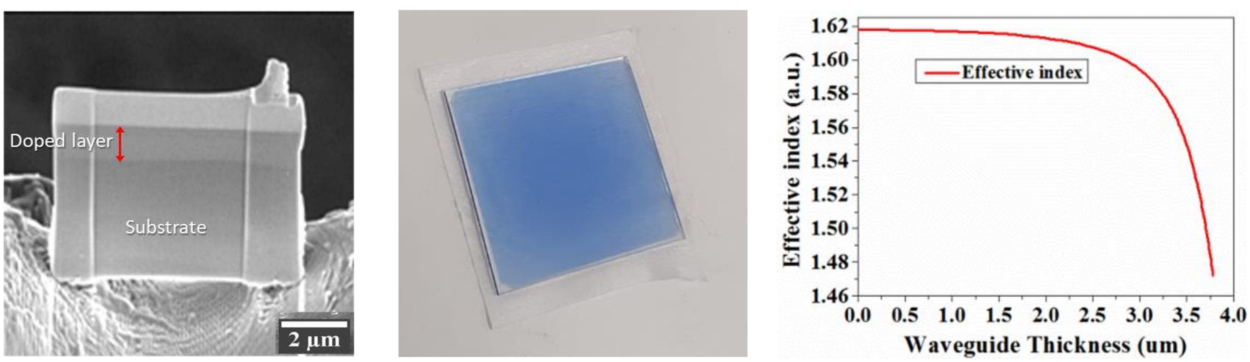
Abstract: Femtosecond laser-induced plasma of tellurite-based glasses is used to modify structurally the surface of silicate glasses and silica-on-silicon to engineer optical and photonic components. The refractive index, doping, mechanical strength, and color can be altered using the methodology.

Here we report the recent advances made in the field of ultrafast last plasma doping (ULPD) method to modify the surface of silica and silicate glasses, and silica-on-silicon. Since first reported in CLEO 2012 [1] the ULPD has been developed for a number of applications. Using a Ti-Saphire amplified femtosecond laser (pulse duration 100 fs, repletion rate) silica and silica-on-silicon were doped with Er^{3+} ions [2-4]. Optical waveguiding by controlling the depth of doping and refractive index increase has been achieved by laser and process parameters. The highest doping in silica is demonstrated with high calculated gain per unit length and low losses to fabricate waveguide amplifiers [6]. Surface doped materials also demonstrated using fs-laser at 10 kHz and higher repetition rate lasers with pulse durations of 45 fs and < 290 fs using different laser systems. The doping process essentially involve deposition of tellurite based glasses with required dopant on a silica based substrate at an elevated temperature below their glass transition temperature. Here we also report the use of this methodology to strengthen glasses as well as to color them. Figure 1(a) shows an example of a doped layer formed within silica glass substrate. In Fig. 1(b) silicate glass with induced dark blue color produced by the ULPD method is shown. Figure 1(c) represents the refractive index profile of a Er^{3+}-ions doped waveguide formed on silica with a surface refractive index of 1.61 (@633nm) and waveguide thickness of ~3 µm. In the talk an overview of the process with all the recent application developments will be presented.



(a) (b) (c)

Figure 1

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