Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.
This journal is © The Royal Society of Chemistry 2022

Supporting Information

Significantly enhancing solar fuel production rate and catalytic durability for photothermocatalytic CO_2 reduction by a synergetic effect between Pt and Co-doped Al_2O_3 nanosheets

Zhenghai Xie, Yuanzhi Li, Zhiyuan Zhou, Qianqian Hu, Jichun Wu, Shaowen Wu*

State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, 122 Luoshi Road, Wuhan 430070, P. R. China.

Experimental

The thermodynamic maximum η_{max} for the present photothermocatalytic CRM is determined by both solar absorption efficiency and Carnot efficiency in according to the following equation.[46,50]

$$\eta_{max} = [1-\sigma \times T_H^4 / (I_{DNI} \times C)] \times [1-T_L/T_H]$$

Where σ is Stefan–Boltzmann constant, I_{DNI} is the direct normal solar irradiation (1 kWm^{-2}), C is the solar flux concentration ratio, T_L and T_H are the low and high temperatures of the equal Carnot heat engine.

For the photothermocatalytic CRM on Pt/Co-Al_2O_3, C is equal to 343.0. Focused UV-Vis-IR irradiation causes the surface temperature of Pt/Co-Al_2O_3 to be quickly raised to an equilibrium temperature of 666 ℃ (T_H = 939.15 K) from room temperature (T_L = 298.15 K). Thus, η_{max} is calculated to be 59.5%.

