Supporting Information

Red Emitting $Y_2O_3:Eu^{3+}$ Nanophosphors with > 80% down Conversion Efficiency

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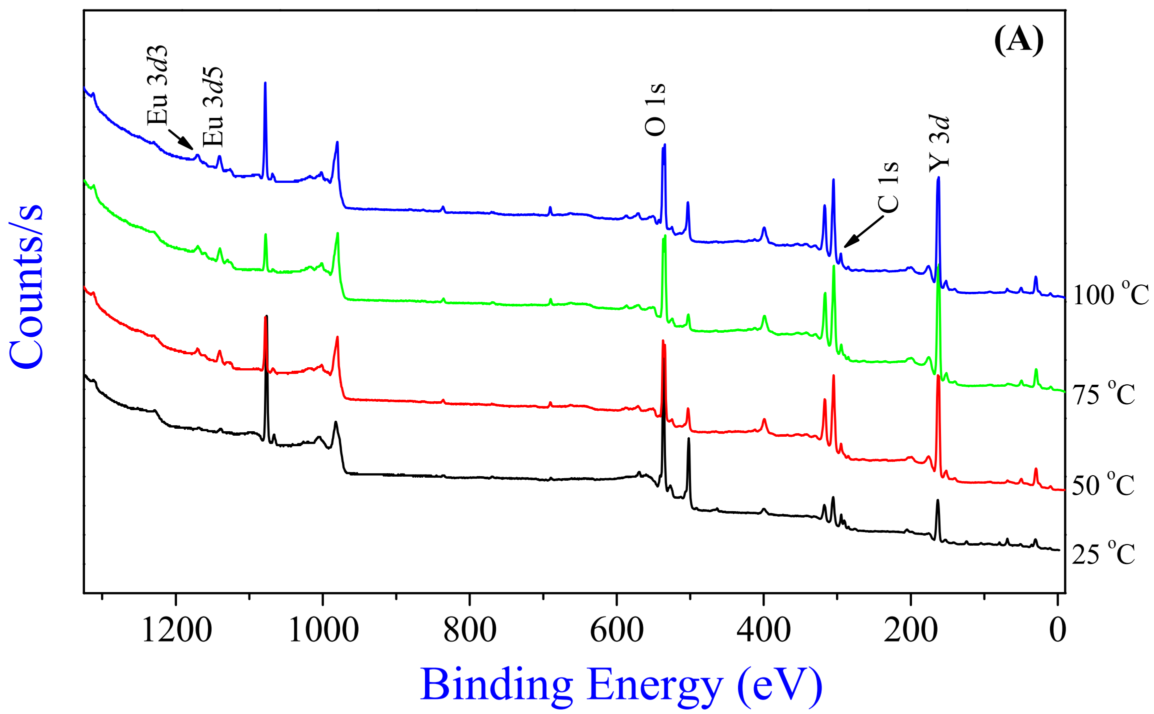

