

Transition Metal Chalcogenides for Hydrogen Evolution Reaction

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Two-dimensional transition metal dichalcogenides (2D-TMDs), such as MoS₂ and WS₂ nanosheets (MeS₂-NS), are reported as efficient catalysts for hydrogen evolution reaction (HER), which can potentially replace the expensive platinum catalyst. We demonstrate a facile and efficient method for the synthesis of a metal-doped WS₂ nanoflower (NF) catalyst. We also report its application for the electrocatalytic HER. The flower-like WS₂ particles were produced by a hydrothermal reaction and the WS₂ was doped with metal chlorides such as AuCl₃, AgCl, PtCl₂, and PdCl₂, followed by reduction with sodium borohydride to form metal-doped WS₂ NFs. The Pd-doped WS₂ NF catalyst showed a high HER performance, having a Tafel slope of 54 mV/dec and an overpotential of -175 mV at -10 mA cm⁻². The improvement is attributed to the energy band alignment near the H⁺/H₂ reduction potential and the large surface area of the WS₂ NFs. In order to remove a heavy metal, 1T phase MeS₂ (1T-MeS₂) NS are synthesized by lithium-intercalation exfoliation method, subsequently being modified by amorphous MoS_x and WS_x (MeS_x@MeS₂-NS) through a solvothermal method. Interestingly, MeS_x@MeS₂-NS significantly improves the HER performance compared with bare MeS₂-NS as catalysts. Among these, MoS_x@MoS₂ is observed to be the best combination for HER, with an onset potential and Tafel slope of 114 mV and 45.1 mV decade⁻¹, respectively. The enhancement in the HER device using MeS_x@MeS₂-NS as the catalyst originates from vertically grown MeS_x, which provides additional active sulfur

sites for the reaction, while inhibiting the restacking of MeS₂-NS. Furthermore, MoS_x@MoS₂-NS shows stable catalytic properties for HER after the 1000 cyclic test, without any observable changes. Thus, this study presents a facile method for the synthesis of 2D-TMD catalyst for HER towards large-scale and long-term stability for practical application.

References

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Figures

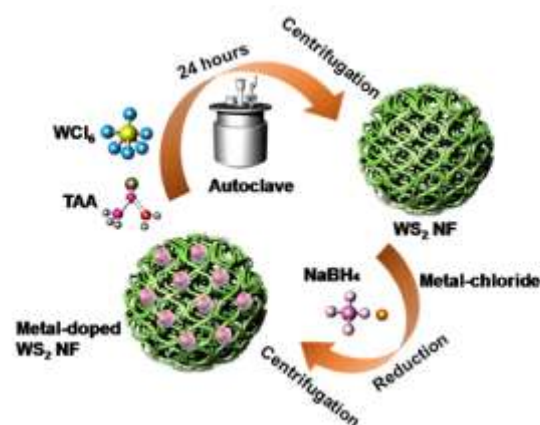


Figure 1: Schematic of the synthesis of WS₂ NFs and metal-doped WS₂ NFs

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