Supporting Information

Syngas production at a near-unity H_2/CO ratio from photo-thermo-chemical dry reforming of methane on Pt decorated Al_2O_3 -CeO₂ catalyst

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Figure S1. DRM experimental setup.



Figure S2. Irradiation spectrum of the concentrated solar light applied in the photo-thermal driven DRM testing. AM 1.5G spectrum credit: U.S. National Renewable Energy Laboratory.



Figure S3. Schematic diagram of the *in situ* DRIFTS chamber setup.



Figure S4. Irradiation spectrum of the concentrated solar light exiting the optical fiber applied in the *in situ* DRIFTS testing. AM 1.5G spectrum credit: U.S. National Renewable Energy Laboratory.



Figure S5. (a-b) TEM images of Pt nanoparticles on Pt-Ce, (c) histogram for Pt-Ce; (d-e) TEM images of Pt nanoparticles on Pt-Al-Ce, (f) histogram for Pt-Al-Ce; (g-h) TEM images of Pt nanoparticles on Pt-Al, (i) histogram for Pt-Al.



Figure S6. Energy dispersive X-ray spectroscopy (EDS) analysis on elemental mapping of Pt, Al, and Ce elements on Pt-Al-Ce catalyst.



Figure S7. XRD patterns of spent catalysts (a) Pt-Ce, (b), Pt-Al-Ce, and (c) Pt-Al.



Figure S8. SEM images of fresh catalysts: (a) Pt-Ce, (c) Pt-Al-Ce, and (e) Pt-Al; and spent catalysts after 10 h DRM reaction under concentrated sunlight: (b) Pt-Ce, (d) Pt-Al-Ce, and (f) Pt-Al.



Figure S9. DRM catalytic performance of (a) Ce-Rich-PAC and (b) Al-Rich-PAC under 30-sun concentrated solar irradiation at 700 °C.

Table S1. DRM test results of Pt-Al-Ce at va	varied reaction temperatures.
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Reaction temperature	H_2 production rate (mmol·g ⁻¹ ·h ⁻¹)	CO production rate $(mmol \cdot g^{-1} \cdot h^{-1})$	H ₂ /CO ratio
Under dark conditions			
700 °C	535	587	0.91
650 °C	382	463	0.82
600 °C	222	325	0.68
Under concentrated solar irradiation			
700 °C	657	666	0.99
650 °С	536	574	0.93
600 °C	375	450	0.83



Figure S10. Deconvolution of Ce 3d XPS spectra on spent Pt-Ce and Pt-Al-Ce catalysts after 10 h DRM reaction at 700 °C.



Figure S11. *In situ* DRIFTS spectra of Pt-Al sample recorded in CO₂ atmosphere. (a) Spectra recorded in dark conditions; (b) spectra recorded in light conditions.



Figure S12. *In situ* DRIFTS spectra of Pt-Al sample recorded in CH₄ atmosphere. (a) Spectra recorded in dark conditions; (b) spectra recorded in light conditions.