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

Supporting Information

A Z-scheme $ZnFe_2O_4$/RGO/In_2O_3 hierarchical photocatalyst for efficient CO_2 reduction enhancement

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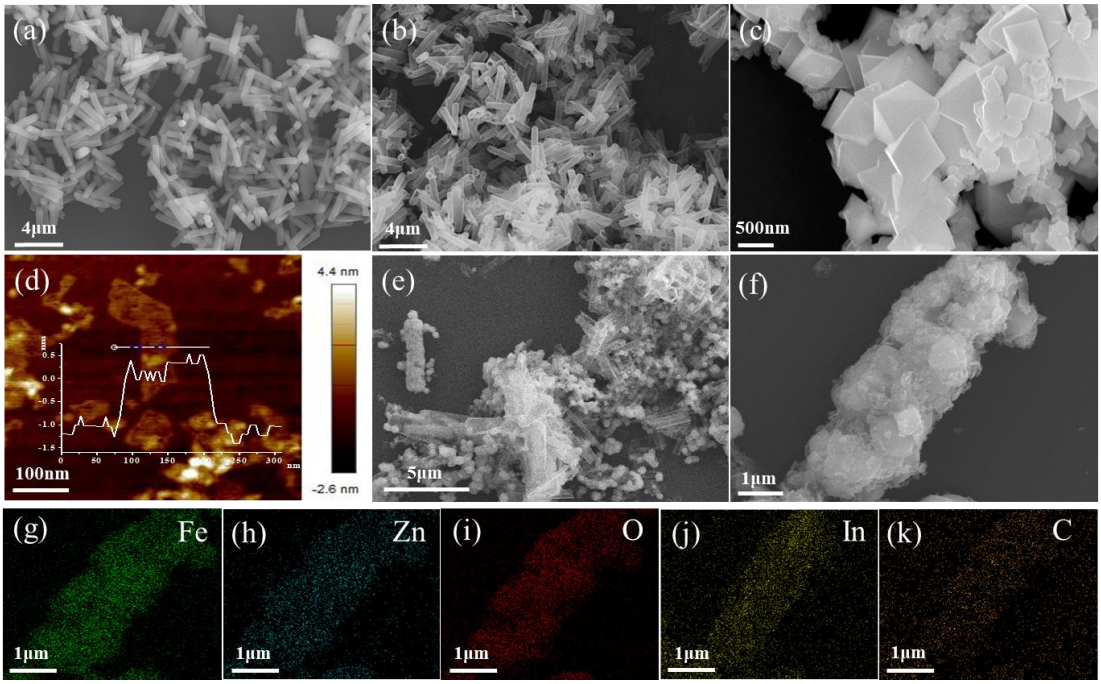

Figure S1. SEM images of In-MIL68 (a), In_2O_3 tubule. (b), $ZnFe_2O_4$ (c), AFM images (d) of GO, SEM images of 20ZFO/10RGO/IO hierarchical tubule (e, f) and element mapping of 20ZFO/10RGO/IO (g, h, i, j, k), respectively.

