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Macrohomogenous Li-Ion-Battery Modeling - Strengths and Limitations

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Presented at the STAR Global Conference 2012

With the advent of vehicle electrification, driven largely by advances in Li-ion battery technology, there is an increasing need for the type of predictive simulation tools that are commonplace in the virtual vehicle development process for classical ICE-propelled automobiles, such as crash, aerothermal and combustion simulation. Such tools are necessary in order to make the overall development effort and cost of electric traction systems competitive by reducing the test and design loops.

Aiming to establish a multiscale simulation process chain bridging material, cell, module/component and system scales, physics-based models to simulate mass and charge transport and conversion in Li-ion batteries have been developed over the past decades. They have been implemented in academic as well as commercial codes. To provide engineers with fast yet accurate Li-ion cell design tools macrohomogeneous models, most of them Newman-based and one-dimensional, have emerged. To reflect the complex multiphase transport phenomena in the porous but unresolved electrodes and to be computationally efficient submodels have been realized and effective constitutive relations and material parameters have been utilized.

This presentation highlights the advantages as well as the challenges of macrohomogeneous Li-ion battery simulation in the light of typical model simplifications.

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