Electronic Supplementary Material (ESI) for Green Chemistry.

Supporting Information

Rare-earth recycling using a functionalized ionic liquid for the selective dissolution and revalorization of $Y_2O_3:Eu^{3+}$ from lamp phosphor waste

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1. Scanning Electron Microscope (SEM) images

The morphology and size distribution of the recycled and purchased Y_2O_3:Eu^{3+} (YOX) phosphor was determined using a Philips XL 30 FEG scanning electron microscope (SEM). The average particle size and distribution of the recycled phosphor (4.11 ± 1.41 µm) is in range with the specifications of the purchased (3.6 ± 1.5 µm) phosphor (Figure S1). However, the morphology is different: the purchased phosphor has a smoother surface than the recycled phosphor due to differences in the calcination process.

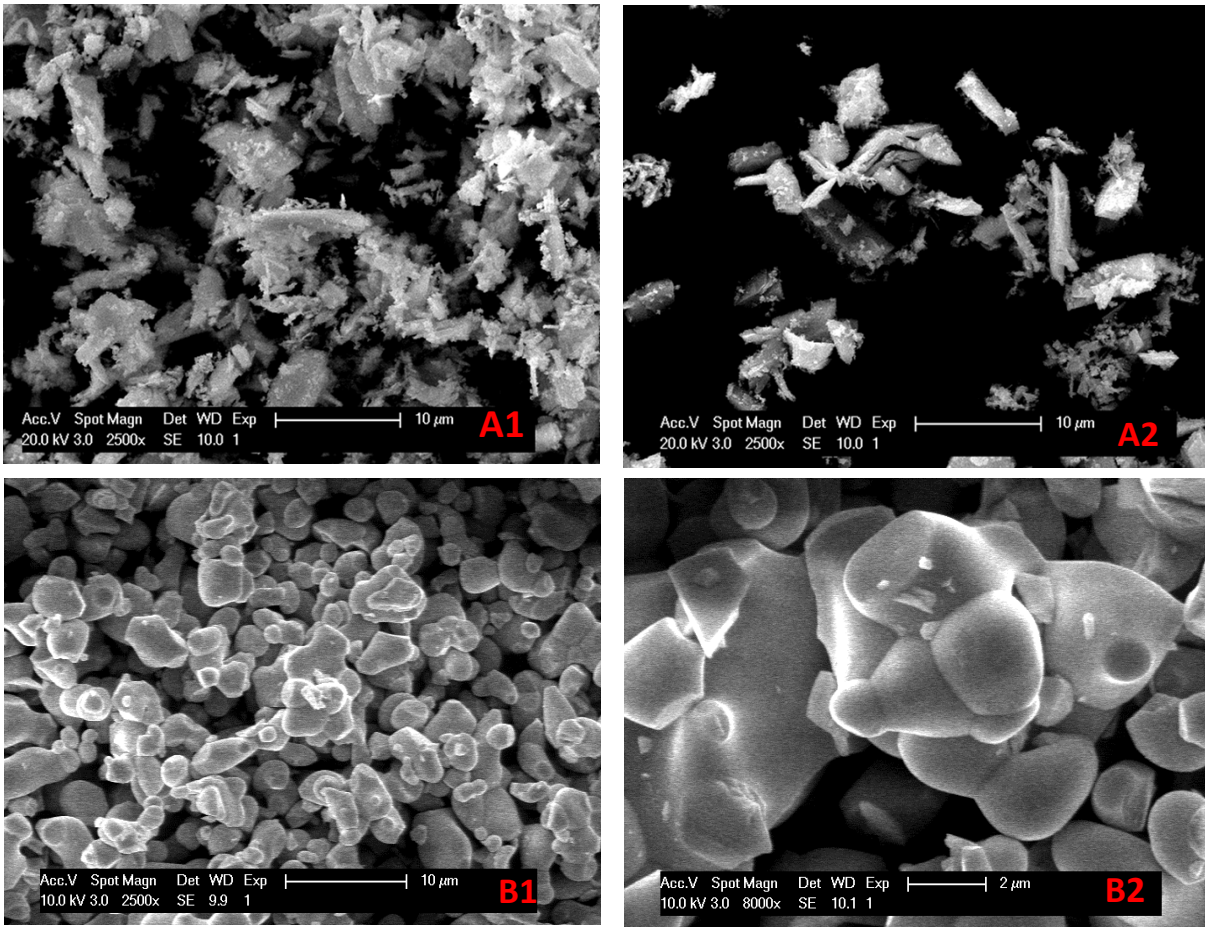

Figure S1. SEM images of the recycled YOX phosphor (A1, A2) and the purchased YOX phosphor (B1, B2). Image A1, A2 and B1 are magnified 2500× and image B2 is magnified 8000×.

2. Powder X-ray Diffraction (XRD)

Powders of commercial Y_2O_3:Eu^{3+} phosphor (YOX) and recycled YOX were both ground in a pestle mortar and placed into a 0.3 mm diameter glass capillary. The samples were then placed into the center of an Agilent SuperNova X-ray diffractometer using Mo Kα radiation (λ = 0.71073 Å) and a CCD detector. One 240 second exposure was recorded whilst rotating the sample about the φ axis giving the powder diffraction up to 1.0 Å (2θ = 40° for Mo Kα radiation). The recorded powder patterns for commercial YOX and recycled YOX were essentially identical (Figure S2), confirming the successful synthesis of YOX.

