Unveiling Morphology-Structure Interplay on Hydrothermal WO3 Nanoplatelets for Photoelectrochemical Solar Water Splitting

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In today's society, energy is crucial in our daily lives and our reliance on traditional energy sources such as fossil fuels are placing an increasing strain on their availability. Climate change due to greenhouse gas emissions imposes an imperative shift to renewable sources. Europe is currently adopting the green-H_2 strategy, which will become an important building block of the future infrastructure for converting solar energy into fuel/electricity. Photoelectrochemical cells (PECs) devices for water splitting and H_2 production, is one of the most promising ways for converting solar energy into hydrogen fuel. A PEC cell comprises a semiconductor (photoanode) and a metallic counter electrode, both immersed in a water-based electrolyte [1,2]. When illuminated, it initiates the electrolysis process, splitting the water into O_2 and H_2 [2]. For this technology to be economically viable, the photoanodes must meet specific criteria, including chemical stability, cost-effective production, non-toxicity, scalability, and efficiency. In this work we present a seed layer-free hydrothermal synthesis approach [3] for tungsten oxide (WO_3) nanoplatelet photoanodes aimed at enhancing PEC water splitting performance. By systematically optimizing synthesis parameters - temperature, time, and number of layers - we achieved significant improvements in photocurrent, with a 5-layer sample showing over 70% enhancement compared to a single-layer counterpart [4]. Structural and morphological features, such as the fractal dimension of nanoplatelets and the emergence of the (220) crystalline orientation, were found to critically influence PEC activity. Rietveld refinement revealed the impact of unit cell expansion and microstrain, while an adapted Mott-Schottky model incorporating fractal geometry further elucidated the role of nanostructure in charge transport. These results underscore the importance of morphology-structure interplay in optimizing WO_3-based photoanodes.

References

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Figures

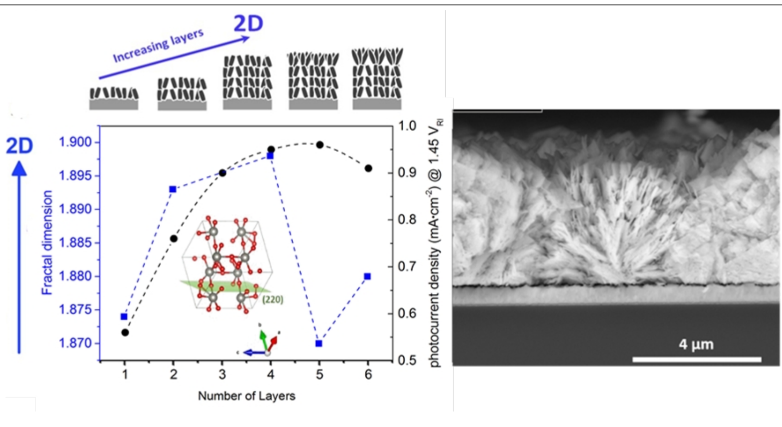

Figure 1: Fractal dimension and photocurrent as a function of number of layers of WO_3 deposited using hydrothermal method repeatedly.