Electronic Supplementary Information

Highly Porous Gallium Oxide with a High CO_2 Affinity for Photocatalytic Conversion of Carbon Dioxide into Methane

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ESI-1 Supplementary characterization data on porous Ga_2O_3 particles

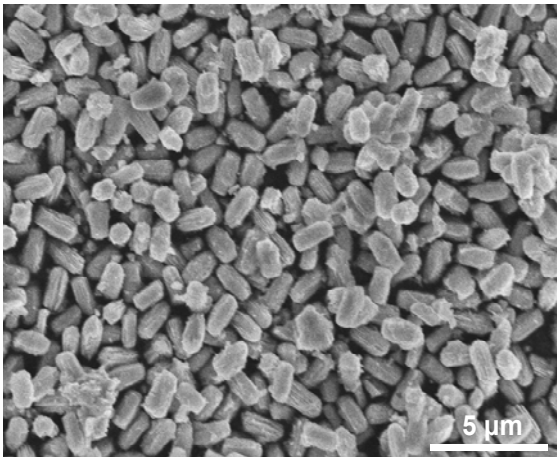

Figure S1 SEM image for porous Ga_2O_3 particles with a low magnification mode, showing the uniformity of the particle sizes and their morphology.

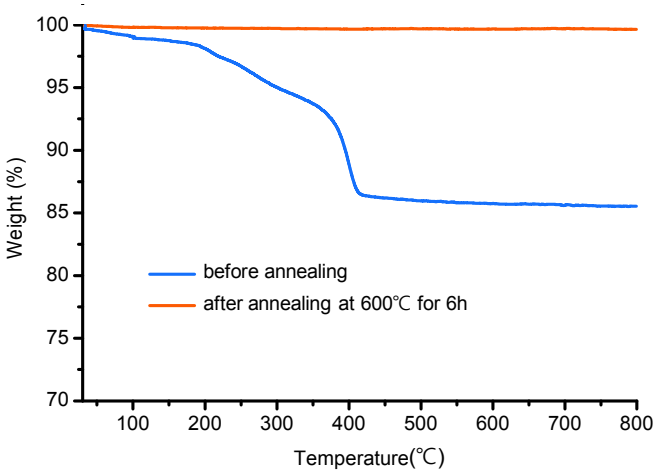

Figure S2 Thermal gravimetric analysis of porous Ga_2O_3 particles before and after annealing at 600°C for 6 hours.

The thermal gravimetric analysis of porous Ga_2O_3 particles was carried out using a thermogravimetry analyzer (TG 209 F3, NETZSCH). The Ga_2O_3 particles' temperature was raised to 800°C under atmospheric air, with a heating rate of 10.0°C/min, as shown in Figure S2. The thermal gravimetric analysis reveals that the amount of weight loss from the sample was occurred before annealing, due to organic materials of surfactants. After annealing at 600°C for 6 hours, we observed that the constant weight of the sample, indicating the evidence of the removal of the surfactant molecules.

