Supporting information

Achieving Direct Z-scheme Charge Transfer through Constructing 2D/2D α-Fe_2O_3/CdS Heterostructure for Efficient Photocatalytic CO_2 Conversion

Liyuan Long[1,2,‡,], Gangyang Lv[1,‡], Qiutong Han[2], Xianchen Wu[1], Yu Qian[1], Dunhui Wang[1,*], Yong Zhou[2,*], and Zhigang Zou[2,*]*

[1] Micro-Electronics Research Institute and School of Electronics and Information, Hangzhou Dianzi University, Hangzhou 310018, China

[2] National Laboratory of Solid State Microstructures and Department of Physics, Nanjing University, Nanjing 210093, China

Email: liyuan-long@hdu.edu.cn; wangdh@hdu.edu.cn; zhouyong1999@nju.edu.cn; zgzou@nju.edu.cn

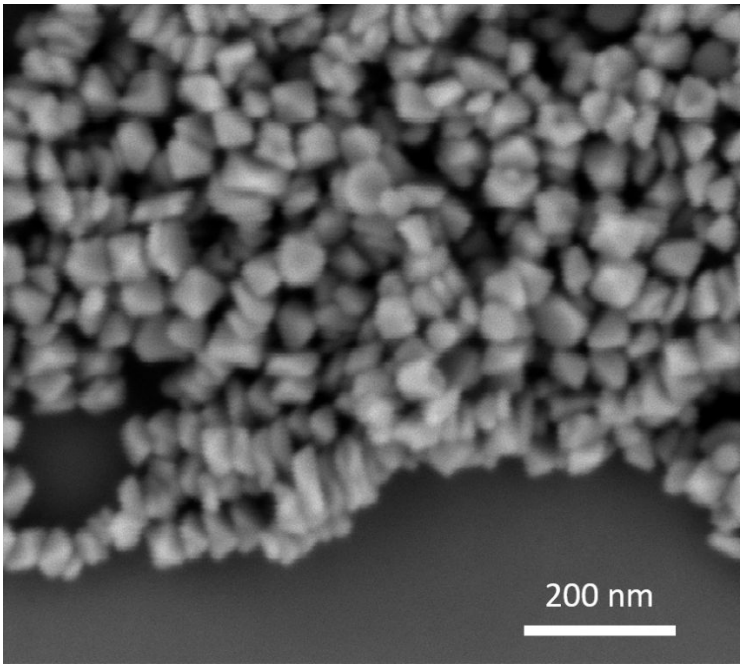
200 nm

Figure S1. The FESEM image of α-Fe_2O_3 nanoparticles fabricated under the precursor solution with 1.4 ml water and without any other growth condition difference compared to α-Fe_2O_3 NSs.

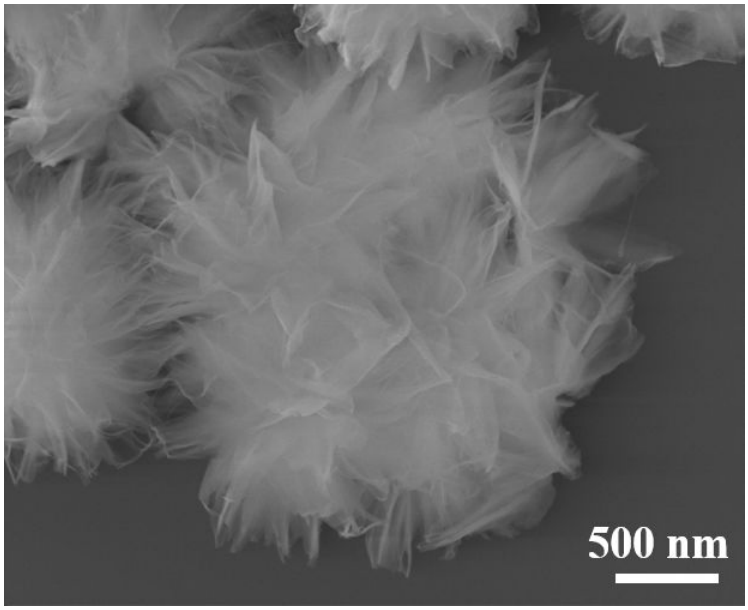

Figure S2. The FESEM image of pure CdS nanosheets. These CdS nanosheets interlace to each other and form hierarchical flower-like microsphere which is highly beneficial to expose their surface for interaction with α-Fe_2O_3 nanosheets.

