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Master thesis/Studienarbeit

Topology optimization of structural battery electrolyte matrices

Structural batteries can store electric energy while also transferring mechanical loads. Consequently, these batteries have been denoted a massless energy storage [1], which could revolutionize the electric driven transport solutions. However, these batteries do not yet perform equally good as existing batteries. One important limiting factor is that a solid electrolyte matrix must be used, that combine transport of ions with transfer of mechanical load. This project aims to use topology optimization to maximize the permeability of such a porous matrix, while still ensuring sufficient shear stiffness.

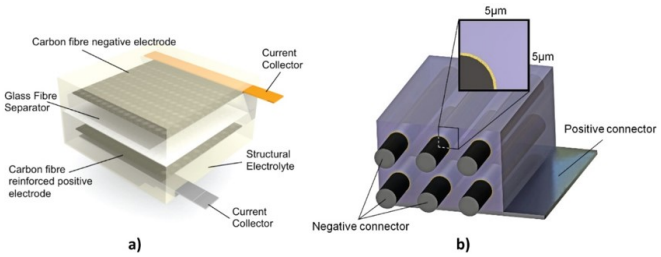

Illustration of the key components of the structural battery [1]

The project will start by formulating the analysis model that can be used to analyze the permeability and mechanical stiffness of a Representative Volume Element (RVE). We will work with the Julia programming language and the finite element library Ferrite.jl. Building on top of the analysis of the fluid-structure interaction, topology optimization can be utilized. This requires investigation of suitable objective functions, filtering techniques and discretization methods.
Prerequisites: Linear Solid Mechanics, Good knowledge of finite elements, Programming experience/interest

Tasks

- Implementation of the fluid and structural finite element models
- Building topology optimization on top of the model
- Investigation of parameters for topology optimization
- Optimization of the matrix electrolyte

References

[1] L. E. Asp, M. Johansson, G. Lindbergh, J. Xu, and D. Zenkert, "Structural battery composites: A review," Funct. Compos. Struct., vol. 1, no. 4, 2019, doi: 10.1088/2631-6331/ab5571.