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Supplementary Information

Eu^{2+} Luminescence in Strontium Aluminates

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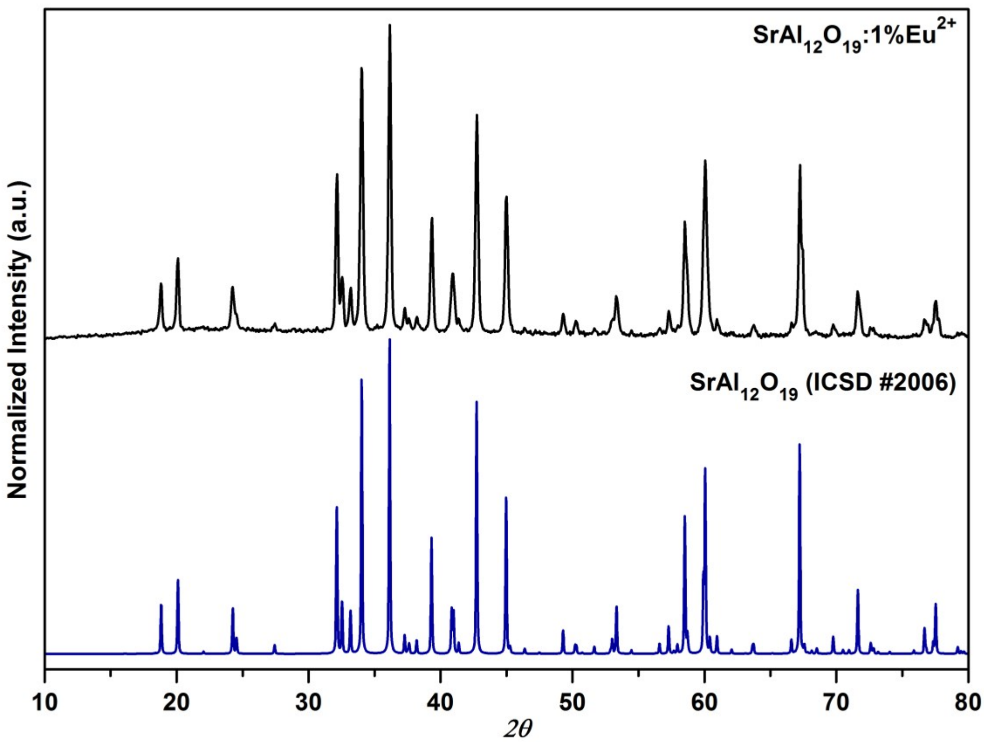
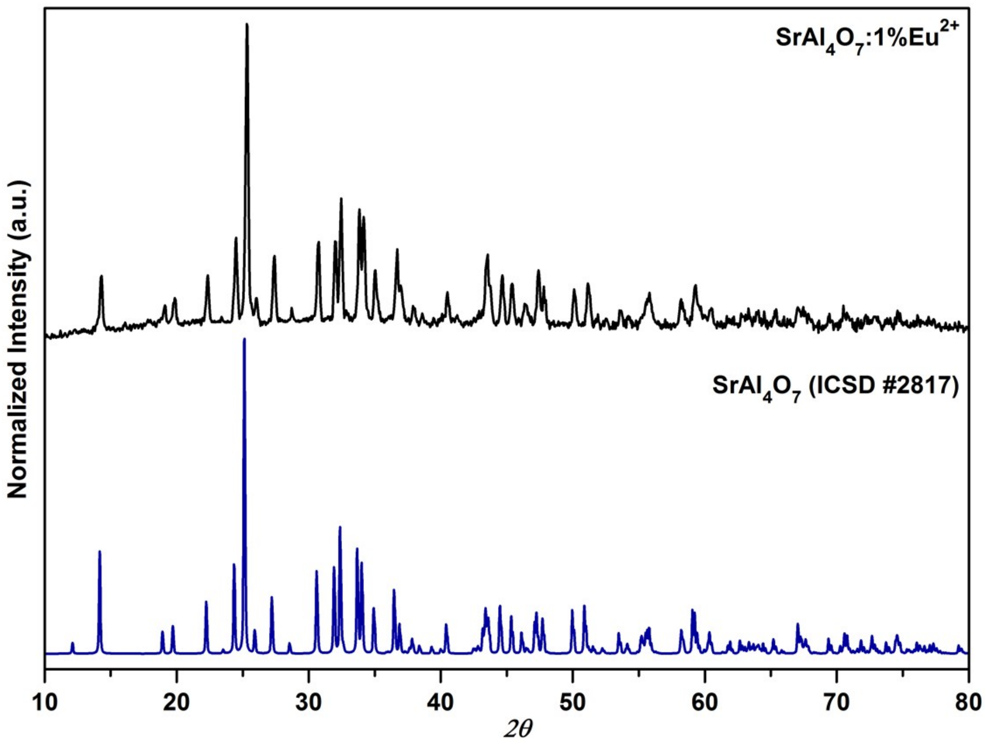
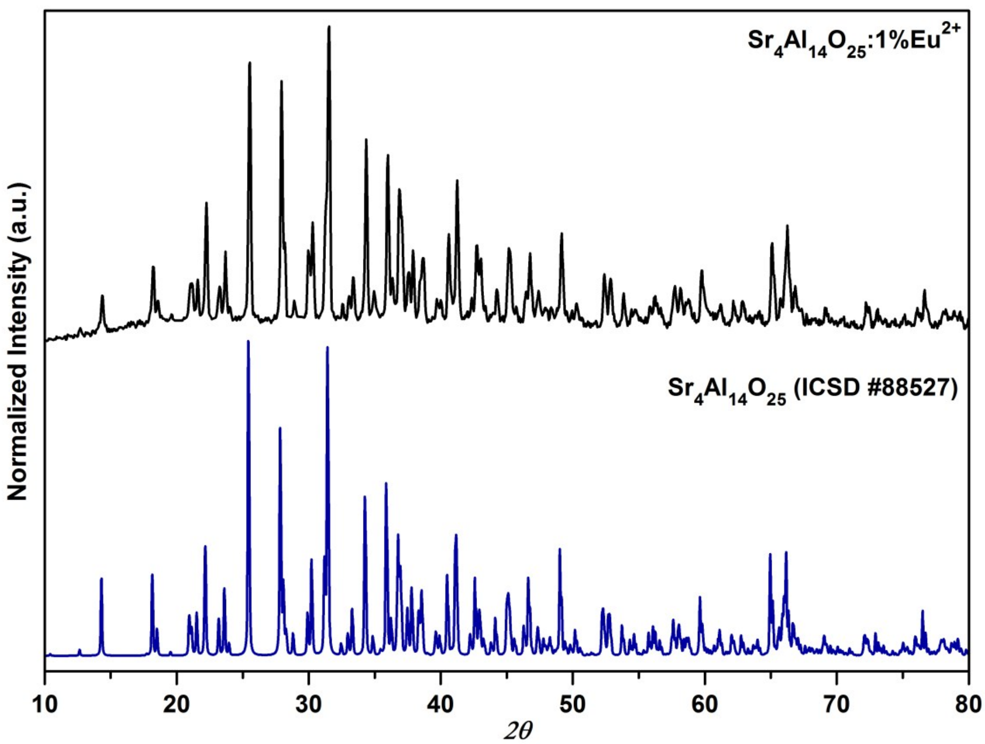
S1 – XRD analysis