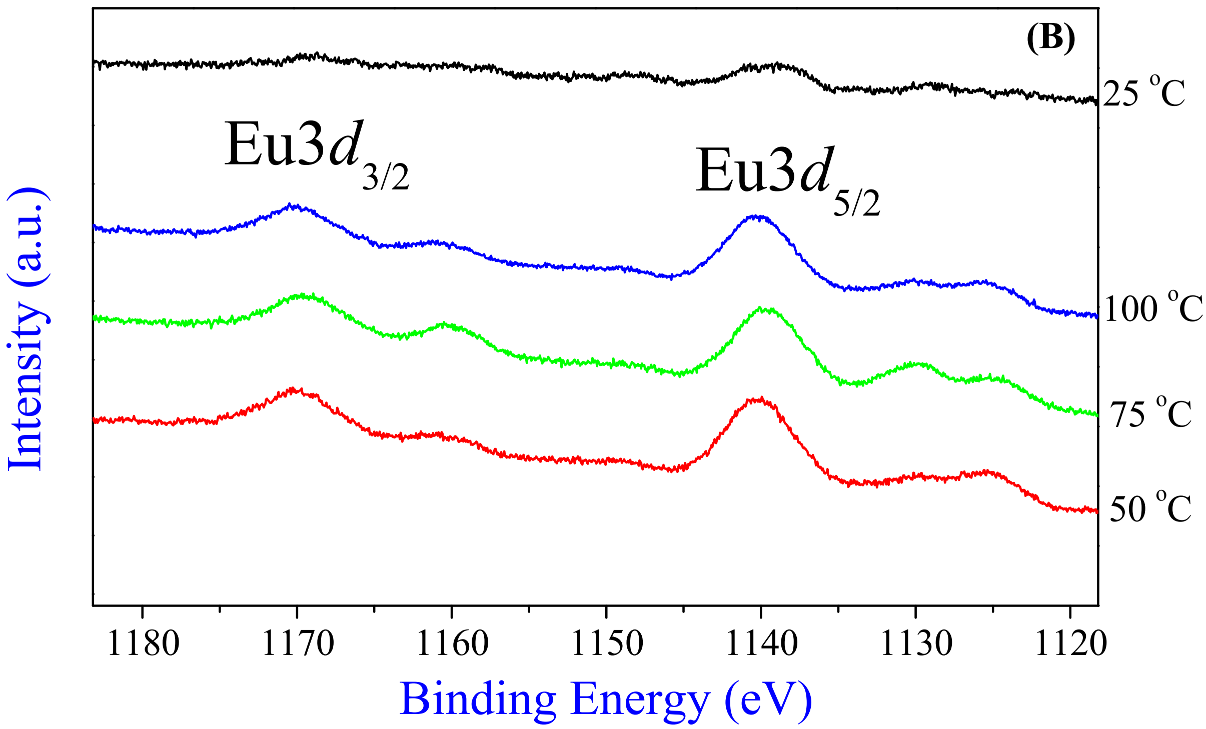

Figure S1. XPS (a) survey and (b) high resolution at Eu3*d* spectra of the Y_2O_3:Eu^{3+} nanoparticles synthesized at 25, 50, 75 and 100 °C.

Comparative XPS survey spectra of Y_2O_3:Eu^{3+} samples synthesized at different temperatures are presented in Figure S1 (a). All the spectra revealed photoelectron peaks correspond to Y3*d*, O1*s*, C1*s* and Eu3*d* emissions. All the emission peak positions were corrected using the C1*s* peak position at 284.6 eV as reference. The surface composition of the samples was estimated from their high resolution XPS (Table 1) spectra. As has been presented in Table 1, though the nominal concentration of Eu in all the samples was kept fixed (Y: Eu = 95:5), only about 0.23 atom % of Eu was introduced into the particles when synthesized at room temperature. However, the concentration of the incorporated Eu increased on increasing the reaction temperature. Figure S1 (b) shows the high resolution XPS emission spectra of the Y_2O_3:Eu^{3+} samples in the Eu3*d* region. The Eu3d peak splits into two sub-peaks Eu3$d_{5/2}$ and Eu3$d_{3/2}$. The binding energy positions of the Eu3$d_{5/2}$ peak for the samples synthesized at 25, 50, 75 and 100 ^oC were revealed at about 1138.95, 1140.35, 1140.10 and 1140.35 eV, respectively and $Eu3d_{3/2}$ peaks shows binding energy around 1170.20 eV. However, the binding energy of the $Eu3d_{5/2}$ peak in Eu_2O_3 is reported to be at about 1135.6 eV.[R1] The positive chemical shifts of $Eu3d_{5/2}$ peak observed in our europium doped Y_2O_3 samples indicate that the incorporated Eu^{3+} ions occupy interstitial sites of the Y_2O_3 host lattice.[R1] As can be observed from the Table 1, the concentration of Eu in the nanoparticles increased with the increase of synthesis temperature. Y_2O_3 crystal has a cubic lattice with space group *Ia3*, where ¾ of Y^{3+} ions occupy the low symmetric C_2 sites and ¼ of Y^{3+} occupy high symmetric S_6 sites. If the Eu^{3+} ions occupy the low symmetry sites of the host lattice, the selection rule will be broken partially and the 614 nm emission would be strengthened greatly, weakening the transition at 594 nm.[R2-R7] Eu^{3+} ion prefers to replace Y^{3+} ion at lower symmetric C_2 sites. As reaction temperature increases, more and more Y^{3+} ions at C_2 sites will get replaced by Eu^{3+} ions, increasing the activator concentration in host lattice.

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