thermal impedance tomography for battery cells

a mathematical approach to find internal thermal conductivities in battery cells

Graduate

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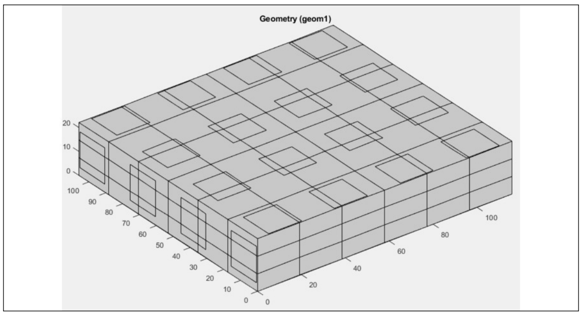
Introduction: Thermal impedance tomography is an imaging technique that allows for the characterization of the internal structure of objects. This is achieved by conducting measurements exclusively at the boundary of the object. By introducing and dissipating heat at external measurement probes, different heat flows are generated within the object. Due to varying thermal conductivity of different materials, the heat flows vary in the measurements. As a result, different temperatures arise at the boundary measurement probes, which can be analyzed. Using the steady-state diffusion equation, along with additional boundary conditions and measurements, the distinct thermal conductivities can be determined locally. Thermal impedance tomography presents an alternative to electrical impedance tomography, focusing on the determination of thermal conductivities within an object's interior. Applications span various fields where thermal conductivity plays a crucial role, such as medicine and battery technology.

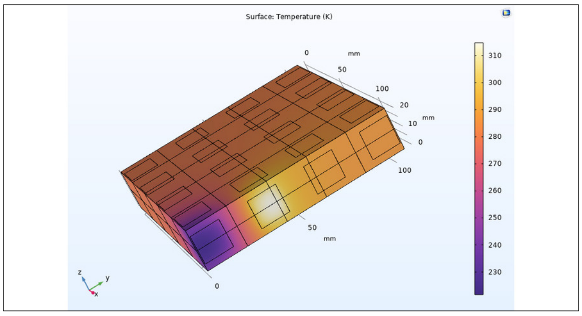
Approach: In this study, the internal thermal conductivities are determined through measurements and the steady-state diffusion equation. Initially, two problem variants are formulated from the steady-state diffusion equation, as certain matrices are provided by COMSOL. These problem variants are discretized and integrated into an objective function along with the measurement results. Finally, suitable thermal conductivities are sought using the Newton-Raphson method. The derived steps are programmed and simulated using MATLAB Livelink and COMSOL. The procedure is then implemented and verified through real measurements.

Result: Simulations to validate the script were successfully conducted. The predetermined thermal conductivities of the virtual objects were achieved in the simulation. Measurements were carried out on an inhomogeneous aluminum block and a homogeneous copper block. These measurements were compared with simulated data and demonstrated similar outcomes. Future simulations and measurements could explore different resolutions of thermal impedance tomography. Additionally, investigating a scenario involving heat sources within the object would prove intriguing.

Geometry with measurement boundaries
Own presentment



Simulation of a measurement where two areas have heat flows
Own presentment



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