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

Supporting Information

Enhanced photoexcited carrier separation in CdS-SnS_2 heteronanostructures: A new 1D-0D visible photocatalytic system for hydrogen evolution reaction

Rama Krishna Chava*, Jeong-Yeon Do, Misook Kang**

Department of Chemistry, College of Natural Science, Yeungnam University,

280 Daehak-Ro, Gyeongsan, Gyeongbuk-38541, Republic of Korea.

Corresponding Author's Address:

*Dr. Rama Krishna Chava (Email: drcrkphysics@hotmail.com, rama@ynu.ac.kr)

**Prof. Misook Kang (Email: mskang@ynu.ac.kr)

Department of Chemistry, College of Natural Science, Yeungnam University, 280 Daehak-Ro, Gyeongsan, Gyeongbuk-38541, Republic of Korea.

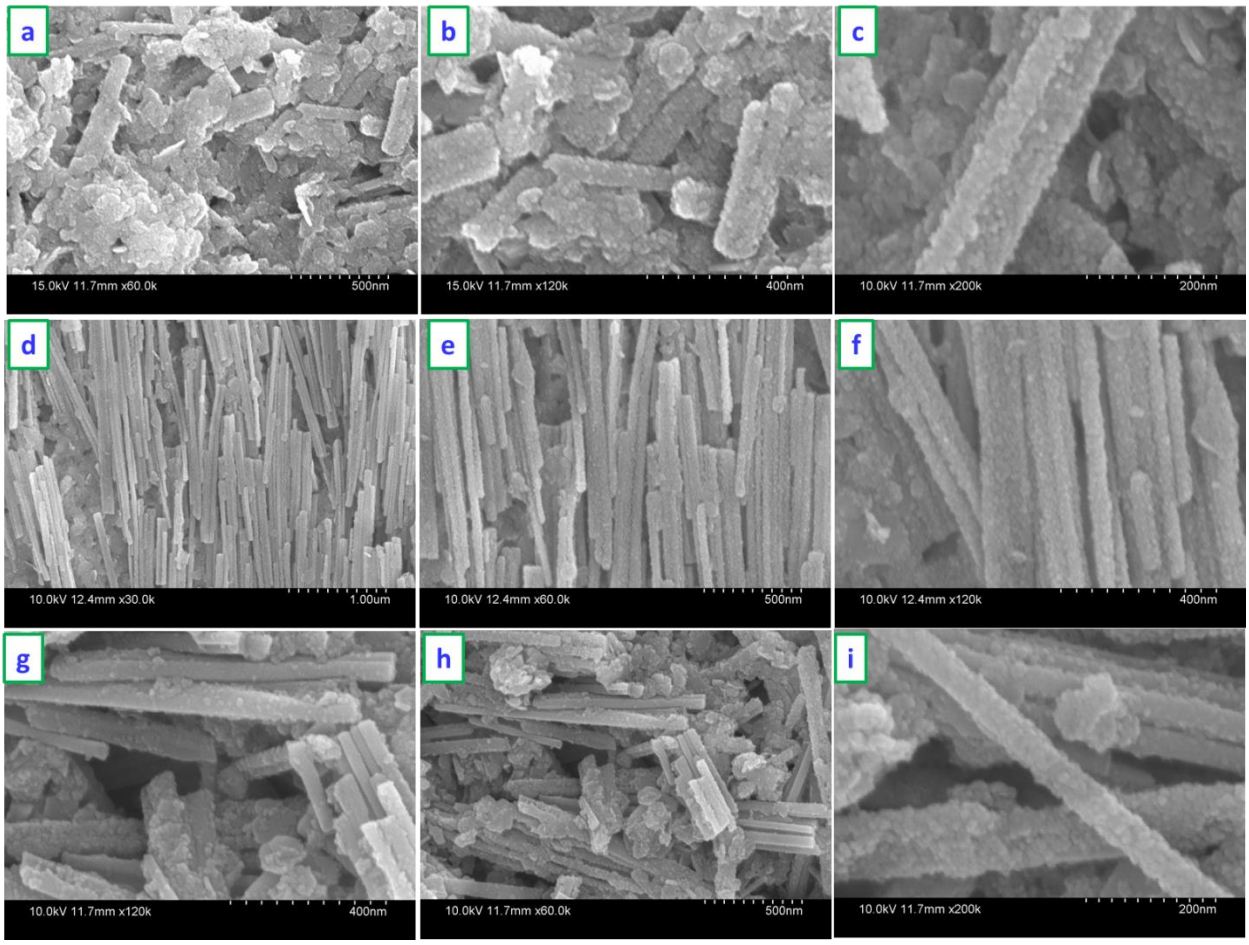

Figure S1. FE-SEM images of synthesized photocatalyst samples, (a-c) CS-20, (d-f) CS-40, (g-i) CS-50 core-shell HNSs.

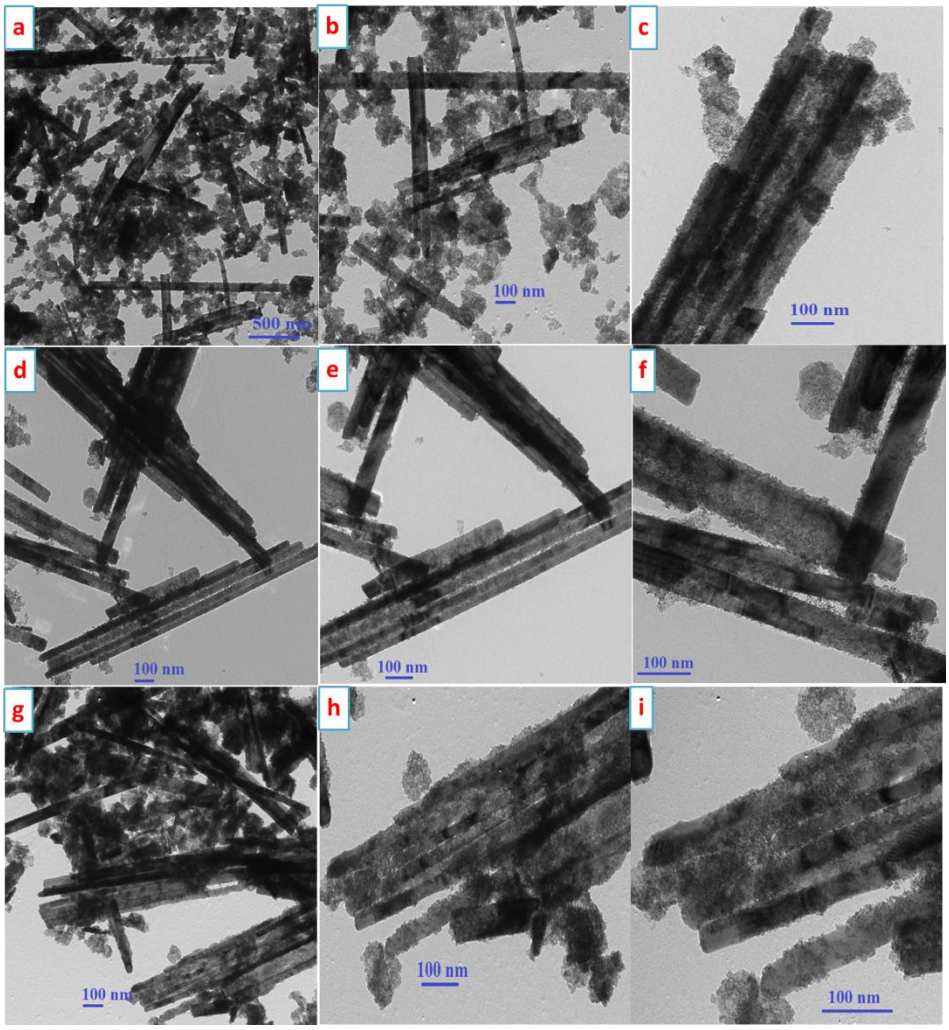

Figure S2. TEM images of (a-c) CS-20, (d-f) CS-40, (g-i) CS-50 HNSs core-shell HNSs.