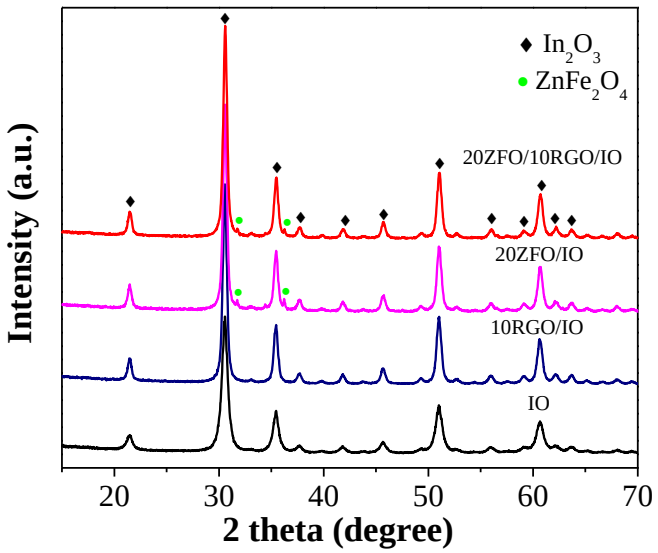

Figure S2. XRD patterns of IO, 10RGO/IO, 20ZFO/IO, 20ZFO/10RGO/IO samples

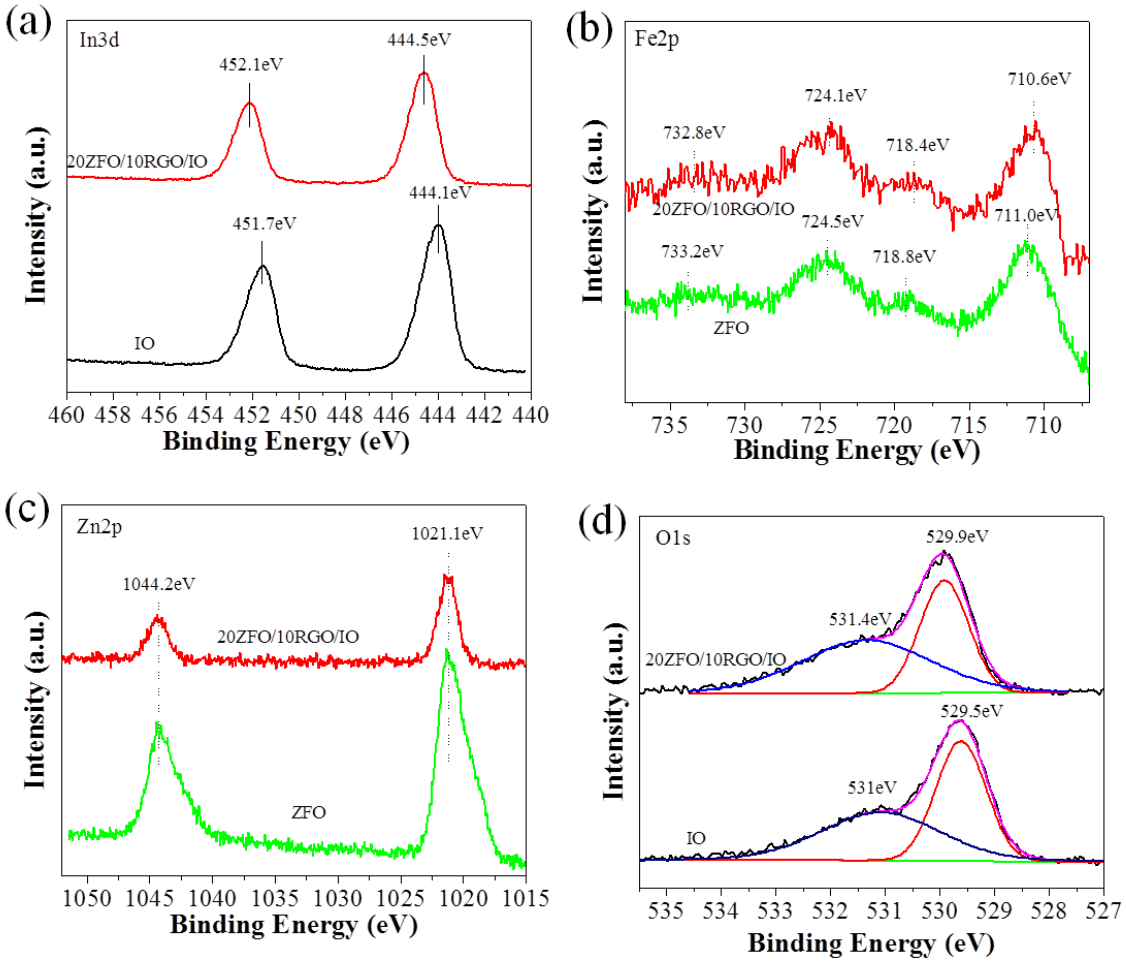

Figure S3. In 3d XPS spectra of IO and 20ZFO/10RGO/IO samples (a). Fe 2p (b) and Zn 2p (c) XPS spectra of ZFO and 20ZFO/10RGO/IO samples. O 1s XPS spectra of IO and 20ZFO/10RGO/IO samples (d).

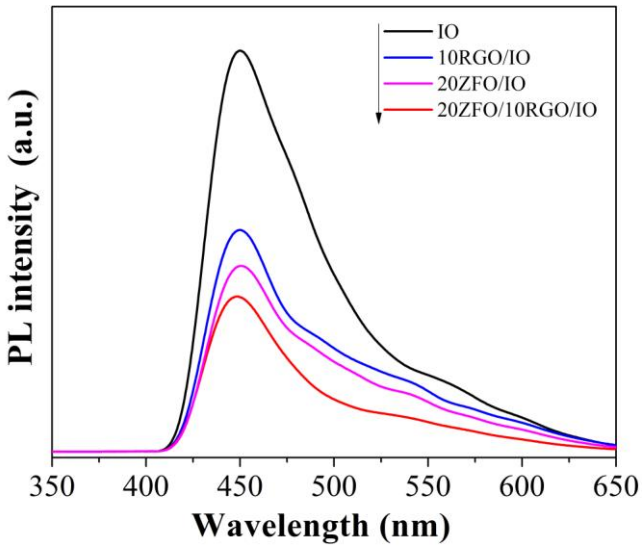

Figure S4. Photoluminescence spectra of IO, 10RGO/IO, 20ZFO/IO, 20ZFO/10RGO/IO samples

