

Electrochemical Reduction of Oxygen on Platinum-Modified Carbon Materials

Summary

This PhD project is concentrated on the selection of sustainably produced carbon materials and heteroatom doping process with the goal to synthesize platinum modified carbon nanomaterials with improved electrochemical activity and stability for fuel cell applications.

Research field:	Chemical and Materials Technology
Supervisor:	Ivar Kruusenberg
Availability:	This position is available.
Offered by:	National Institute Of Chemical Physics And Biophysics
Application deadline:	Applications are accepted between June 01, 2020 00:00 and July 03, 2020 23:59 (Europe/Zurich)

Description

Fuel cells are one of the most promising alternatives to the existing energy generation and storage technologies. Oxygen reduction reaction (ORR) is one of the main and most important reactions in fuel cells. At this time, the most widely used catalyst for ORR is platinum (Pt). As platinum is scarce and has a high market price, it is important to develop novel electrocatalysts for ORR, which would have lower concentration of platinum, increased electrochemical activity and extended stability and lifetime.

The main objective of this doctoral project is to model and design novel platinum-modified carbon materials as possible catalysts for ORR taking place in fuel cells. For this, different sustainably produced nanocarbon materials will be used and doped by different heteroatoms. Heteroatom doping of carbon materials has been shown positively impact the dispersion of platinum nanoparticles on carbon supports. Oxygen reduction reaction measurements will be carried out employing the rotating disk electrode (RDE) method and electrochemical impedance spectroscopy (EIS). This method enables a quick characterization of the initial activity of the electrocatalysts to establish structure-activity correlations in tandem with physical characterization of the catalyst materials. This will then help to direct the research efforts towards optimizing the synthesis conditions. The stability testing is carried out with the most active and promising catalysts. This is important for evaluating the long-term properties of the catalyst and gives more information on the catalyst degradation mechanisms. The catalyst materials that show very good electrochemical activity towards ORR will be also tested in fuel cells.

The main goals of this doctoral project are:

1. Substitute the carbon black materials used commercially as a Pt carrier with a sustainably produced carbon material
2. Increase the uniformity of Pt dispersion by heteroatom doping of carbon materials prior to Pt modification
3. Investigate the electrochemically active sites on these materials and the effect of support material towards the final ORR activity
4. Lower the Pt loading compared to commercially available Pt/C while retaining the ORR activity

Responsibilities and tasks:

- Synthesis of platinum nanomaterial modified carbon catalysts.
- Performing oxygen reduction reaction experiments, stability tests and fuel cell tests.
- Interpretation of physical characterization data.
- Writing of scientific articles.

The applicants should fulfill the following requirements:

- scientific background in physical chemistry, especially electrochemistry and catalysis;
- very good practical skills for working in the laboratory;
- previous experience in synthesis platinum-based catalyst powders;

- experience in using rotating disc electrode method;
- ability to interpret XRD data; motivated to work in a team;
- good writing skills.

Qualifications:

- Applicant should have master's degree in chemistry, material technology, energy technology, sustainability, physics or in similar subject.
- Applicant should be qualified to work in the chemistry lab, with pyrolysis and electrochemical equipment.



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