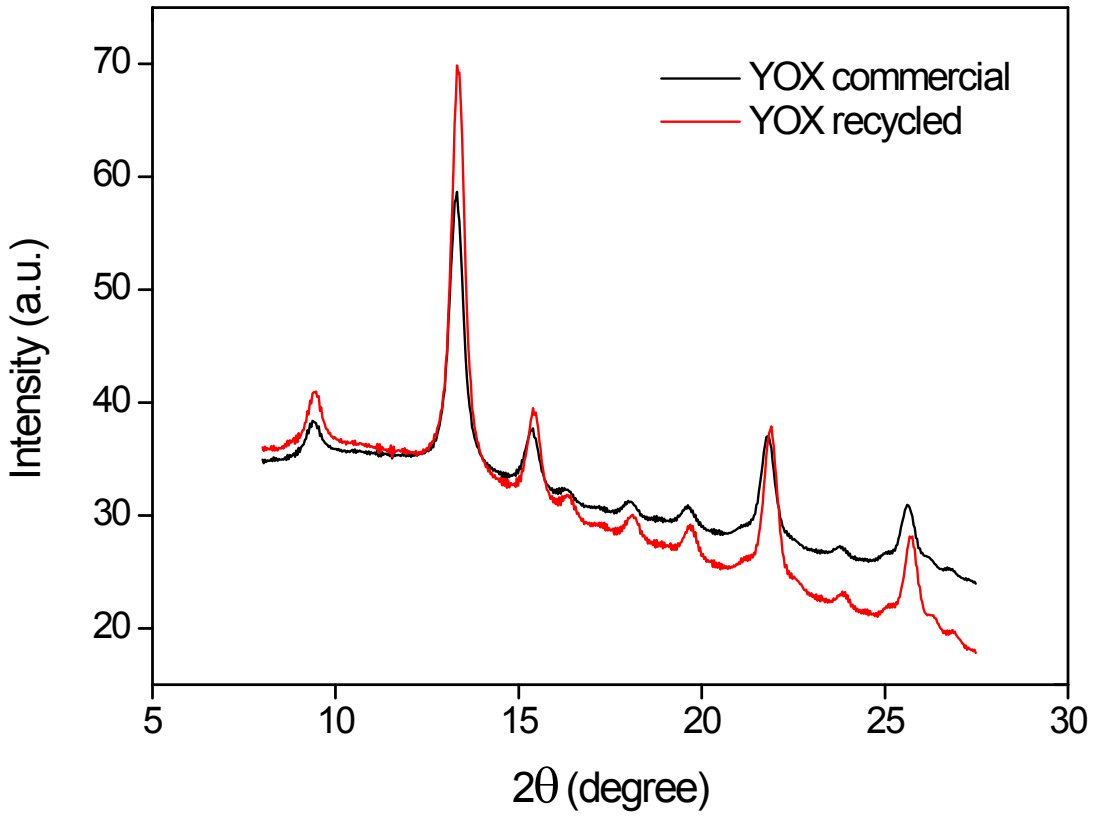

Figure S2. Powder XRD patterns of the commercial YOX and recycled YOX, collected with Mo Kα radiation (λ = 0.71073 Å).

3. Luminescence lifetime

Luminescence lifetimes were recorded using an Edinburgh Instruments FS920 spectrofluorimeter. The lifetime of the $^5D_0$ emitting state of Eu^{3+} was determined for the recycled phosphor and the commercial phosphor. The samples were excited with 254 nm light using a microsecond xenon