Spectroscopic Properties of Rare Earth (Eu^{3+}, Tb^{3+}, Er^{3+}) Doped WO_3-$NaPO_3$ Glasses With and Without Silver Nanoparticles

M. Reza Dousti[1,2*], R. Junaid Amjad[2,3], Gael Poirier[4], Andrea S.S. de Camargo[2]

[1]Institute of Physics, Federal University of Alagoas, Maceió-AL, Brazil, [2]São Carlos Institute of Physics, University of São Paulo, São Carlos-SP, Brazil, [3]Department of Physics, COMSATS Institute of Information Technology, Lahore, Pakistan, [4]Institute of Science and Technology, Federal University of Alfenas, Poços de Caldas – MG, Brazil.

*e-mail: mrdphysics@gmail.com

Tungsten-phosphate glasses could be nominated as interesting amorphous hosts for various applications in photonics and nanophotonics. The optical and structural properties of these glasses varies in a wide range by changing the $WO_3/NaPO_3$ compositional molar ratio. Therefore, we examined the spectroscopic properties of the rare earth doped tungsten phosphate glasses in a wide compositional and dopant concentration range. The transparency of the glasses with high amount of WO_3 (>40 mol%) could be increased by addition of only 1mol% of Sb_2O_3 agent. However, the photon-cut-off energy at the ultraviolet edge of the absorption spectra shifts to higher wavelength by addition of tungsten oxide. The improved transparency by addition of antimony agent is due to oxidation of W^{5+} to W^{6+}, as revealed by EPR spectroscopy. Eu^{3+} doped glasses show an intense emission band at 612 nm, at high WO_3 concentration (~50 mol%), which is associated to the large asymmetry sites of rare earth ions. However, other rare earth ions (Er^{3+} and Tb^{3+}) do not show significant luminescence properties, perhaps due to large absorption cross section of glass host in visible spectral range and low rare earth solubility of glasses. The glasses doped with rare earth ions and silver nanoparticles are also studied by absorption and luminescence spectroscopic techniques. The silver nanoparticles are nucleated and grown by heat-treatment process around the glass transition temperature of the glasses. The surface plasmon resonance band frequency depends on the $WO_3/NaPO_3$ ratio, and varies from 420 to 537 nm for 10 mol% and 50 mol% of WO_3. The luminescence bands of the Eu^{3+} and Tb^{3+} ions quench by addition of silver nanoparticles and increasing the holding time of heat-treatments. The phenomenon could be associated to an energy transfer from rare earth ions to the metallic particles. However, the luminescence intensity and lifetime of the broadband emission of Er^{3+} ions (centered at 1.53 µm) undergoes an enhancement. The results are discussed in details from different points of view; energy transfer, local filed enhancement and chemical reaction. Some new proposals could be driven.