SEMINAR

APPLIED MATHEMATICS AND MECHANICS

FS1004 27 January 2025

A DCAMM seminar No. 781 will be presented by

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The title of the lecture is

Topology optimization of porous electrodes in flow batteries using multi-scale electrochemical modeling

Abstract:

The urgent need to address global climate change necessitates transitioning to renewable energy technologies, with large-scale energy storage playing a crucial role. Redox flow batteries (RFBs) are a promising class of rechargeable electrochemical systems for grid-level energy storage, leveraging electroactive species dissolved in liquid electrolytes pumped to an electrochemical reactor where they undergo electrochemical reactions on the surface of porous electrodes. Aiming to boost cost-effectiveness, one effective strategy is to increase the stack power density by increasing the efficiency of the electrodes leading to an increase in the overall system performance, which involves balancing high surface area, reduced ohmic drop, facile mass transport, and low pumping power.

My research project TopeSmash aims to develop novel computational models for accelerating the design of porous electrodes and understanding the role of structure in their performance. The project proposes using topology optimization (TO) to design micro-architected variable porosity 3D porous electrodes for RFBs to decrease the power and electrochemical losses across various operating conditions. We have developed high-performance TO frameworks for 3D porous electrodes and multi-physics models of the transport phenomena in next-generation RFBs. The models were developed across various length scales using finite element/volume/difference methods implemented using the open-source codes Firedrake, OpenFOAM, and PETSc and in-house CUDA codes. The resulting TO designs were transformed into cellular architectures using triply periodic minimal surface (TPMS) structures using open-source codes ASLI and CGAL, the output of which was additively manufactured using stereolithography 3D printing to assess the performance of the inversely designed electrodes in a real setup.

In this presentation, I will first discuss the structure of the multi-physics modeling approach. Second, I will present the integration of these models into the TO framework. Finally, I will show the transformation of the TO results into cellular infills.

DATE: **Friday, 7 February 2025**

TIME: **13:00 – 13:45**

PLACE: **Benz Seminar room, (Ø31-605-2), Moseskovvej 72, Odense**
SDU, University of Southern Denmark

REGISTRATION for virtual participation at the following link:
https://syddanskuni.zoom.us/meeting/register/9ek72LyVQIKAW5zylKAqmA

Cake, coffee and tea will be served 15 minutes before the seminar starts.

All interested persons are invited.

Jan Becker Høgsberg