**Prof. Dr.-Ing. Harry Hoster**

Lehrstuhl Energietechnik

UNIVERSITÄT DUISBURG ESSEN

Offen im Denken

Die Universität Duisburg-Essen sucht am Campus Duisburg in der Fakultät für Ingenieurswissenschaften, Fachgebiet Maschinenbau, Lehrstuhl für Energietechnik eine:n Studierende:n für eine

**Bachelor thesis**

Effect of the catalyst loading on the non-noble metal carbon-based electrocatalysts for the oxygen evolution reaction and hydrogen evolution reaction

**Task focus:**

Green hydrogen ($H_2$) from water electrolysis is studied for global decarbonization and consequently, mitigation climate change. Electrolysis-based green $H_2$ production for large-scale renewable energy power plants and other industrial and transport applications has become increasingly popular. Electrochemical water splitting consists of two main half- reactions, namely the water reduction hydrogen evolution reaction (HER) at the cathode and the water oxidation oxygen evolution reaction (OER) at the anode.

Your task is to measure the electrocatalytic activity of the electrocatalyst towards HER and OER, to investigate the effect of some parameters on the catalyst activity including the catalyst loading on the surface of the glassy carbon electrode and the amount of ionomer in the suspension.

All of measurements are carried out in alkaline media and with the rotating disk electrode (RDE) technique in three-electrode system. After the measurements and collecting the data, the current density vs potential plot is drawn to compare the activity of the electrocatalysts.

**Methodology:**

- **Preparation of the electrocatalyst suspension:** mixed the exact amount of electrocatalyst with ethanol, milli-Q water and 5% Nafion and sonicate the mixture in the ultrasound to have a humogen suspension.
- **Preparation of electrode:** Clean the working electrode (commonly glassy carbon (GC) electrode) using a series of polishing steps with alumina slurries and rinsing with isopropanol and deionized water.
- **Drop-casting the catalyst suspension on the surface of the working electrode**
- **Electrolyte preparation:** prepare the supporting electrolyte (1.0 M KOH) by dissolving the appropriate amount of the electrolyte salt in milli-Q water.
- **Setup the electrochemical cell:** assemble the three-electrode cell setup, including the working electrode, reference electrode (Reverse Hydrogen Electrode (RHE)), and counter electrode.
- **Purging:** purge the electrolyte solution with oxygen (for OER) or an inert gas (nitrogen or argon) (for HER).
- **Cyclovoltammetry measurements:** perform cyclic voltammetry scans over a specified potential range and scan rate, typically from negative to a positive potential, to observe the electrochemical behaviour of the system.
- **Linear sweep voltammetry (LSV) curve:** by applying the rotation speed of 1600 rpm over a specified potential range and scan rate.

**The evaluation of the HER/OER data:**

- **Analysis of voltammogram:** analyse the cyclic voltammogram to identify the potential region corresponding to HER/OER.
- **Analysis of LSV curve:** analyse the LSV curve to identify the onset potential for the HER/OER.

- **Peak current density:** determine the peak current density, which represents the maximum rate of the given experimental conditions.
- **Determination of HER/OER onset potential:** onset potential is the potential at which hydrogen evolution/oxygen evolution begins.
- **Tafel slope:** analyse the Tafel slope, which is the slope of the Tafel plot obtained from the LSV curve (it releases the logarithm of the current density to the overpotential). The Tafel slope provides information about the reaction kinetics and can be used to assess the catalyst's efficiency in facilitating the reaction.
- **Overpotential:** calculate the overpotential required to achieve specific current densities. Overpotential is the difference between the applied potential and the thermodynamic potential required for the reaction to occur. Lower overpotentials indicate better catalyst efficiency.
- **Evaluation of HER/OER activity:** assess the HER/OER activity of the catalyst by comparing their performance such as onset potential, Tafel slope, and exchange current density.

**Your profile:**

• Ongoing studies in chemistry (water sciences) or chemical engineering at the University of Duisburg-Essen

**Previous knowledge:**

• Experience in chemical laboratories desired

**Date of occupation:**

• Mid-end March, prior meetings and induction period

Please send your application with the usual documents (curriculum vitae and certificates) in digital form to Mrs. Maryam Kazemi at the following email address:

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You can find our current scientific work here:

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