Core Shell Ternary Nanostructures based on Mo(W)S_2 For Hydrogen Evolution Reaction

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Water splitting, a vital process for clean energy production via hydrogen, relies on efficient catalysts. Transition metal dichalcogenides (TMDs), notably MoS_2 and WS_2, have garnered significant interest for their catalytic potential. Specifically, core@shell nanostructures like Au@MoS_2 have demonstrated enhanced activity in the hydrogen evolution reaction (HER) [1-2]. This work delves into the influence of W-based heteroatoms on HER performance within Au@MoS2 nanostructures. Synthesis involved the sodium borohydride reduction method, followed by thorough characterization using XPS and aberration TEM microscopy. Electrochemical analyses, including linear sweep voltammetry, cyclic voltammetry and impedance spectroscopy, were conducted to assess HER efficiency.

The STEM images (**Fig. 1**) vividly illustrate the core@shell structure, with a single Mo(W)S_2 layer enveloping the metallic Au core, indicating excellent crystallinity. Notably, tungsten presence was confirmed through both XPS and EELS analysis. The electrochemical data further underscore the efficacy of these hybrid structures, revealing reduced overpotential and Tafel slope compared to counterparts lacking W-based heteroatoms. Remarkably, the Au@Mo(W)S_2 sample containing a 3% molar ratio of the tungsten precursor, exhibited superior performance (**Fig. 2**).

These findings signify the potential for tailored synthesis strategies to fine-tune catalyst properties, thereby enhancing HER performance. The integration of W-based heteroatoms offers a promising avenue for advancing the efficiency of Au@MoS_2 nanostructures in hydrogen production applications, contributing to the quest for sustainable energy solutions.

References

[1] A.R. Baz-Ziv et al., **ACS Appl. Ener. Matter.** 2, 8, 6043-6050 (2019)
[2] J.J. Quintana Gonzalez et al., **Int. J. Hydrogen Energy.** 51, 371-382 (2024)

Figures

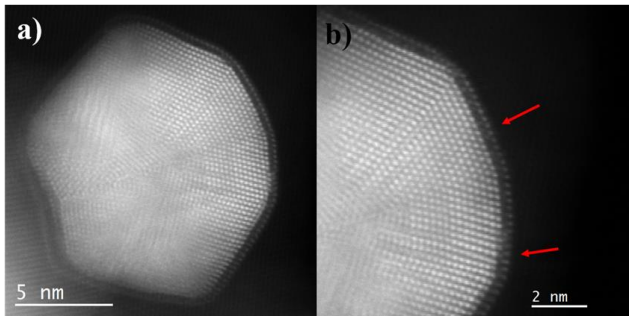

Figure 1: HAADF-STEM images of the Au@Mo(W)S_2 sample. The arrows highlight the presence of the Mo(W)S_2 layer.

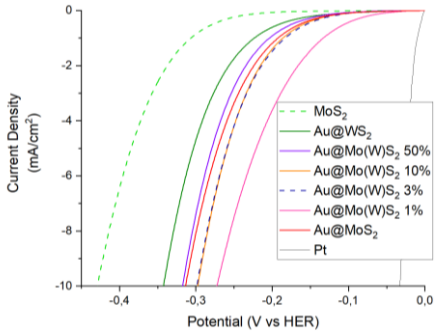

Figure 2: Polarization curves of the core@shell samples with different proportions of dichalcogenides.