Supporting Information

Efficient and stable CF_4 decomposition over θ-Al_2O_3 with extraordinary resistance to HF

Hang Zhang[a], Kang Liu[a,b,c], Yingkang Chen[a], Xiaojian Wang[a], Hongmei Li,[a,d] Junwei Fu[a], Liyuan Chai[b,c], Zhang Lin[b,c], and Min Liu[a]*

[a]Hunan Joint International Research Center for Carbon Dioxide Resource Utilization, School of Physics and Electronics, Central South University, Changsha 410083, Hunan, P.R. China

[b]School of Metallurgy and Environment, Central South University, Changsha 410083, Hunan, P.R. China

[c]Chinese National Engineering Research Center for Control & Treatment of Heavy Metal Pollution, Changsha 410083, Hunan, P.R. China

[d]School of Materials Science and Engineering, Zhengzhou University, Zhengzhou 450002, Henan, P.R. China

*Corresponding author: Prof. Min Liu

Hunan Joint International Research Center for Carbon Dioxide Resource Utilization, School of Physics and Electronics, Central South University, Changsha 410083, Hunan, P.R. China

E-mail: minliu@csu.edu.cn

The Supporting Information includes 9 pages, 2 tables and 6 figures.

Table S1 Kinetic parameters for HF corrosion onto γ-Al_2O_3, θ-Al_2O_3 and α-Al_2O_3

corrode	kinetic model	model parameter				
		k_1 (min^{-1})	$q_{e,calc,1}$ (mg g^{-1})	k_2 (g mg^{-1} min^{-1})	$q_{e,calc,2}$ (mg g^{-1})	R^2
γ-Al_2O_3	Pseudo-first-order model	0.5310	482.32			0.9930
	Pseudo-second-order model			1.34×10^{-3}	503.92	0.9994
θ-Al_2O_3	Pseudo-first-order model	0.0062	391.48			0.9874
	Pseudo-second-order model			1.90×10^{-5}	415.53	0.9876
α-Al_2O_3	Pseudo-first-order model	0.0025	242.62			0.9867
	Pseudo-second-order model			1.30×10^{-5}	265.24	0.9901

Table S2 The stability comparison between γ-Al_2O_3 and θ-Al_2O_3 catalysts in previous literature

catalysts	reaction temperature	initial CF_4 decomposition %	CF_4 decomposition % (20 h)	CF_4 decomposition % (50 h)	CF_4 decomposition % (100 h)	Ref.
θ-Al_2O_3	750 °C	100	100	100	100	This work[a]
γ-Al_2O_3	750 °C	100	64	-	-	18[b]
γ-Al_2O_3	700 °C	48	32	14	-	19[c]
γ-Al_2O_3	750 °C	100	80	40	-	31[b]

a: 0.5% CF_4, 1.0 g catalyst, a gas hourly space velocity of 2,000 h^{-1};
b: 0.7% CF_4, 1.0 g catalyst, a gas hourly space velocity of 2,000 h^{-1};
c: 0.7% CF_4, 1.0 g catalyst, a gas hourly space velocity of 2,000 h^{-1}.

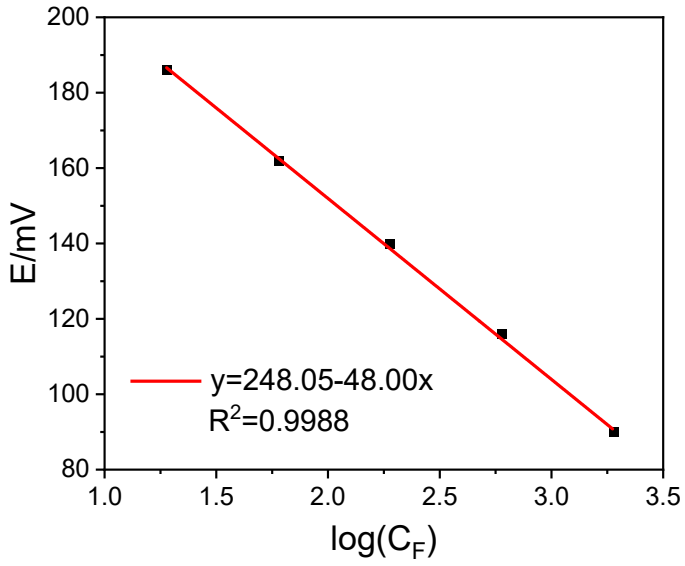

Figure S1. F^- standard curve.

