Low Temperature Materials Synthesis Based in the Benzenetrycarboxylate Method

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Rare earth (RE) benzenetricarboxylate (BTC) complexes (1,3,5-benzenetricarboxylic acid – TMA and 1,2,4-benzenetricarboxylic acid – TLA) present favorable thermal properties to prepare oxides at low temperatures [1]. The luminescent nanophosphors were obtained by annealing the complexes from 500 to 1000 °C. The thermogravimetric curves of the [RE(BTC):Eu^{3+} (x %)] complexes (RE^{3+}: Y, Gd and Lu; x: 0.1, 0.5, 1.0 and 5.0) show that the organic moiety of the complexes decomposes in a single-step from 430 to 580 °C, allowing the formation of RE_2O_3 after 1 h annealing at 500 °C. The decomposition temperature decreases for all complexes with increasing Eu^{3+} concentration.

The X-ray powder diffraction patterns confirm the formation of the cubic RE_2O_3 phase, indicating the total decomposition of the organic phase during annealing. The crystallinity of the oxides increases with the annealing temperature. According to the Scherrer's equation, the crystallite sizes of Y_2O_3:Eu^{3+} (TMA precursors) grow from 6 to 52 nm between 500 and 1000 °C for Y_2O_3:Eu^{3+}.

The luminescent properties were investigated by the excitation and emission spectra as well as lifetime measurements of the ^5D emitting level of Eu^{3+}. The number of lines for the $^5D \rightarrow {}^7F_1$ transition indicates the presence of Eu^{3+} in two sites (C_2 and S_6). An intense hypersensitive $^5D \rightarrow {}^7F_2$ transition due to the non-centrosymmetric C_2 site was observed. Finally, [RE(BTC)] complexes emerge as suitable precursors for the preparation of Eu^{3+}-doped RE_2O nanophosphors at low temperature, yielding strong luminescence with quantum efficiency up to 96 %.

[1] E.R. Souza, I.G.N. Silva, E.E.S. Teotonio, M.C.F.C. Felinto, H.F. Brito, J. Lumin. 130 (2010) 283–291.