Supporting Information

Excellent red upconversion luminescence in GdLaO$_3$:Er^{3+}/Yb^{3+}/Sc^{3+} under 980 nm laser excitation

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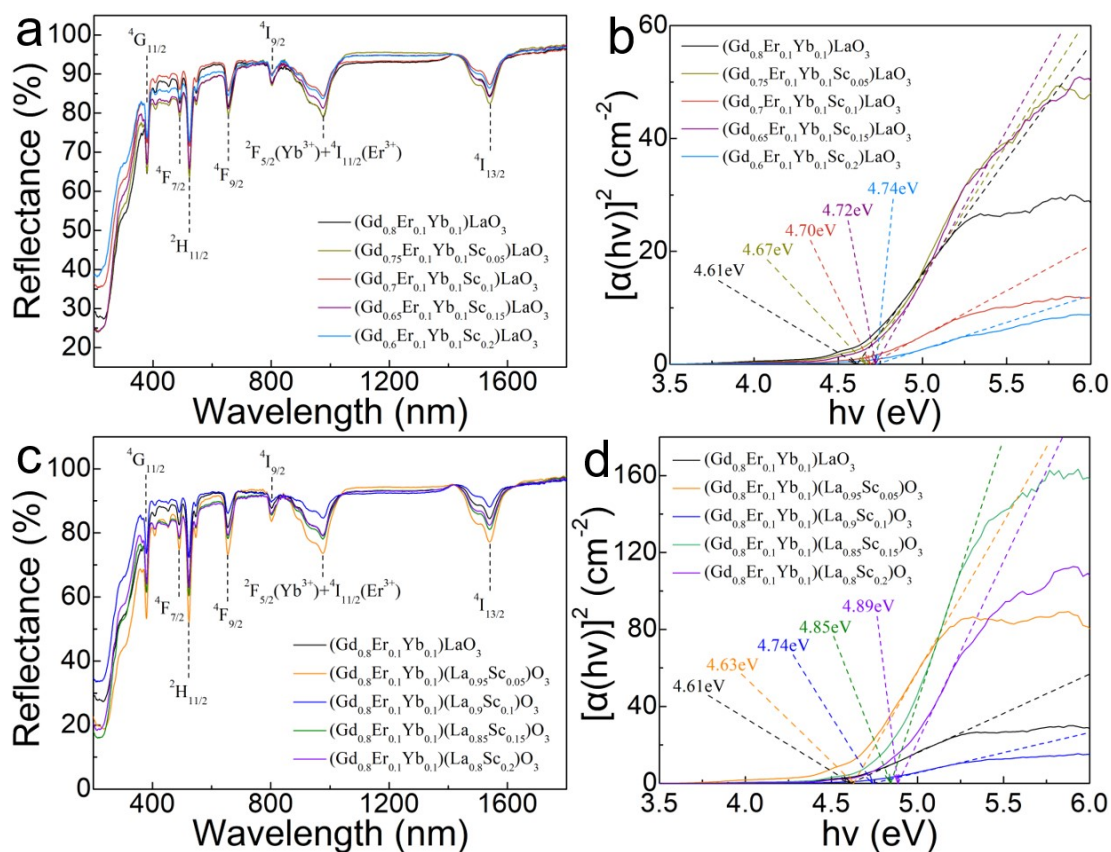*Corresponding authors: cyz@dlmu.edu.cn (Y. Cao); bjchen@dlmu.edu.cn (B. Chen)

Fig. S1. Diffuse reflectance spectra of (Gd$_{0.8-x}$Er$_{0.1}$Yb$_{0.1}$Sc$_x$)LaO$_3$ (x=0, 0.05, 0.1, 0.15, 0.2) phosphors (a) and (Gd$_{0.8}$Er$_{0.1}$Yb$_{0.1}$)(La$_{1-x}$Sc$_x$)O$_3$ (x=0, 0.05, 0.1, 0.15, 0.2) phosphors (c). (b) and (d) are corresponding calculated bandgap values.
