INVESTIGATIONS TO ENHANCE THE STABILITY & PERFORMANCE OF NANOSTRUCTURED MATERIALS FOR PHOTO-ELECTROCHEMICAL WATER SPLITTING APPLICATIONS

Abstract

The thesis describes the importance of solar energy conversion, which can be efficiently harvested in the form of H₂ fuel via photoelectrochemical (PEC) water splitting application. The aim of this thesis is to obtain suitably designed nanostructures to prevent photocorrosion and enhance the performance of the metal oxide and metal sulphide semiconductors by fabricating composite and core/shell semiconductor heterostructures. MoS₂/rGO as a co-catalyst with Cu₂O is studied to reduce the rate of recombination of photogenerated charge carriers in Cu₂O and provide an electron-rich environment to the system and inhibit photocorrosion. It results in a 26-fold higher photocurrent density compared to the bare catalyst Cu₂O, making the photocatalyst more attractive for water splitting applications. VS₄-MoS₂-rGO composite heterostructures have been studied for photoelectrochemical water splitting application. The ternary composite has 4.5 times higher photoelectrochemical activity and stability as compared to the bare photocatalyst (VS₄). Rod-like Cu₂O with core/shell heterojunction of NaNbO₃-SnS₂ have been designed to yield NaNbO₃/SnS₂/Cu₂O heterostructure for highly efficient photogenerated electron-hole pair separation which helps to improve the overall photoelectrochemical activity as well as enhanced stability of the photocatalyst, Cu₂O. The Type-II band alignment formed in the heterojunction allows for a high charge transfer rate at the interface of the heterojunction, which helps to prevent photocorrosion and extends the absorption spectrum from UV to visible. The activity of the resulting heterostructure (NaNbO₃/SnS₂/Cu₂O) is greatly enhanced, with nearly 32 times higher activity than the bare Cu₂O as shown by the LSV data and the stability of the photocatalyst revealed by transient photocurrent response measurement.