Microstructuration by Direct Laser Writing in silver doped glasses : Structure-property relationships

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The development of integrated optical components requires miniaturizing the optical functions. Nowadays, 3D laser writing is emerging throughout the use of femtosecond lasers for designing new functionalities in glass. Then it becomes possible to avoid the use of expensive steps of multilayer process in order to build optical storage device, waveguides, etc. [1]. Indeed, the nonlinear multiphotonic absorption results in depositing energy in a confined volume leading to submicrometric material modifications.

Phosphate glasses containing d^{10} ions such as silver oxide allow the inscription of patterns owing original luminescence or nonlinear optical properties. The development of silver containing tailored glass compositions can allow obtaining a variety of photo-induced species or nano-particles. There are two main aspects: glass composition and more particularly the photosensitive ions quantity, and the laser writing parameters (wavelength and repetition rate). The use of high pulse repetition rate lasers allows a heat control via cumulative effects. Adapting the glass composition and the laser characteristics permits to benefit from the photochemical and the ionic migration mechanisms. T

Luminescence and nonlinear optical spectroscopies become a unique tool to identify the silver species and to follow the physicochemical modifications after laser irradiation. At the early of the interaction, strong embedded electric field can be implemented. Oxidation-reduction phenomena combined with the migration of mobile ions and atoms leads to localized highly light-emitting photo-induced structures in the voxel region. Migrations of silver ions have been clearly evidenced by local chemical analysis. IR and Raman spectroscopies allow establishing a link between the glass structure, the photochemical modifications and the luminescence or nonlinear optical properties

[1] Femtosecond laser induced photochemistry in materials tailored with photosensitive agents, A. Royon *et al*, OME Vol. 1, No. 5, (2011), p867.