Hydrated Tungsten Oxide/Tungsten Disulphide Heterostructures: Synthesis and their Applications in Electrocatalysis

Prasad V Sarma,
Vishnu Sreepal and Manikoth M Shaijumon

School of Physics, Indian Institute of Science Education and Research Thiruvananthapuram, Vithura, Kerala, 695551 India

prasadvs13@iisertvm.ac.in

Abstract

Transition metal dichalcogenides (TMDs) have been of great interest seize the attention of research community in recent times owing to their unique structure and layer dependent properties and have shown great promise for applications in electronics, optoelectronics and energy conversion.[1-2] Heterostructures of TMDs have emerged as a fascinating platform to explore both fundamental and device applications. However, controlled synthesis of layered 2D heterostructures still remains a challenge. Here we report a novel approach towards the synthesis of $WO_3.nH_2O/WS_2$ heterostructures through electrophoretic deposition onto a conducting substrate. We found that these heterostructures can provide catalytic sites with extraordinary electrochemical activity towards Hydrogen Evolution Reaction (HER).[3] We attribute this behaviour towards the larger proton diffusion coefficient of tungsten oxide hydrate and the hydrogen spill over mechanism exhibited by the hybrid catalyst.[4-5] Various factors like hydrogen spill over from $WO_3.nH_2O$ species to WS_2, substrate interaction effect, improved electronic conductivity and induced defects in the lattice during electrodeposition synergistically contribute to the exceptional catalytic activity. The deposited heterostructure offers a high exchange current density of 75.85 μA cm^{-2}, lower onset potential of 83 mV and very low Tafel slope of 47 mV $decade^{-1}$, which makes it a highly promising candidate for electrocatalytic HER.

Figures

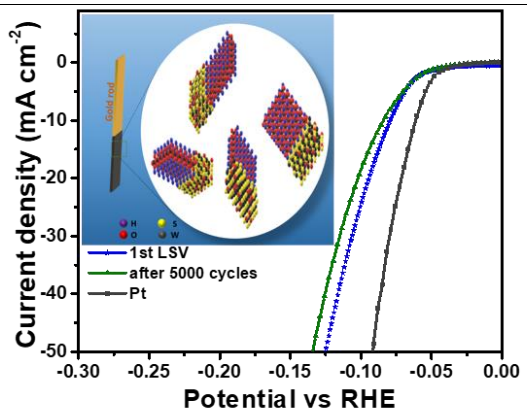

Figure 1: Polarization curves of $WO_3.nH_2O/WS_2$ heterostructure electrocatalyst after 1st and 5000 HER cycles. Inset shows the schematic of Heterostructure.

References

[1] A. Ambrosi, Z. Sofer, M. Pumera, *Chem. Commun* **2015**, 51, 8450.

[2] D. Gopalakrishnan, D. Damien, M. M. Shaijumon, *ACS Nano* **2014**, 8, 5297.

[3] P. Zhou, Q. Xu, H. Li, Y. Wang, B. Yan, Y. Zhou, J. Chen, J. Zhang, K. Wang, *Angew. Chem. Int. Ed.* **2015**, 54, 15226.

[4] B. Kattouf, G. L. Frey, A. Siegmann, Y. Ein-Eli, *Chem. Commun.* **2009**, DOI: 10.1039/B913461A7396.

[5] L. Yang, X. Zhu, S. Xiong, X. Wu, Y. Shan, P. K. Chu, *ACS Appl. Mater. Interfaces*, **2016**, 8, 13966.