Photo-assisted effectively selective reduction of CO$_2$ to methanol

on Cu-ZnO-ZrO$_2$ catalyst

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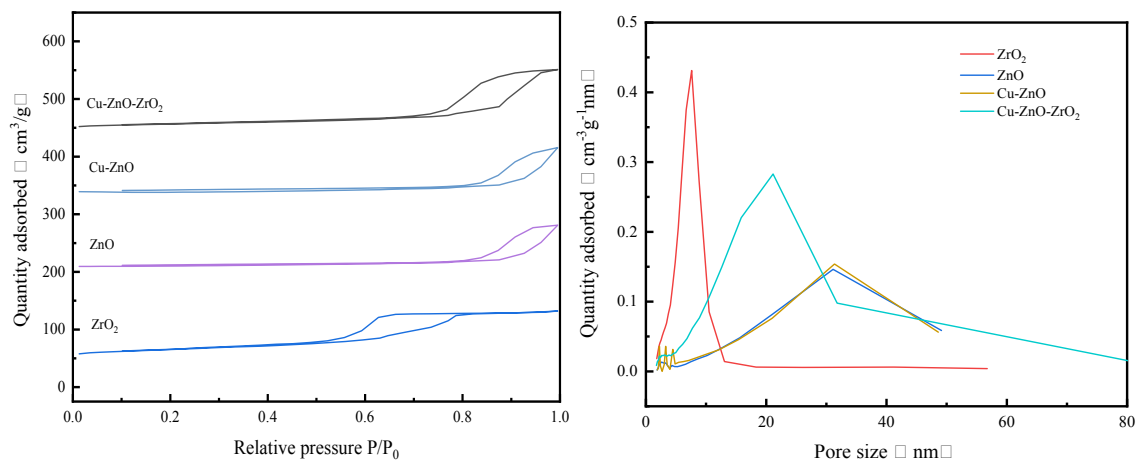27

Fig. S1. Diagram of a photothermal synergistic catalytic reactor.

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Fig. S2. (a) N$_2$ sorption isotherms. (b) pore size distribution curves of the corresponding catalysts
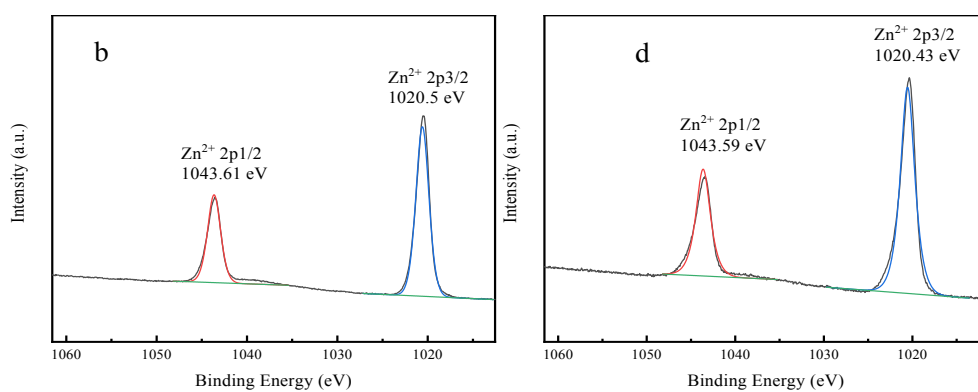
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Fig. S3. XPS spectra of catalyst: (a) and (b) Cu and Zn narrowing spectra of Cu-ZnO and Cu-ZnO-ZrO$_2$ catalysts.

Table S1. Percentage of elements in the catalyst for semi-quantitative analysis of XPS.

Catalyst	Cu(%)	Zn(%)	Zr(%)	O(%)	O_v(%)	O^{2-}(%)
Cu-ZnO	0.33	45.91		53.76	40.04	59.96
Cu-ZnO-ZrO$_2$	0.26	26.72	11.93	61.09	53.63	46.57

Table S2. CO_2-TPD quantitative analysis results.

	Peak 1		Peak 2	
	adsorption quantity	adsorption temperature	adsorption quantity	adsorption temperature
	(μmol/g)	(^{o}C)	(μmol/g)	(^{o}C)
Cu-ZnO	74.9	262.6	313.8	411.3
Cu-ZnO-ZrO$_2$	939.0	271.9	1096.5	413.2

Table S3. Controlled experiments under different experiment conditions.

group	Catalyst	Condition	Time (h)	Methanol yield ($g \cdot kg_{cat}^{-1} \cdot h^{-1}$)
1	Blank	N_2	6	0
2	Blank	CO_2	6	0
3	Blank	CO_2+H_2	6	0
4	Blank	CO_2+H_2 (light)	6	0
5	Cu-ZnO-ZrO$_2$	N_2	6	0
6	Cu-ZnO-ZrO$_2$	CO_2+H_2	6	44.88
7	Cu-ZnO-ZrO$_2$	CO_2+H_2 (light)	6	65.84