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**Supporting information for article:**

**Crystal Chemistry of Hydrothermally-Grown Ternary Alkali Rare Earth Fluorides**

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**Table S1** Selected interatomic distances ( $\text{\AA}$ ) for  $\text{ARE}_2\text{F}_7$ .

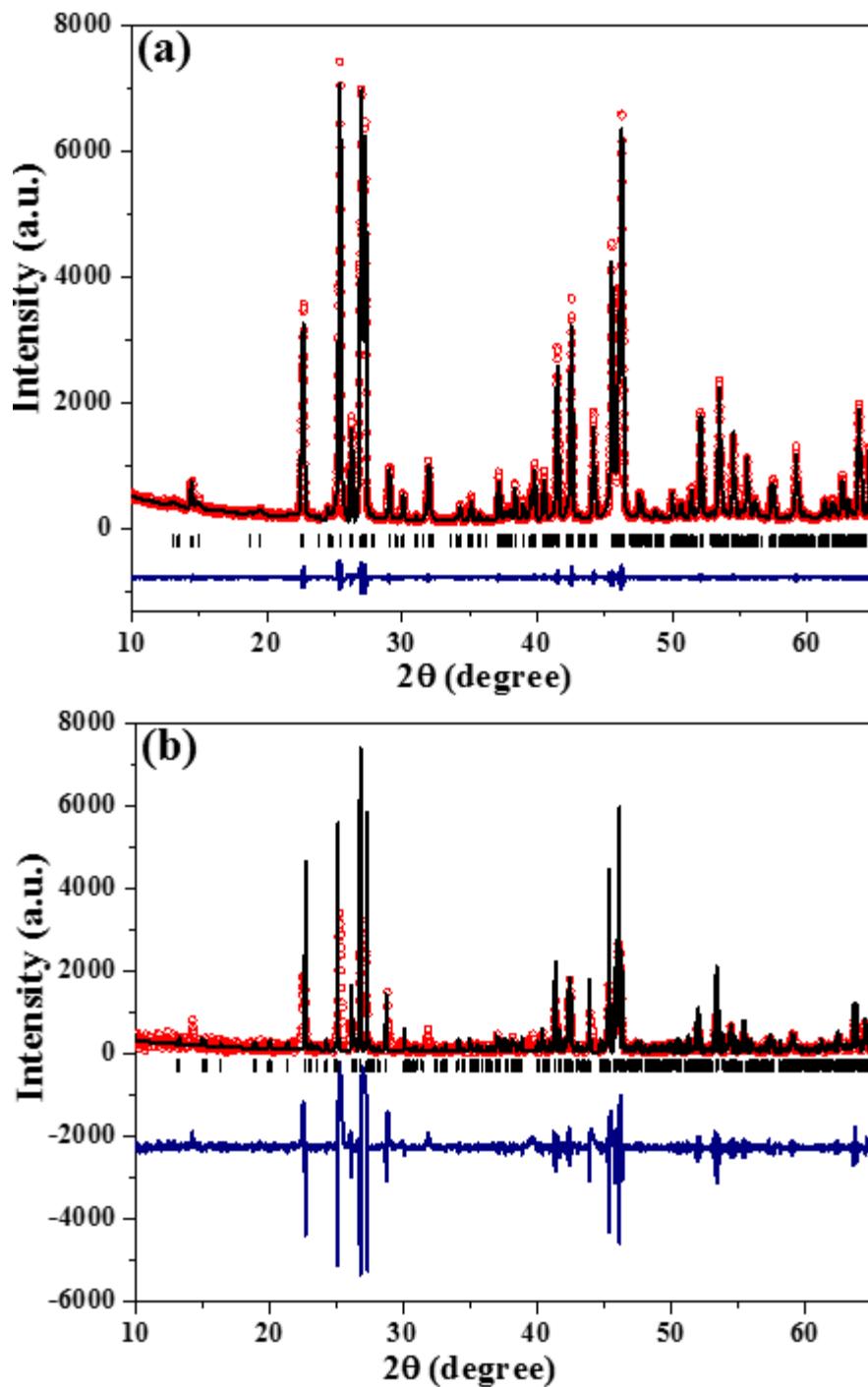
	<b>CsY<sub>2</sub>F<sub>7</sub></b>	<b>RbSm<sub>2</sub>F<sub>7</sub></b>	<b>CsGd<sub>2</sub>F<sub>7</sub></b>
A1 – F4	2.853(4)	2.814(7)	2.880(11)
A1 – F2A	2.933(11)	2.795(14)	2.91(2)
A1 – F6	3.024(4)	2.983(9)	3.037(11)
A1 – F6	3.037(5)	3.018(9)	3.067(11)
A1 – F5	3.051(5)	3.054(8)	3.104(11)
A1 – F7	3.197(5)	3.034(9)	3.182(12)
A1 – F8A	3.235(11)	3.147(17)	3.25(2)
A1 – F8A	3.250(10)	3.252(17)	3.29(2)
A1 – F7	3.270(5)	3.332(9)	3.313(13)
A1 – F3	3.273(10)	3.247(16)	3.34(2)
