The impact of the silver-containing phosphate glass composition on femtosecond laser induced optical properties

Théo Guerineau[*1], Clément Strutynski[†1], Sylvain Danto[‡1], Marc Dussauze[§2], Lionel Canioni[¶3], Real Vallée[‖4], Alain Abou Khalil[**4], Yannick Petit[††1], and Thierry Cardinal[‡‡1]

[1]Institut de Chimie de la Matière Condensée de Bordeaux (ICMCB) – Université de Bordeaux, Centre National de la Recherche Scientifique : UPR9048 – 87 Av du Dr A. Schweitzer 33608 PESSAC CEDEX, France

[2]Institut des Sciences Moléculaires (ISM) – Centre National de la Recherche Scientifique : UMR5255, Université de Bordeaux (Bordeaux, France) – Bâtiment A 12 351 cours de la Libération 33405 TALENCE CEDEX, France

[3]Laboratoire Ondes et Matière d'Aquitaine (LOMA) – Université de Bordeaux : UMR5798, Centre National de la Recherche Scientifique : UMR5798 – Bât. A4 Recherche Physique 351, Cours de la Libération 33405 TALENCE CEDEX, France

[4]Centre d'optique, photonique et laser (COPL), Université Laval – 2375, rue de la Terrasse- Quebec-QC G1V 0A6 , Canada

Abstract

The manufacturing of innovating and novel photonic materials is inevitably linked to the development of non-conventional fabrication techniques for designing multiscale structured photonic materials. In the two last decades, Direct Laser Writing (DLW) using femtosecond laser has been investigated in transparent glasses. In the specific case of silver-containing phosphate glass, DLW leads to the formation of silver clusters which exhibit photoluminescence properties in the entire visible range and can be at the origin of a local refractive index modification. Nonlinear optical absorption and cumulative thermal effect are responsible for these silver clusters formation at the edge of the voxel of interaction. Rewritable phenomenon, even for high energy deposition, dependent on the glass composition has been demonstrated.

The phosphate glass composition has a determinant impact on the nature of the clusters and the photo-generated properties. Polyphosphate, pyrophosphate and orthophosphate glass

[*]Speaker

[†]Corresponding author:

[‡]Corresponding author: sylvain.danto@u-bordeaux.fr

[§]Corresponding author: marc.dussauze@u-bordeaux.fr

[¶]Corresponding author: Lionel.Canioni@u-bordeaux.fr

[‖]Corresponding author: rvallee@copl.ulaval.ca

[**]Corresponding author: alain.abou-khalil@u-bordeaux.fr

[††]Corresponding author: yannick.petit@icmcb.cnrs.fr

[‡‡]Corresponding author: thierry.cardinal@icmcb.cnrs.fr

composition have been investigated in order to establish the impact of the phosphate network on the glass photosensitivity. Raman and infrared spectroscopies have allowed characterizing the glass structure. Luminescence spectroscopy of the silver ions has been investigated. The study has allowed undergoing a systematic investigation of the relationship between the glass structure, the silver ions environment in phosphate glass and the overall material photosensibility. Fiber drawing of the most promising composition has been demonstrated. The results obtained contribute to demonstrate that silver containing phosphate glasses are excellent candidates for the development of micro-optic systems embedded into glass fiber for cutting-edge technologies.

Keywords: Photosensitive glass, silver, containing glass, phosphate glass, matter, laser interaction, femtosecond laser, spectroscopy