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Technological Features of Creating Hole Structures on the Base of MoS_2 and the Electrochemical Behavior of MXene/Holey MoS_2 Hybrids in Oxygen Reduction Reactions

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Abstract

High-performance noble metal-free two-dimensional (2D) electrochemical catalysts have gained great importance to replace the Pt-based catalysts in oxygen reduction reactions (ORR) to reduce not only the cost of the fuel cells but also enhance the energy efficiency. Herein, we designed a novel ORR catalyst by forming MXene/holey MoS_2 hybrids. The holes were created on the basal plane of MoS_2 both to create electroactive defective regions and enhance the diffusion of the reactants in the catalyst layer. Holey 2D MoS_2 layers were characterized using transmission electron microscopy (TEM), UV-ViS spectroscopy, scanning electron microscope (SEM), and Raman spectroscopy. The TEM images indicated the formation of nano-holes on the basal plane of MoS_2. The increased defect concentration was revealed from the Raman spectra of the samples. The successful synthesis of the V_2C MXene layers was confirmed using SEM and EDS results. The holes created on the basal plane of 2D MoS_2 boosted the electrochemical ORR performance compared to the pristine 2D counterparts, which is attributed to the defect-rich active sites on the edge of the holes and enhanced diffusion of the reactants. In conclusion, our designed MXene/holey MoS_2 hybrid catalyst exhibits superior electrochemical performance in ORR, offering a promising approach for the development of cost-effective and efficient catalysts for fuel cell applications.

Keywords: holey structures, oxygen reduction reactions catalyst, molybdenum disulfide, holey layers

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