

Electronic supplementary information

Synthesis of hexagonal phase $\text{Gd}_2\text{O}_2\text{CO}_3:\text{Yb}^{3+},\text{Er}^{3+}$ upconversion nanoparticles via SiO_2 coating and Nd^{3+} doping

Wen Ge,¹ Zhiang Li,¹ Zhiwei Lei,¹ Tong Chen,¹ Min Liu,^{1,3*} Zhengping Fu,^{1,3} Ranran Peng^{1,3} and Yalin Lu^{1,2,3,4*}

¹ CAS Key Laboratory of Materials for Energy Conversion; Department of Materials Science and Engineering, University of Science and Technology of China, Hefei 230026, P. R. China

² Hefei National Laboratory for Physical Sciences at the Microscale, University of Science and Technology of China, Hefei 230026, P. R. China

³ Synergetic Innovation Center of Quantum Information & Quantum Physics, University of Science and Technology of China, Hefei 230026, P. R. China

⁴ Laser Optics Research Center, Physics Department, United States Air Force Academy, Colorado 80840, USA

Synthesis of GdVO_4 : 20% Yb^{3+} , 2% Er^{3+} , 4% Nd^{3+} nanoparticles.

The prepared P1 samples dispersed in 35mL deionized water to form uniform solution. 0.1404g of NH_4VO_3 introduced into P1 solution and stirred for 10min, then adding 120 μL of 2 M HCl. After additional stirring for 30min, the mixed solution transferred to a 50 mL Teflon-lined stainless steel autoclave up to 80% of the total volume. The autoclave was sealed and heated at 180°C for 10h and then cool to room temperature. The product was obtained by centrifugation and washing three times with deionized water and ethanol, respectively. The final product was obtained after dried under vacuum at 60°C for 12h.¹

