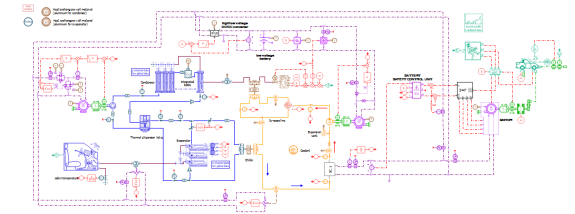
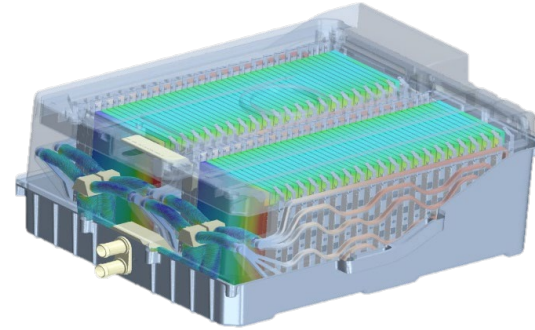
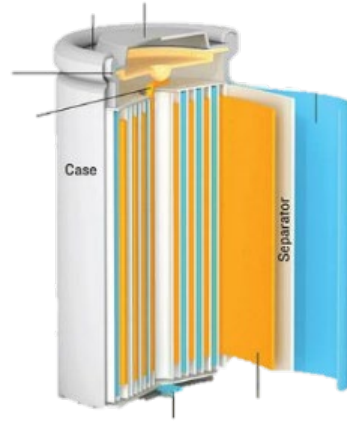
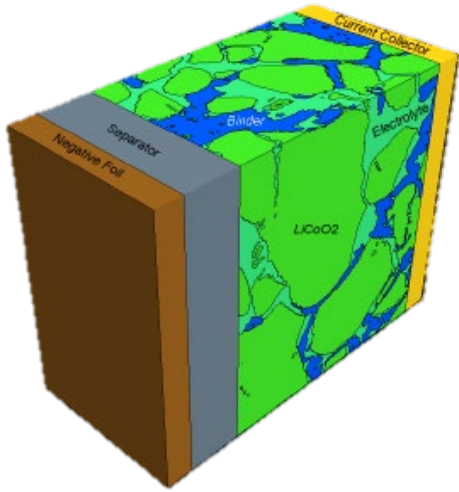




Simcenter Battery Modeling Solutions

The Battery Modelling Process

From micro-structure electrochemistry to cell, pack and system design



Micro-Structure Electrochemistry

Virtually test SEM produced electrode geometry

Conduct design studies on new concepts

Virtual Cell Design/Test

Detailed geometrical representation coupled to performance model to build cell digital twin

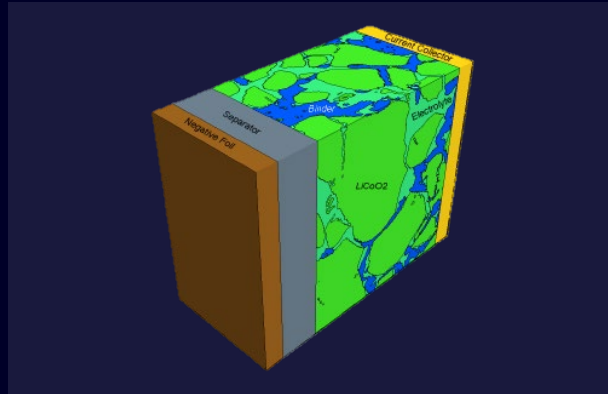
Battery Pack Design

Flow, thermal & electrochemistry analysis of complex power systems
Study detailed spatial effects at cell, module & pack level

System Design

Simulate electrical & electromechanical systems from concept design to control validation

