

Upconversion In $Gd_3Ga_5O_{12}$ Nanocrystals Doped With Trivalent Lanthanide Ions

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Over the past several years there has been an ongoing search for nanometer sized powered phosphors with superior performance characteristics over their micrometer counterparts. This research has been stimulated by the fact that significant changes in the optical properties have been observed with decreasing particle size. While numerous studies have focused on examining the luminescence generated by exciting with UV light or electrons, very few have examined the upconversion phenomenon in nanocrystalline materials.

In this paper we report on the upconversion properties of $Gd_3Ga_5O_{12}:Er^{3+}$ co-doped with Yb^{3+} . Two nanocrystal samples synthesized through a solution combustion method were examined. Both synthesis routes provide crystallite sizes in the nanometer range but with differing morphologies. Intense green and red emission was observed from the $(^2H_{11/2}, ^4S_{3/2}) \rightarrow ^4I_{15/2}$ and $^4F_{9/2} \rightarrow ^4I_{15/2}$ transitions, respectively, after excitation with 980 nm radiation. Furthermore, the various mechanisms, which are responsible for populating the emitting levels, following excitation with lower energy radiation, will be elucidated and discussed.

The effect of Yb^{3+} co-doping on the upconversion luminescence in combustion synthesized $Gd_3Ga_5O_{12}:Ho^{3+}$ will also be discussed. NIR excitation of a $Gd_3Ga_5O_{12}$ sample doped with 1 mol% Ho^{3+} and 1 mol% Yb^{3+} resulted in green and red anti-Stokes emissions from the $(^5F_4, ^5S_2)$ and 5F_5 levels respectively. The temporal evolutions of both emissions revealed that two distinct Energy Transfer Upconversion (ETU) mechanisms from the 5I_6 and 5I_7 Ho^{3+} levels were responsible for the green and red upconversion emissions. The effect of Yb^{3+} concentration on the upconversion luminescence will also be discussed.

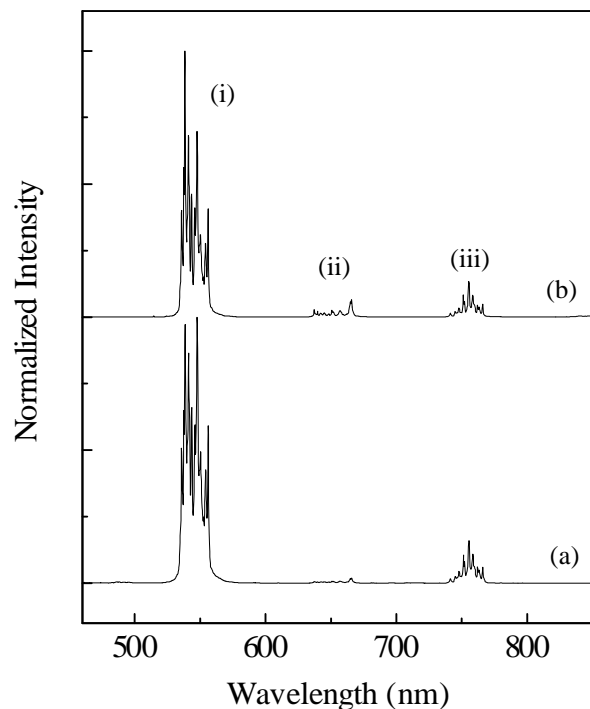


Figure 1: (a) RT emission spectrum under $\lambda_{ex} = 457.9$ nm is also shown for comparative purposes. (b) RT anti-Stokes luminescence of nanocrystalline $Gd_3Ga_5O_{12}:Ho^{3+}, Yb^{3+}$ upon excitation at 978 nm. (i) $(^5F_4, ^5S_2) \rightarrow ^5I_8$ (ii) $^5F_5 \rightarrow ^5I_8$ (iii) $(^5F_4, ^5S_2) \rightarrow ^5I_7$