

Electronic Supplementary Material

Ni nanoparticles with high thermal stability for methane dry reforming

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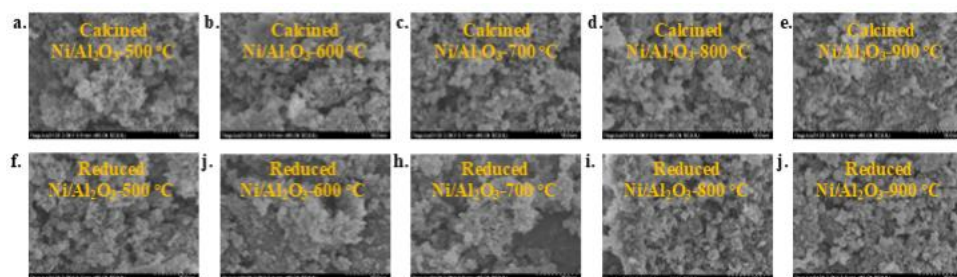


Figure S1. SEM images of (a–e) calcinated and (f–j) reduced of Ni/Al₂O₃ catalysts with different calcination temperatures ranging from 500 °C to 900 °C.

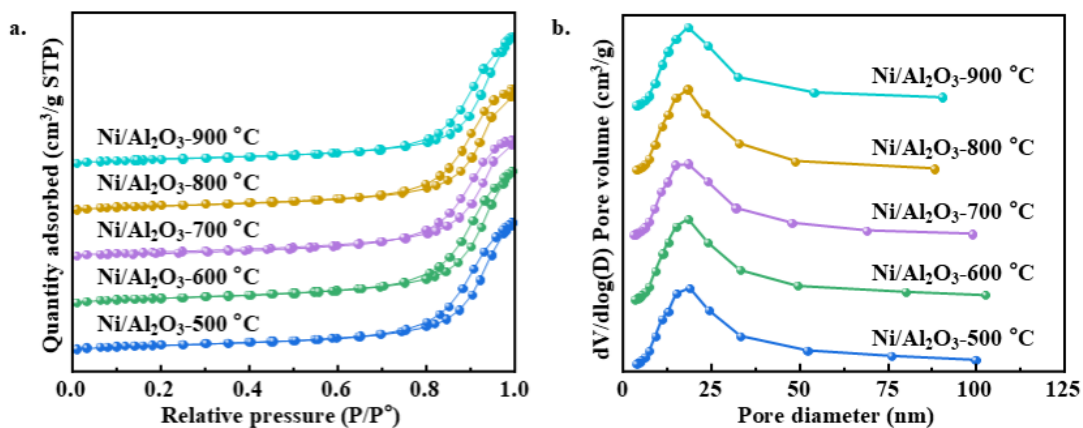


Figure S2. (a) N₂ adsorption-desorption isotherms and (b) pore size distribution curves of Ni/Al₂O₃ catalysts with different calcination temperatures ranging from 500 °C to 900 °C.

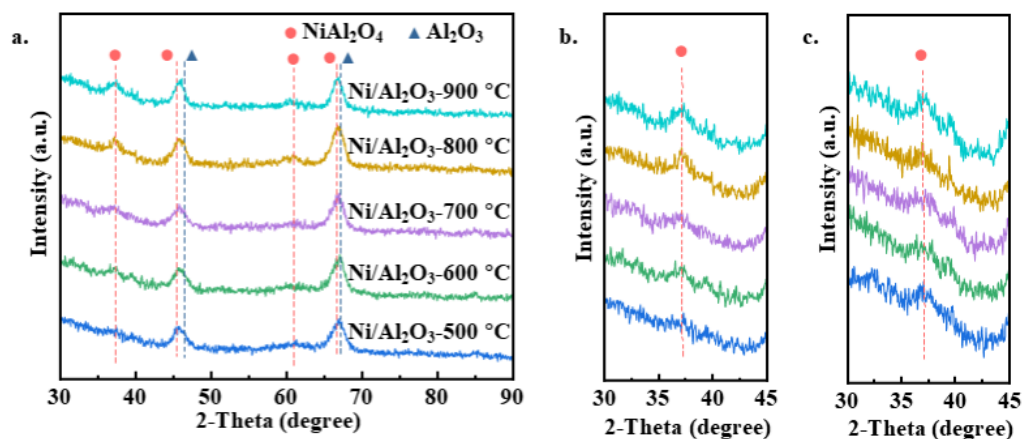


Figure S3. XRD patterns of (a) the Ni/Al₂O₃ catalysts with calcination temperature ranging from 500 °C to 900 °C; enlarged view of the (311) crystal plane of the spinel phase (b) in the calcined Ni/Al₂O₃ Catalysts and (c) in the reduced Ni/Al₂O₃ catalysts.

