Near-Infrared to Near-Infrared Upconversion in Tm^{3+}/Yb^{3+} co-doped Y_2O_3 and $Y_2SiO_5@SiO_2$ Nanoparticles

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Upconversion Tm^{3+}/Yb^{3+} co-doped nanoparticles have shown great potential for biological applications. A new approach for bioimaging *in vitro* and *in vivo* has been shown utilizing near infrared to near infrared upconversion in nanophosphors. This process provides deeper light penetration into biological specimen, minimum damage to living organisms and results in high contrast optical imaging due to absence of an autofluorescence from biological tissues and decreased light scattering[1]. Furthermore, silica coating provides optical transparency, mechanical stability and biocompatibility for these particles, not to mention the possible functionalization with particular molecules, such as, proteins, enzymes and antibodies[2]. Tm^{3+}/Yb^{3+} co-doped $Y(OH)CO_3$ particles with were prepared by homogeneous precipitation method with urea decomposition using $Y(NO_3)_3$ as precursor. After, these particles were submitted for a TEOS coating and annealing at 900°C for 2 or 24 hours. The core@shell particles were characterized by TEM, XRD, FTIR and photoluminescence spectroscopy. The obtained spherical and monodisperse particles presented a narrow size distribution with average diameter of 200 nm and 15 nm of shell thickness were obtained. The heat treatment for 24 hours led to disruption of particle shells. The XDR reflection peaks showed to a mixture of Y_2O_3 cubic and Y_2SiO_5 monoclinic crystalline phases. The Yb^{3+} ions, excited with 980 nm diode laser, transfer energy to Tm^{3+} resulting in the characteristic Tm^{3+} emission bands at 480, 650, and 800 nm. The visible blue peak emission corresponds to $^1G_4 \rightarrow {}^3H_6$ transition of Tm^{3+} ions and it can be observed by naked-eye, the weak peak at 650 nm is attributed to $^1G_4 \rightarrow {}^3F_4$ whereas the strongest NIR peak at 800 nm corresponds to the $^3H_4 \rightarrow {}^3H_6$ transition. The increase in annealing time becomes narrower peaks. Upconversion dynamics were determined by the photons number, suggesting ETU mechanisms. The observed strong upconversion emission from core@shell particles makes them promising materials for photonics in biomedical applications.

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The authors would like to thank FAPESP, CAPES, and CNPq for financial support.