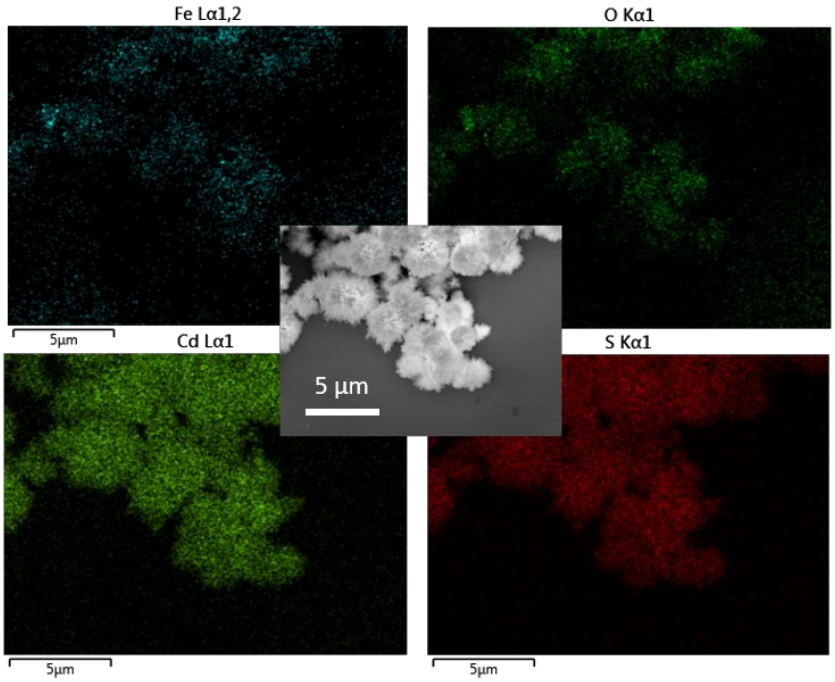

Figure S3. The EDX mappings of Fe, O, Cd, S elements and the corresponding FESEM image of large area of α-Fe_2O_3@CdS heterostructure. To obtain the EDX mappings, the corresponding FESEM image is acquired at 20 KV, leading to exhibiting hierarchical microspheres with relatively vague surface morphology. The distribution of Fe and O elements uniformly correspond to their morphology image as well as element distribution of Cd and S, effectively demonstrating the formation of homogenous α-Fe_2O_3@CdS heterostructure.