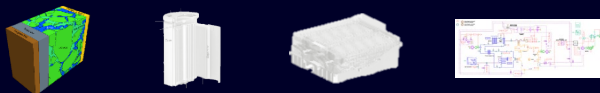
Simcenter STAR-CCM+ Electrode design



Micro-Structure Electrochemistry

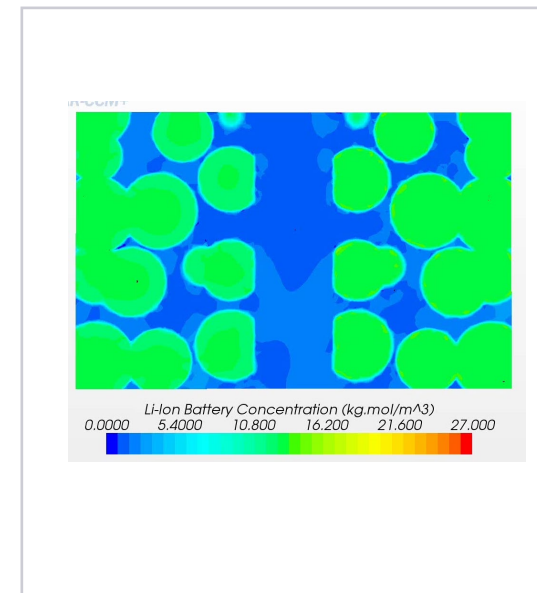
Virtually test SEM produced
electrode geometry

Conduct design studies
on new concepts

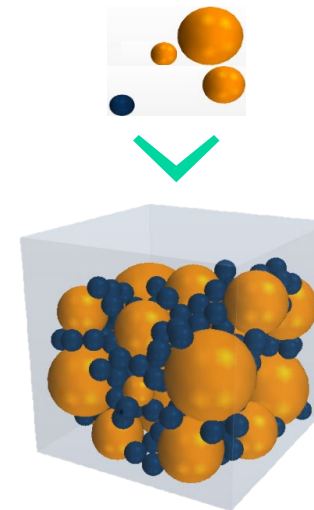


Predict the spatial distribution of ions and potential within an arbitrary, multi-phase micro-structure region

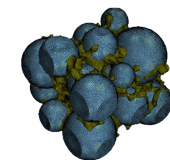
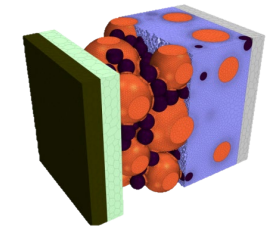
- Electric potential in solid and electrolyte regions
- Salt concentration in electrolyte
- Concentration of Li in active parts of electrode



Active Material



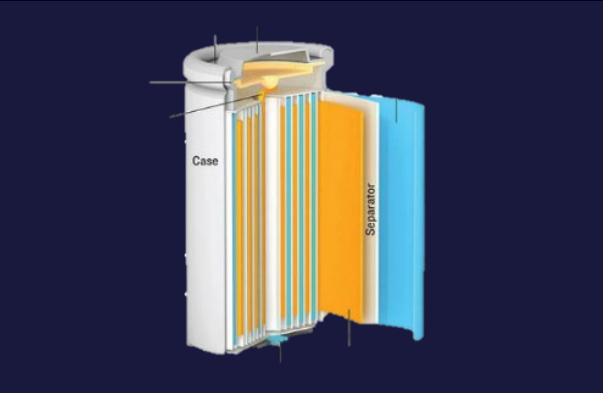
3 Phases model



Use Simcenter STAR-CCM+ CAD
tool to improve binder's realism

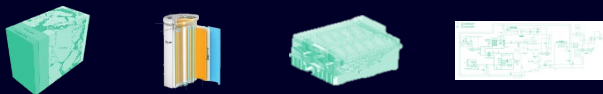
Simcenter Battery Design Studio

Cell design



Virtual Cell Design/Test

Detailed geometrical representation coupled to performance model to build cell digital twin



Design and analyze electrochemical reactions and detailed geometry of battery cells

- Design optimization
- Cell characterization
- Physics-based and equivalent circuit models
- Simulations of: Duty cycles, aging, abuse

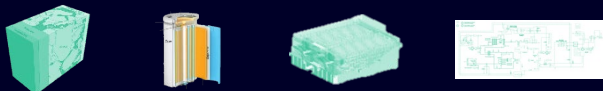
Design

Simcenter STAR-CCM+ Cell design



Virtual Cell Design/Test

Detailed geometrical representation
coupled to performance model to build
cell digital twin

