Synthesis of four-phase composite Janus particles (CoPi/)$BiVO_4$/CdS(/MoS_2) by sequential layering deposition for visible-light photocatalytic water-splitting

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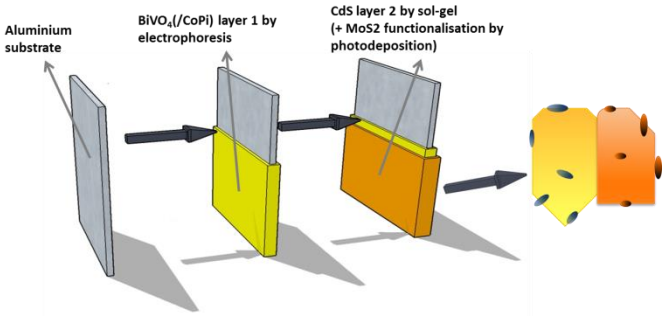
Abstract

A composite assembly (from two to four-phases material) of (CoPi/)$BiVO_4$/CdS(/MoS_2) in the form of Janus nanoparticles was synthesised by a novel sequential layering deposition technique with high versatility. The structure aimed at combining the benefits of different materials synergies to enhance their photocatalytic activity towards visible-light water-splitting from the pure, neutral pH suspension without sacrificial reagents.

A thin film of $BiVO_4$ nanoparticles (optionally pre-functionalised with 1 wt% of photodeposited surface co-catalyst CoPi) was first deposited on an Al substrate via electrophoretic drift in iodine-acetone media, followed by a second thin layer of drop-casted CdS sol with surface stabilising additives. The CdS sol was then reacted in-situ to form an intimate junction with the $BiVO_4$ seed layer, subsequently recovered as a composite powder by rubbing, and further annealed under inert atmosphere to tune its crystallites phase and size for improved photocatalytic activity. An additional photodeposition of 1 wt% MoS_2 as surface co-catalyst was also tested, achieving the four-phase composite powder.

The products were studied by traditional characterisation techniques: SEM, EDX, XRD, DRS, and BET; and the photocatalytic activity assessed by online gas chromatography. The apparent quantum yields of each material combination were compared, which gave experimental proof of the validity of the system and of its novel layer-to-powder synthesis concept for high versatility Janus particles preparation.

Image



Recent Publications

1. Kudo, A. and Y. Miseki (2009). "Heterogeneous photocatalyst materials for water splitting." Chemical Society Reviews 38(1): 253-278.
2. Wu, X., J. Zhao, et al. (2017). "Carbon dots as solid-state electron mediator for BiVO4/CDs/CdS Z-scheme photocatalyst working under visible light." Applied Catalysis B: Environmental 206: 501-509.
3. Bao, S., Q. Wu, et al. (2017). "Z-scheme CdS-Au-BiVO4 with enhanced photocatalytic activity for organic contaminant decomposition." Catalysis Science & Technology 7(1): 124-132.
4. Yan, H., J. Yang, et al. (2009). "Visible-light-driven hydrogen production with extremely high quantum efficiency on Pt–PdS/CdS photocatalyst." Journal of Catalysis 266(2): 165-168.
5. Martinez Suarez, C., S. Hernández, et al. (2015). "BiVO4 as photocatalyst for solar fuels production through water splitting: A short review." Applied Catalysis A: General 504: 158-170.



Biography

Bertrand Rome is a final year Ph.D. Student at the Energy Safety Research Institute in Swansea University. His present research focus is in hydrogen production from sun-light and water, using multi-phase materials active for visible-light photocatalytic water-splitting. With a broader interest in renewable energies, he has previously achieved Master in Chemical and Materials Engineering in co-diploma at the Université Libre de Bruxelles (ULB) and the Vrije Universiteit Brussel (VUB). He also conducted earlier a photochemistry research project in Lisbon at the UNL-FCT on self-assembly of gold-based supramolecular hydrogels.

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