

Das Innenleben von Batterien

PD Dr. Birger Horstmann



**Deutsches Zentrum
für Luft- und Raumfahrt e.V.**
German Aerospace Center



ulm university universität
uulm

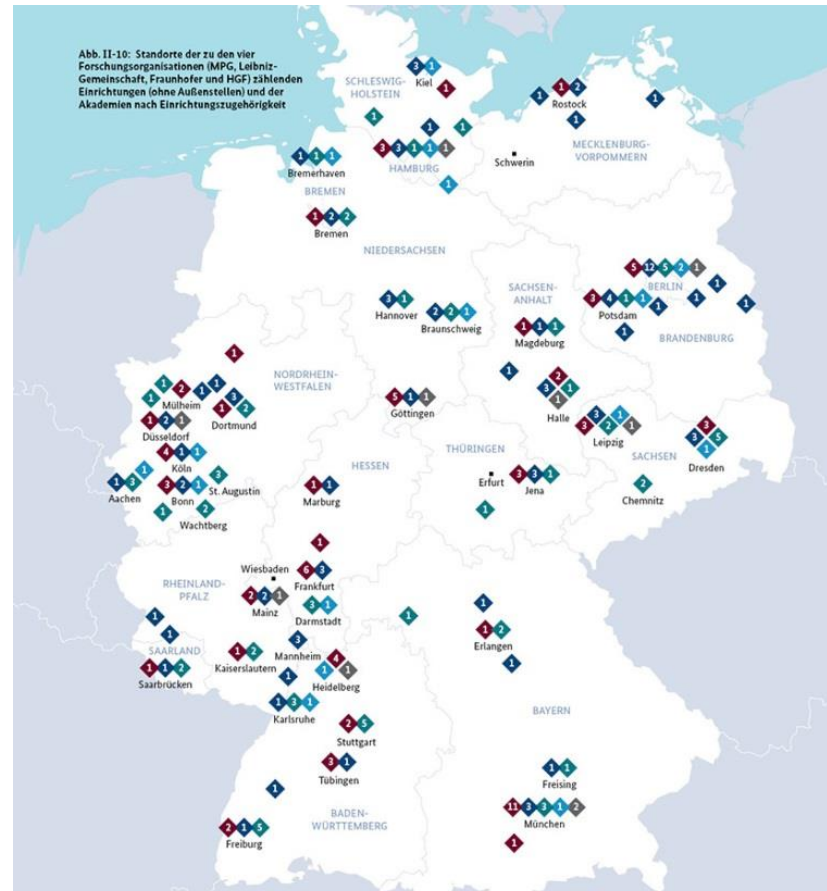


Knowledge for Tomorrow





Research Organisations



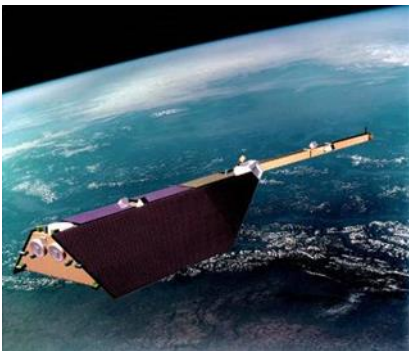
Außeruniversitäre Forschungseinrichtungen
Anzahl der Standorte auf Ebene der Landkreise/
kreisfreien Städte

- ◆ Max-Planck-Gesellschaft
- ◆ Leibniz-Gemeinschaft
- ◆ Fraunhofer-Gesellschaft
- ◆ Helmholtz-Gemeinschaft
- ◆ Wissenschaftliche Akademien

Dargestellt sind ausschließlich die Hauptstandorte der Einrichtungen, beschriftet sind Orte mit mehr als einer Einrichtung.

Society of national Research Centers

Mission: „We contribute to solving major and pressing issues facing society, science and industry through strategic programmatic cutting-edge research in energy, earth and environment, health, aeronautics, space and transportation, matter, and key technologies.“



Universities and Research Organisations

- Universitäten: Ausbildung und Grundlagenforschung



Fundamentals



Application

- Center of Excellence for research in electrochemical energy storage since 2011
- Campus of University Ulm since 2014: more than 200 scientists
- DFG Excellence Cluster from 2019
- DLR battery modeling activities are integrated into HIU



Universität Ulm



Zentrum für
Sonnenenergie- und
Wasserstoff-Forschung
Baden-Württemberg



Deutsches Zentrum
für Luft- und Raumfahrt

Greatest engineering achievements of the 20th century.*

1. Elektrification!

2. Automobile

3. Planes

4. Water supply

8. Computers

12. Space-flight

13. Internet

16. Health technology

19. Nuclear technology

20. New materials

Theory of batteries for electrification, traffic, aerospace!