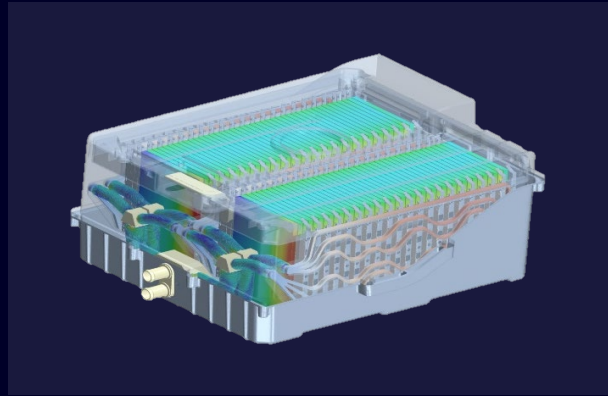


Safety analysis at the cell level including combustion



Simcenter STAR-CCM+ Batteries

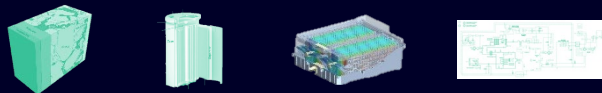
Module and pack thermal design



Battery Pack Design

Flow, thermal and electrochemistry analysis of complex power systems

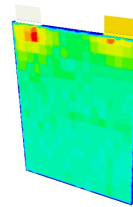
Study detailed spatial effects at cell, module and pack level



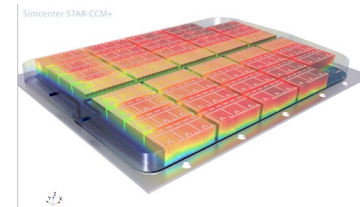
Calculate 3D thermal, fluid and electrochemical properties of battery modules and packs

- **Electro-thermal simulation** through coupled resolution of cell electrochemical behavior with thermal environment
- Computes the **cell heat 3D distribution**
- Resolves **complex cooling system** of various types (air, liquid, multi-phase)

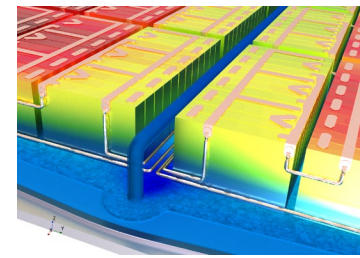
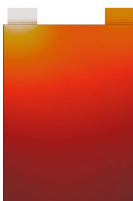
Heat map



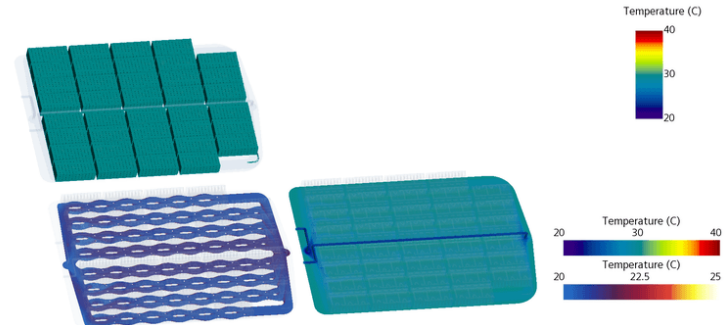
Full pack



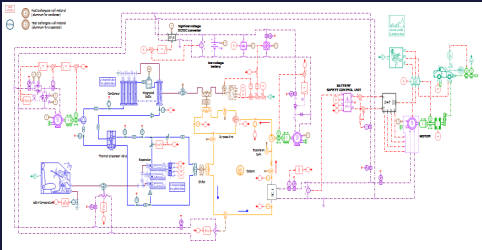
Temperature map



Simcenter STAR-CCM+

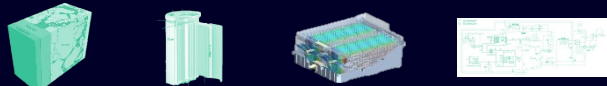


Solution Time 1 (s)



System Design

Simulate electrical and electromechanical systems from concept design to control validation



Assess the energy performance of electrochemical storage systems integrated in xEVs

- Obtain battery performance requirements
- Pre-size the battery pack
- Early battery pack performance validation
- Battery pack requirement validation
- Battery cooling validation
- Aging analysis
- Thermal runaway indication

