

NIOK Advanced CAIA course

Electrocatalysis – A hands-on workshop

Course content:

Workshop A “Fundamental aspects of electrochemistry and –catalysis; electroanalysis”, Dr. Marta Figueiredo

Workshop A will consist of a set of experiments on oxygen reduction reaction (ORR). The experiments will start with cyclic voltammograms of Pt and Au electrodes for identification of fingerprint voltammetry and comparison of the catalytic activity of the two electrode materials. ORR will be used to explain the rotating ring disk technique and the data analysis will include Koutecky-Levich equation and Tafel slopes.

Workshop B “Spectroscopy/spectroelectrochemistry for electrocatalysis research: a case study”, Dr. Bastian Mei and Dr. Ward van der Stam

In workshop B, the participants will be introduced to several spectroscopy techniques for electrocatalysis research, from theoretical to practical aspects, including vibrational spectroscopy (IR/Raman) and X-ray spectroscopy (XPS/XAS). Afterwards, this knowledge will be applied in a case study, in which the participants will unravel the structure and composition of their virtual catalyst, and the reaction this catalyst is performing, utilizing different spectroscopy, electrochemical and microscopic characterization techniques. This workshop will give the participants solid foundation for using spectroscopy and characterization techniques in their PhD research.

Workshop C “Mass transport in convection-enhanced electrochemical systems”, Dr. Antoni Forner Cuenca

Mass transport processes are at the core of electrochemical technologies for energy conversion and storage (e.g. fuel cells, electrolyzers, redox flow batteries). Understanding and optimizing mass transport processes can enable improvements in performance and thus costs reduction. In workshop C, the students will investigate the role of electrode microstructure on the performance of a redox flow battery with a particular focus on mass transport overpotentials. Electrochemical impedance spectroscopy and polarization will be employed in tandem with diagnostic cells and redox couples with facile kinetics.

Workshop D “Electrochemical cell design”, Dr. Thijs de Groot

Workshop D explores how electrochemical cell design influences the relationship between cell potential and current density for alkaline and anion-exchange membrane water electrolysis. Both finite gap and zero gap cell configurations will be studied. A combination of polarization curve measurements and electrochemical impedance spectroscopy will be used to separate the different contributors to the cell potential, namely the ohmic resistance, the overpotentials and the equilibrium potential. The influence of operating parameters such as temperature and flow will also be measured as a basis for a discussion on what is needed to come to an electrochemical cell with top performance.

Provisional Schedule

Day 1

- 9.30 – 9.45 Welcome and introduction
- 9.45 – 12.45 Practical round 1
- 12.45 – 13.45 Lunch
- 13.45 – 16.45 Practical round 2
- 16.45 – 18.00 Wrap-up day 1
- 18.00 – 21.00 Dinner (Zwart Dos, TU/e Campus)

Day 2

- 9.00 – 12.00 Practical round 3
- 12.00 – 13.00 Lunch
- 13.00 – 16.00 Practical round 4
- 16.00 – 17.00 Wrap-up day 2 and closing remarks