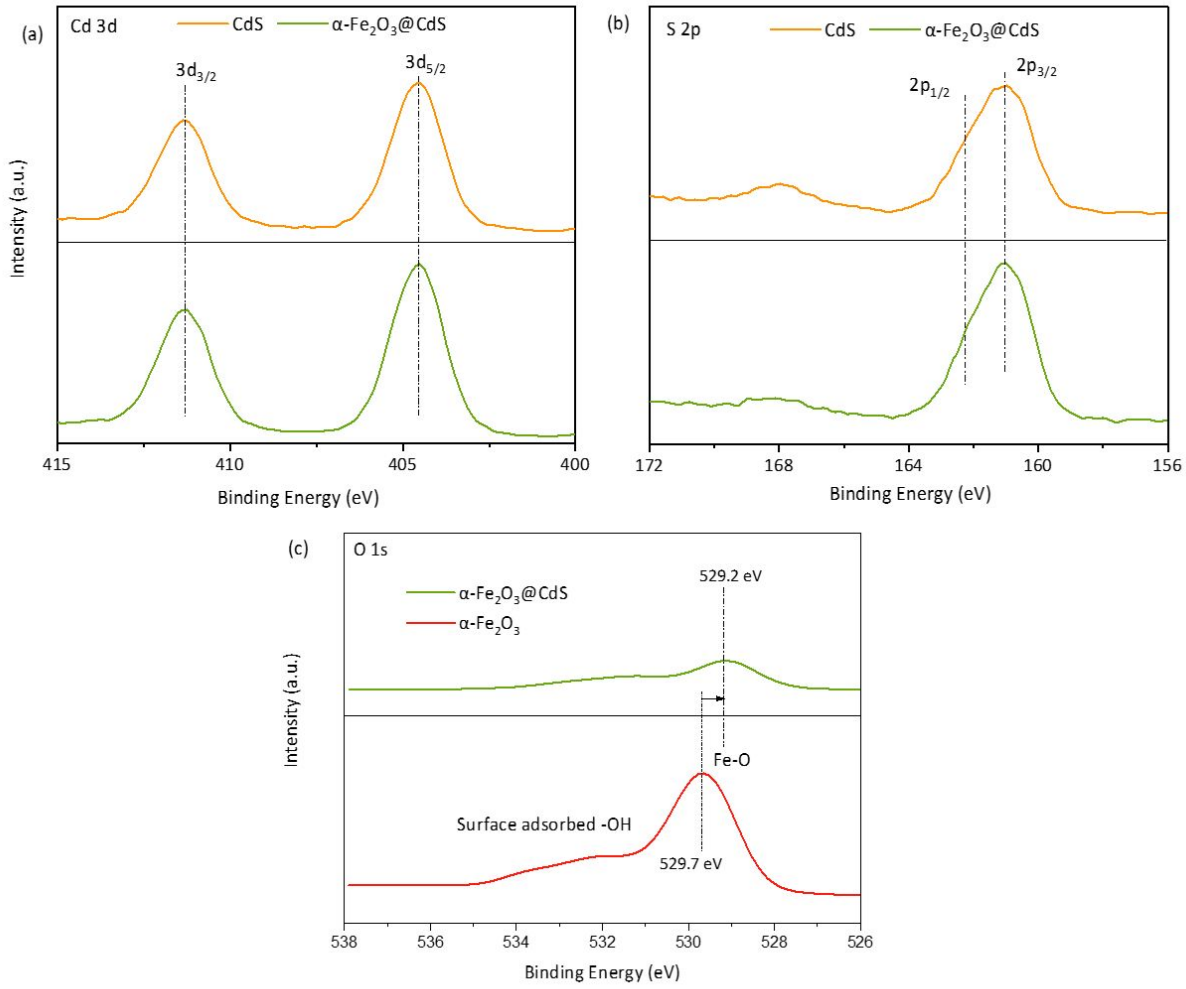

Figure S4. High-resolution XPS spectra of (a) Cd 3d, (b) S 2p and (c) O1s. The left shoulder of O1s XPS spectra should come from surface adsorbed hydroxyl.[1]

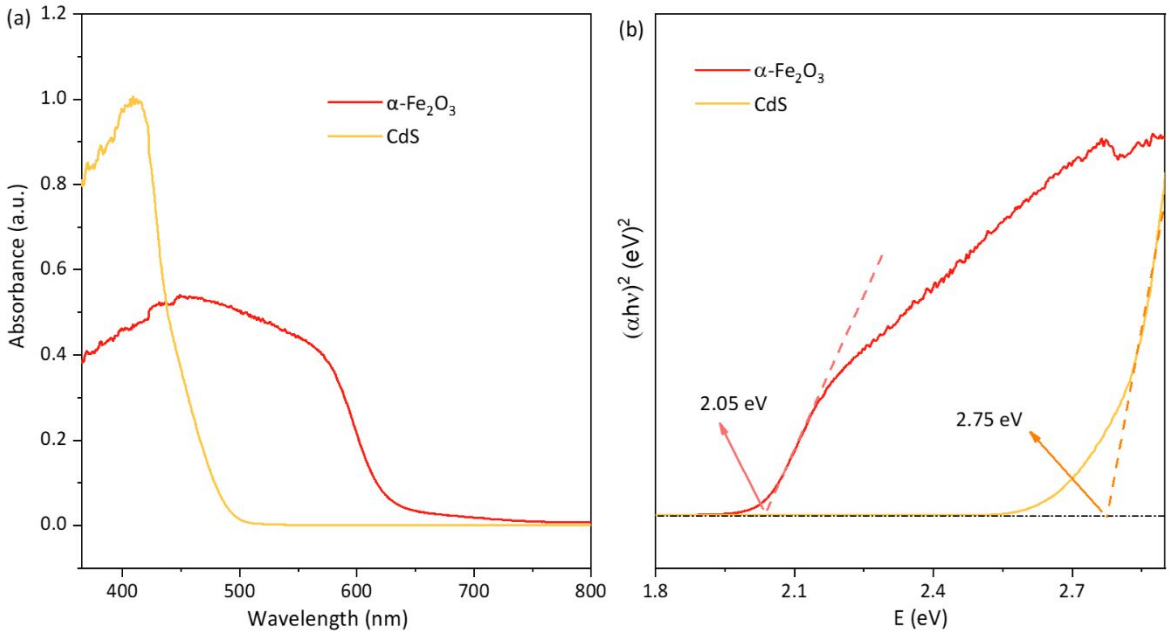

Figure S5. (a) UV-vis diffusive reflectance spectra of pure α-Fe_2O_3 NSs and CdS NSs. (b) Tauc plots of direct-bandgap α-Fe_2O_3 and CdS converted from spectra in Figure S5a according to Kubelka-Munk functions.

