New route to obtain Sb_2O_3-$SbPO_4$ glass containing silver nanoparticles

Wesley R Viali[1] (PQ), Ricardo S Baltieri[2] (IC), Marcelo Nalin[2*] (PQ). *mnalin@iq.unesp.br

1 Departamento de Química, Universidade Federal de São Carlos, São Carlos, SP, Brasil.
2 LAVIE- Instituto de Química, Universidade Estadual Paulista, Júlio de Mesquita Filho, Araraquara, SP, Brasil.

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Introduction

Glasses are versatile materials and have been used as hosts for incorporation of a large variety of nanoparticles, for application in distinct technological fields, such as photonics and medicine. Another emerging field for technological applications of glasses is related to dispersion of other chemical elements in their composition as rare earth ions, and metallic nanoparticles (MNP).[1] Oxide glasses, have been used as host material due their wide range of applications in photonics and their interesting properties[2]. In addition, glasses containing MNP, such silver nanoparticles, are also promising photonic materials for nonlinear optics[3]. Generally, these nanocomposites glasses contain MNP were prepared by introduction of metal ions into the transparent glass matrix, and followed by metal reduction process that can be achieved by heat treatment, promoting the MNP precipitation within the glass matrix[4].

This work aimed to prepare a glass nanocomposite in the system $60Sb_2O_3$-$40SbPO_4$ containing silver MNP by a new route, using core@shell nanostructures to allow the dispersion of MNP in the glass matrix.

Results and Discussion

The nanoparticles were synthesized by the reduction of the metal precursors method (Ag) in solution using high-boiling solvent and reductant. The nanoparticles were coated with an insulating layer, forming a core@shell type structure, in order to allow their dispersion in the glass matrix. The glass samples were prepared by melting-quenching method and subsequent annealing below the glass transition temperature (T_g) for 2 h and cooled to room temperature. We prepare samples containing 1 and 3% w/w of silver MNP. The samples containing the core@shell nanostructure were compared with samples containing the same mass ratio of silver ions (traditional method of synthesis). All samples were undergoing to heat treatment above T_g (T = 335°C). The Figure 1 shows the glass images, after and before the heat treatment above T_g. It is possible to observe that the glass containing the core@shell silver MNP presented a homogeneous yellowish color, as like the original glass matrix before the annealing, that change to orange after the annealing. In the traditional method samples, after the annealing we see a less homogeneous color distribution and particles segregation when the silver content was increased.

The absorption spectrum for he glasses during the heat treatment shows the increase in the absorption bands at 470 nm, that can be assigned to the surface plasmon resonance band (SPR) of silver nanoparticles. The band is narrower in the glasses containing the silver core@shell structures

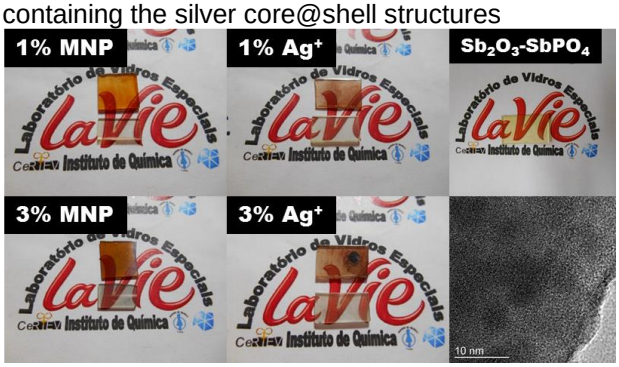

Figure 1. Images of glass synthesized after and before the heat treatment above T_g and TEM of 1% MNP without heat treatment.

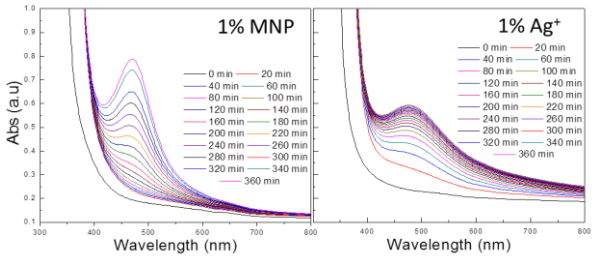

Figure 2. Absorption Spectrum data for SbO_3-$SbPO_4$ glasses containing silver MNP and silver ions during the heat treatment above T_g.

Conclusions

The synthesis method was efficient to obtain antimony phosphate glasses containing silver MNP. The core@shell silver MNP allowed the dispersion of a higher ratio of silver in the glass matrix when compared to the traditional method. Furthermore, after the heat treatment above T_g the samples containing the silver MNP exhibited more homogeneous color and the absorption band at 470 nm was narrower, possibly due to a more controlled diffusion and growth of this particles in the hostage matrix.

Acknowledgments

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