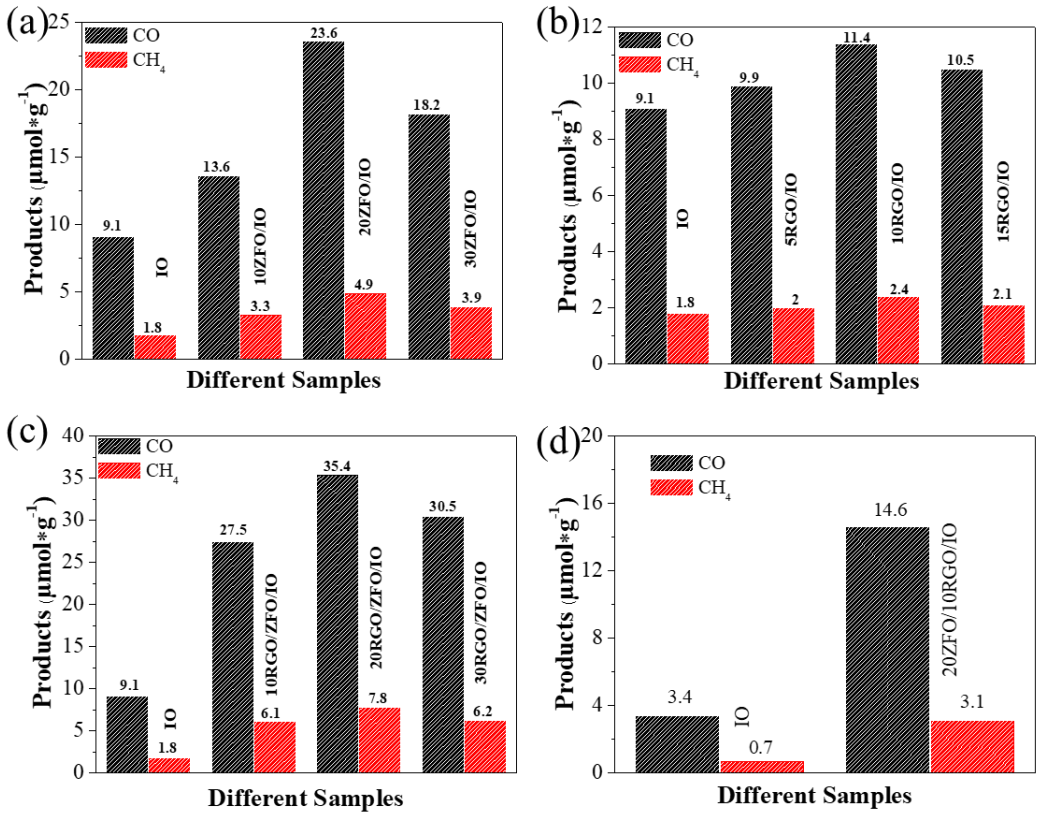

Figure S5. Photocatalytic activities for CO_2 reduction of pure IO and different amount of ZFO coupled with IO samples (a), pure IO and different amount of RGO coupled with IO samples (b) and different amount of RGO and ZFO co-coupled IO samples (c) under UV-visible light. Photocatalytic activities for CO_2 reduction (d) of IO and 20ZFO/10RGO/IO under visible light for 4h.

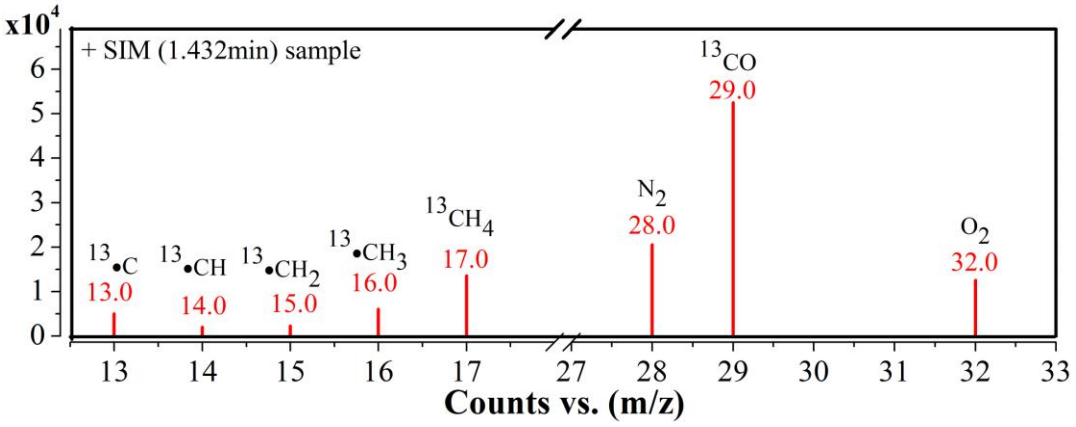

Figure S6. Mass spectra of the products over 20ZFO/10RGO/IO in photocatalytic reduction of $^{13}CO_2$.

