Supporting information

Cation Exchange in Lanthanide Fluoride Nanoparticles

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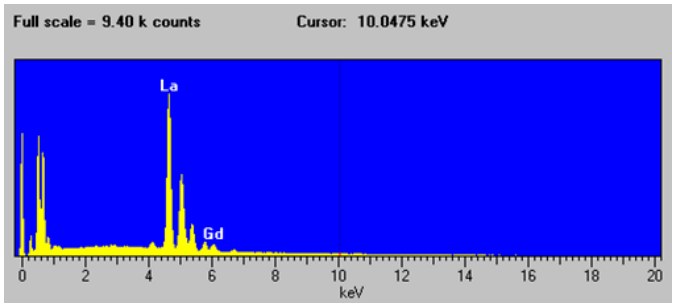
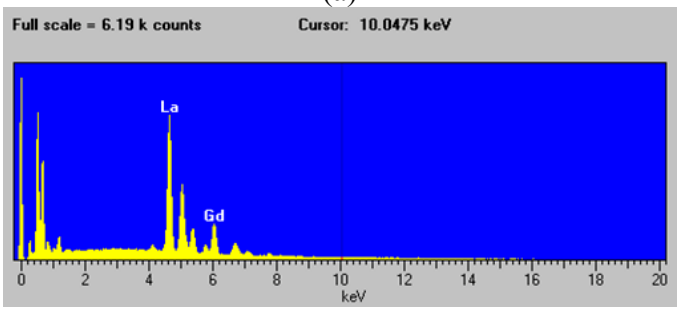
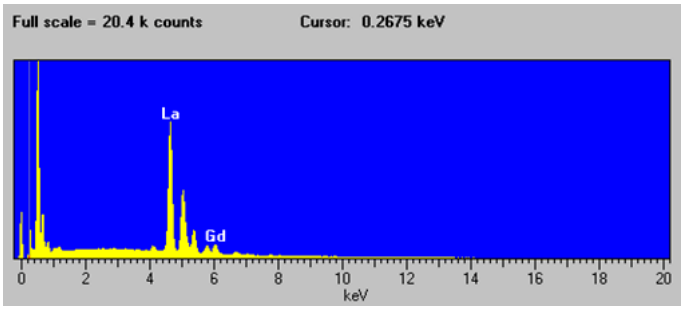


(a)

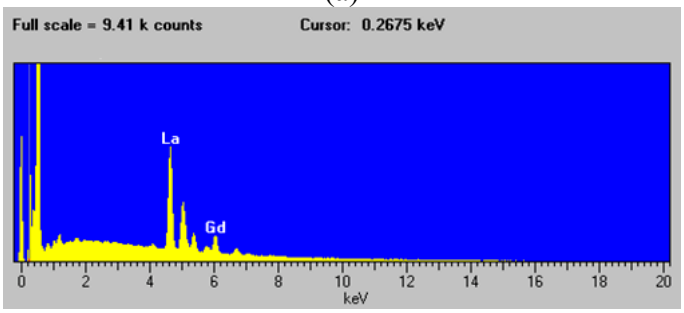


(b)

Figure S1. EDX spectra of nanoparticles made (a) by exposing GdF_3 nanoparticles to La^{3+} and (b) by exposing LaF_3 to Gd^{3+}.



(a)



(b)

Figure S2. EDX spectra of nanoparticles made (a) by exposing GdF_3 nanoparticles to La^{3+} and (b) by exposing LaF_3 to Gd^{3+}.

Calculation of solubility product[1]

For the reaction

$$M_mA_n(s) \rightleftharpoons mM^+(aq) + nA^-(aq)$$

Where M_mA_n is the slightly soluble substance and M^+ and A^- are the dissociated ions, then the Gibbs energy change is

$$\Delta G^0 = m\,\Delta_fG^0\,(M^+, aq) + n\,\Delta_fG^0\,(A^-, aq) - \Delta_fG^0\,(M_mA_n, s)$$

Where Δ_fG^0 (M^+, aq) is the free energy of formation of M^+ ion, Δ_fG^0 (A^-, aq) the free energy of formation of A^- ion and Δ_fG^0 (M_mA_n, s) the free energy of formation of M_mA_n.

The solubility product was calculated from:

$$\ln K_{sp} = -\,\Delta G^0/RT$$

where R is the gas constant and T is temperature in Kelvin.

The calculated K_{sp} and the data used are tabulated in Table S1.

Table S1. Data from literature[1-3] and the calculated solubility product K_{sp} (unit: kJ/mol)

	Δ_fG^0 (M^+, aq)	Δ_fG^0 (A^-, aq)	Δ_fG^0 (M_mA_n, s)	ΔG^0	Calculated K_{sp}
YF_3	-693.8	-278.8	-1644	113.8	1.16×10^{-20}
ScF_3	-586.6	-278.8	-1554	131	1.09×10^{-23}
LaF_3	-683.7	-278.8	-1625	104.9	4.26×10^{-19}
GdF_3	-661	-278.8	-1624	126.6	4.30×10^{-23}

The calculated K_{sp} of YF_3 and ScF_3 are 1.16×10^{-20} and 1.09×10^{-23}, respectively, which are very close to data from literature (8.62×10^{-21} and 5.81×10^{-24}, respectively[1]).

References

(1) Lide, D. R. *Handbook of Chemistry and Physics*; CRC press: Boca Raton, 1996.

(2) Greis, O.; Haschke, J. M. Handbook on the Physics and Chemistry of Rare Earths; Gschneidner, K. A., Eyring, L., Eds.; Elsevier North-Holland: Amsterdam, 1982; Vol. 5.

(3) Marcus, Y. *Ion Properties*; Marcel Dekker: New York, 1997.