

Supporting Information

Transformation of YF_3 into $\text{Y}(\text{OH})_3$ by a mechanochemical process: Extract yttrium from rare earth smelting slag under mild conditions

Yucheng Liu ^{a, b}, Kaibo Hu ^b, Xiaowen Zhou ^b, Chuanqi Zhang ^b, Fang Gao ^b, Xuewei Li ^{b, c*}, Yinhua Wan ^{b, c*}

a. Faculty of Materials Metallurgy and Chemistry, Jiangxi University of Science and Technology, Ganzhou 341000, P. R. China

b. Ganjiang Innovation Academy, Chinese Academy of Sciences, Ganzhou 341119, P. R. China

c. Jiangxi Province Key Laboratory of Cleaner Production of Rare Earths, Ganzhou 341000, P. R. China

*Corresponding Author: Yinhua Wan, E-mail: yhwan@gia.cas.cn; Xuewei Li, E-mail: xwli@gia.cas.cn.

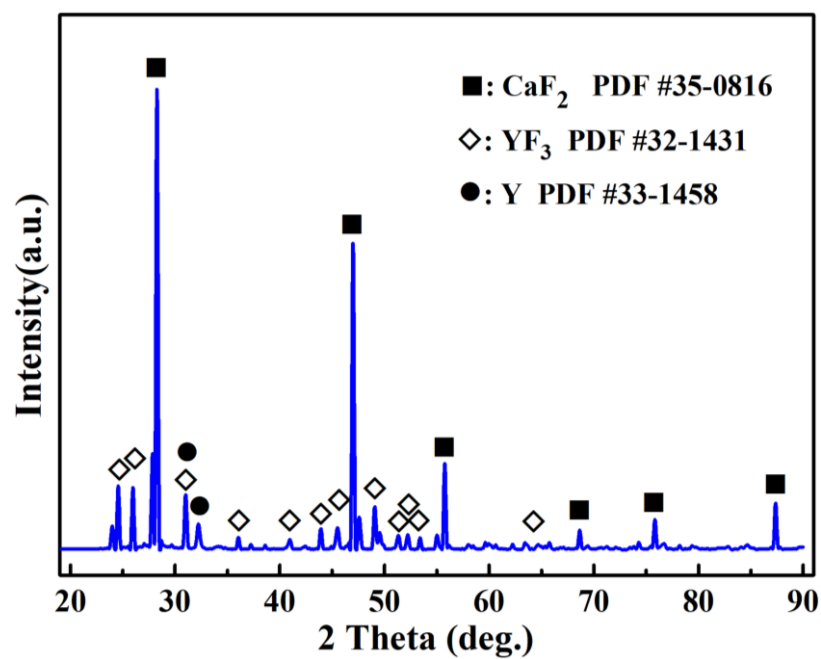
Supporting information includes:

Total number of pages: 9

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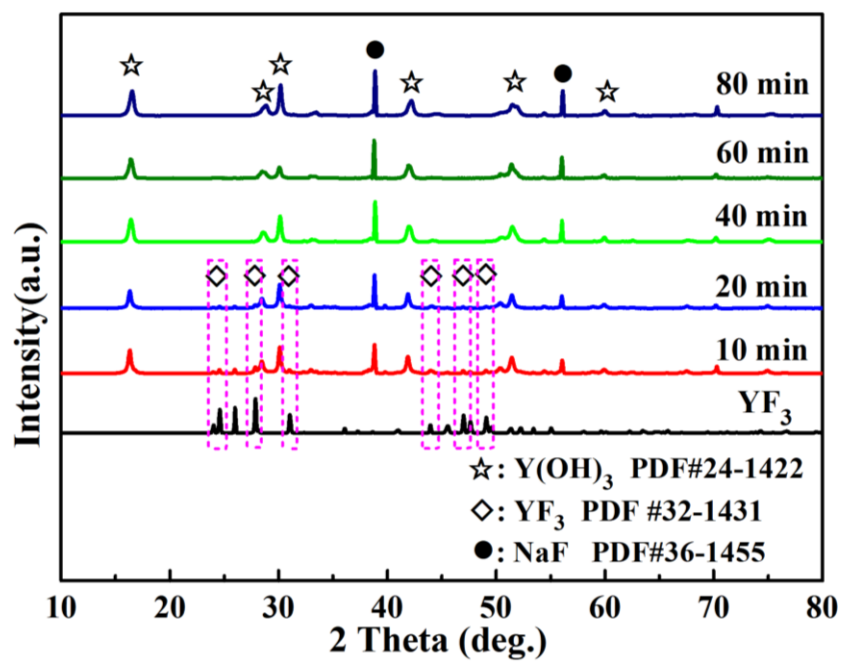
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25 **Figure S1.** XRD pattern of YSS.