flashlamp, while the emission light was collected at 612 nm. The resulting curves (Figure S3) were fitting with as a mono-exponential decay in order to determine the lifetime of the recycled phosphor (0.989 ms, $R^2 = 0.998$) and the commercial phosphor (1.003 ms, $R^2 = 0.997$).

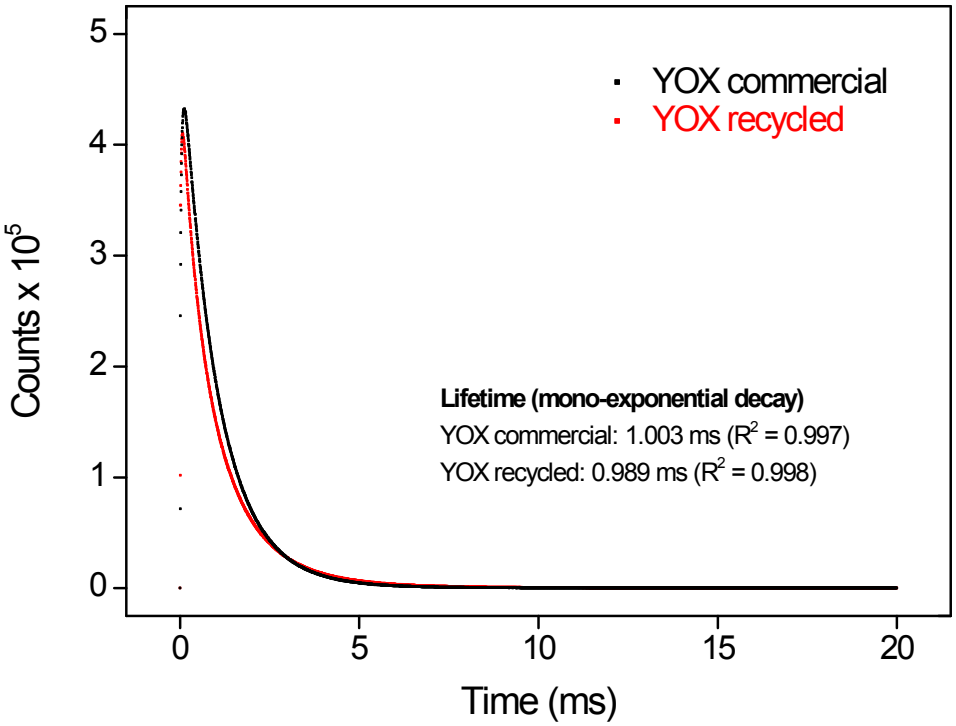

Figure S3. Decay of the $^5D_0$ emitting state of Eu^{3+} in commercial YOX and recycled YOX. The lifetimes (ms) were calculated based on a mono-exponential decay fit.