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Ni-decorated $CaTiO_3/WO_3/BiVO_4$ layered photoanodes for photoelectrochemical applications

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The development of photoactive materials in the anode of electrochemical cells has the potential to decrease the overall energy consumption of the system by providing an extra flow of electrons to the cathode [1]. In this regard, the use of semiconductors such as BiVO4 may improve light absorption [2], thus enhancing the use of incident light in photoelectrochemical (PEC) systems. Moreover, considering the high energy consumption of the Oxygen Evolution Reaction (OER) [3], Ni-decorating strategies might help reducing the required overpotential, which can also result in improved kinetics for water oxidation [4]. Hence, this work convers the development of layered Ni-based $BiVO_4$ photoanodes for an enhanced PEC activity under solar light for water splitting and CO_2 reduction to renewable energy carriers (RECs).

The layered photoanodes are prepared with an optimized automated spray pyrolysis echnique, where $BiVO_4$ is coated onto Fluorine Doped Tin Oxide (FTO) supports. The photoanodes are decorated with commercial Ni nanoparticles with different loadings (0.5-1 mg cm^{-2}). Different electrode configurations are proposed for an enhanced PEC performance, including the manufacturing through independent layer-by-layer deposition or physical mixing between $BiVO_4$ and Ni, as well as adding other layers such as WO3 and perovskites for an improved performance [2].

The PEC characterization of the surfaces includes chronoamperometries analyses with and without visible light, as well as electrochemical impedance spectroscopy measurements to study charge transfer resistance and charges recombination. The performance in continuous mode is then evaluated in a photoanode-driven divided filter-press PEC reactor under visible light irradiation (100 mW cm^{-2}), with a platinized titanium plate as the dark cathode for hydrogen production and an aqueous solution of 0.5 M $KHCO_3$ as the electrolyte. The use of simulated sunlight and concentrated light (> 1 sun) is also considered, seeking to improve the overall energy efficiency of the process. Finally, after testing and optimizing the photoanodes for solar water splitting, the surfaces are used in the conversion of CO_2 to RECs.

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