Upconversion Luminescence of Yb^{3+}: Tm^{3+} and Yb^{3+}: Tm^{3+}: Er^{3+}-doped Beta-Tricalcium Phosphate nanoparticles

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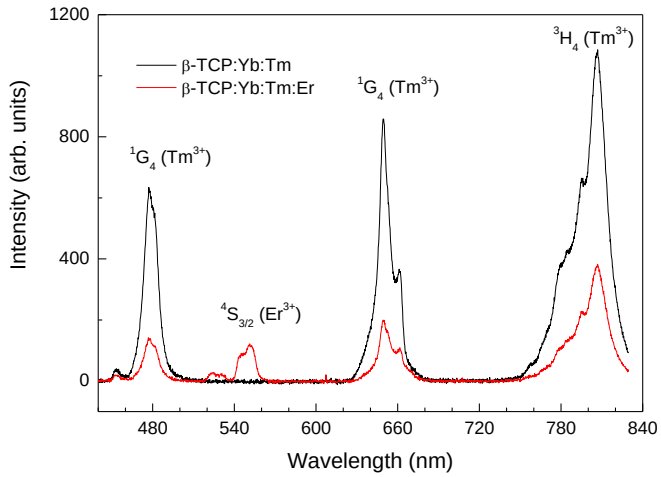
A novel class of fluorescence nanoparticles of 5.5 mol% of Yb^{3+}, 0.5 mol% of Er^{3+} and 0.5 mol% Tm^{3+}: calcium deficient hydroxyapatite were synthesized by co-precipitation method in aqueous solution (pH adjusted to 6) and specially treated with microwave radiation at 1000°C for 10 minutes to produce nanocrystals of Yb:Tm: and Yb:Tm:Er:β-tricalcium phosphate (β-TCP). As a result, we report for the first time, a single-phase β-TCP:Yb:Tm:Er and β-TCP:Yb:Tm exhibiting an efficient visible and near infrared upconversion luminescence from the $^1G_4$ (blue emission), $^4S_{3/2}$ (green emission), $^3F_2$ (red emission) and $^3H_4$ (near infrared emission) induced by the $Yb^{3+} \rightarrow Tm^{3+}$ / Er^{3+} energy transfer under pulsed laser excitation at 972 nm (Yb^{3+}) with an average energy of 11 mJ. The emission decay curves of the upconversion transients, from $^1G_4$ excited state of Tm^{3+} and $^4S_{3/2}$ excited level of Er^{3+}, indicate that ESA process occurs in β-TCP:Yb/Tm/Er nanopowder measured for the 550 nm luminescence of Er^{3+}, which has a time constant (t_2) of 0.4 μs. However, $Yb^{3+} \rightarrow Tm^{3+}$ upconversion (Up_2) has a time constant (t_2) of 14.4 μs and does not exhibit ESA absorption.



This β-TCP activated by Yb^{3+} and Tm^{3+} ions constitutes a new nanobiomaterial that can be used as diagnostic and therapeutic agents, affording deeper tissue penetration and higher resolution and sensitivity for visible-near infrared bioimaging and treatments.

Keywords: beta tricalcium phosphate, ytterbium, thulium, erbium, upconversion luminescence

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