Aerosol-assisted synthesis mesoporous Cu/ZnO-ZrO_2 catalyst with high selective photothermal CO_2 reduction to methanol

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Fig. S1. Diagram of a photothermal catalytic reactor.

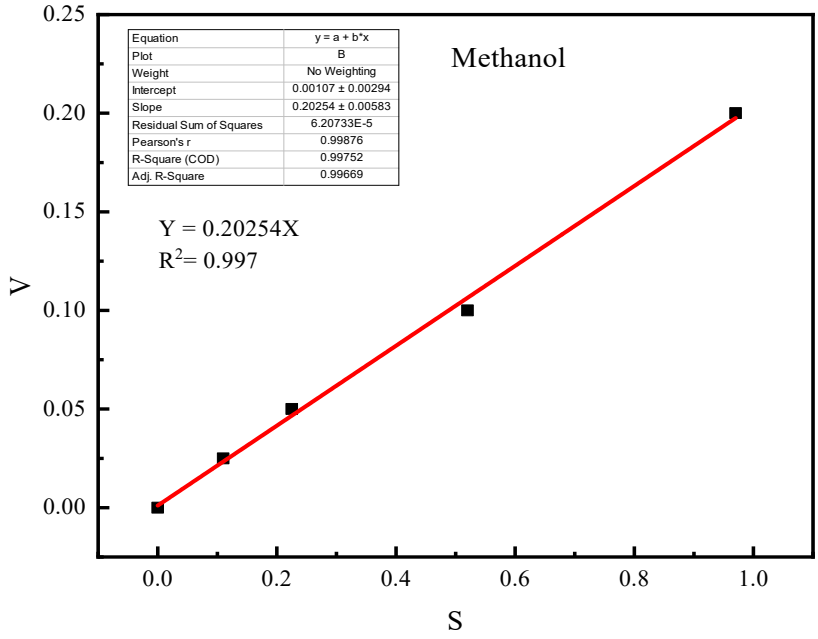

Fig. S2. The calibration curve for product methanol.

Five standard solutions were prepared with different ratios (V) of methanol/n-butanol (5 mL of n-butanol contained 0, 0.125, 0.25, 0.5, and 1 mL of methanol, respectively). The standard solutions were injected into the GC (FID detector) to obtain the methanol and n-butanol peak area. The area ratio (S) of methanol/n-butanol was measured and fitted to form a standard curve (R^2=0.995).