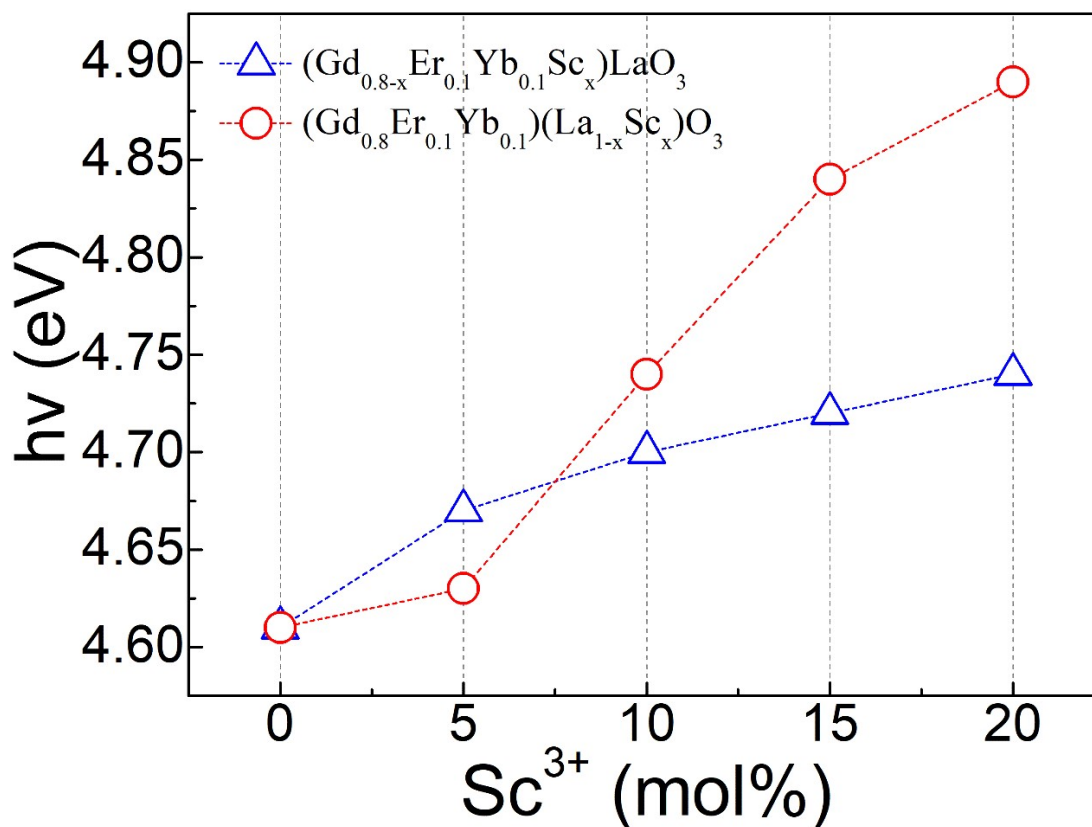
Fig. S2. Relationship between bandgap and doping Sc^{3+} concentration in $(Gd_{0.8-x}Er_{0.1}Yb_{0.1}Sc_x)LaO_3$ (x=0, 0.05, 0.1, 0.15, 0.2) and $(Gd_{0.8}Er_{0.1}Yb_{0.1})(La_{1-x}Sc_x)O_3$ (x=0, 0.05, 0.1, 0.15, 0.2) phosphors.
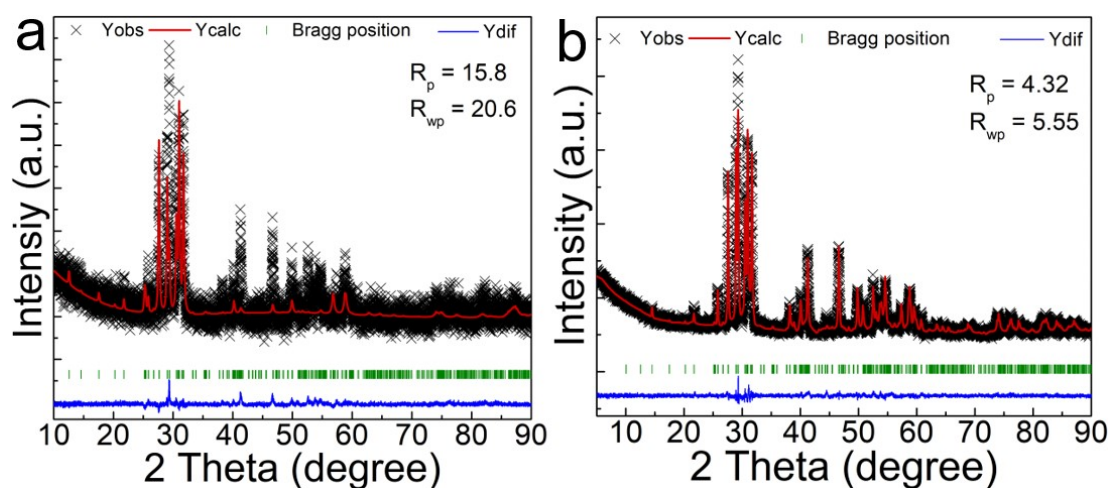

Fig. S3 (a) Rietveld refinement of the assumption with Er^{3+} and Yb^{3+} replacing Gd^{3+}, Sc^{3+} replacing La^{3+}, (b) Rietveld refinement of the assumption with $Er^{3+}/Yb^{3+}/Sc^{3+}$ randomly replacing Gd^{3+} and La^{3+} in $(Gd_{0.8}Er_{0.1}Yb_{0.1})(La_{0.9}Sc_{0.1})O_3$, respectively.
