Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting information

Thermo-photo catalytic CO_2 hydrogenation over Ru/TiO_2

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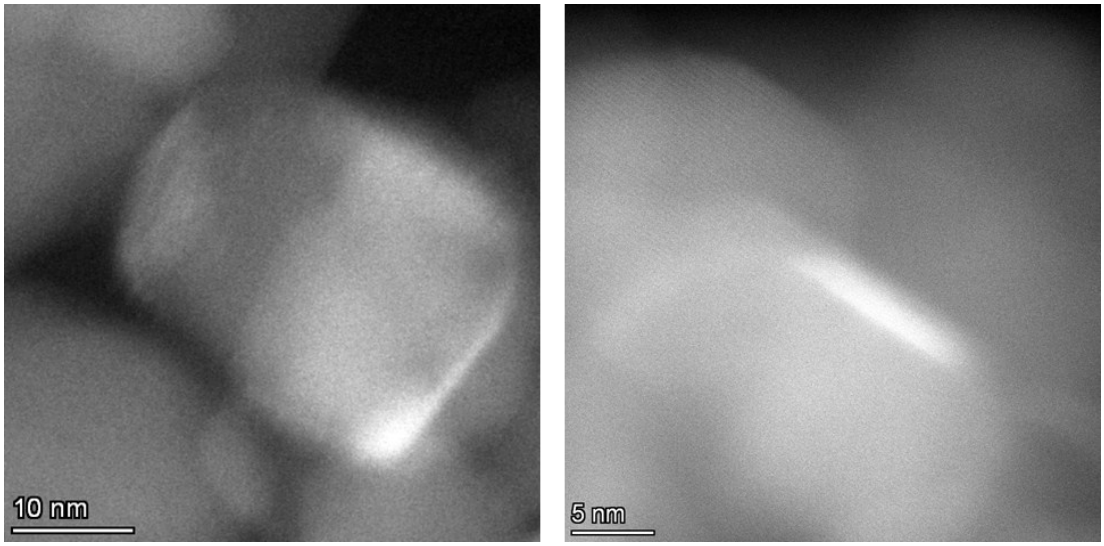

Figure S1. HAADF-STEM images of Ru/TiO_2

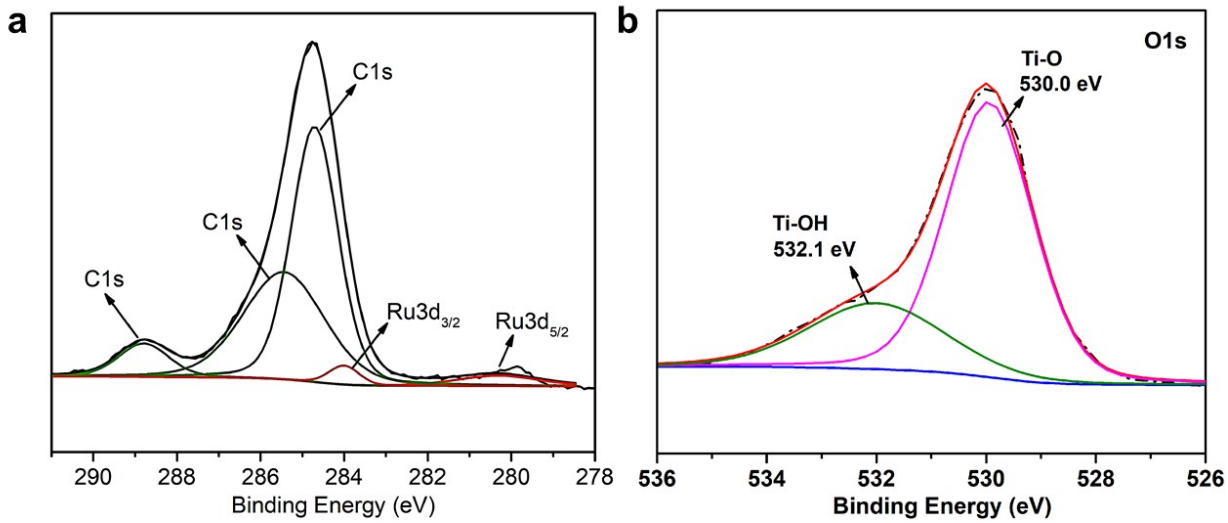

Figure S2. XPS spectra of (a) C1s and Ru3d and (b) O1s for Ru/TiO_2 sample.

