Single-Crystalline $PtTe_2$ for Efficient Ethylene Glycol Oxidation Reaction with Bias-free Solar-to-Hydrogen

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ABSTRACT

My background in materials science and electrochemistry motivated me to pursue sustainable energy technologies that address both global energy demand and environmental challenges. During my studies, I recognized the limitations of conventional water electrolysis, particularly its dependence on freshwater and the sluggish oxygen evolution reaction (OER). Meanwhile, the growing impact of plastic waste, especially PET, highlighted the potential of integrating clean energy generation with carbon-based waste conversion. These interests aligned with the research focus of Prof. Chun-Wei Chen's laboratory, which specializes in photoelectrochemical (PEC) systems, two-dimensional catalysts, and sustainable electrochemical processes. My previous collaboration with Prof. Chen during my master's studies, which resulted in a co-first-author publication in *Journal of Materials Chemistry A*,[1] further strengthened my motivation to continue in this field.

Ethylene glycol (EG), obtainable from PET hydrolysis, serves as an ideal molecule for value-added oxidation.[2] Replacing OER with the ethylene glycol oxidation reaction (EGOR) enables simultaneous hydrogen production and chemical upcycling.[3] My current work focuses on developing catalysts for EGOR in 1 M NaOH + 1 M EG, where the reaction proceeds at much lower potential and produces high-value glycolic acid (GA), confirmed by ^{1}H NMR spectroscopy. Single-crystalline $PtTe_2$ demonstrates excellent EGOR performance with a low onset potential of 0.41 V vs. RHE, along with strong HER activity in acidic media. To improve overall system efficiency, I integrated a $PtTe_2$ anode with a $PtTe_2$/graphene/silicon photocathode to construct a bias-free PEC-EC system. According to Nernst equation, the alkaline-acidic pH gradient provides a built-in 0.83 V potential, enabling photocurrent densities up to 37.8 mA/cm^2 without external bias. Moving forward, I aim to deepen mechanistic understanding and advance PEC-driven plastic upcycling toward scalable solar-to-chemical conversion.

REFERENCES

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