26 **Table S1.** Gibbs free energy calculated by HSC software for leaching of YF_3 powder by using
 27 NaOH solution at the temperature of 25°C (298.15 K).

Temperature (K)	$\Delta_r G$ (kJ)	$\Delta_r H$ (kJ)	$\Delta_r S$ (J/K)	K^θ	$\ln(K^\theta)$
298.15	-133.777	-146.546	-42.85	2.82^{23}	54

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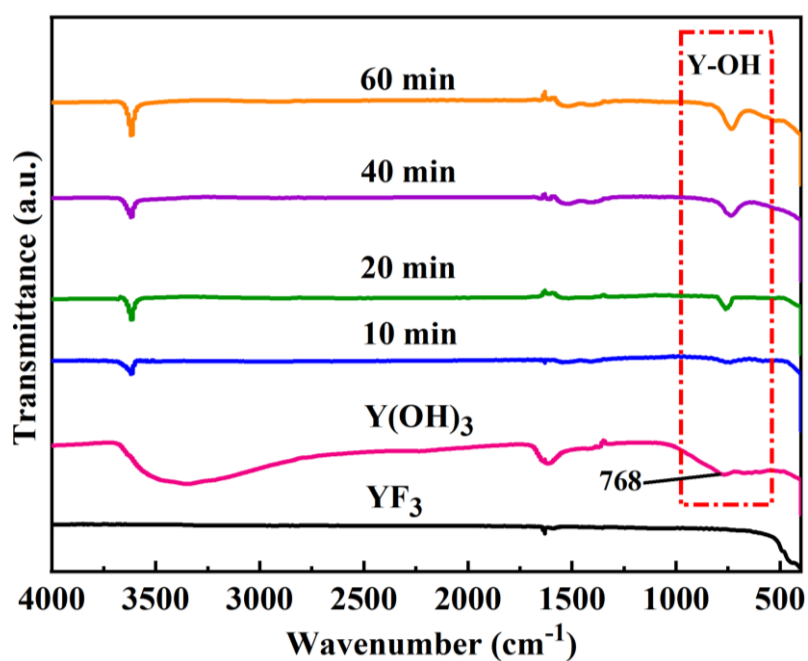
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31 **Figure S2.** The reaction products of NaOH/ YF_3 mixture at different milling times (no water

32 washing)

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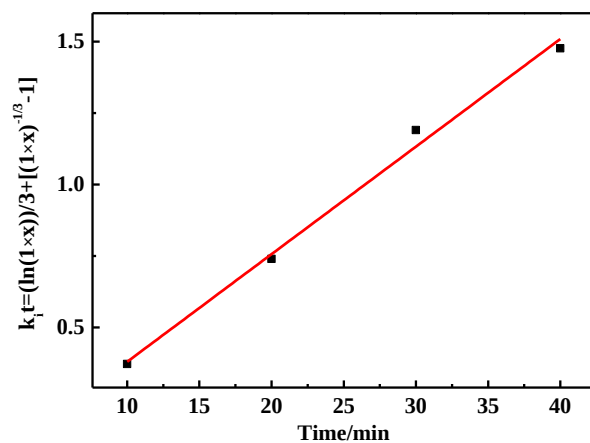
36 **Figure S3.** FT-IR spectra of different samples after mechanochemical reaction under different
 37 milling time (Y/N=1:0.9, L/S=1:1, milling speed of 400 rpm).