RE1 – F7 (x2)	2.229(4)	2.272(8)	2.258(13)
RE1 – F6 (x2)	2.232(4)	2.291(8)	2.280(11)
RE1 – F1 (x2)	2.239(5)	2.326(8)	2.331(11)
RE1 – F4 (x2)	2.385(4)	2.427(8)	2.426(11)
RE2 – F8	2.014(10)	1.97(2)	2.02(3)
RE2 – F2	2.116(10)	2.114(15)	2.12(2)
RE2 – F6	2.221(5)	2.308(8)	2.268(10)
RE2 – F5	2.221(4)	2.301(7)	2.260(9)
RE2 – F1	2.249(5)	2.337(8)	2.300(11)
RE2 – F3	2.304(10)	2.379(15)	2.35(2)
RE2 – F4	2.357(4)	2.407(8)	2.391(10)
RE2 – F3	2.365(10)	2.467(15)	2.40(2)
RE2 – F8A	2.373(9)	2.478(14)	2.43(2)
RE2 – F2A	2.378(10)	2.474(13)	2.42(2)
RE2 – F4	2.394(4)	2.438(7)	2.412(11)
RE3 – F8 (x2)	2.130(10)	2.24(2)	2.19(3)
RE3 – F2 (x2)	2.205(10)	2.318(16)	2.29(2)
RE3 – F2A (x2)	2.245(10)	2.352(14)	2.31(2)
RE3 – F7 (x2)	2.248(5)	2.342(8)	2.310(12)
RE3 – F8A (x2)	2.281(9)	2.348(15)	2.32(2)
RE3 – F3 (x2)	2.674(10)	2.594(17)	2.66(2)
RE3 – F1 (x2)	2.787(6)	2.568(9)	2.678(12)