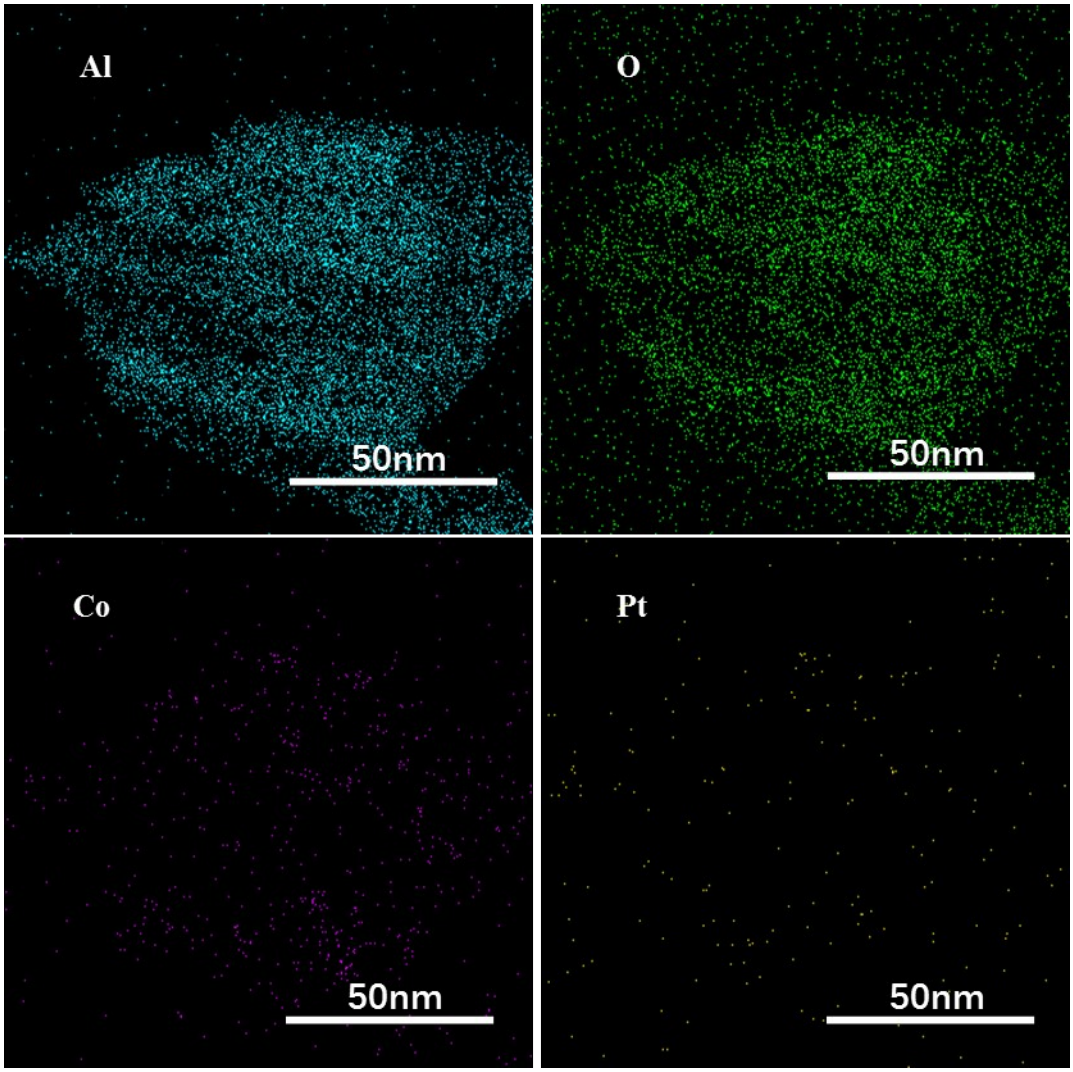

Figure S1. EDS mappings of Al, O, Co, and Pt for Pt/Co-Al_2O_3.

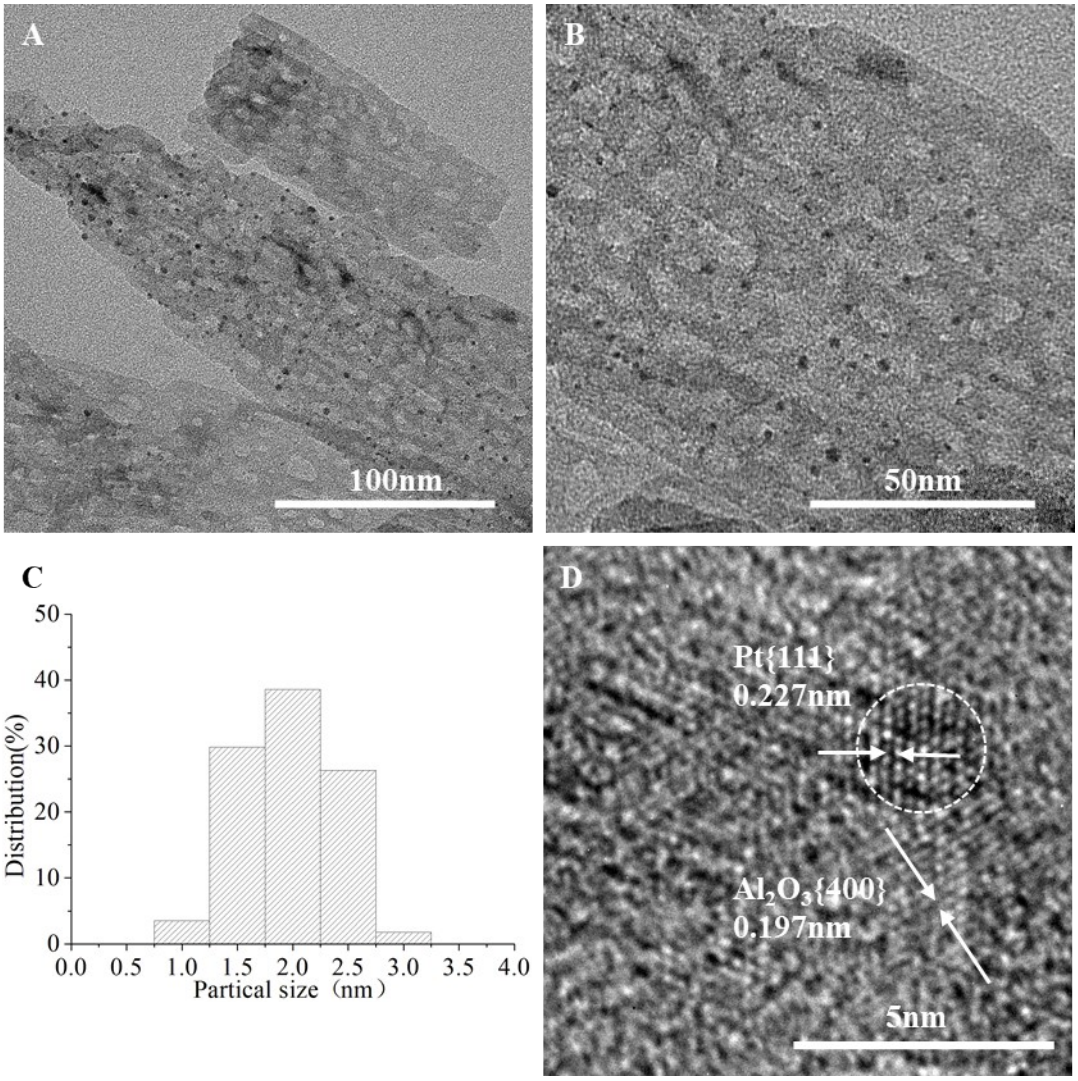

Figure S2. TEM images with lower and higher resolution (A, B), the size distribution of Pt nanoparticles (C), HRTEM image (D) of Pt/Al_2O_3.

