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Optical and Structural Characterization of Rare Earth Doped Phosphate Glasses

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Abstract : Advances in telecommunications grow with the development of optical amplifiers based on rare earth ions. The focus has been concentrated in silicate glasses although their amplified spontaneous emission is limited to a few tens of nanometers (~ 40nm). Recently, phosphate glasses have received great attention due to their potential application in optical data transmission, detection, sensors and laser detector, waveguide and optical fibers, besides its excellent physical properties such as high thermal expansion coefficients and low melting temperature. Compared with the silica glasses, phosphate glasses provide different optical properties such as, large transmission window of infrared, and good density. Research on the improvement of physical and chemical durability of phosphate glass by addition of heavy metals oxides in P2O5 has been performed. The addition of Na2O further improves the solubility of rare earths, while increasing the Al2O3 links in the P2O5 tetrahedral results in increased durability and aqueous transition temperature and a decrease of the coefficient of thermal expansion. This work describes the structural and spectroscopic characterization of a phosphate glass matrix doped with different Er (Erbium) concentrations. The phosphate glasses containing Er3+ ions have been prepared by melt technique. A study of the optical absorption, luminescence and lifetime was conducted in order to characterize the infrared emission of Er3+ ions at 1540 nm, due to the radiative transition 4I13/2 → 4I15/2. Our results indicate that the present glass is a quite good matrix for Er3+ ions, and the quantum efficiency of the 1540 nm emission was high. A quenching mechanism for the mentioned luminescence was not observed up to 2,0 mol% of Er concentration. The Judd-Ofelt parameters, radiative lifetime and quantum efficiency have been determined in order to evaluate the potential of Er3+ ions in new phosphate glass. The parameters follow the trend as Ω2 > Ω4 > Ω6. It is well known that the parameter Ω2 is an indication of the dominant covalent nature and/or structural changes in the vicinity of the ion (short range effects), while Ω4 and Ω6 intensity parameters are long range parameters that can be related to the bulk properties such as viscosity and rigidity of the glass. From the PL measurements, no red or green upconversion was measured when pumping the samples with laser excitation at 980 nm. As future prospects: Synthesize this glass system with silver in order to determine the influence of silver nanoparticles on the Er3+ ions.

Keywords : phosphate glass, erbium, luminescence, glass system
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