Self-standing Molybdenum Sulphoselenide catalyst for electrochemical hydrogen production

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Abstract
Hydrogen (H_2) is a promising clean energy carrier that can mitigate environmental pollution arising from fossil fuels. Among the available production routes, electrochemical water splitting is an attractive pathway for sustainable hydrogen generation.[1] Although platinum-based materials are the benchmark catalysts for the hydrogen evolution reaction (HER), their high cost and scarcity hinder large-scale deployment. Transition metal dichalcogenides (TMDs), such as MoS_2 and $MoSe_2$, have emerged as cost-effective alternatives due to their favourable hydrogen adsorption free energies.[1-3] In this study, we report the synthesis of a self-standing molybdenum sulphoselenide (MoS_xSe_y) catalyst directly grown on carbon fiber paper (CFP) via a facile hydrothermal method. Structural and compositional analyses, including XRD, Raman spectroscopy, XPS, and electron microscopy, confirmed the successful incorporation of selenium into the MoS_2 lattice and revealed a defective, disordered morphology (Figure 1) that facilitates catalytic activity. Electrochemical evaluation in acidic medium demonstrated that MoS_xSe_y/CFP exhibits superior HER activity compared to pristine MoS_2/CFP and $MoSe_2$/CFP, achieving a low overpotential of 174 mV at 10 mA cm^{-2} and a favorable Tafel slope of 46 mV dec^{-1}. Furthermore, the catalyst exhibited excellent long-term stability, retaining its activity after 5000 cyclic voltammetry cycles. These results highlight the crucial role of selenium doping in enhancing electronic structure and active site availability, thereby boosting HER kinetics. The findings suggest that MoS_xSe_y is a promising non-precious catalyst for scalable hydrogen production, offering an effective pathway toward sustainable energy technologies.

References

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Figures

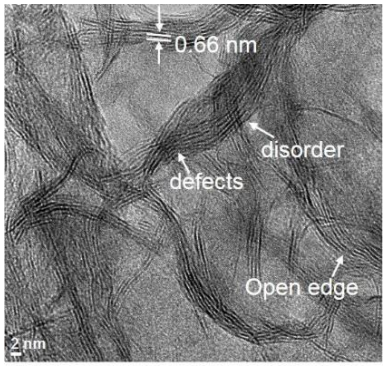

Figure 1: HR-TEM image of MoS_xSe_y catalyst