

Inorganic semiconductor photocathodes toward efficient and durable photoelectrochemical water splitting

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Photoelectrochemical(PEC) water splitting has received considerable attention as a promising way for producing eco-friendly and sustainable hydrogen since it was observed by Fujishima and Honda in 1972 [1]. In the PEC water splitting, inorganic p-type semiconductors have been widely used to implement photocathodes for generating hydrogen because minority carriers in the p-type semiconductor easily move to the water interface, enabling to split water to the hydrogen. There are some prerequisite for the inorganic p-type semiconductors to generate hydrogen in the PEC water splitting [2]. First, its conduction band energy level should be lower than one for the hydrogen evolution reaction. Second, it should be visible light responsive to utilize the sufficient sunlight. Finally, it should be stable in the aqueous solution. Therefore, many researchers are focusing on the investigation of the suitable inorganic p-type semiconductors that meet these conditions.

In this presentation, two inorganic p-type semiconductors will be introduced in terms of the stability and the efficiency: one is lanthanum iron oxide (LaFeO₃) and the other is amorphous silicon (a-Si). LaFeO₃ is a perovskite semiconductor with a 2.1~2.4 eV of band gap, suitable band position for water splitting and excellent stability in the aqueous solution [3,4]. The LaFeO₃ photocathodes is fabricated by the sputtering deposition and the post annealing process. It shows the stable PEC performance in the strong alkaline solution, hence it paves the way for the development of the durable PEC water splitting system. On the other hand, a-Si is an inorganic semiconductor with a 1.6~1.8 eV of band gap, high light absorption coefficient and optimal band alignment for PEC water splitting [5,6]. It is possible to absorb the plenty of visible light due to the small band gap, allowing to the improved PEC performance. Finally, the a-Si photocathodes with a p-i-n junction, TiO₂ protection layer and platinum hydrogen evolution reaction catalysts show the significant improved PEC performance.

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