X-ray diffraction patterns were recorded to analyze the phase purity of the various crystalline aluminates. In Figure S1 the X-ray diffraction patterns are shown for all aluminates, together with the reference patterns from the ICDS data base ($SrAl_{12}O_{19}$ (ICSD #2006), $SrAl_4O_7$ (ICSD #2817), $Sr_4Al_{14}O_{25}$ (ICSD #88527), $SrAl_2O_4$ (ICSD #26466) and $Sr_3Al_2O_6$ (ICSD #71860). The close agreement between the references and the recorded XRD shows that the materials are single phase (no second crystalline phase present within the detection limit of ~1%).

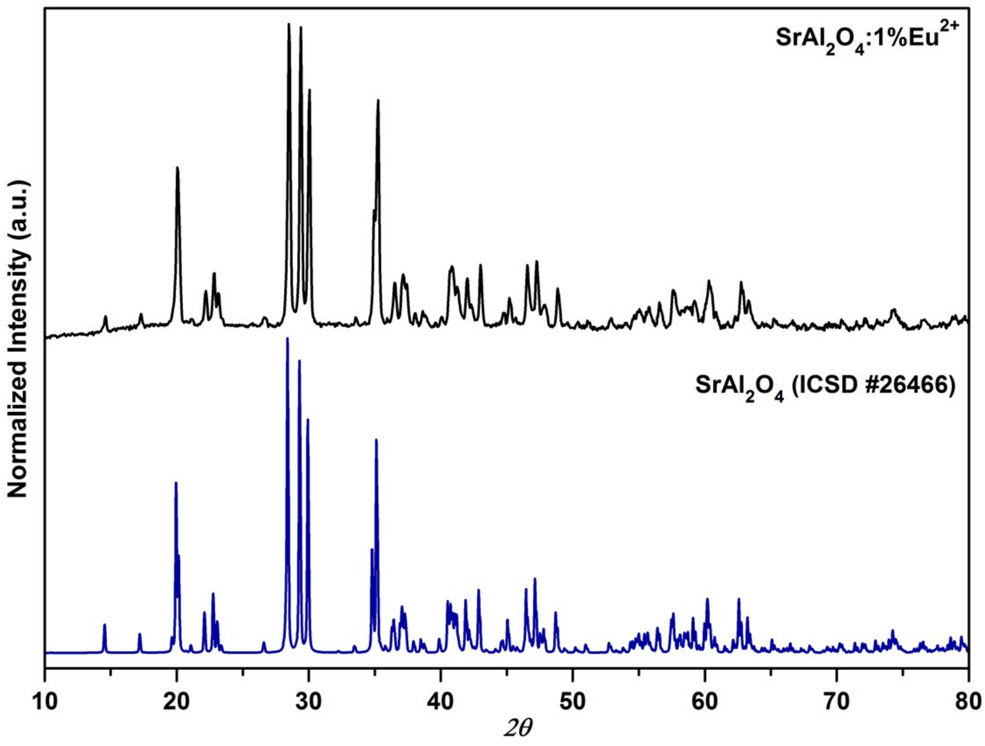




$SrAl_4O_7$:1%Eu^{2+}
$SrAl_4O_7$ (ICSD #2817)
Normalized Intensity (a.u.)
10
20
30
40
50
60
70
80
2θ



$Sr_4Al_{14}O_{25}$:1%Eu^{2+}
$Sr_4Al_{14}O_{25}$ (ICSD #88527)
Normalized Intensity (a.u.)
10
20
30
40
50
60
70
80
2θ