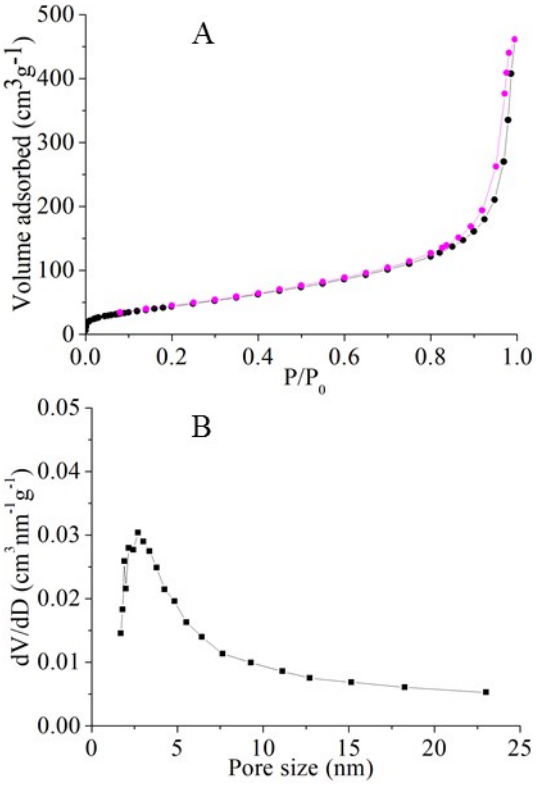

Figure S3. N_2 adsorption-desorption isotherms (A) and BJH adsorption pore size distribution (B) of Pt/Co-Al_2O_3.

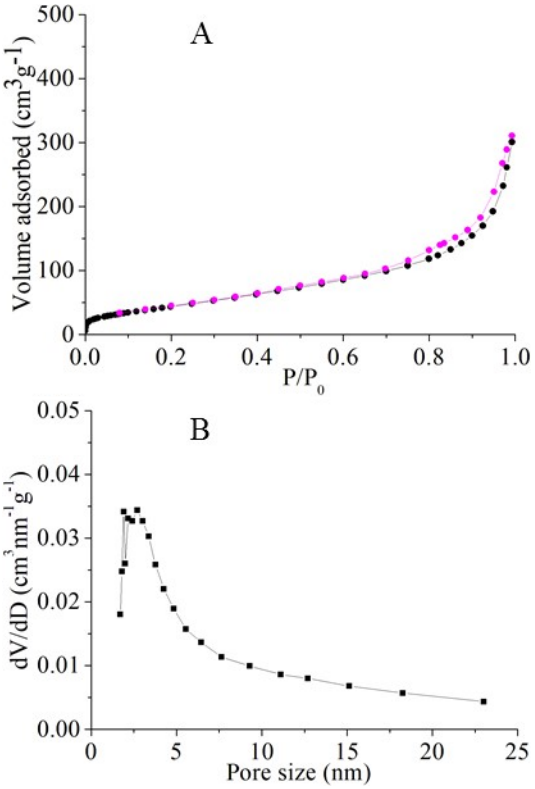

Figure S4. N_2 adsorption-desorption isotherms (A) and BJH adsorption pore size distribution (B) of Pt/Al_2O_3.

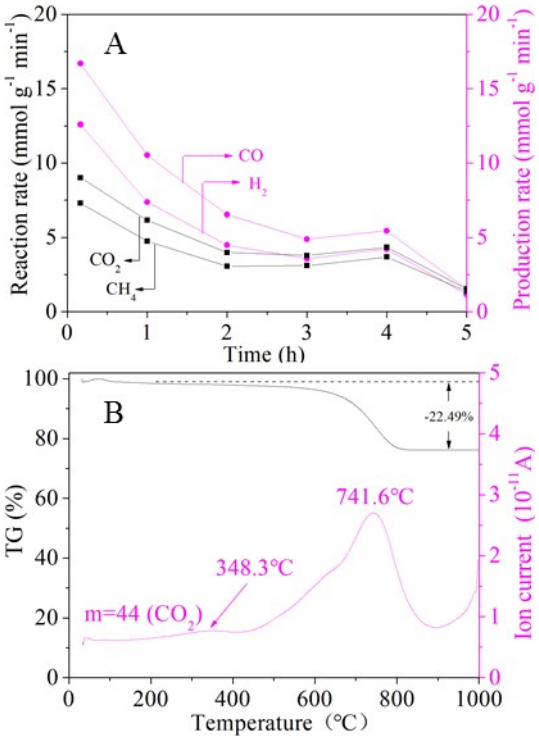

Figure S5. Time course of reaction rates for photothermocatalytic CRM on Pt/Al_2O_3 under focused UV-vis-IR irradiation (A). TG-MS profiles of the used Pt/Al_2O_3 sample after 5 h photothermocatalytic durability test (B).

