Nanocomposites based on $Gd_2O_3:Tb^{3+}$ grown into SiO_2 with potential application as green lasers

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Rare earths (RE^{3+}) are found in the main green emitting materials. Among UV-pumped green phosphors the Tb^{3+}-doped materials highlights due its emission at 545 nm, assigned to the $^5D_4 \rightarrow {}^7F_5$ transition. The main problem about Tb^{3+}-doped materials is the Tb^{3+} stability, due terbium can be found as Tb^{3+} or Tb^{4+} oxidation forms, and the last one do not show photoluminescence. In literature are reported the use of other ions to stability the oxidation state or then the control of the heat-treatment atmosphere.[1] Another way is the encapsulating these phosphors to avoid oxidation processes or to avoid surface effect. The present work search grown $Gd_2O_3:Tb^{3+}$ particles into SiO_2 by sol-gel process and evaluate its photoluminescent properties as a function of Tb^{3+} amounts in the host. It was used the molar ratio of $70Si^{4+}$-$30Gd^{3+}$ and the concentration of Tb^{3+} was 0.1; 0.3; 0.5, 1 and 3 mol% in relation to the amount of $Gd^{3+}+Si^{4+}$.[2] TEOS and alcoholic solutions of Gd^{3+} and Tb^{3+} were used as precursors. The sols obtained were kept in an oven at 60 °C for 24h and, after macerates, heat-treated at 1000 °C for 8h. FTIR indicate Gd_2O_3 and SiO_2 formation, and by XRD was proven that only the Gd_2O_3 cubic phase was formed, indicating nanocomposite structures. SEM analysis reveal that spherical particles were formed, assigned to Gd_2O_3, and TEM confirm that these particles were grown into amorphous SiO_2. Diffuse reflectance indicates high absorption of host at UV-region, good characteristic for UV-pumped phosphors. Excitation spectra show bands at UV-region at characteristic wavelengths of Gd_2O_3 host absorption, and confirmed materials as good UV-absorber. Emission spectra reveal most efficient excitation at 311 nm. The intense emission bands $^5D_4 \rightarrow {}^7F_J$ confirm energy transfer processes between Gd^{3+} and Tb^{3+}. The intense and well centered emission at 545 nm makes the material applicable in green laser devices. CIE chromaticity shows color shifted from blue to green regions on visible electromagnetic spectra when materials are excited from 230 to 311 nm. The maximum lifetime for Tb^{3+} in materials was 2.18 ms, lifetime ideal for lasers development. The higher Tb^{3+} emission intensities can indicate that when nanoparticles Tb^{3+}-doped are grown in SiO_2 favors the Tb(III) stability. Sol-gel methodology make possible obtain Terbium doped SiO_2-Gd_2O_3 materials with intense photoluminescence. Its intense emission at green region and the high UV absorption make the materials applicable as Near-UV lasers in crystal or fiber forms.

1 Terra, I.A.A. et al. *J. Appl. Phys.* **2013**, 113, 073105.

2 Rocha, L.A. et al. *J. Sol-Gel Sci. Technol.* **2015**, 76, 260.

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