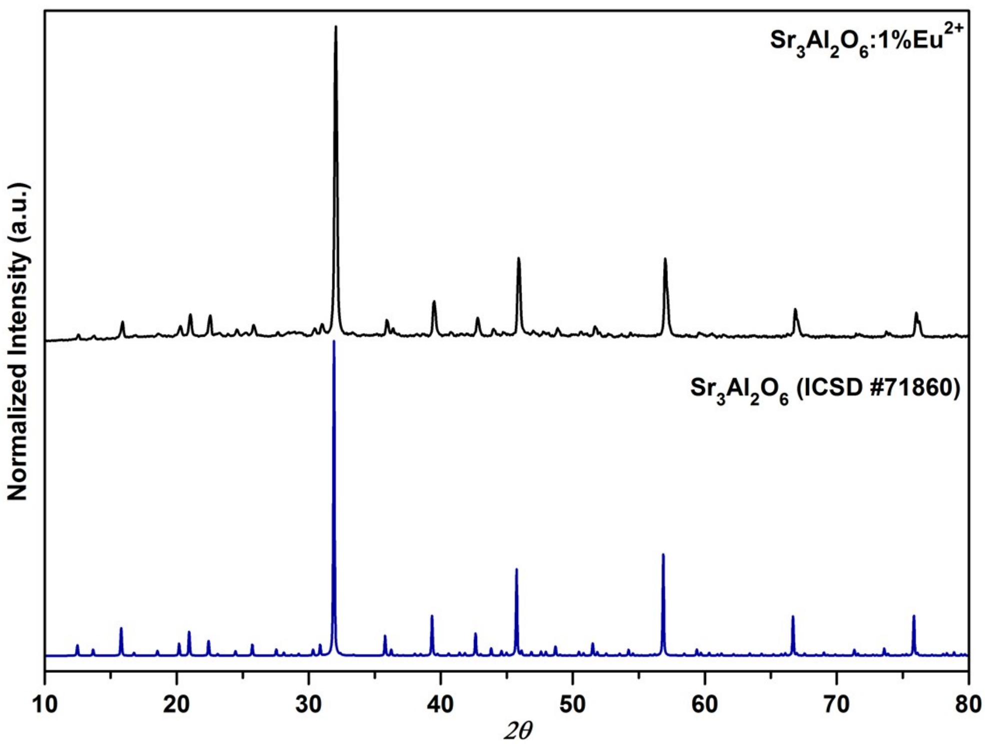
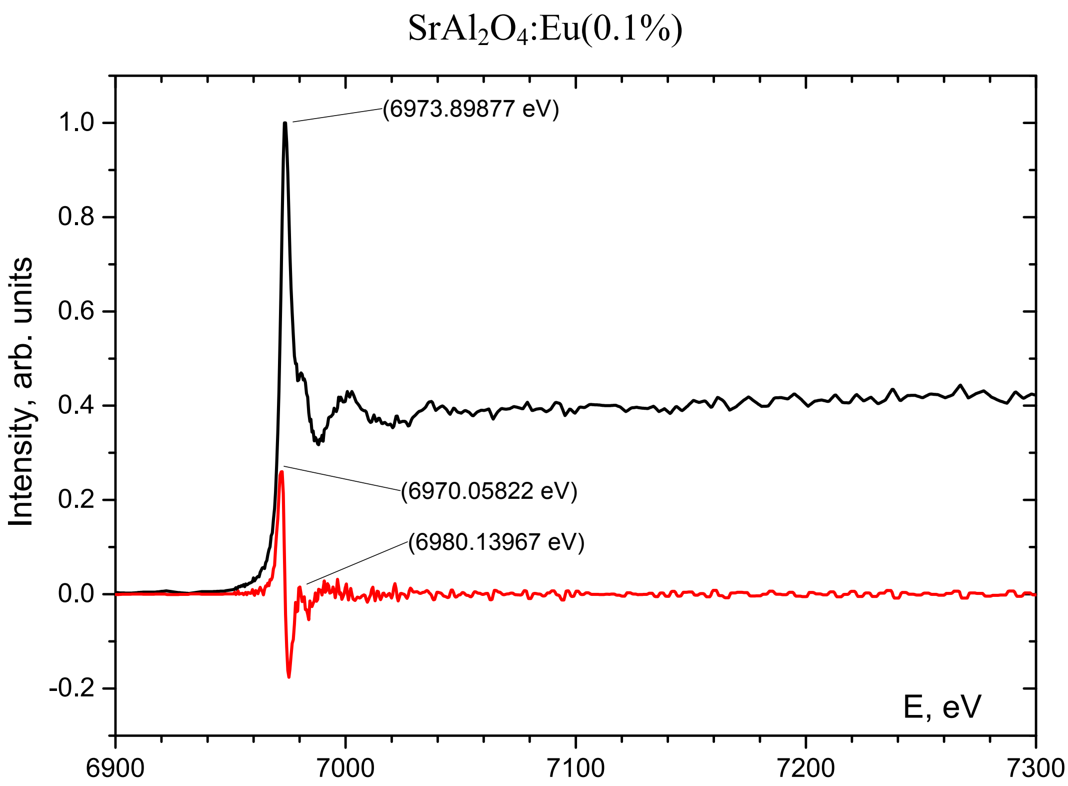


Figure S1 - The powder XRD patterns of $SrAl_{12}O_{19}$:1%Eu, $SrAl_4O_7$:1%Eu, $Sr_4Al_{14}O_{25}$:1%Eu, $SrAl_2O_4$:1%Eu and of $Sr_3Al_2O_6$:1%Eu together with ICSD reference patterns (ICSD numbers and compositions are indicated in the figure).

