Accepted for presentation at 7th ESG conference "YALOS 2004"

Strong refractive index changes induced in Ag^+ ion-exchanged Er-doped phosphate glass using 248nm excimer laser radiation

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Er-doped phosphate glasses are excellent host materials for the fabrication of high-gain waveguide and fibre lasers and amplifiers emitting in the 1.55μm telecommunication window. The photosensitivity of those glasses under intense UV radiation may be of great significance, since diffraction gratings and waveguide structures may be inscribed in such glasses, leading to the development of functional photonic devices. The photosensitivity of a commercial phosphate glass (Schott IOG-1), which is doped with Er^{3+} ions and has been ion-exchanged with Ag^+ ions, is examined using nanosecond 248nm excimer laser radiation. Grating structures of 510nm period are inscribed in un-treated and ion-exchanged Er-doped IOG-1 glass by employing phase mask interference in contact mode. The dependence of UV-induced refractive index changes upon the Ag^+ concentration during ion-exchange and the exposure conditions were studied using diffraction efficiency measurements. Refractive index changes in untreated glasses are of the order of $\approx 10^{-5}$, whereas for silver ion-exchanged samples such changes reach values of $\approx 2.0 \times 10^{-3}$, for UV exposures of 30000 pulses and 400mJ/cm^2 energy density. Measurements of the absorption spectra of exposed and un-exposed samples are carried out in order to reveal specific absorption bands and illustrate photosensitivity mechanisms. Furthermore, energy dispersive x-ray microanalysis (EDX) of the exposed ion-exchanged glass samples, reveal that UV radiation induces significant migration of the Ag^+ ions towards the areas of high energy densities. Such observation is also supported by scanning electron microscopy (SEM) scans of the inscribed gratings, where shallow relief structures of few nanometer height are formed in the bright fringes of the interference pattern; pronouncing significant structural changes due to the UV exposure.

Topic: Glasses in optics and photonics

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