Electrochemical conversion of CO2 in molten salts

Summary

The aim of this PhD project is to study the low and mid-temperature splitting of CO2 in molten salt mixtures with the aim of creating carbon nanomaterials for electrocatalysis with cheap and available electrodes.

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 November 16, 2020 00:00 and December 16, 2020 23:59 (Europe/Zurich)

Description

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The rising CO2 concentration in the atmosphere and its consequences require a rapid reduction of emissions. It is possible to reduce carbon emissions by merely decreasing the usage of fossil fuels, but the transition to cleaner energy sources is currently clearly too slow. CO2 capture and utilisation is one of the technological solution that can significantly reduce CO2 emissions from the industrial sector in the meanwhile.

The molten salt carbon capture and electrochemical transformation (MSCC-ET) process is one of the proposed methods of splitting CO2 for capturing. In this process, carbon dioxide is split into solid carbon and gaseous oxygen via a molten salt electrolyte. The main objective of this PhD project is to synthesise and characterise the carbon materials created by this method. Thus far, a most of the high purity carbon created by this process has been with expensive, usually noble metal electrodes or on the small scale. In this project, cheap and available electrodes will be used for the creation of the carbon via MSCC-ET. Another important aspect is the utilisation of the carbon product. Here, the main aim will be to use it for electrocatalysis purposes. The MSCC-ET method allows for the tuning of the porosity, degree of graphitisation and morphology of the carbon materials by selection of synthesis conditions. Rationally designing materials for specific electrochemical reactions (aqueous CO2 reduction (CO2RR) and the oxygen reduction reaction (ORR)) will be the main task in this project. The synthesis of carbon materials will be carried out in the Energy Technologies Laboratory using the MSCC-ET method. The rotating disk electrode method (RDE) and electrochemical impedance spectroscopy (EIS) will be used to characterise the resulting materials' activity towards CO2RR and ORR.

The main goals of this doctoral project are:

1. Synthesise high purity carbon via the MSCC-ET method with cheap and available metal electrodes
2. Successfully employ the synthesised material for the CO2RR and ORR
3. Investigate the electrochemically active sites on these materials and the effect of support material towards the final CO2RR and ORR
4. Create relations between the synthesis conditions and the final activity of the material for electrocatalytic purposes

Responsibilities and tasks:

- Synthesis of carbon via the MSCC-ET method, purification the carbon from impurities
- Post-synthesis modification of the carbon by deposition of metal particles or doping
- Performing RDE and EIS experiments
- Interpretation of physical characterization data
- Writing of scientific articles

Qualifications
The applicants should fulfil the following requirements:

- 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 furnaces and electrochemical equipment
- scientific background in physical chemistry, especially electrochemistry and catalysis

- very good practical skills for working in the laboratory
- ability to interpret the results of electrochemical tests and the XRD data
- motivated to work in a team
- good writing skills .

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