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39 **Table S2.** Correlation coefficients (R^2) of the three kinetics models at different leaching time.

Kinetic model	Solid product layer diffusion control model		Chemical reaction control model	
	$k_d t = 1 - 3 \times (1-x)^{2/3} + 2 \times (1-x)$		$k_r t = 1 - (1-x)^{1/3}$	
Leaching time (min)	k_d	R^2	k_r	R^2
	0.00317	0.8912	0.00696	0.9143
Kinetic model	Interfacial transfer and diffusion control model			
	$k_i t = (\ln(1-x))/3 + [(1-x)^{-1/3} - 1]$			
Leaching time (min)	k_i	R^2		
	0.03765	0.99		

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47 **Figure S4.** Relationship between $k_t t = \frac{\ln(1-x)}{3} + [(1-x)^{-1/3} - 1]$ and leaching time.

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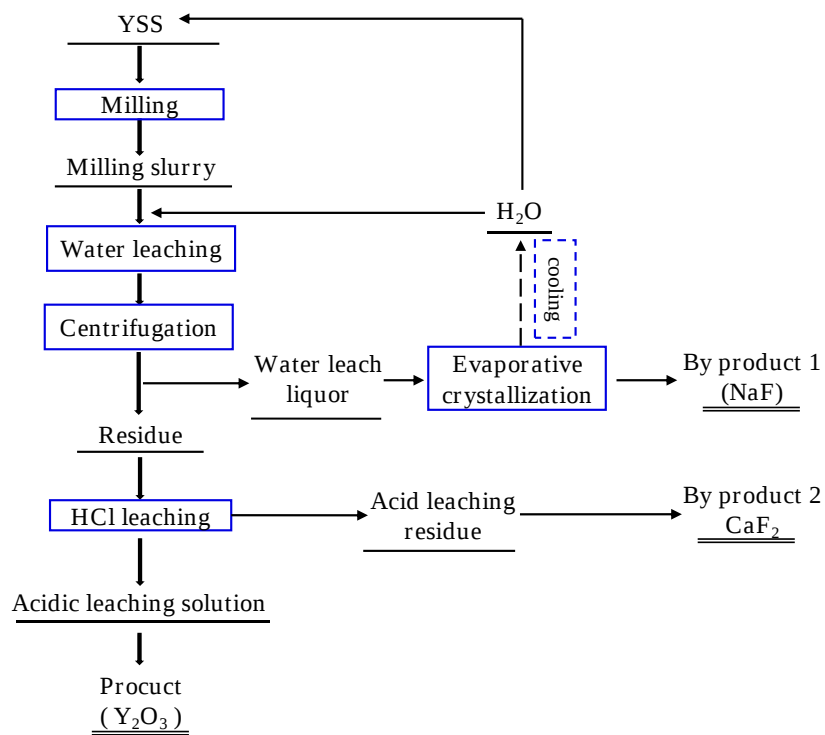


Figure S5. Process for recovering rare earth from YSS.

52 **Table S3.** Raw material cost and product income.

Items	Slag	Electricity	NaOH	HCl	Others	NaF	Y ₂ O ₃	CaF ₂
Amount (unit)	20 (g)	0.42 (kw*h)	6 (g)	25 (ml)	\	3.88 (g)	5.38 (g)	13.5 (g)
Unit-price (unit)	0 (\$/kg)	0.09 (\$/kw*h)	0.70 (\$/kg)	0.14 (\$/L)	\	1.39 (\$/kg)	9.07 (\$/kg)	0.38 (\$/kg)
Purity (wt%)	\	\	>98	36~37	\	99	99	>98
Cost and income calculation (\$)	0	0.0378	0.0034	0.0028	0.005	0.0054	0.0488	0.0051
Total amount (\$)			0.049				0.0593	
Income (\$)				0.0103				

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