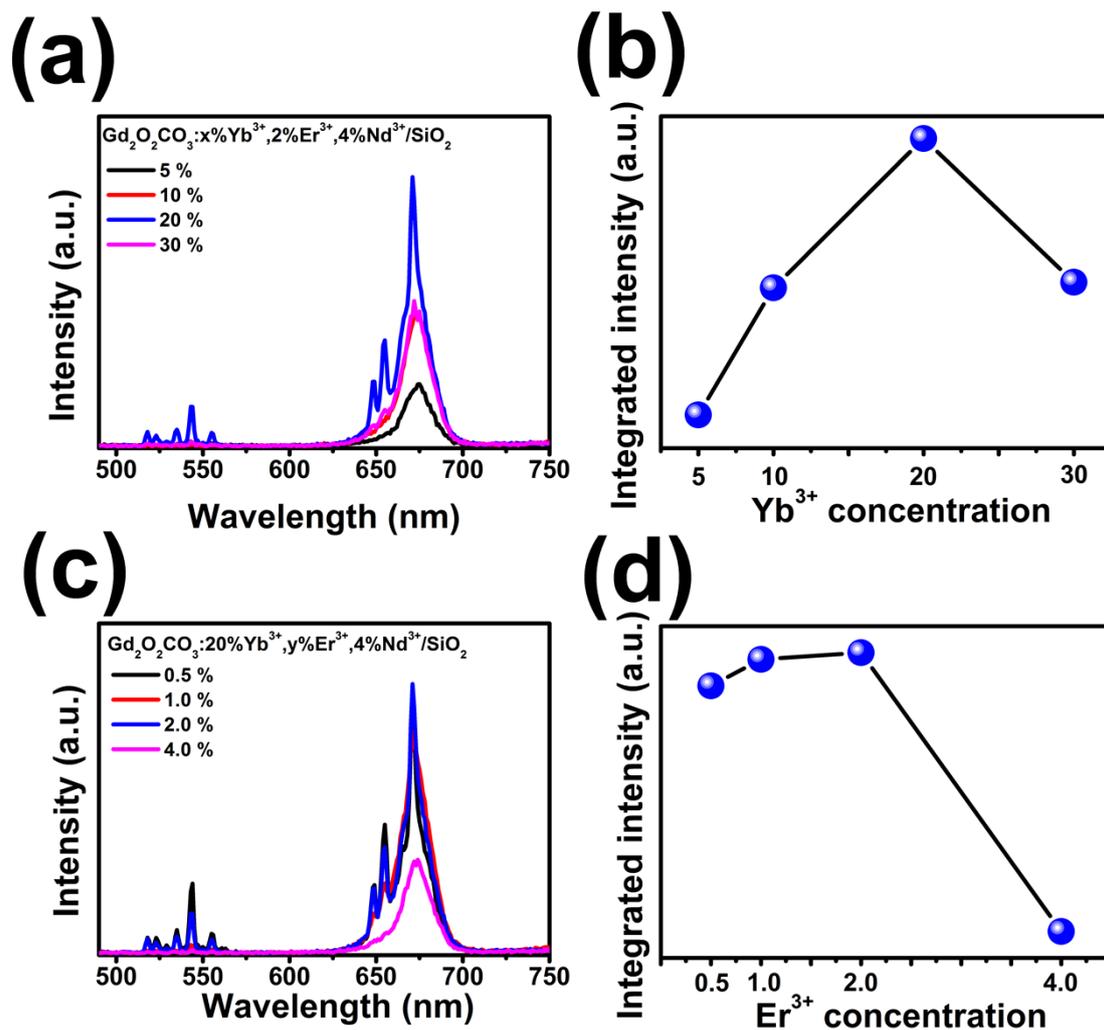


Fig. S1 Upconversion emission spectra of the $\text{Gd}_2\text{O}_2\text{CO}_3: x\% \text{Yb}^{3+}, y\% \text{Er}^{3+}, 4\% \text{Nd}^{3+}/\text{SiO}_2$ samples as a function of (a) Yb^{3+} and (c) Er^{3+} ions concentration, respectively; the corresponding integrated intensity vs (b) Yb^{3+} and (d) Er^{3+} ions concentration.

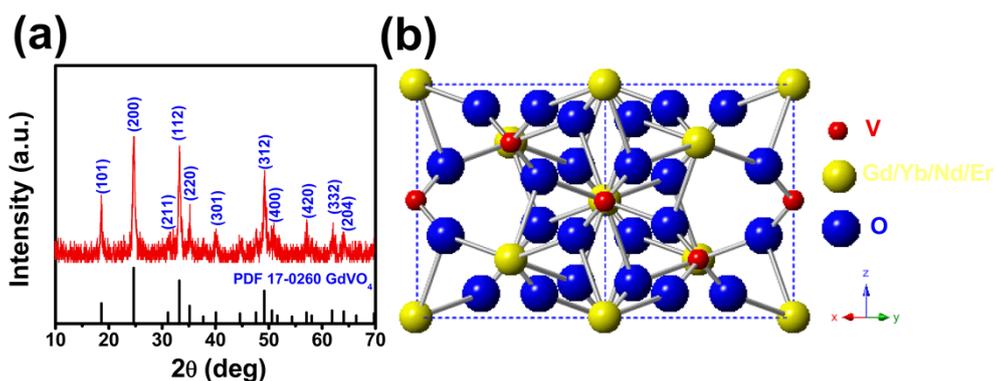


Fig. S2 (a) The XRD pattern of GdVO_4 : 20% Yb^{3+} , 2% Er^{3+} , 4% Nd^{3+} nanoparticles, and (b) the corresponding 3D model structure.

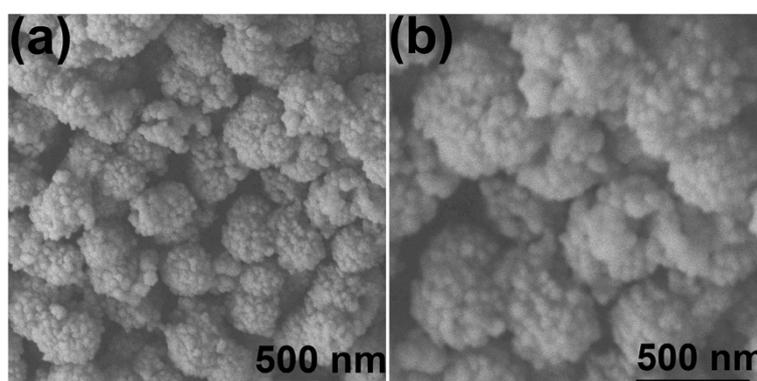


Fig. S3 (a) (b) The SEM images of GdVO_4 : 20% Yb^{3+} , 2% Er^{3+} , 4% Nd^{3+} nanoparticles with different magnification.

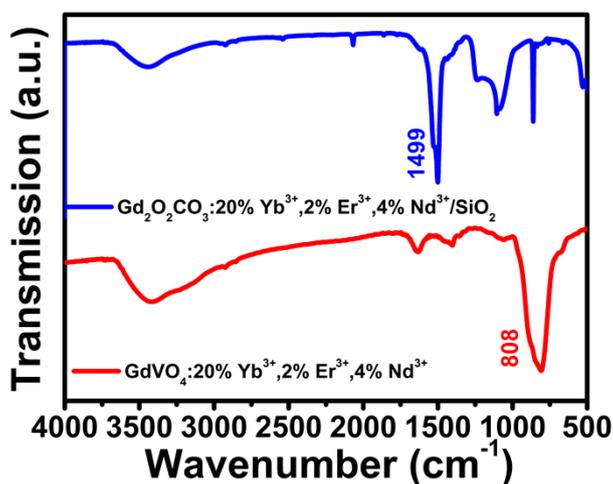


Fig. S4 The FT-IR spectra of GdVO_4 : 20% Yb^{3+} , 2% Er^{3+} , 4% Nd^{3+} and $\text{Gd}_2\text{O}_2\text{CO}_3$: 20% Yb^{3+} , 2% Er^{3+} , 4% Nd^{3+} / $\sim 15\text{nm}$ SiO_2 nanoparticles.

References

1. X. J. Kang, D. M. Yang, P. A. Ma, Y. L. Dai, M. M. Shang, D. L. Geng, Z. Y. Cheng and J. Lin, *Langmuir*, 2013, 29, 1286-1294.