Development of Semiconductor Nanomaterial based Heterostructures for Photocatalytic Applications

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ABSTRACT

Design and fabrication of artificial catalytic systems to mimic natural photosynthesis which can harvest solar energy and directly convert into usable or storable energy resources may resolve the global energy and environment crisis. Remarkably, photocatalysis is an efficient approach to utilize solar photons in order to drive the thermodynamic uphill reaction to generate chemical fuels H_2 and O_2 by water splitting in presence of efficient photocatalyst. In this regards, Bi-based semiconductors are focused as photocatalyst due to low cost, nontoxic, facile synthesis, interesting optoelectronic and physicochemical properties. As single semiconductor could not meet all the stringent requirements for water splitting under visible light, development of new functional semiconductor based hybrid materials and understanding of interfacial band edge energetics have been studied in this thesis work, which are useful for photocatalytic and photoelectrochemical solar fuel H_2 generation. The coupling of two materials as a semiconductor heterostructures is an effective strategy to increase charge separation efficiency and lowering the fast electron-hole recombination by allowing multiple active sites and thereby improve their solar light harvesting efficiency. The conventional heterostructures of Type-II, Schottky junction, p-n junction and advanced type direct and indirect Z-scheme heterostructures have been developed by facile methods and studied their physical, morphological, optical and electrochemical properties and finally the charge transfer mechanisms through the junction interfaces are proposed. Therefore, the present work will be focused to introduce a stable, reusable, nontoxic, cost effective and visible light active Bi-based heterostructures as photocatalysts for the environmental remediation and renewable energy production.

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