Facile Synthesis of TiS₂/CsPbBrI₂ Heterostructures for Hydrogen Evolution Reaction

Hana Khan and Mohammad Zulfequar\*

 **Department of Physics, Jamia Millia Islamia, New Delhi-110025**

 \*Corresponding Author: mzulfe@rediffmail.com

**Abstract**: Hydrogen Evolution Reaction (HER) catalysis is pivotal for advancing sustainable hydrogen production, necessitating the development of efficient and robust materials [1, 2]. In this work, TiS₂/CsPbBrI₂ heterostructures were synthesized and characterized as potential catalysts for HER applications. A solution-phase synthesis method was utilized to create well-defined heterostructures, ensuring a high degree of interfacial interaction and structural integrity.

Comprehensive characterization using X-ray diffraction (XRD), scanning electron microscopy (SEM), and high-resolution transmission electron microscopy (HR-TEM) confirmed the successful integration of TiS₂ and CsPbBrI₂ into a hybrid system with nanoscale precision. Optical properties were analysed via UV-Vis spectroscopy. Electrochemical evaluation i. e. cyclic voltammetry (CV), demonstrated excellent catalytic activity with a low overpotential, high current density, and superior stability under acidic conditions.

The TiS₂/CsPbBrI₂ heterostructures leveraged the synergistic effects of TiS₂’s high conductivity and CsPbBrI₂’s tuneable band structure [3, 4], resulting in efficient charge transfer and enhanced catalytic performance. These results position the heterostructures as promising candidates for next-generation HER catalysts, offering a pathway to scalable and eco-friendly hydrogen production.

References:

1. Cao, Shuang, Lingyu Piao, and Xiaobo Chen. "Emerging photocatalysts for hydrogen evolution." *Trends in Chemistry* 2.1 (2020): 57-70.
2. Lin, Liangxu, Peter Sherrell, Yuqing Liu, Wen Lei, Shaowei Zhang, Haijun Zhang, Gordon G. Wallace, and Jun Chen. "Engineered 2D transition metal dichalcogenides—a vision of viable hydrogen evolution reaction catalysis." *Advanced Energy Materials* 10, no. 16 (2020): 1903870.
3. Nguyen, Thang Phan, Seokhoon Choi, Jong-Myeong Jeon, Ki Chang Kwon, Ho Won Jang, and Soo Young Kim. "Transition metal disulfide nanosheets synthesized by facile sonication method for the hydrogen evolution reaction." *The Journal of Physical Chemistry C* 120, no. 7 (2016): 3929-3935.
4. Ullah, Saad, Jiaming Wang, Peixin Yang, Linlin Liu, Yuqiao Li, Shi-E. Yang, Tianyu Xia, Haizhong Guo, and Yongsheng Chen. "All‐Inorganic CsPbI2Br Perovskite Solar Cells: Recent Developments and Challenges." *Energy Technology* 9, no. 12 (2021): 2100691.