Solar-driven direct Z-scheme using hierarchical CdS/SiC heterostructure for enhanced photocatalytic water splitting

Mohsen Bayat, Master's Student, Department of Chemistry,
Khajeh Nasir Toosi University of Technology (KNTU), Iran

Abstract

Due to the increasing human need for energy, science is moving towards finding a sustainable and clean alternative to meet the world's energy needs; and among these, Photoelectrochemical and Photocatalytic Water Splitting is the best eco-friendly option!

To attain an acceptable performance from overall water splitting, a photocatalyst must have a suitable band structure with sufficient redox power, and also definitely must have a high separation efficiency for photogenerated charge carriers, and have a sufficient number of active sites. But there are few photocatalysts that have all of these basic properties; However, a suitable and easy solution to achieve the photocatalytic reaction of this is to use the direct Z-scheme structured from two semiconductor photocatalysts.

When CdS and SiC are in contact, the transfer of free CdS electrons to SiC begins immediately and continues until their Fermi levels are balanced. Therefore, in the interface of these two semiconductors, CdS will have a positive charge, and SiC will have a negative charge. Hence, an internal electric field is created and causes the band edge bending. After excitation by incoming light, both photocatalysts have the ability to create electron-hole pairs. The formation of this internal electric field forms a passage for the recombination of electrons photogenerated in the CdS conduction band and holes photogenerated in the SiC valance band, and a barrier to the transfer of photogenerated electrons from the CdS CB to the SiC CB, as well as the barrier to the transfer of photogenerated holes from SiC VB to CdS VB. Meanwhile, the electrons of the CdS CB and the holes of the SiC VB are conserved and spatially separated and can participate in specific photocatalytic reactions.

The photocatalytic performance direct Z-scheme photocatalysts depend on their morphology. studies have shown that hierarchical structure photocatalysts have the best form; Large specific surface area, sufficient porous structure, more surface-active sites, and better mass transfer.

Image

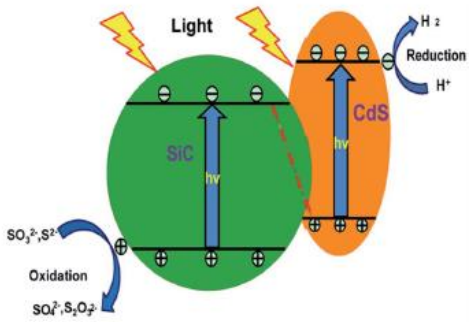


Figure 1. Schematic illustrations of the mechanism over direct Z-scheme CdS/SiC photocatalysts

Recent Publications (minimum 5)

1. Xu, Quanlong, et al. "Direct Z-scheme photocatalysts: Principles, synthesis, and applications." Materials Today 21.10 (2018): 1042-1063.
2. Peng, Yuan, et al. "Enhanced photocatalytic H_2 evolution over micro-SiC by coupling with CdS under visible light irradiation." Journal of Materials Chemistry A 2.18 (2014): 6296-6300.
3. Liu, Jianjun, Bei Cheng, and Jiaguo Yu. "A new understanding of the photocatalytic mechanism of the direct Z-scheme gC_3N_4/TiO_2 heterostructure." Physical Chemistry Chemical Physics 18.45 (2016): 31175-31183.
4. Zhang, Li J., et al. "Highly efficient CdS/WO_3 photocatalysts: Z-scheme photocatalytic mechanism for their enhanced photocatalytic H_2 evolution under visible light." ACS Catalysis 4.10 (2014): 3724-3729.
5. Li, Xin, Jiaguo Yu, and Mietek Jaroniec. "Hierarchical photocatalysts." Chemical Society Reviews 45.9 (2016): 2603-2636.



Biography

Mohsen Bayat is a master's student in Analytical Chemistry at the Khajeh Nasir Toosi University of Technology (KNTU: The Oldest Technical University in Iran). His main research interest and also master's thesis is in the fields of Photoelectrochemistry, Photocatalyst, Semiconductors, and Nanotechnology. Therefore, his research focus is on integrating theory and experiment with the design and fabrication of photoelectrodes for use in Photocatalytic and (Photo)electrochemical Water Splitting.

Email: mohsenbayatchem@gmail.com