ENHANCED PEC WATER SPLITTING ACTIVITY OF HEMATITE PHOTOANODES DEPOSITED BY ADVANCED PLASMA-ASSISTED METHOD

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Abstract

Hematite, α-Fe2O3, is considered as one of the most promising materials for sustainable hydrogen production via photoelectrochemical water splitting with a theoretical solar-to-hydrogen efficiency of 17%. However, the poor electrical conductivity and short diffusion length of photogenerated holes are substantial limitations reducing hematite's efficiency in real experimental conditions. Despite of computing models suggesting that the electrical conductivity is extremely anisotropic, revealing up to four orders of magnitude higher electron transport with conduction along the (110) hematite crystal plane, synthetic approaches allowing the sole growth in that direction have not been reported yet. We present a new strategy for controlling the crystal orientation of very thin hematite films during advanced pulsed reactive magnetron sputtering technique. Another way to significantly enhance the photoeficiency is a passivation of surface states acting as traps by isocrystalline overlayers. Highly active hematite films fabricated by plasma deposition were thus in the next stage covered by ultra-thin (< 2 nm) alumina films using the atomic layer deposition (ALD) method. The effect of plasma deposition modes, hematite texture, and the alumina passivating films on the properties of hematite photoanodes were monitored by XRD, conversion electron Mössbauer spectroscopy, XPS, SEM, AFM, PEC water splitting, IPCE, transient photocurrent measurements, and Mott-Schottky analysis.

Keywords: PEC solar water splitting, hematite Fe2O3, thin films, HiPIMS

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