**Table S2** Selected interatomic distances ( $\text{\AA}$ ) for cubic  $\text{ARE}_3\text{F}_{10}$ .

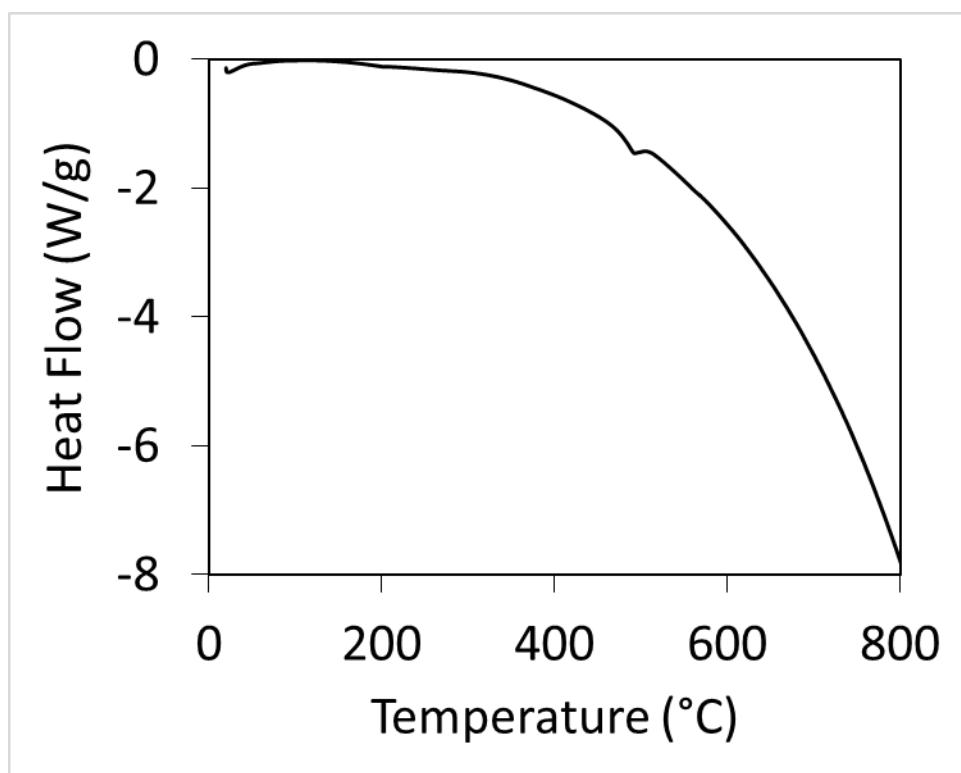
	<b>KY<sub>3</sub>F<sub>10</sub></b>	<b>RbSm<sub>3</sub>F<sub>10</sub></b>
A1 – F1 (x4)	2.758(5)	2.861(13)
A1 – F2 (x8)	3.1957(18)	3.264(6)
RE1 – F2 (x4)	2.1973(12)	2.261(4)
RE1 – F1 (x4)	2.3573(15)	2.425(4)

**Table S3** Selected interatomic distances ( $\text{\AA}$ ) for hexagonal  $\text{ARE}_3\text{F}_{10}$ .

	<b>RbY<sub>3</sub>F<sub>10</sub></b>	<b>RbGd<sub>3</sub>F<sub>10</sub></b>	<b>KLu<sub>3</sub>F<sub>10</sub></b>
A1 – F1	2.817(17)	2.77(3)	2.74(3)
A1 – F3 (x3)	2.838(7)	2.888(15)	2.722(13)
A1 – F5 (x6)	3.192(9)	3.302(18)	3.124(13)
A1 – F6 (x2)	3.199(10)	3.28(2)	3.12(2)
A2 – F4 (x3)	2.787(8)	2.807(16)	2.702(14)
A2 – F5 (x6)	3.205(8)	3.248(19)	3.21(2)
A2 – F6 (x3)	3.216(8)	3.244(16)	3.148(12)
RE1 – F5 (x2)	2.198(10)	2.192(17)	2.197(17)
RE1 – F6 (x2)	2.207(3)	2.252(4)	2.165(3)
RE1 – F3	2.357(8)	2.368(13)	2.298(13)
RE1 – F1	2.363(4)	2.430(8)	2.327(5)
RE1 – F4 (x2)	2.377(4)	2.410(8)	2.328(6)
RE2 – F7 (x2)	2.203(2)	2.249(4)	2.167(3)
RE2 – F5 (x2)	2.204(10)	2.310(18)	2.130(17)
RE2 – F3 (x2)	2.338(4)	2.400(7)	2.327(6)
RE2 – F2	2.346(4)	2.374(5)	2.302(4)
RE2 – F4	2.357(9)	2.424(16)	2.320(13)



**Figure S1** Comparison of powder refinement for hydrothermally-grown  $\text{CsGd}_2\text{F}_7$  in (a) space group *Pnna*, and (b) space group *Pnam* (based on the coordinates for the  $\text{KEr}_2\text{F}_7$  structural model). Red circles indicate the observed powder data, black lines are the calculated patterns, and blue lines are the difference between the experimental and calculated patterns.



**Figure S2** DSC of hexagonal  $\text{RbGd}_3\text{F}_{10}$ . Conversion to cubic  $\text{RbGd}_3\text{F}_{10}$  occurs at 490-500C.