

Intense upconversion emission of $\text{Er}^{3+}/\text{Yb}^{3+}$ co-doped CaTiO_3 under excitation at 980 and 1550 nm

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Photoluminescent materials containing Rare Earth ions (RE^{3+}) have been employed in many industrial technological or biotechnological devices, such as lasers, telecom, biological markers and energy conversion devices.¹ Among the most of RE^{3+} studied Er^{3+} is noteworthy. This ion presents the upconversion emission phenomenon (UC), attributed to the emission in the visible region under excitation in infrared region, usually at 980 nm.² Among many kind of materials, CaTiO_3 has physical and chemical characteristics which makes it suitable to be used as RE^{3+} host. Thus, this work presents the synthesis of CaTiO_3 containing 0.3 mol% of Er^{3+} changing the concentration of Yb^{3+} ($x = 1.0; 1.5; 2.0$ mol%) in powder form prepared by sol-gel process and heat-treated at 1200 °C for 4 h. The structural and photoluminescent properties are evaluated and related to the RE^{3+} concentration in the host matrix. The XRD analysis showed that the material obtained exhibited an orthorhombic structure with a space group $Pbnm$. A small amount of the secondary phase attributed to rutile phase of TiO_2 was detected. It is important to note that the presence of this secondary phase did not influence the photoluminescent properties of materials. No crystalline phase assigned to Er_2O_3 or Yb_2O_3 was detected. The crystallite size, calculated from Scherrer's equation, are between 58 and 66 nm. The microstrain values showed direct relation to the increase of the RE^{3+} concentration in CaTiO_3 structure. All materials showed intense emission attributed to the UC phenomenon in the region between 500 and 750 nm under excitation at 980 and 1550 nm. All samples showed green UC emission more intense than red UC emission when excited at 980 nm and, when excited at 1550 nm, exhibited red UC emission more intense than the green UC emission. The UC mechanisms using excitation at 980 and 1550 nm are different. While the mechanism involved using excitation at 980 nm occurs through the absorption and sequential transfer of two photons from Yb^{3+} to Er^{3+} , the UC mechanism that occurs in the 1550 nm excitation involves the sequential absorption of at least three photons by Er^{3+} . The structural and photoluminescent properties presented by obtained materials make them possible candidates for applications in solid-state lasers, energy conversion devices and as biological markers.

1. Perrella, R. V.; Santos, D. P.; Poirier, G. Y.; Góes, M. S.; Ribeiro, S. J. L.; Schiavon, M. A.; Ferrari, J. L.; *J. Lumin.* **2014**, 149, 333.

2. Ferrari, J. L.; Lima, K. O.; Pecoraro, E.; Ferreira, R. A. S.; Carlos, L. D.; Gonçalves, R. R.; *J. Mater. Chem.* **2012**, 22, 9901.

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