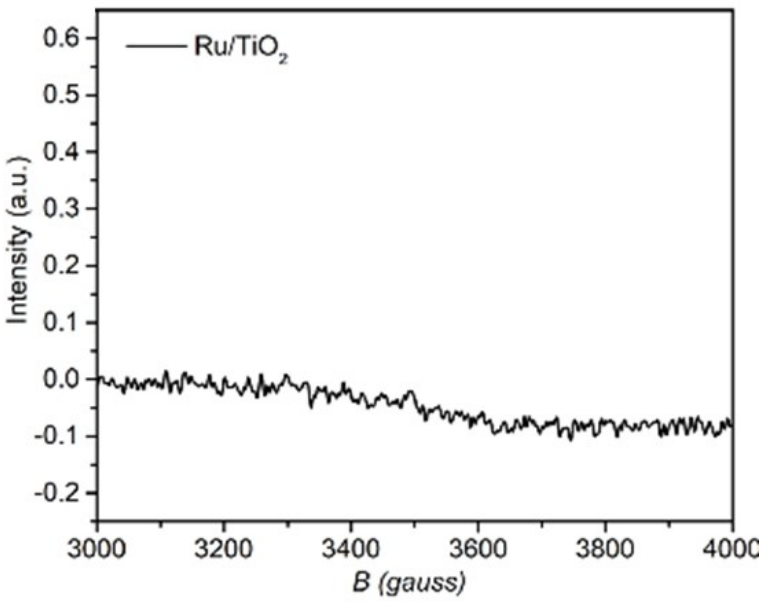

Figure S3. Electron paramagnetic resonance (EPR) spectra of Ru/TiO_2.