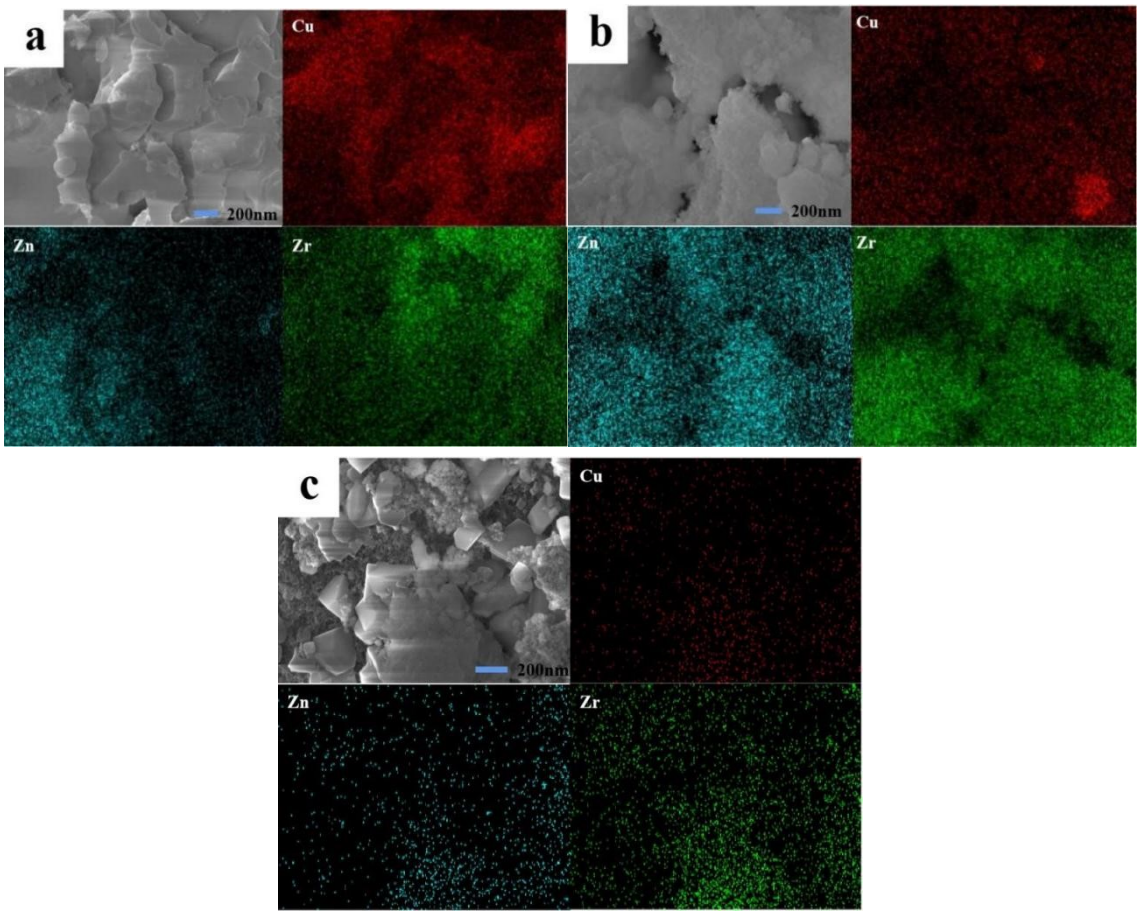

Fig. S3. SEM images and mapping of Cu, Zn, and Zr elements of (a) CZZ (CTAB), (b) CZZ (Non), and (c) CZZ (Pr).

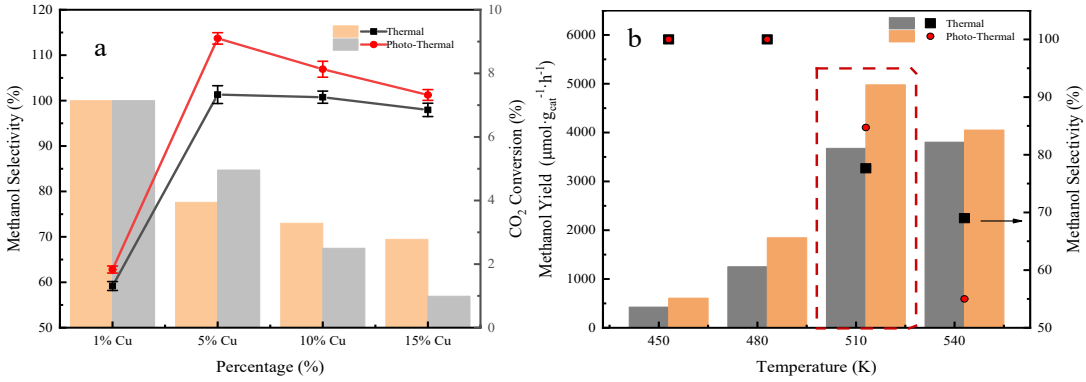

Fig. S4. (a) The performance of different Cu percentage loaded ZnO-ZrO_2 (CTAB) support. (b) The performance of CZZ (CTAB) under reaction temperature.