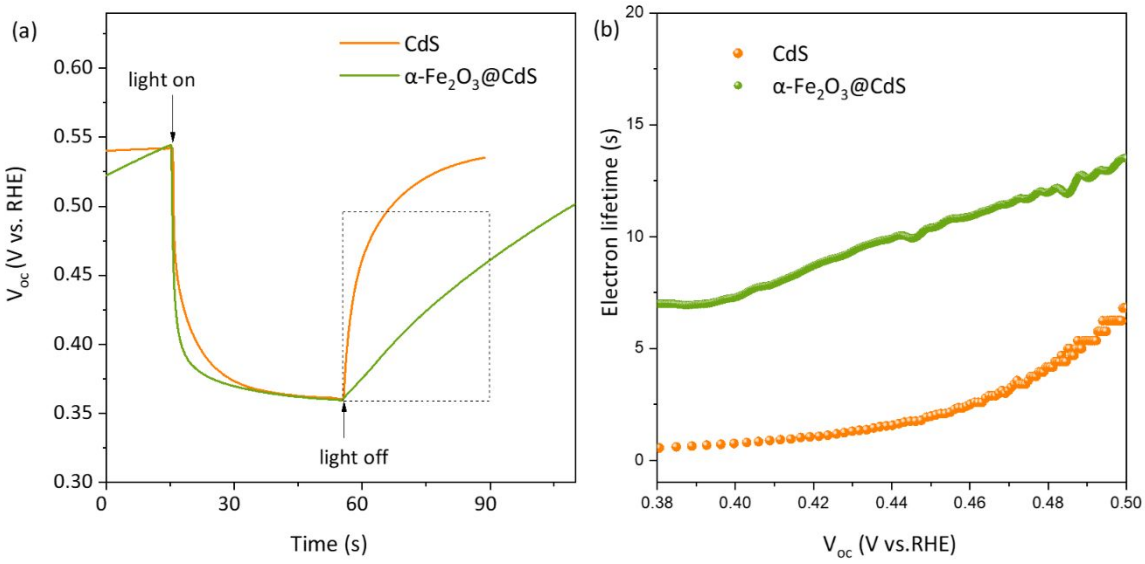

Figure S6. (a) Transient open circuit potential plots under simulated solar light-switching. (b) The photoelectron lifetime under different potential converted from the decay dynamics of V_{oc} at the moment of light off.[2-3]

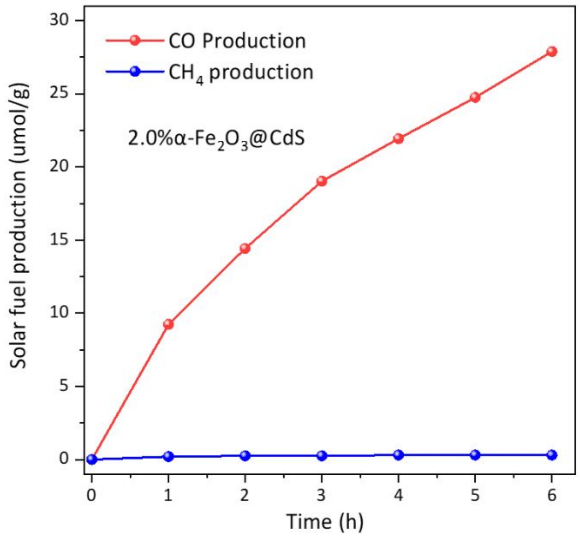

Figure S7. Comparison of CO and CH_4 production of photocatalytic CO_2 conversion for 2%α-Fe_2O_3@CdS heterostructure. The negligible CH_4 production which is beyond the detection accuracy of gas chromatograph reflects the high product selectivity of α-Fe_2O_3@CdS photocatalyst for CO_2 conversion.

REFERENCES

[1] Pan, J.; Guo, F.; Sun, H.; Li, M.; Zhu, X.; Gao, L.; Shi, W. Nanodiamond Decorated 2D Hexagonal Fe_2O_3 Nanosheets with a Z-Scheme Photogenerated Electron Transfer Path for Enhanced Photocatalytic Activity. *J. Mater. Sci.* 2021, *56*, 6663-6675.

[2] Yang, H.; Fan, W.; Vaneski, A.; Susha, A. S.; Teoh, W. Y.; Rogach, A. L. Heterojunction Engineering of CdTe and CdSe Quantum Dots on TiO_2 Nanotube Arrays: Intricate Effects of Size-Dependency and Interfacial Contact on Photoconversion Efficiencies. *Adv. Funct. Mater.* 2012, *22*, 2821-2829.

[3] Bang, J. H.; Kamat, P. V. Solar Cells by Design: Photoelectrochemistry of TiO_2 Nanorod Arrays Decorated with CdSe. *Adv. Funct. Mater.* **2010,** *20*, 1970-1976.