Photoelectrochemical (PEC) water splitting is a promising technology for solar hydrogen production to build a sustainable, renewable and clean energy economy. Although significant progress has been made over the last four decades, the development of efficient, long-time stable, scalable, and cost-effective photoanodes has remained one of the key challenges for the practical application of hydrogen production purposes. Recently, semiconductor photoanodes have emerged as a new generation of photoactive materials for artificial photosynthesis owing to their capability of sun light photo-charge generation and catalytic properties.

The major challenge in water splitting process is the oxidation part of the chemical reaction. So far, extensive research has been devoted to prepare efficient photoanodes based on semiconductor materials. However, most of them suffer from low absorption efficiency, charge transfer limitations, environmental incompatibility, slow surface kinetics and cost effective issues. Here, we discuss the use of some semiconductor photoanodes such as Fe2O3, Wo3 and BiVO4 as photoanodes for photoelectrochemical water splitting purposes. We provide some promising modifications and material design strategies used in our recent researches to improve photocatalytic activity of these photoanodes. The improvement designs focus on electro-catalysts surface modification, plasmonic improvement and heterojunction composites.