ESI-2 Supplementary characterization data on the ref-Ga_2O_3

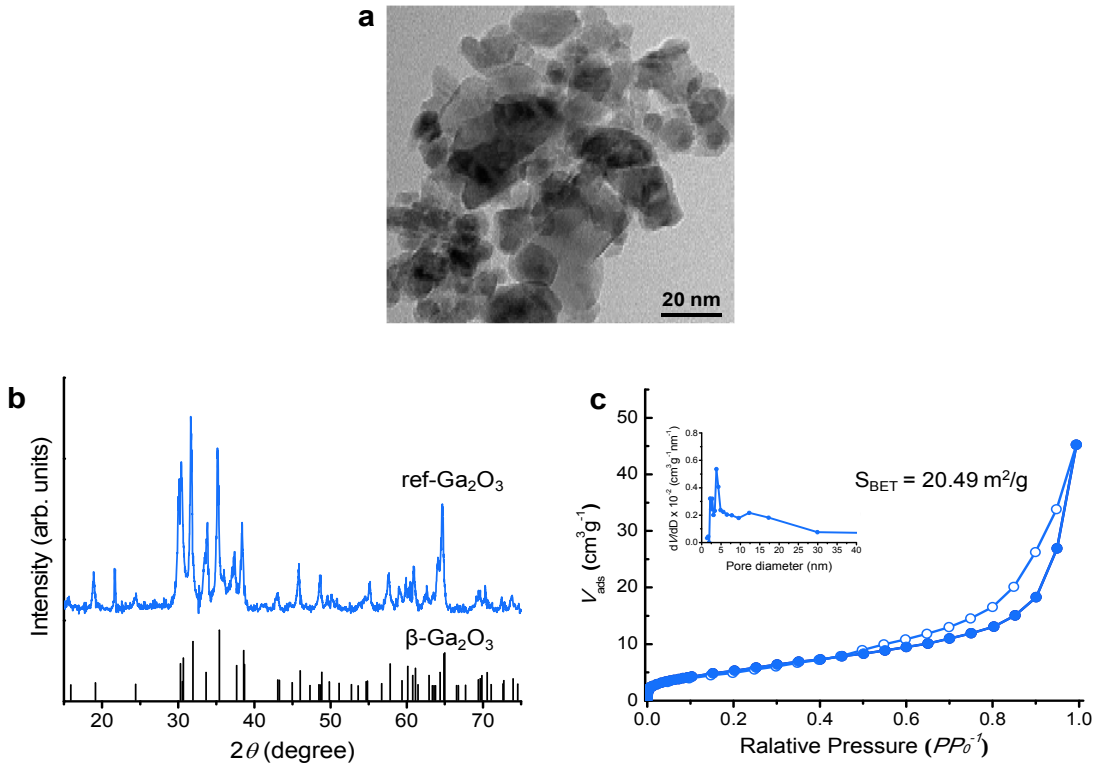

Figure S3 (a) TEM image, (b) XRD pattern, and (c) nitrogen adsorption-desorption isotherm where the pore size distribution of the ref-Ga_2O_3 is shown as its inset.

In order to compare the photocatalytic conversion of CO_2 into CH_4 over the porous Ga_2O_3 samples, the commercially available reference Ga_2O_3 has been purchased from Aldrich and we analyzed its morphology, crystal structure, and surface area, along with the pore size distribution. The TEM image in Figure S3 (a) displays that the ref-Ga_2O_3 exhibits irregular nano-size particles without any pores in a microscopic image, compared to the porous Ga_2O_3 which has inner mesopores and macropores within the rod-shaped particle. The XRD analysis, as shown in Figure S3 (b), also indicates that the ref- Ga_2O_3 particle is on the monoclinic β-phase (JCPDS 87-1901), which is on the same phase as that of the porous Ga_2O_3. In addition, the BET measurement of the ref-Ga_2O_3 in Figure S3 (c) shows that it has a lower surface area of 20.49 m^2/g, as well as a lower hysteresis loop than those of the porous Ga_2O_3.

ESI-3 Supplementary data for UV-vis absorption properties

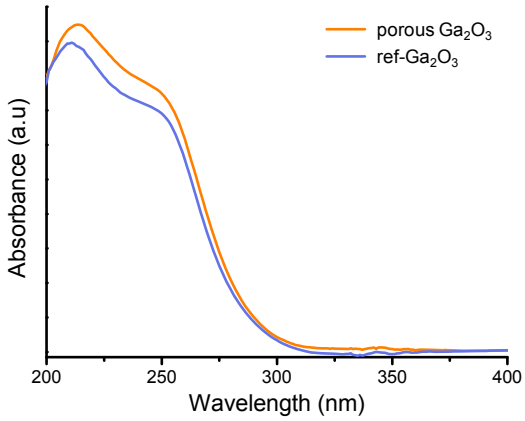

Figure S4 The UV-vis diffuse spectra of porous Ga_2O_3 and ref-Ga_2O_3 samples. The solid state UV-vis diffuse reflectance spectra were recorded using a JASCO V-570 spectrometer. The absorption edge of both samples is approximately 280nm.