

Temperature control of nanowire/hexagonal prismatic WO₃ structure with a high performance for photoelectrochemical water oxidation

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A photoanode capable of efficiently promoting water oxidation is a key essence for realizing a photoelectrochemical (PEC) water splitting cell for hydrogen production. WO₃ is a promising photoanode for PEC water oxidation due to its high oxidation potential. WO₃ photoanodes with specific nanostructures have been actively studied to improve PEC performance for water oxidation, and there are various ways to control the nanostructure. Recently, we reported efficient visible-light-driven water oxidation on an in situ N₂-intercalated WO₃ nanorod photoanode using hydrazine (N₂H₄).¹ In this report, we demonstrate that nanowire (NW) and hexagonal prismatic (HP) WO₃ photoanodes can be easily produced by controlling the synthesis temperature during the synthesis of WO₃ powder using N₂H₄.

N₂H₄ derived WO₃ ((N₂H₄)WO₃) precursor was synthesized by adding tungstic acid to water at controlled temperatures of 20~45°C and adding N₂H₄·H₂O dropwise with stirring. The (N₂H₄)WO₃ precursor synthesized at 20°C had a nanowire structure, which transitioned to a hexagonal prismatic structure (45°C) as the synthesis temperature was increased (Fig. 1A). The NW-WO₃ and HP-WO₃ photoanodes were prepared by adding the NW- or HP- (N₂H₄)WO₃ precursor to a methanol solution dissolved in polyethylene glycol, coating it on an ITO substrate, and sintering it at 550°C under an oxygen atmosphere. Interestingly, the WO₃ morphology was maintained after calcination. IPCE at 420 nm (47%) was 3.1 times higher than that of the NW-WO₃ photoanode (15%) (Fig. 1B). Electrochemical impedance spectra and X-ray diffraction revealed that the high PEC performance of the HP-WO₃ electrode was attributed to the crystal structure of the HP-WO₃ particle surface.

- 1) D. Chandra, D. Li, T. Sato, Y. Tanahashi, T. Togashi, M. Ishizaki, M. Kurihara, E. A. Mohamed, Y. Tsubonouchi, Z. N. Zahran, K. Saito, T. Yui, M. Yagi, *ACS Sustainable Chem. Eng.* **2019**, *7*, 17896-17906.

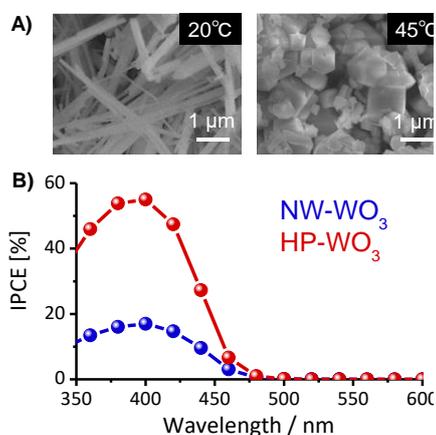


Fig. 1 A) SEM images of precursor (left; 20°C, right; 45°C), B) IPCE curves of NW-WO₃ (blue) and HP-WO₃ (red) in HClO₄ (pH 0) at 1.23 V vs. RHE under light irradiation.