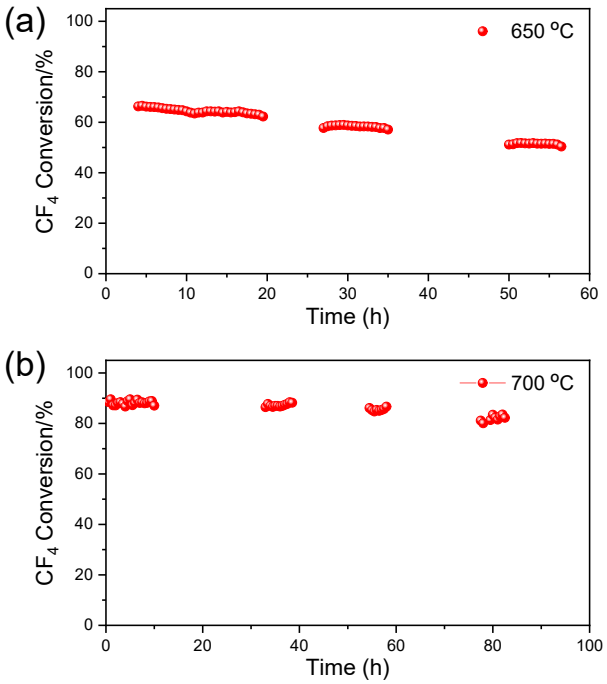

Figure S2. CF_4 decomposition rate % in decomposition reaction as a function of time-on-stream over θ-Al_2O_3 under (a) 650 °C and (b) 700 °C.

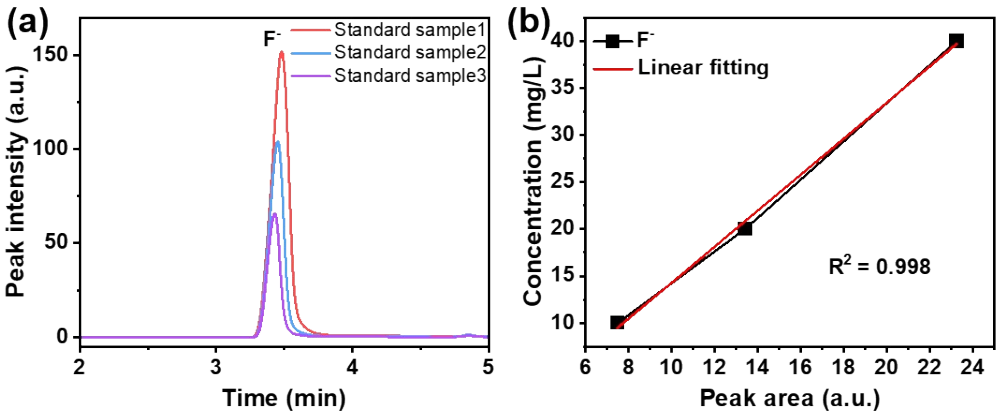

Figure S3. (a) The F content standard curve and (b) linear fitting of F content with peak area.

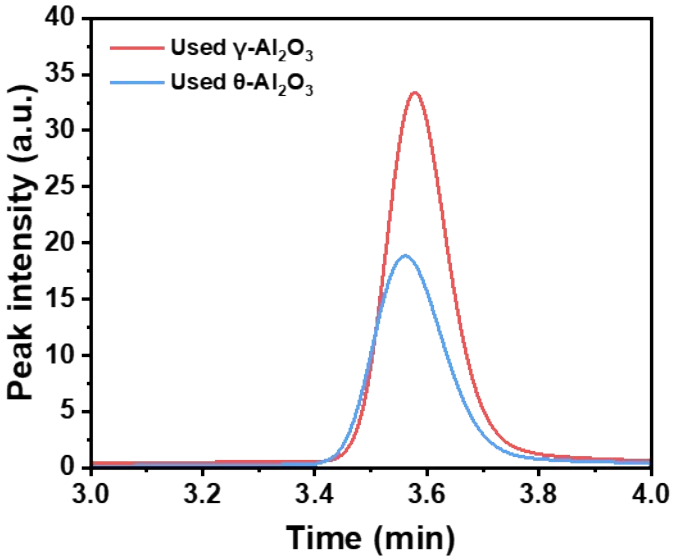

Figure S4. The IC spectra of the used γ-Al_2O_3 and θ-Al_2O_3 sample.