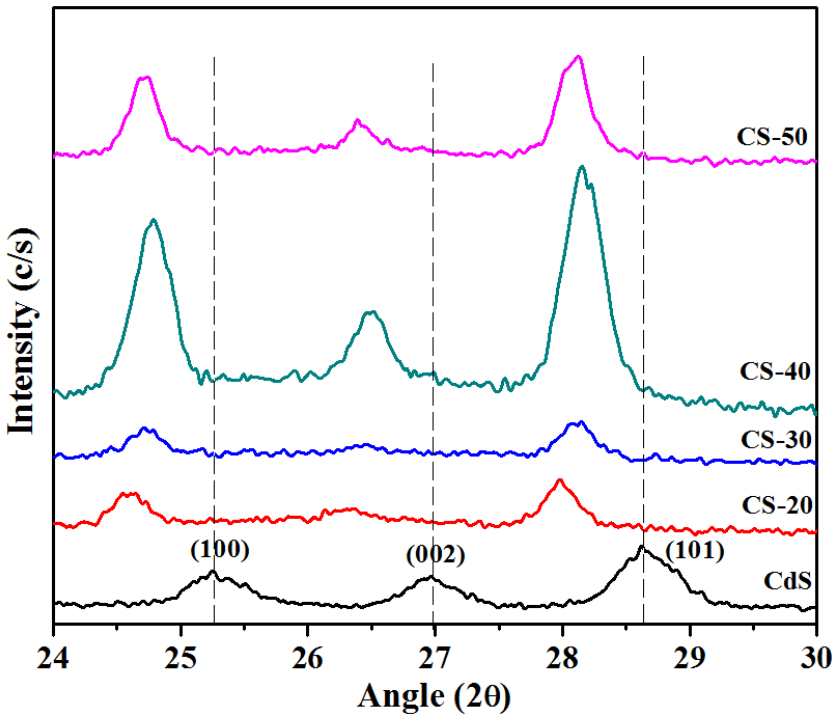

Figure S3: Powder X-ray diffraction patterns of CdS and CdS-SnS_2 CSHNSs in the range of 24 ^{o}-30^{o} demonstrating the left shift of (100), (002) and (101) planes after making heterostructures.