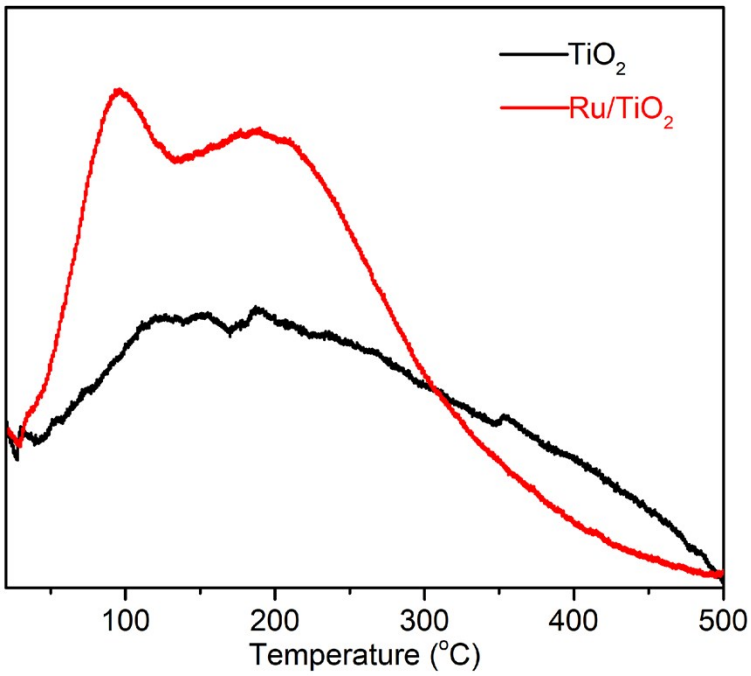

Figure S4. CO_2-TPD for TiO_2 and Ru/TiO_2

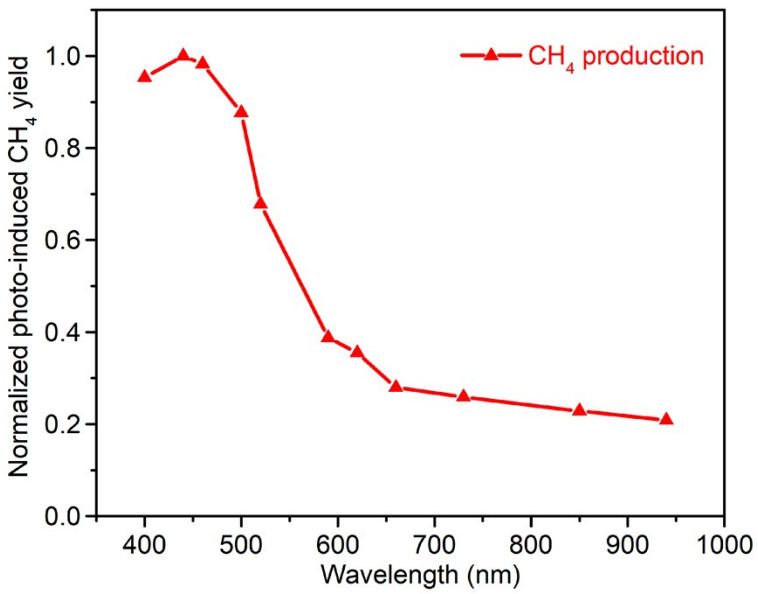

Figure S5. Normalized photo-induced CH_4 yield vs. wavelength of incident light for CO_2 hydrogenation (single-wavelength LED lights were used; temperature: 300 ^oC; CO_2/H_2 = 1:3, flow rate 10ml/min; and 15 mg catalyst).

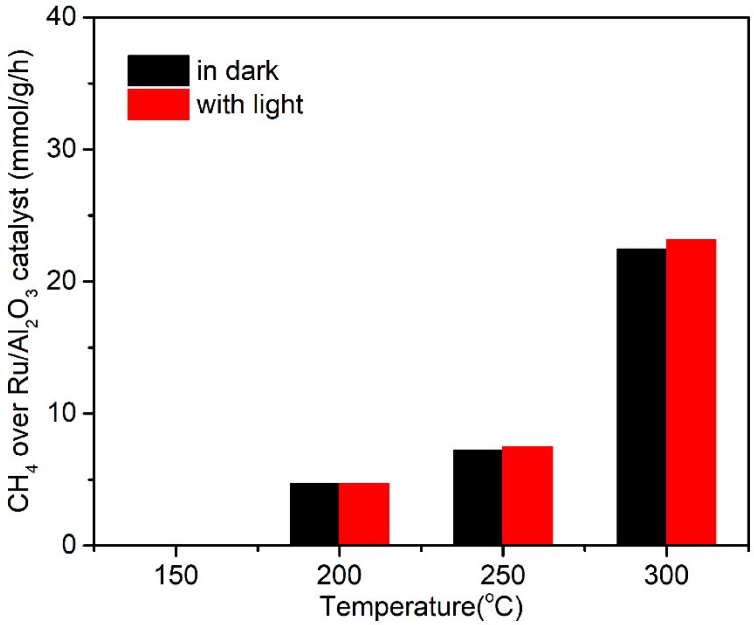

Figure S6. Thermo-catalytic (black bar) and thermo-photo catalytic (red bar) over Ru/Al_2O_3 catalyst for CO_2 reduction with H_2 at various temperatures