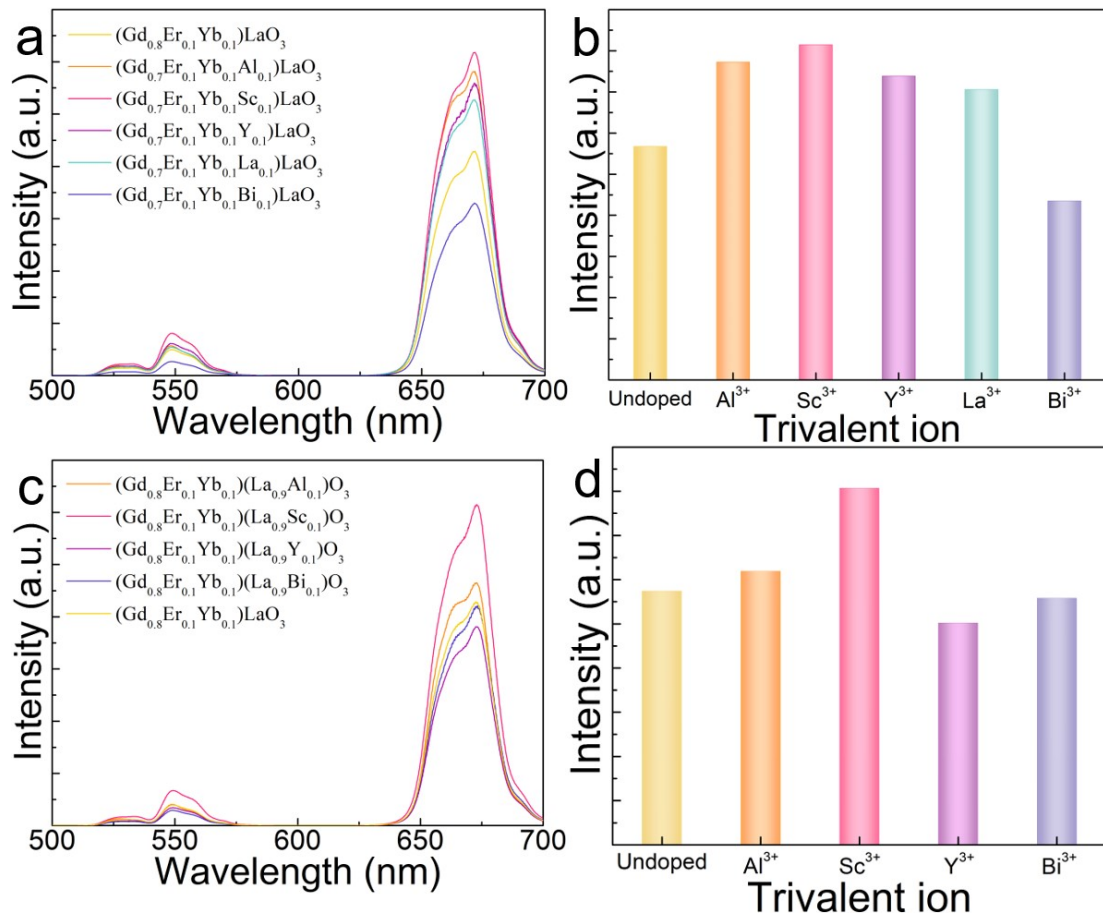
Fig. S4. UCL emission spectra of (a) $(Gd_{0.8}Er_{0.1}Yb_{0.1})LaO_3$ and $(Gd_{0.7}Er_{0.1}Yb_{0.1}X_{0.1})LaO_3$ (X= Al^{3+}, Sc^{3+}, Y^{3+}, La^{3+}, Bi^{3+}) phosphors as well as (b) $(Gd_{0.8}Er_{0.1}Yb_{0.1})LaO_3$ and $(Gd_{0.8}Er_{0.1}Yb_{0.1})(La_{0.9}X_{0.1})O_3$ (X= Al^{3+}, Sc^{3+}, Y^{3+}, Bi^{3+}) phosphors. (b) and (d) show corresponding emission intensity trends as the radius of doping trivalent ions changes.