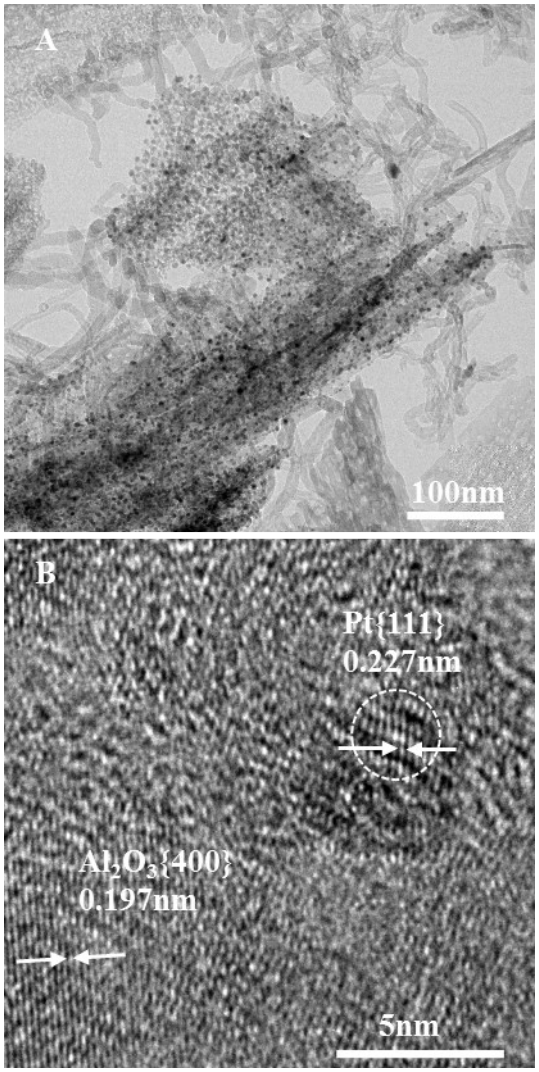

Figure S6. TEM (A) and HRTEM (B) images of the used Pt/Co-Al_2O_3 sample after 50 h photothermocatalytic test.

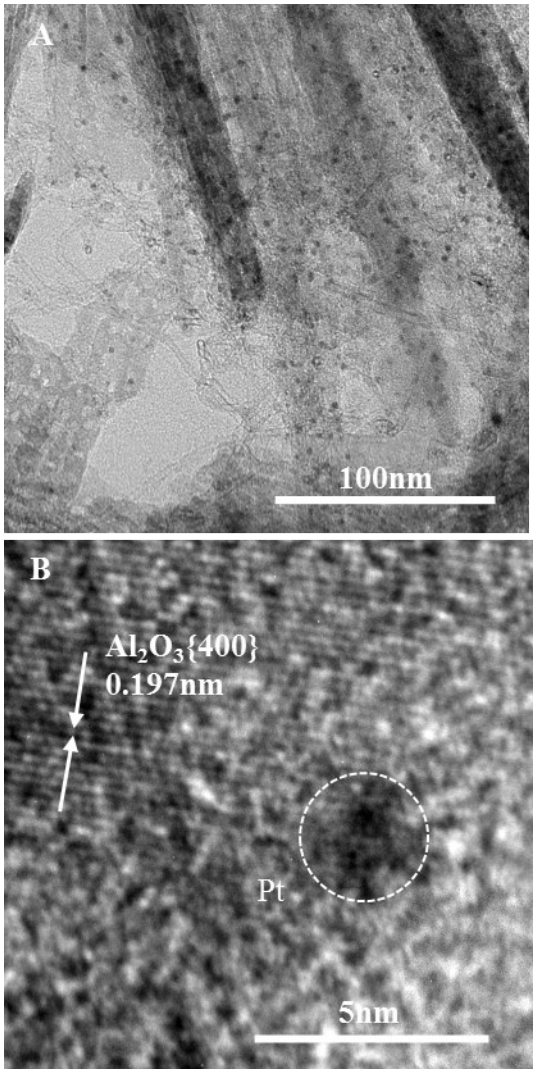

Figure S7. TEM (A) and HRTM (B) images of the used Pt/Al_2O_3 sample after 5 h photothermocatalytic durability test.