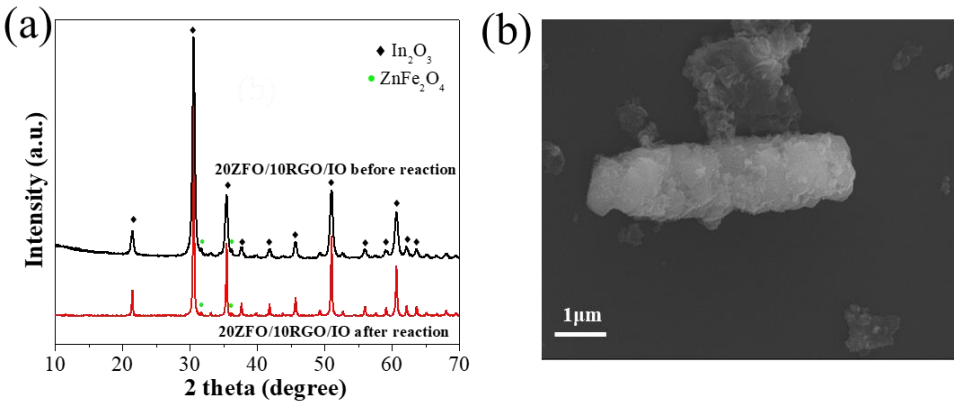

Figure S7. XRD patterns (a) and SEM image of 20ZFO/10RGO/IO after photocatalytic experiment.

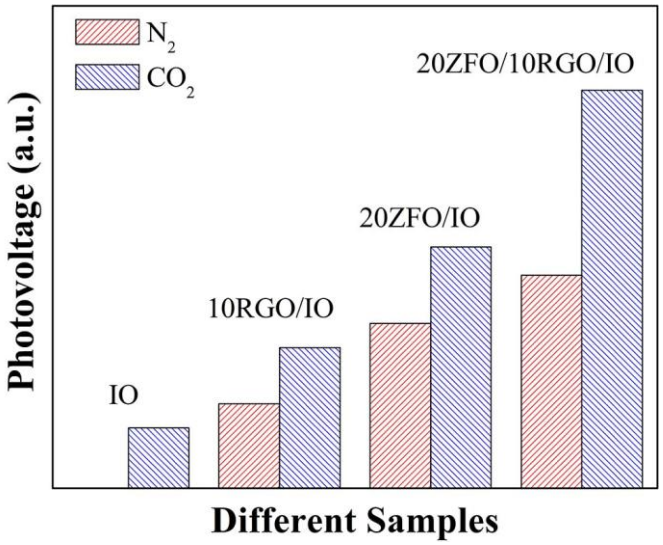

Figure S8. The intensities of SS-SPS response peak at 360 nm in different atmospheres of IO, 10RGO/IO, 20ZFO/IO and 20ZFO/RGO/IO samples.

Table S1 Performance comparison of our work with other Z-scheme photocatalytic systems for CO_2 reduction.

Photocatalyst	Light Source	Major Product	Yield ($\mu molg^{-1}h^{-1}$)	Reference
$ZnFe_2O_4/RGO/In_2O_3$	300 W Xenon arc lamp	CO	8.85	This work
		CH_4	1.95	
$ZnIn_2S_4/TiO_2$	300 W Xenon arc lamp	CH_4	1.135	[1]
Cu_2O/TiO_2	1KW high-pressure Hg（Xe）lamp	CO	2.11	[2]
$ZnPc/BiVO_4$	300 W Xenon lamp cut off UV (λ>420nm)	CO	0.98	[3]
		CH_4	0.145	
CdS/WO_3	300 W Xenon lamp cut off UV (λ>420nm)	CH_4	1.02	[4]

Reference

1. G. Yang, D. Chen, H. Ding, J. Feng, J. Z. Zhang, Y. Zhu, S. Hamid and D. W. Bahnemann, *Appl. Catal., B*, 2017, **219**, 611-618.
2. M. E. Aguirre, R. Zhou, A. J. Eugene, M. I. Guzman and M. A. Grela, *Appl. Catal., B*, 2017, **217**, 485-493.
3. J. Bian, J. Feng, Z. Zhang, Z. Li, Y. Zhang, Y. Liu, S. Ali, Y. Qu, L. Bai, J. Xie, D. Tang, X. Li, F. Bai, J. Tang and L. Jing, *Angew. Chem. Int. Ed.*, 2019, **58**, 10873-10878.
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