CHALMERS

**Division of Material and Computational Mechanics**

# Modeling and Finite Element Simulation of Deformation in a Porous Structural Battery Electrode

## Background

One major challenge on the way towards a carbon-neutral circular economy is to find innovative solutions for a light-weight storage of electric energy. This need gives rise to the development of structural battery composites that combine the functionalities of bearing mechanical loads and storing electric energy in the same device, see Fig. 1.

## Goal

The goal of this thesis project is to model and to simulate the deformation of a (positive) structural battery electrode under combined battery operation and mechanical loading. The electrode consists of carbon fibers that are coated with a porous polymer matrix. Dispersed in the polymer matrix are Lithium-rich particles that serve as Lithium sources. Moreover, the pore space of the polymer matrix is saturated with an ion-conductive liquid electrolyte. In Figure 2, these three phases are visualized as follows: Brown - Lithium-rich particles; Green - Polymer embedding and connecting the particles; Transparent - pore space filled with liquid electrolyte.

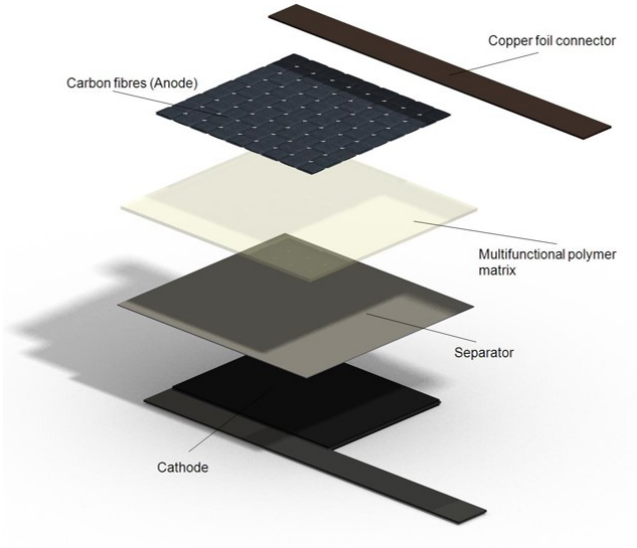


*Figure 1: Schematic illustration: Structural battery laminate*

Your tasks in this project will be:

- Generation of synthetic Representative Volume Elements (RVE) of the three-phase problem for computer simulation
- Modeling and computer simulation of the deformation during battery operation
- Perform a parametric analysis to study the effect of particle volume fraction, pore size, polymer stiffness etc. on stiffness, ionic conductivity and storativity

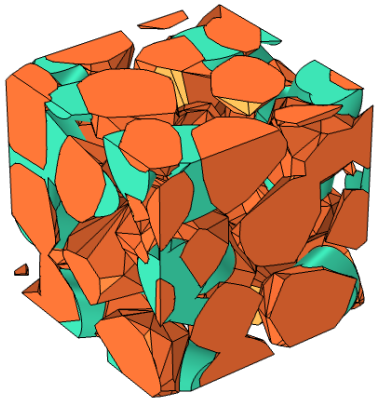

*Figure 2: Synthetic three-phase structure*

## Main steps in the project

- Literature study, theoretical background
- Investigate and implement microstructure generation techniques
- Model development and FE implementation of RVE problems in COMSOL Multiphysics

## Student background

This project is preferably suitable for students with an interest in computational mechanics and the finite element method. The project will give you an understanding in multi-physics modeling and FE simulation. At the same time, the project and its result will be part of current research at the Division of Material and Computational Mechanics.

**Conditions**: The thesis work comprises 30 ECTS and will be conducted during January-June 2021. The project is suitable for individual students or for teams of 2 students.

**Supervisors**:

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