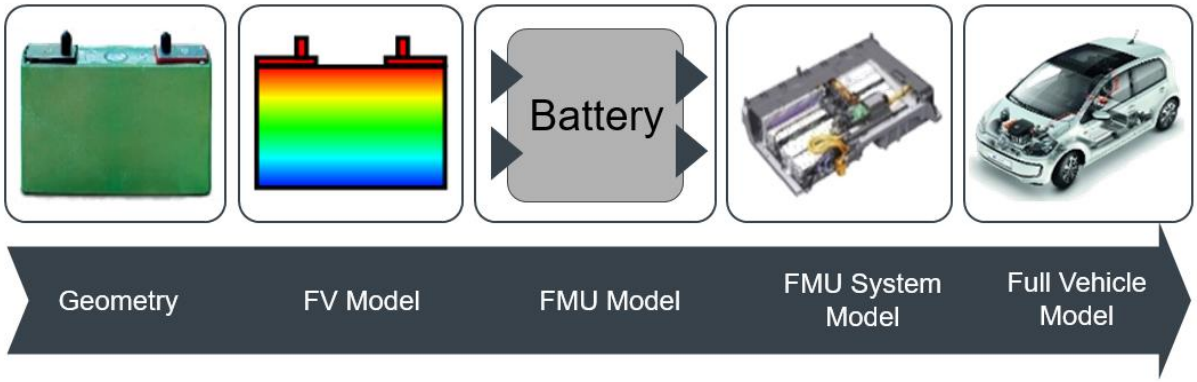
Diagnostics and Management of Hotspots in Battery Systems



Particular Highlight of Application

- Hotspot Detection in Battery Cells Forming a Holistic Battery System
- Real-Time Capability
- Individual Dimensioning of Battery Thermal Management System (BTMS)
- Diagnosable Operating Strategies

Model Rationale

In battery systems of electrified vehicles local overheating zones (so called hotspots) can occur at various points e.g. on contactors, fuses, bus bars, in battery cells or in proximity of exhaust systems for PHEVs. The causes for hotspots can be e.g. an inadequate thermal system design, a cooling system failure, an electric overload or a component defect. Hotspots can lead from losses in system performance, to premature aging of battery cells, to a system failure, all the way to a safety critical thermal run-away of individual cells. Against this background the avoidance of hotspots based on a holistic and consistent thermal design process and online diagnostic systems for the detection of hotspots is aimed.

The temporal and spatial analysis of hotspots in battery cells require a high dimensional dynamical modelling of the individual battery cells forming the battery system. Real-time analysis in combination with launching appropriate countermeasures in automotive applications requires a fast system based modelling.

In order to meet all the requirements the modelling of the battery cells is carried out as coarse-grid FV-Model. The interaction due to the spatial connection of the individual battery cells forming a holistic battery system is carried out using the FMI1.0 or FMI2.0 standard. The resulting individual battery FMUs can be connected and executed as Model Exchange or Co-Simulation FMUs and therefore also integrated in the full vehicle model.

Modelling Overview

- PDE-Semi-Discretization: Finite Volume (Open-Source FV-Solver)
- Physical Domain: Thermal
- Industrial Background: Automotive

Modelling Items

- PDE: FV Model of Battery Cells
- Model Reduction: Mesh, Linear Regression, Proper Orthogonal Decomposition (POD)
- Standardise: FMI1.0/2.0 (ME or Co-Sim)
- System Model: FMI Based Full Vehicle Model

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