Geometric optimization of a Lithium-ion battery model

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Résumé

The homogenized model known as the Newman model - or more precisely, the Doyle Fuller and Newman model (DFN) - serves as the foundation for numerous academic and industrial softwares used to simulate the operation of lithium-ion batteries during charging and discharging. Its multiscale equations, derived from the theory of porous electrodes, form a coupled system of two unsteady diffusion equations for the concentration of lithium in the solid phase and the concentration of ions in the liquid phase. The ultimate objective of our work is to apply geometric and topological optimization tools to the electrode interfaces in order to optimize a performance function calculated using the DFN model. Thus, within this context, we propose here an implementation of the so-called pseudo-3D (P3D) version of the DFN model, which combines finite element and finite difference methods using the FreeFem++ and C++ languages. We discuss the validation methods for our implementation, explain the application of shape optimization tools with interfaces developed in recent years to this model, and present an initial result of geometric optimization of the interfaces between the separator and electrodes during discharge.

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