Supporting Information

Bright White Upconversion Emission from Yb^{3+}, Er^{3+}, and Tm^{3+}-Codoped Gd_2O_3 Nanotubes

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Fig. S1 show the XRD patterns of $Gd(OH)_3$:10%Yb^{3+}/1%Er^{3+}/0.7%Tm^{3+} and Gd_2O_3:10%Yb^{3+}/1%Er^{3+}/0.7%Tm^{3+} nanocrystals. All diffraction peaks can be readily indexed to pure hexagonal $Gd(OH)_3$ and cubic Gd_2O_3, which are in good agreement with the standard values for the $Gd(OH)_3$ and Gd_2O_3 (JCPDS No.83−2037 and 11−0604), respectively. No other impurity peaks can be detected from the XRD patterns, indicating that the nanocrystals are single-phased and Ln^{3+} ions have effectively incorporated into the $Gd(OH)_3$ and Gd_2O_3 host lattices.

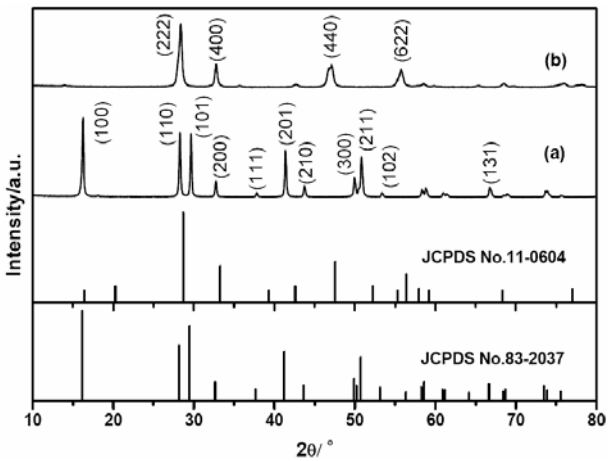

Fig. S1. XRD patterns of (a) $Gd(OH)_3$:10%Yb^{3+}/1%Er^{3+}/0.7%Tm^{3+} and (b) Gd_2O_3:10%Yb^{3+}/1%Er^{3+}/0.7%Tm^{3+} nanocrystals. The standard data for $Gd(OH)_3$ (JCPDS No.83−2037) and Gd_2O_3 (JCPDS No.11−0604) are also presented in the figure for comparison.

Fig. S2 shows the TGA curve of $Gd(OH)_3$:10%Yb^{3+}/1%Er^{3+}/0.7%Tm^{3+} nanocrystals. It can be observed that there are two major stages of rapid weight loss at about 311°C and 420°C, indicating the existence of intermediate phase other than $Gd(OH)_3$ and Gd_2O_3 during the thermal conversion process. The weight loss for the two stages and the total weight loss are 8.86%, 4.32%, and 13.18%, respectively. The total weight loss is in agreement with the theoretical value of $Gd(OH)_3$, calculated from the reaction of its complete dehydration to produce Gd_2O_3. Since most of the rare earth compounds can exist in the form of LnOOH, this dehydration process can be supposed to be two steps: $Gd(OH)_3 \rightarrow GdOOH + H_2O$ and $2GdOOH \rightarrow Gd_2O_3 + H_2O$. The theoretical weight loss for the two processes is 8.64% and 4.73%, respectively, which is quite close to the experimental data.

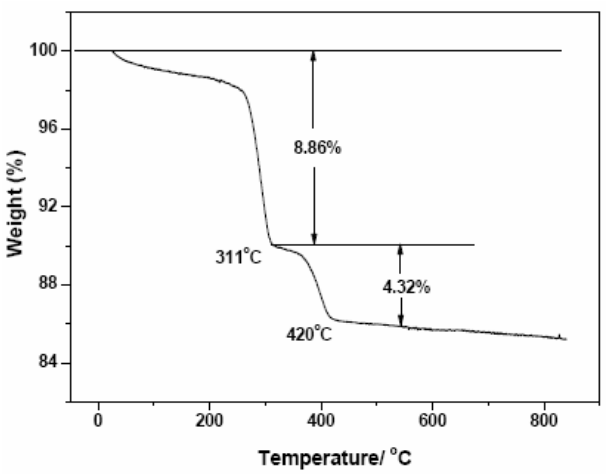

Fig. S2. TGA curve of $Gd(OH)_3$:10%Yb^{3+}/1%Er^{3+}/0.7%Tm^{3+} nanotubes.

Fig. S3 describes the XRD pattern for the product calcinated at 300°C. It fit well with the GdOOH, which has been well addressed by *C Chang et al.* (*Mater. lett.*, 2005, **59**, 1037. and *Nanotechnology*, 2006, **17**, 1981.).

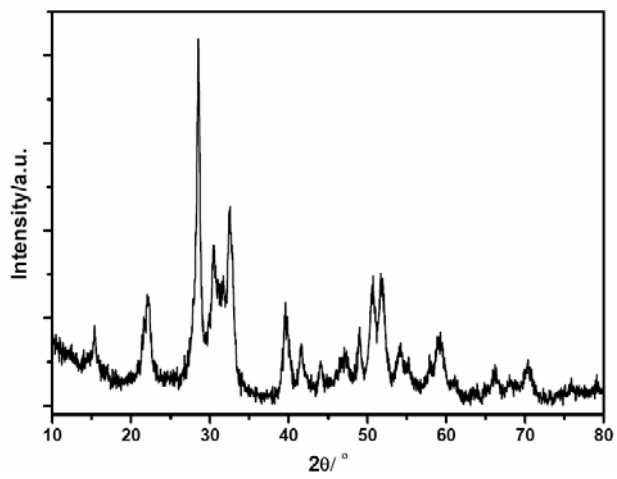

Fig. S3. XRD pattern of GdOOH:10%Yb^{3+}/1%Er^{3+}/0.7%Tm^{3+}