Structure, spectral and luminescent properties of germanate and silicate glasses doped with europium and silver

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Today, silver nanostructures are of great interest for many applications in photonics due to their unique optical [1,2], nonlinear [3], and electrical [4] properties. Silver clusters (subnanosized aggregates consisting of several silver atoms and/or ions) in glass are well known [5,6] to have an intense broadband luminescence in the visible. Glasses with luminescent silver clusters were proposed to be used as phosphors for white LEDs [8], luminescence down-shifting cover glasses for solar cells [9], and optical data storage media [10].

In order to investigate the effect of glass composition on the formation of silver clusters and nanoparticles were synthesized glass of the following composition. First one is a silicate glass based on the 14Na2O–3Al2O3–5ZnO–71.5SiO2–6.5F (mol. %) matrix doped with different concentrations of Sb2O3 (0-0.01 mol%) and Eu2O3 (0.1-0.5 mol %). Second one is germanate glass 70GeO2-19.95Na2O-9.5RO-0.5Eu2O3 mol%, where RO - La2O3, Sb2O3, Nb2O5, doped with different concentration of Ag2O from 0 to 0.05 mol%. The silver ions is introduced into the glass by two different methods, ion-exchange method and it was added to glass composition during the synthesis.

The UV-Visible-IR absorption, X-ray diffraction (XRD) analysis, energy-dispersive X-ray (EDX) spectroscopy, Fourier transform infra-red (FTIR) and Raman spectroscopy, techniques have been used to study the formation of silver nanostructures in the glassy network. To determine the interaction of silver nanostructures and europium ionions spectral and luminescent properties of the europium ion (absorption and luminescence spectra, luminescence lifetime, and the absolute quantum yield) have been investigated.

Figure 1 shows the spectrum of a silicate glass containing silver luminescence and europium before and after the heat treatment (450^0 C 4h). Excitation wavelength is chosen in such a way so as not to overlap with the absorption band of europium that is excited only silver clusters.

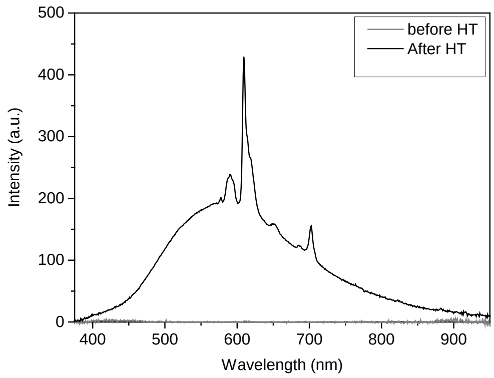

Figure 1. Luminescence spectrum of silver clusters and europium ions. Exectation wavelength 350 nm.

In initial glass (before a heat treatment) luminescence was not observed/ On the resulting luminescence spectrum (after HT) we can be observed luminescence band corresponding the europium ions as well as silver ions. Perhaps such luminescence is related to the energy transfer from the silver clusters on the europium ions.

Effect of glass composition, reduce conditions and heat treatments on the formation of silver nanoparticles have been studied. Dependence of luminescence intensity on size and concentration of the silver nanostructures and conditions of their incorporation in the glass host (high temperature synthesis and low temperature ion exchange) have been investigated. Effects of the glass composition and methods of incorporation of silver ions into the glass host on formation of the silver nanostructures, as well as energy transfer from silver nanostructures to europium ions have been discussed.

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