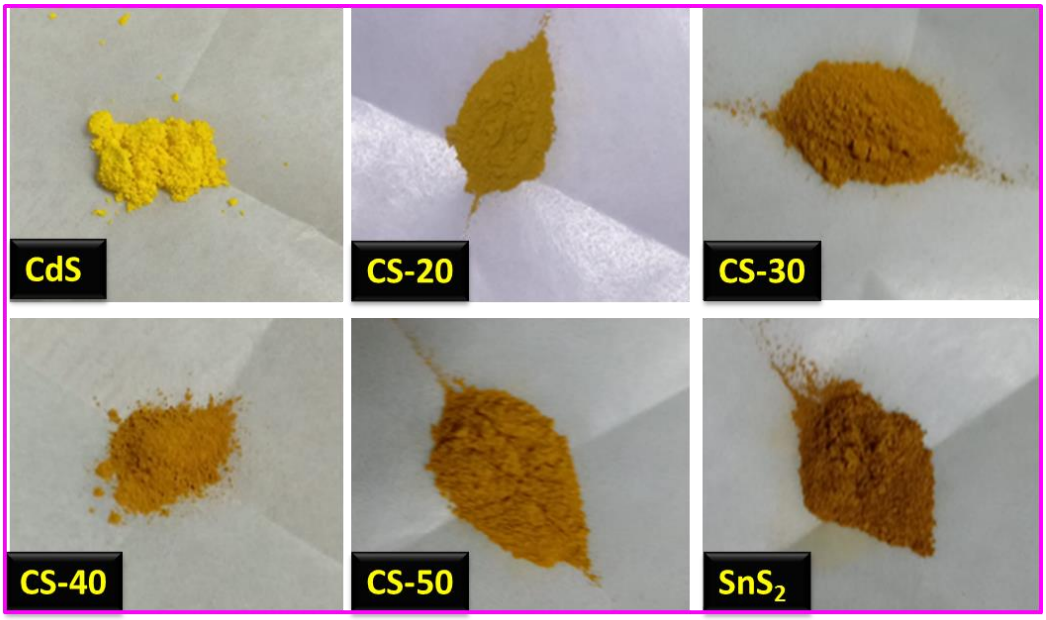

Figure S4: Digital images of as prepared CdS, CdS-SnS_2 and SnS_2 photocatalysts samples.

Table S1: The EIS fitted parameters for the studied photocatalyst samples

Sample	R_s (Ohm)	R_{ct} (Ohm)
CdS	3.019×10^3	1.740×10^5
SnS_2	6.543×10^2	3.788×10^4
CS-30	5.011×10^2	1.053×10^4

Table S2: Comparison of H_2 evolution activities of 1D CdS based heterostructures.

Catalyst	**Light source λ> 420 nm**	**H_2 evolution rate (mmol.g^{-1}.h^{-1})**	**Quantum Efficiency**	**Ref.**
CdS/CoO_x	350 W Xe lamp	3.5	--	S1
CdS-Au/MoS_2	150 W Xe lamp	7	27.85%	S2
CdS-MoS_2	300 W Xe lamp	49.80	41.37%	S3
CdS-WS_2	---	61.1	28.9%	S4
CdS-$CdIn_2S_4$	300 W Xe lamp	0.823	1.2%	S5
CdS- β-NiS	300 W Xe lamp	793.6 μmol.h^{-1}	74.11%	S6
CdS-$Co(OH)_2$	350 W Xe lamp	14.43	--	S7
CdS-Pt	350 W Xe lamp	1.49 mmol. h^{-1}	6.70%	S8
CdS-MoS_2	300 W Xe lamp	60.28	50.07%	S9
CdS-MoS_x	300 W Xe lamp	404 μmol.h^{-1}	--	S10
CdS-MoS_2-graphene	350 W Xe lamp	621.3 μmol.h^{-1}	54.4%	S11
CdS-Pd	---	71.0	--	S12
CdS-MoS_2	300 W Xe lamp	9.73	60.3%	S13
CdS-MoS_2	300 W Xe lamp	12.38	--	S14
CdS-WS_2-MoS_2	150 W Xe lamp	169.82	51.4%	S15
CdS-ZnO	300 W Xe lamp	9.618	--	S16
CdS-MoS_2	300 W Xe lamp	10.85	22.0%	S17
CdS-g-C_3N_4	300 W Xe lamp	44.450	46.3%	S18
CdS-g-C_3N_4-$Ni(OH)_2$	300 W Xe lamp	0.115	16.7%	S19
CdS-SnS_2	150 W Xe lamp	35.65	18.45%	This work

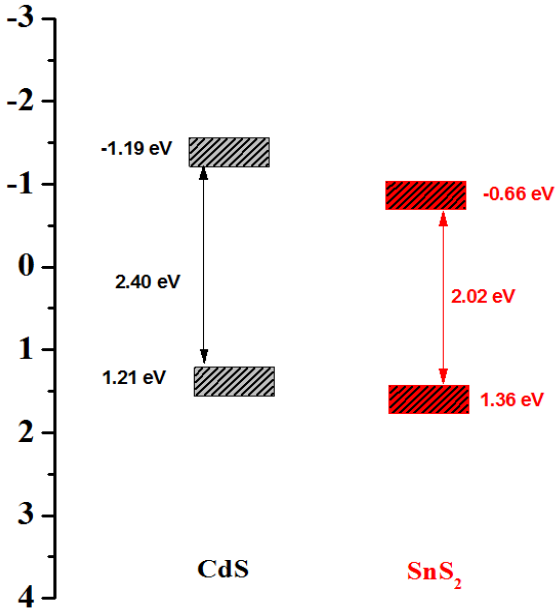

Figure S5: Electronic band structures of CdS and SnS_2 nanostructures.

