FABRICATION OF 3D NANOPARTICLE STRUCTURES BY FEMTOSECOND LASER RADIATION

E. Iordanova[1], G. Yankov[1], N. Nedyalkov[2]

[1] *Institute of Solid State Physics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee,1784 Sofia, Bulgaria*
[2] *Institute of Solid State Physics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee,1784 Sofia, Bulgaria*
e-mail: eiordanova@issp.bas.bg

Glasses composed by noble metal nanoparticles attract significant attention due to the unique optical properties that they express in the near UV and visible spectral range. These are related to the high values of the extinction cross section and nonlinear optical characteristics.

In this work, we present results on the response of noble metal-doped borosilicate glass to laser radiation with femtosecond pulse duration. Furthermore, the ability of laser irradiation to induce modification of the optical properties of borosilicate glasses doped with gold and silver ions is used. The samples are obtained by conventional melt quenching method and noble metal concentration up to 10 wt%. Morphology and optical changes of the glass samples induced by femtosecond laser pulses within a wide range of parameters are investigated. The femtosecond processing is done by regenerative Ti:Sapphire amplified laser system that generates laser pulses with 35 fs duration, at repetition rate of 1 kHz.

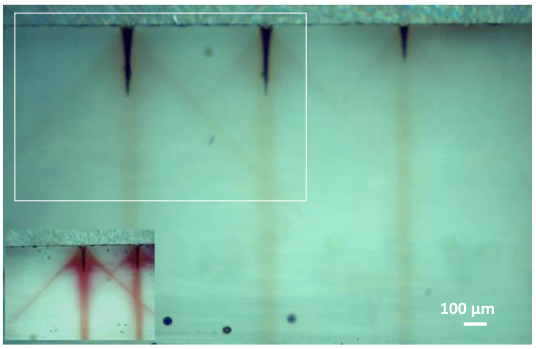

Figure 1. Cross section of ablation lines fabricated in glass with 1wt % Au

Two regimes of laser-matter interactions are considered: i) at laser fluences below the ablation threshold, and ii) above the ablation threshold. Defects associated with formation of color centers in the material, below the permanent modification threshold, are observed (Figure 1). Their properties as a function of the processing conditions are discussed. When permanent morphology modifications are induced, different micro- and nanostructures are observed depending on the laser parameters. The morphology of the ablated area is studied as function of the laser fluence and number of the applied pulses. It is found that the presence of noble metal in the glass at concentrations up to 10 wt% (the maximal used) does not influence the ablation rate.

Novel effects related to laser irradiation refraction by the formed ablated groves are demonstrated. A special attention is dedicated to estimation of the main ablation parameters, the structure and composition modifications in the laser effected zones.

Acknowledgments: The authors express their acknowledgments to the financial support of: BNSF under the project ДН08-16/14.12.2016 entitled “Laser induced fabrication of three dimensional nanoparticle structures and study of their optical properties”