Superbroadband emission from rare earth doped-SiO_2-Nb_2O_5 and SiO_2-Ta_2O_5 nanocomposites

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The rising demand for more efficient telecommunication networks carrying a larger volume of data is one of the current technological challenges. In this sense, rare earth doped glasses and glass-ceramics have reported on literature enabling optical amplification in a broadband of third telecom window. Recently, some efforts aim to achieve a superbroadband amplification to supply the increasing telecom demand. Niobium and tantalum oxides features a series of advantageous properties related to luminescence process, namely low phonon energy, high refractive index, NIR and visible transparency. SiO_2 drawbacks on rare earth doped materials are well known in the literature, including a high phonon energy, low RE solubility and low refractive index. Nevertheless, SiO_2 has a broad transparency window, from 0.2 to 2.5 μm and have been used as rare earth hosts in optical amplifiers working at 1.5 μm. In this sense, over the last years [1,2] we have used the sol gel method to design SiO_2-based materials with controlled distribution of rare earth ions at convenient low phonon environment attaining luminescent properties improvement. Currently we obtained different rare earth doped SiO_2-Nb_2O_5 and SiO_2-Ta_2O_5 nanocomposites focusing superbroadband emission materials. Tm^{3+}/Yb^{3+} co-doped $70SiO_2$-$30Nb_2O_5$ and $70SiO_2$-$30Ta_2O_5$ (mol%) as well Tm^{3+}/Er^{3+}/Yb^{3+} $70SiO_2$-$30Nb_2O_5$ nanocomposites were successfully prepared by sol method [1,2] using different rare earth ratios. Intense and very broad emission extending from 1.5 μm to 2.1 μm with maximum at 1.8 μm was observed for Tm^{3+}/Yb^{3+} co-doped $70SiO_2$-$30Nb_2O_5$ and $70SiO_2$-$30Ta_2O_5$ nanocomposites. The FWHM (full width at half maximum) values were around 260 nm for both nanocomposites. Discrete quenching was observed increasing rare earth content, which attests for good rare earth solubility and distribution on the hosts. For the tri-doped Tm^{3+}/Er^{3+}/Yb^{3+} $70SiO_2$-$30Nb_2O_5$ nanocomposites intense emission extending from 1.4 μm to 2.1 μm with maxima at 1.5 and 1.8 μm was observed. FWHM values were 62 nm e 249 nm, respectively. Luminescence quenching was observed increasing the rare earth content. This indicates rare earth cluster formation, resulting in energy migration between the rare earth ions. The observed luminescence results are an outstanding achievement in terms of silicate hosts, and bring a great potential application of these materials as optical amplifiers, remote sensing and LIDAR systems. Further studies to optimize the rare earth ratio are in progress.

References

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