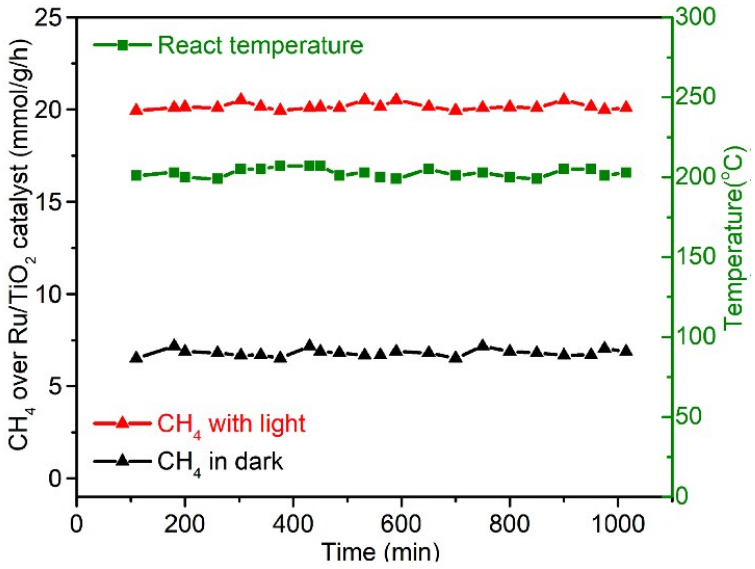

Figure S7. Time-resolved CH_4 production over Ru/TiO_2 catalyst at 200°C in dark (black line) and under simulated AM 1.5G sunlight irradiation (red line)

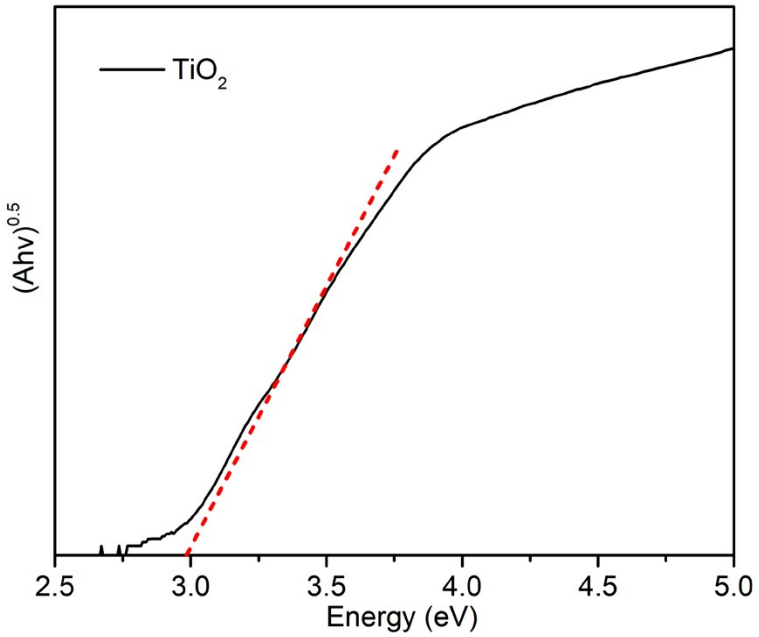

Figure S8. The band gap of TiO_2 estimated via the Kubleka-Munk equation

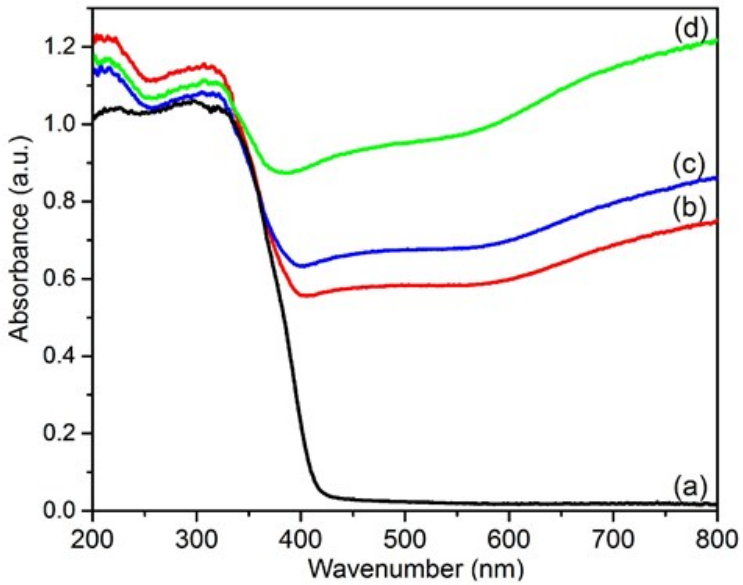

Figure S9. Diffuse reflectance UV-visible absorption spectra of fresh samples of (a) TiO_2; (b) 0.2Ru/TiO_2; (c) 1Ru/TiO_2; (d) 4Ru/TiO_2.

