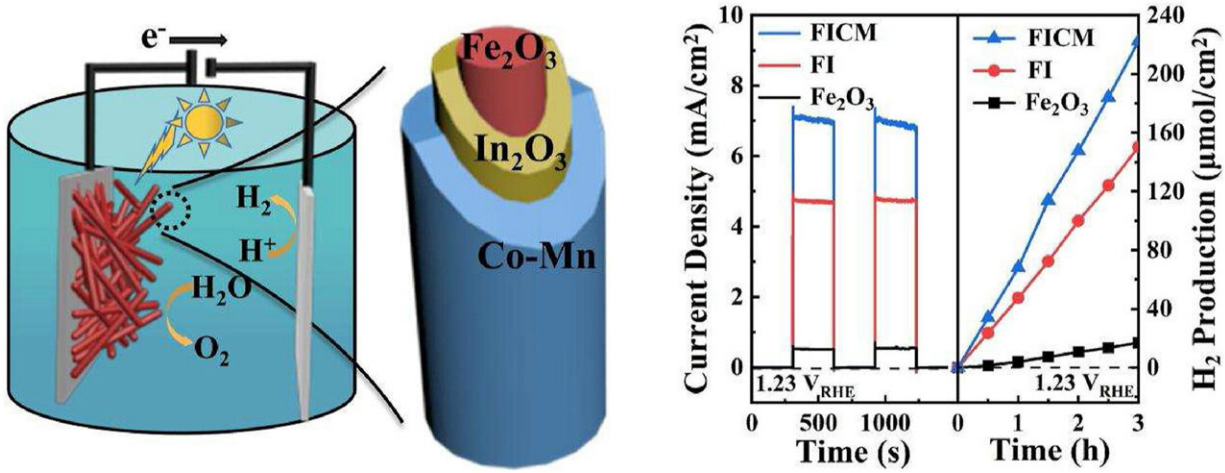
Photoanode with multilayered nanostructure developed for efficient photoelectrochemical water splitting

September 5 2023, by Liu Jia



Credit: *International Journal of Hydrogen Energy* (2023). DOI: 10.1016/j.ijhydene.2023.08.061

Hematite (α-Fe_2O_3) is considered one of the most promising materials for photoelectrochemical (PEC) water splitting under solar light. However, the drawbacks of lower charge transfer efficiency and slow oxygen evolution reaction (OER) kinetics limit the practical application of α-Fe_2O_3 photoanodes. Therefore, efforts have been made to promote the PEC properties of α-Fe_2O_3, such as elemental doping, morphology modulation, and construction of heterojunctions.

In a study published in *International Journal of Hydrogen Energy*, the research group led by Prof. Lu Canzhong from the Fujian Institute of Research on the Structure of Matter of the Chinese Academy of Sciences reported a novel α-Fe_2O_3 photoanode with multilayered In_2O_3/Co-Mn nanostructure for efficient photoelectrochemical water splitting.

The researchers synthesized α-Fe_2O_3 nanorod arrays using classic hydrothermal methods, followed by a layer of In_2O_3 nanolayers covered on the α-Fe_2O_3 using wet chemical deposition, and ultimately covered with a layer of nanosheet combining ultrathin non-crystalline $Co(OH)_x$ and Mn_3O_4 nanocrystals (Co-Mn nanosheet coating) using electrodeposition.

By linear sweep voltammetry (LSV) testing, the researchers found that the high photocurrent density of In_2O_3/Co-Mn modified α-Fe_2O_3 photoanode is 13.8 times that of ordinary α-Fe_2O_3 materials. They also tested the efficiency of incident photons photocurrent(IPCE), and found that the IPCE value of pristine α-Fe_2O_3 at an incident light wavelength of 400 nm is only 9.5 %, and the IPCE value of In_2O_3/Co-Mn modified α-Fe_2O_3 photoanode is 57.9 %.

In addition, they evaluated the H_2 production rate. The In_2O_3/Co-Mn modified α-Fe_2O_3 photoanode production reached 74.10 mmol/cm^2/h, which was 13.12 times higher than the α-Fe_2O_3 photoanode.

The researchers also revealed that the loading of In_2O_3 nanolayers significantly improves the photoelectrochemical water oxidation activity of α-Fe_2O_3 nanorods. The heterojunction formed by the In_2O_3 passivation layer and α-Fe_2O_3 effectively promotes charge separation, increasing photocurrent density.

The Co-Mn nanosheet coating loading helps improve the water oxidation

performance of α-Fe_2O_3, and this multi-layer structure enables efficient photoelectrochemical water decomposition of α-Fe_2O_3 nanorods.

More information: Ming-Hao Ji et al, A novel α-Fe2O3 photoanode with multilayered In2O3/Co–Mn nanostructure for efficient photoelectrochemical water splitting, *International Journal of Hydrogen Energy* (2023). DOI: 10.1016/j.ijhydene.2023.08.061

Provided by Chinese Academy of Sciences