MEP : Non-noble Metal Electrocatalyst for Hydrogen Evolution Reaction in Water Electrolysis

Motivation

"The sun will be the fuel of the future" has long been a dream, and one way to fulfill this dream is by using renewable energy to power our homes and industries, instead of relying on fossil fuels. This includes hydrogen production from solar and wind energy through 'water splitting' into hydrogen and oxygen, a process carried out using electrolysers. However, these electrolysers heavily rely on precious metals such as platinum and iridium to activate the hydrogen and oxygen evolution reactions.

Transition metal dichalcogenides (TMDs), represented by MX_2 (M=Mo, W; X=S, Se, Te), are among the most explored electrocatalysts considered for replacing precious platinum in catalyzing the hydrogen reaction, with MoS_2 being one of the most promising candidates [1]. A recent study conducted by Xie, Wang et al. stated that the tetra-coordinated W_2S_3 outperforms the state-of-the-art Pt in both acidic and alkaline media in terms of activity and stability [2],[3]; however, it still lacks exact synthesis procedures. This project aims to explore the synthesis procedure for Mo_2S_3 and W_2S_3 nanostructures (see right figure). Following successful synthesis, the as-prepared tetra-coordinated sulfides will be compared with their disulfide counterparts and state-of-the-art Pt in acidic and alkaline media based on activity and stability.

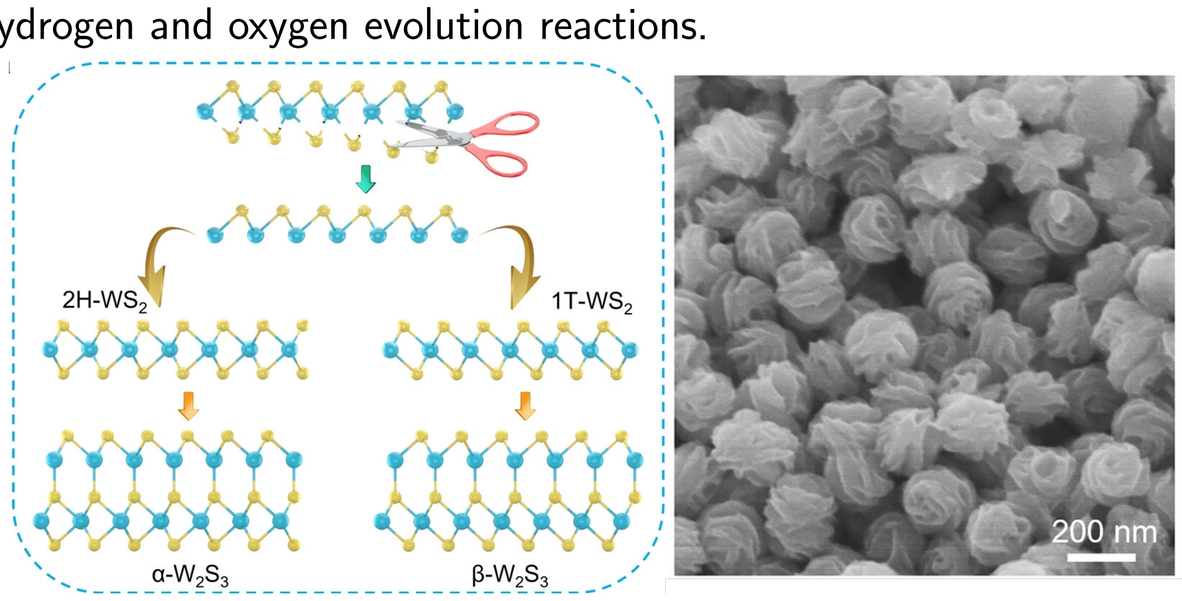

Fig. Design of W_2S_3 structure with SEM micrographs [2]

Objectives

As a master thesis student, you will perform:

- Preliminary synthesis of tetra-coordinated W_2S_3 and Mo_2S_3 nanostructures. This will include hands-on lab work involving organic/inorganic chemical handling and challenging wet chemistry/solid-state synthesis.
- Study the catalyst morphology using characterization techniques such as XRD, XPS, SEM, etc.
- Conduct electrochemical performance tests, primarily focused on activity and stability in acidic and alkaline media. If time permits, perform post-performance catalyst characterization.

Interested?

Are you interested in conducting experimental research and developing your own electrocatalysts? Then contact us at B.S.Chavan@tudelft.nl for more information! The project will be supervised by Bhavesh Chavan and Prof.Dr. Ruud van Ommen, with an expected start date in April 2024, where you will jointly work with PPE, P&E, and other research groups within the university.

References

[1] *Mondal, A., Vomiero, A. (2022b). 2D Transition Metal Dichalcogenides-Based Electrocatalysts for hydrogen Evolution Reaction. Advanced Functional Materials, 32(52). https://doi.org/10.1002/adfm.202208994*

[2] *Xie, Wang et al. (2023b). Tetra-coordinated W_2S_3 for efficient dual-pH hydrogen production. Angewandte Chemie International Edition, 63(5). https://doi.org/10.1002/anie.202316306*

[3] *Zhou, Zhao et al. (2018). Urchin-like Mo_2S_3 prepared via a molten salt assisted method for efficient hydrogen evolution. Chemical Communications, 54(90), 12714–12717. https://doi.org/10.1039/c8cc06714g*

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