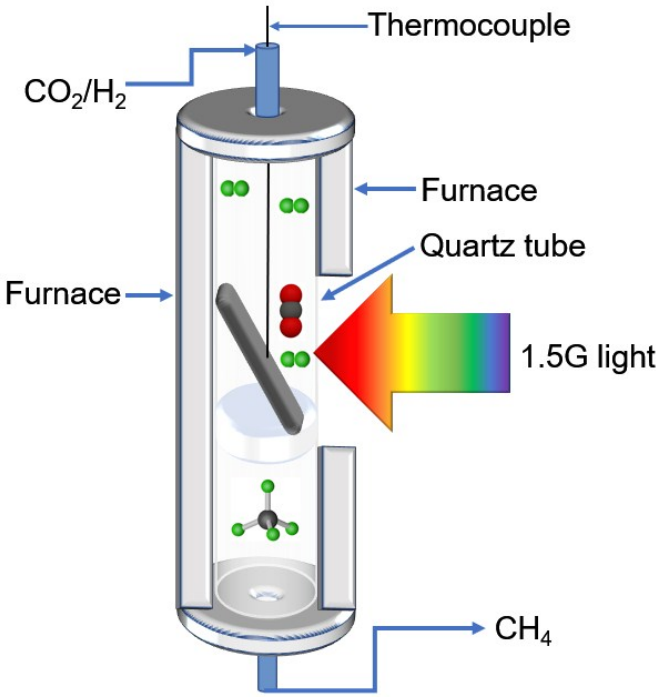

Figure S10. Scheme of the fixed bed reactor for photocatalytic reaction.

Table S1 Elemental statistics according to EDS analysis for Ru/TiO_2 catalyst.

Element	Line Type	k Factor	k Factor type	Absorption Correction	Wt%	Wt% Sigma	Atomic %
O	K series	1.165		1.00	44.65	0.19	70.80
Ti	K series	0.635		1.00	54.92	0.19	29.09
Ru	L series	1.052		1.00	0.42	0.09	0.11
Total:					100.00		100.00

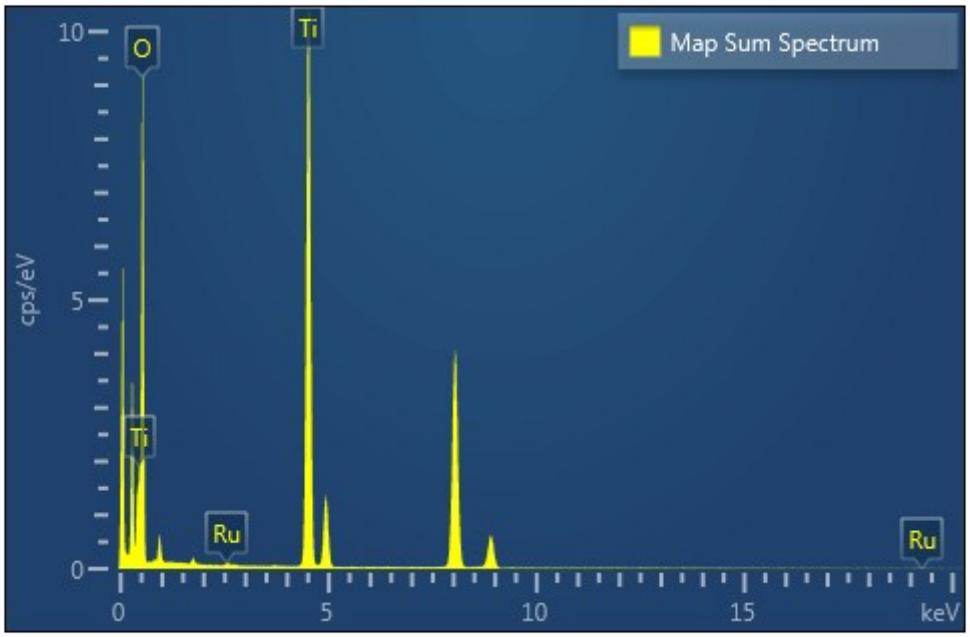

Figure S11. Elemental statistics according to EDS analysis for Ru/TiO_2 catalyst.