S2 – XANES analysis of the valence of Eu

The technique X-ray Absorption Near Edge fine Structure (XANES) is a powerful tool to discriminate between different valence states of elements. Small shifts occur in the electron binding energies of core electrons for the same element in different valence states and this allows for the detection of the valence state of elements. X-ray absorption near-edge structure (XANES) spectroscopic measurements at the Eu LIII edge were performed at beamline 20BM (PNC/XSD) at the Advanced Photon Source (APS). We used the L_{III} (or $L_3 2P_{3/2}$) edge of Eu around 6970-6980 eV of Eu. Excitation spectra of the 5857.5 eV x-ray fluorescence (Eu (Lα1) emission) are recorded around this edge for Eu in $Sr_4Al_{14}O_{25}$:0.1%Eu and $SrAl_2O_4$:0.1%Eu. XANES has been applied before to analyze the valence state of Eu in solids and more specifically to determine the presence of Eu^{2+} and Eu^{3+} [s1, s2]. In Figure S2 the XANES spectra are shown. In both spectra a strong peak is observed at 6974 eV (with a sharp peak in the derivative spectrum ~4 eV lower in energy). The peak position of 6974 eV is typical for divalent Eu [s1, s2]. For trivalent Eu a peak some 7 to 8 eV higher is energy is expected (with a similar shift for the peak in the first derivative spectrum). Clearly the XANES spectra in Figure S2 confirm that Eu in these aluminates is primarily in the divalent form. The weak shoulder some 8 eV higher in energy may be related to Eu^{3+} although also in the spectra of Eu^{2+} a higher energy shoulder is commonly observed. Based on the analysis of the XANES measurements it is evident that Eu in the aluminates is incorporated mainly as Eu^{2+}



$Sr_4Al_{14}O_{25}$:Eu(0.1%)

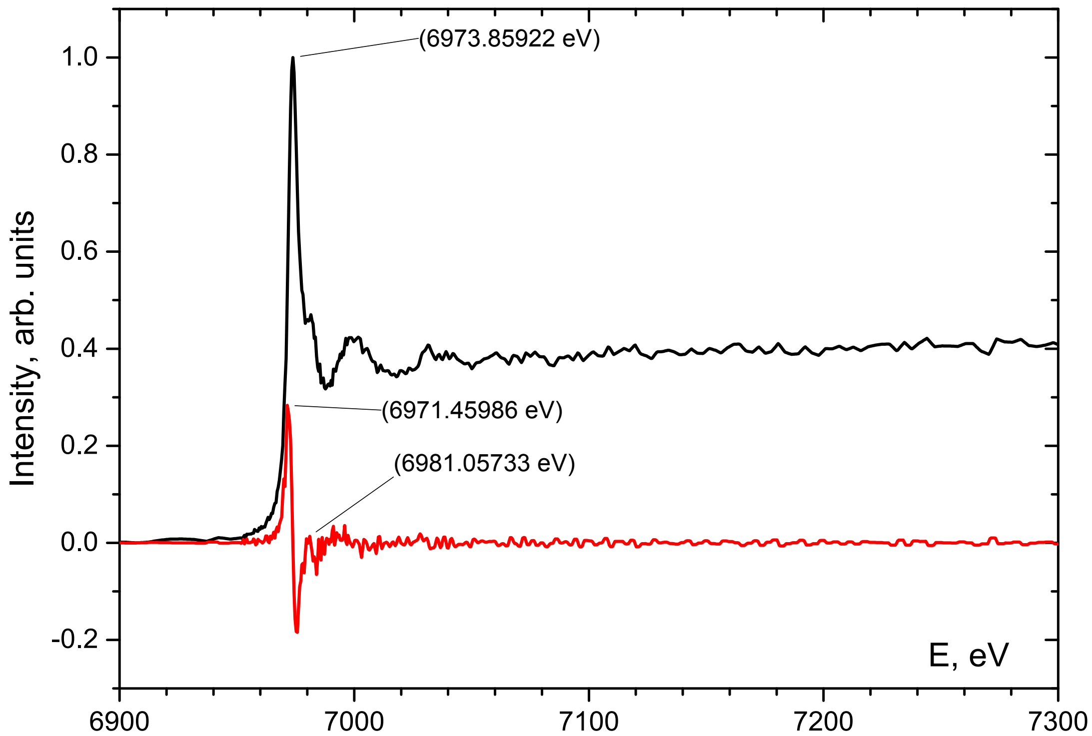


Figure S2 – XANES measurements recorded at 300 K for the L_{III} (or $L_32P_{3/2}$) edge of Eu between 6900 and 7300 eV. Excitation spectra in this energy region were recorded for the 5857.5 eV x-ray fluorescence (Eu (Lα1) emission) for Eu in $SrAl_2O_4$:0.1%Eu (top) and $Sr_4Al_{14}O_{25}$:0.1%Eu (bottom).

References

S1 M. Lastusaari, H. F. Brito, S. Carlson, J. Hölsä, T. Laamanen, L.C.V. Rodrigues, E. Welter, *Phys. Scr.*, 2014, **89**, 044004

S2 N. Avci, K. Korthout, M.A. Newton, P. F. Smet, D. Poelman, *Opt. Mat. Express*, 2012, **2**, 321.