References

S1 Y. Liu, S. P. Ding, Y. Q. Shi, X. F. Liu, Z. Z. Wu, Q. Q. Jiang, T. F. Zhou, N. K. Liu and J. C. Hu, *Appl. Catal., B*, 2018, **234,** 109–116.

S2 R. K. Chava, J. Y. Do and M. Kang, *ACS Sustainable Chem. Eng.*, 2018, **6,** 6445−6457.

S3 X. –L. Yin, L. –L. Li, W. –J. Jiang, Y. Zhang, X. Zhang, L. –J. Wan and J. –S. Hu, *ACS Appl. Mater. Interfaces*, 2016, **8,** 15258-15266.

S4 J. He, L. Chen, Z.-Q. Yi, C.-T. Au and S.-F. Yin, *Ind. Eng. Chem. Res.*, 2016, **55,** 8327−8333.

S5 T. Wang, Y. Y. Chai, D. K. Ma, W. Chen, W. W. Zheng and S. M. Huang, *Nano Res.*, 2017, **10,** 2699-2711.

S6 S. D. Guan, X. L. Fu, Y. Zhang and Z. J. Peng, *Chem. Sci.*, 2018, **9,** 1574–1585.

S7 X. Zhou, J. Jin, X. J. Zhu, J. Huang, J. G. Yu, W. –Y. Wong and W. –K. Wong, *J. Mater. Chem. A*, 2016, **4,** 5282–5287..

S8 J. Jin, J. G. Yu, G. Liu and P. K. Wong, *J. Mater. Chem. A*, 2013, **1**, 10927–10934.

S9 X. -L. Yin, G.-Y. He, B. Sun, W.-J. Jiang, D.-J. Xue, A.-D. Xia, L.-J. Wan and J.-S. Hu, *Nano Energy*, 2016, **28,** 319−329.

S10 X. L. Fu, L. Zhang, L. H. Liu, H. Li, S. G. Meng, X. G. Ye, and S. F. Chen, *J. Mater. Chem. A*, 2017, **5,** 15287–15293.

S11 D. Lang, T.T. Shen and Q. J. Xiang, *ChemCatChem*, 2015, **7**, 943 – 951.

S12 H. Park, D. A. Reddy, Y. J. Kim, S. H. Lee, R. Ma and T. K. Kim, *Chem. Eur. J.* 2017, **23**, 13112-13119.

S13 Y. Li, L. L. Wang, T. Cai, S. Q. Zhang, Y. T. Liu, Y. Song, X. Dong, and L. Hu, *Chem. Eng. J*,. 2017, **321**, 366–374.

S14 C. Feng, Z. Y. Chen, J. Hou, J. Li, X. B. Li, L. K. Xu, M. X. Sun and R. C. Zeng, *Chem. Eng. J.*, 2018, **345**, 404-413.

S15 D. A. Reddy, H. Park, R. Ma, D. P. Kumar, M. Lim and T. K. Kim, *ChemSuSChem*, 2017, **10**, 1563-1570.

S16. S. Tso, W. –S. Li, B. –H. Wu and L. –J. Chen, *Nano Energy*, 2018, **43**, 270-277.

S17. H. F. Lin, Y. Y. Li, H. Y. Li and X. Wang, *Nano Res.*, 2017, **10**, 1377-1392.

S18 T.F. Wu, P. F. Wang, J. Qian, Y.H. Ao, C. Wang and J. Hou, *Dalton Trans.*, 2017, **46**, 13793–13801.

S19 Z. P. Yan, Z. J. Sun, X. Liu, H. X. Jia and P. W. Du, *Nanoscale*, 2016, **8**, 4748-4756.