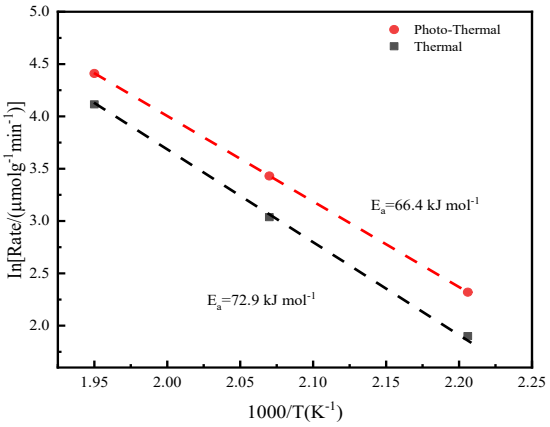

Fig. S5. The activation energy of CZZ (CTAB) at thermal and photo-thermal conditions.

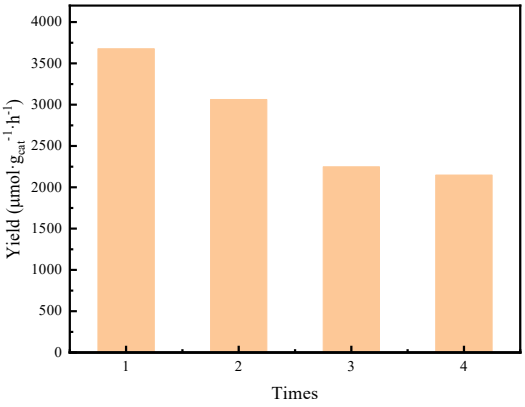

Fig. S6. The CZZ (CTAB) stability under thermal catalysis reaction.

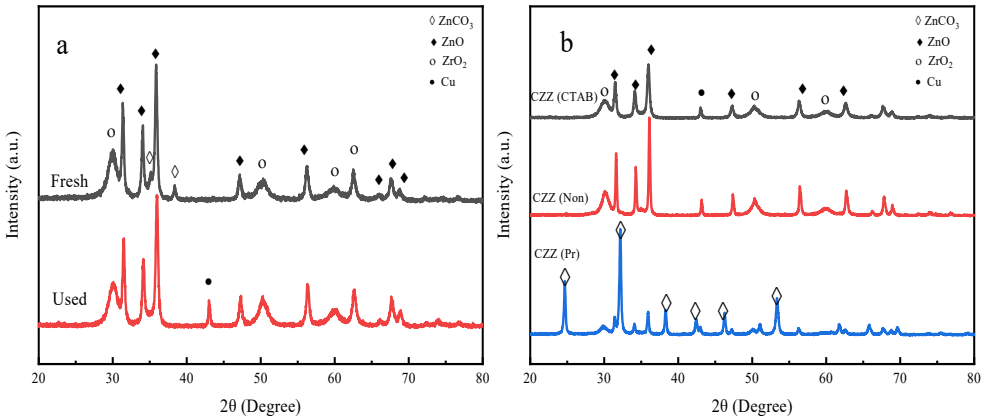

Fig. S7. (a) XRD pattern for fresh and used CZZ (CTAB) catalysts. (b) The XRD pattern of the catalysts after the reaction.

Table S1. Controlled experiments under different experiment conditions.

group	Catalyst	Reaction gas	Temperature (K)	Condition	Time (h)	Methanol yield (umol·g_{cat}^{-1}·h^{-1})
1	Blank	CO_2+H_2	298.15	Thermal	6	0
2	Blank	CO_2+H_2	298.15	Photo	6	0
3	Blank	CO_2+H_2	513.15	Thermal	6	0
4	Cu/ZnO-ZrO_2(CTAB)	N_2	513.15	Thermal	6	0
5	Cu/ZnO-ZrO_2(CTAB)	CO_2+H_2	513.15	Thermal	6	3677.89
6	Cu/ZnO-ZrO_2(CTAB)	CO_2+H_2	513.15	Photo-Thermal	6	4978.87

Table S2. The N_2O titration for the CZZ(CTAB) catalyst.

Catalyst	Integral area for reduction peak		Cu dispersion (%)
	First	Second	
CZZ(CTAB) Fresh	285.8	90.9	31.7
CZZ(CTAB) Used	372.2	101.78	27.3