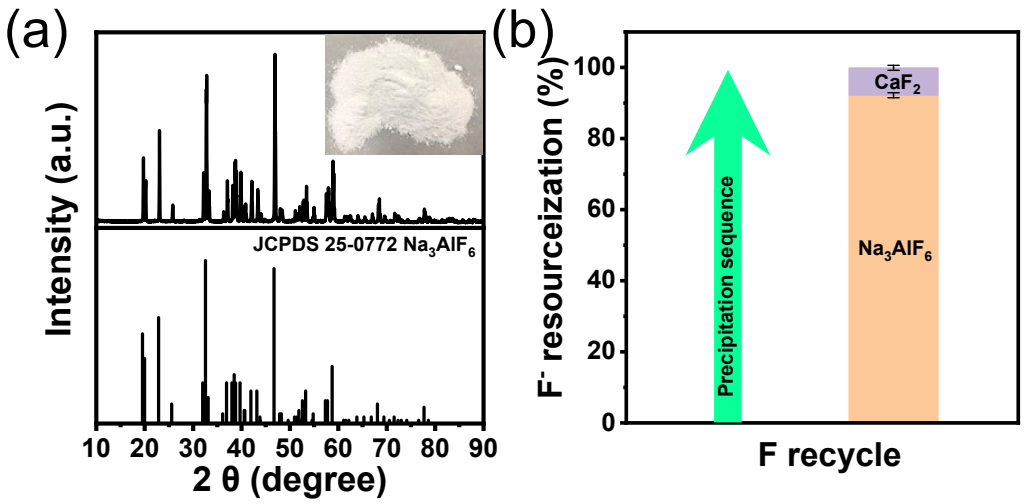

Figure S5. (a) The XRD pattern of the obtained Na_3AlF_6 by recycling F^-. (b) F^- resource utilization rate (%) as Na_3AlF_6 and CaF_2.

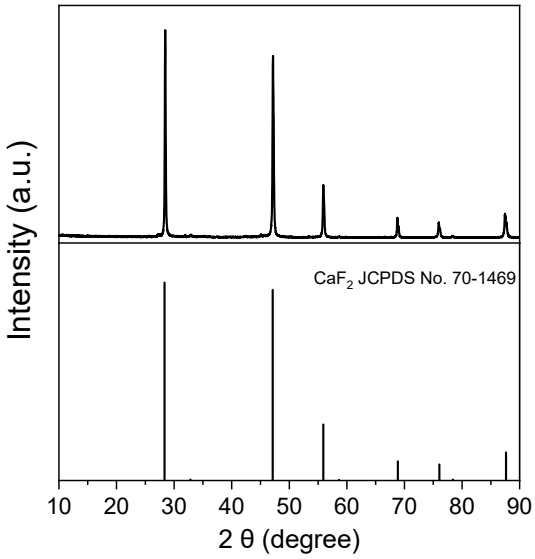

Figure S6. The XRD pattern of CaF_2.

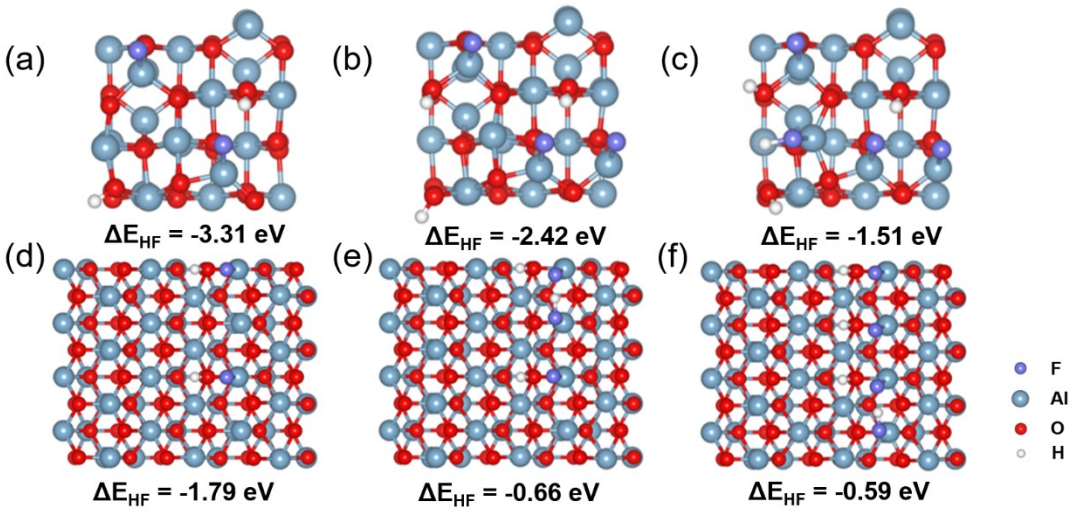

Figure S7. (a-c) two, three and four HF molecules adsorbed the surface of γ-Al_2O_3. (d-f) two, three and four HF molecules adsorbed the surface of θ-Al_2O_3.