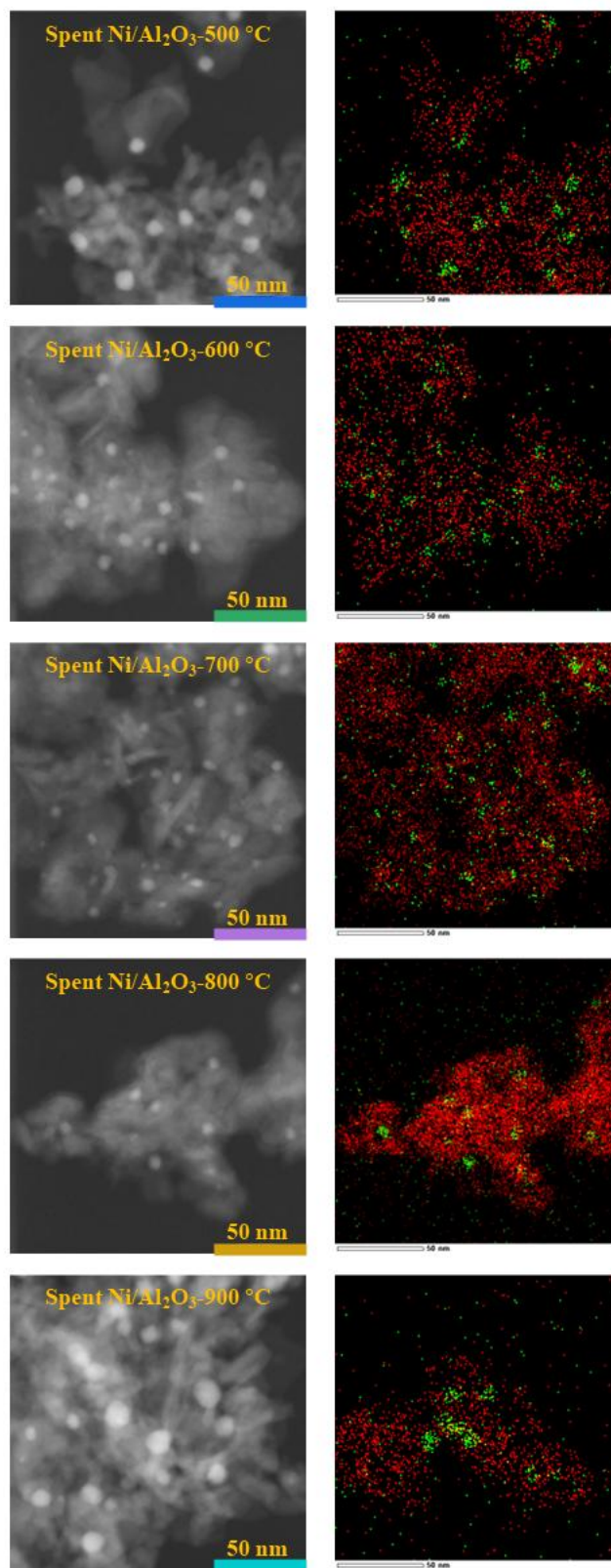


Figure S4. HAADF-STEM images and elemental distribution maps of spent Ni/Al₂O₃ catalysts with different calcination temperature ranging from 500 °C to 900 °C. (Red represents aluminum and green represents nickel.)

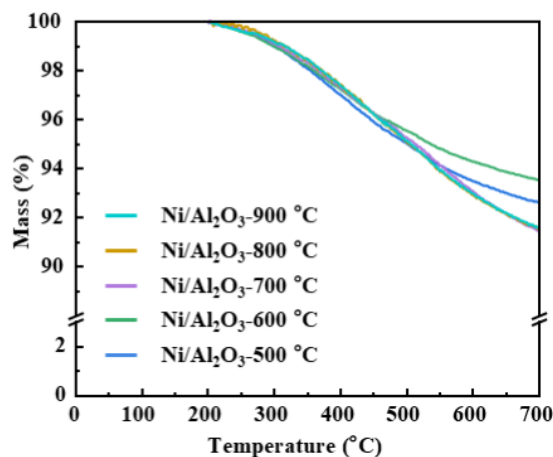


Figure S5. TGA profiles of Ni/Al₂O₃ catalysts with different calcination temperatures ranging from 500 °C to 900 °C.

Table S1. Physical properties of Ni/Al₂O₃ catalysts with different calcination temperatures ranging from 500 °C to 900 °C.

Sample	Specific surface area (m ² /g)	Pore volume (cm ³ /g)	Average pore diameter (nm)
Ni/Al ₂ O ₃ -500 °C	128.49	0.61	18.92
Ni/Al ₂ O ₃ -600 °C	131.73	0.62	18.95
Ni/Al ₂ O ₃ -700 °C	123.11	0.59	19.13
Ni/Al ₂ O ₃ -800 °C	122.45	0.59	19.27
Ni/Al ₂ O ₃ -900 °C	116.48	0.58	20.02

Table S2. The area of different peak for H₂-TPR and XPS analysis

Sample	α peak area ^a (%)	β peak area ^a (%)	γ peak area ^a (%)	Ni ⁰ peak area ^b (%)	Ni ²⁺ peak area ^b (%)
Ni/Al ₂ O ₃ -500 °C	29.18	47.33	23.49	22.35	77.65
Ni/Al ₂ O ₃ -600 °C	5.93	60.65	33.42	21.22	78.78
Ni/Al ₂ O ₃ -700 °C	2.56	74.67	22.77	19.84	80.16
Ni/Al ₂ O ₃ -800 °C	1.97	72.26	25.77	19.09	80.91
Ni/Al ₂ O ₃ -900 °C	3.82	16.67	79.51	17.39	82.61

^a The peak distribution is calculated by deconvoluting the H₂-TPR profiles.

^b The peak distribution is calculated by deconvoluting the XPS spectra.