* National Academy of Engineering, USA

Application of Lithium-Ion Batteries

5 MWh



27 kWh



10 kWh



1 Wh



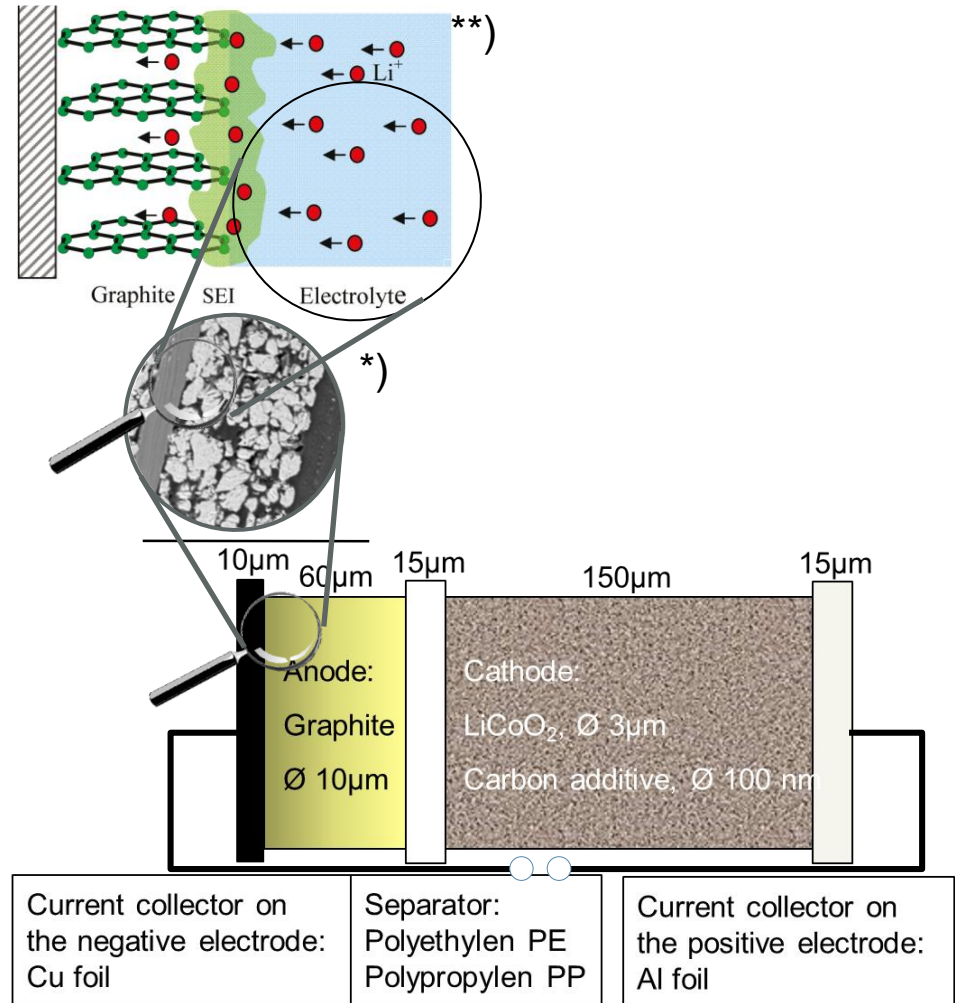
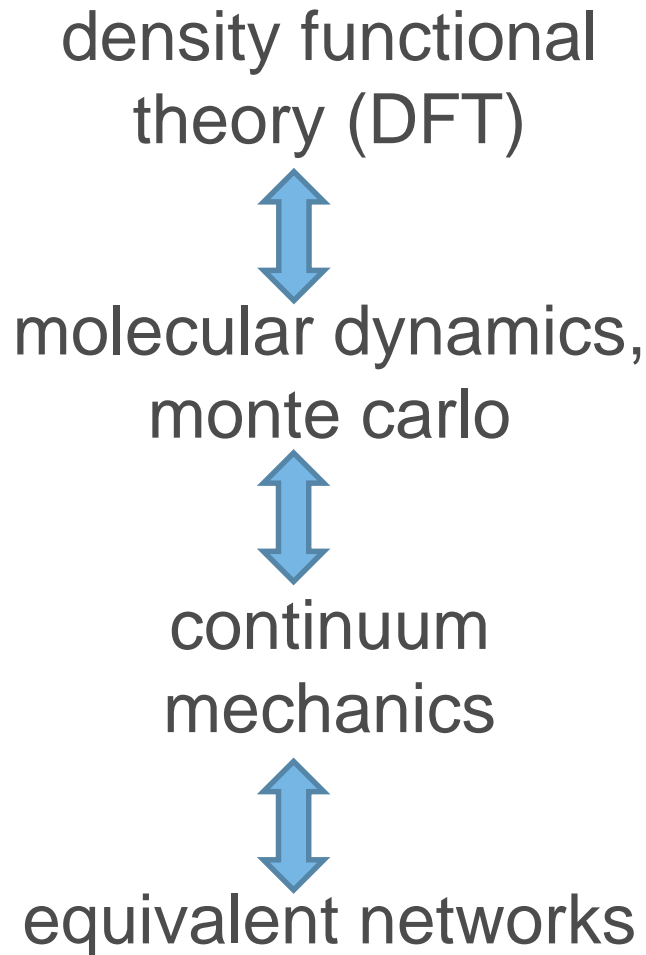
500 Wh



5 Wh



Scale-bridging Simulation Methodology



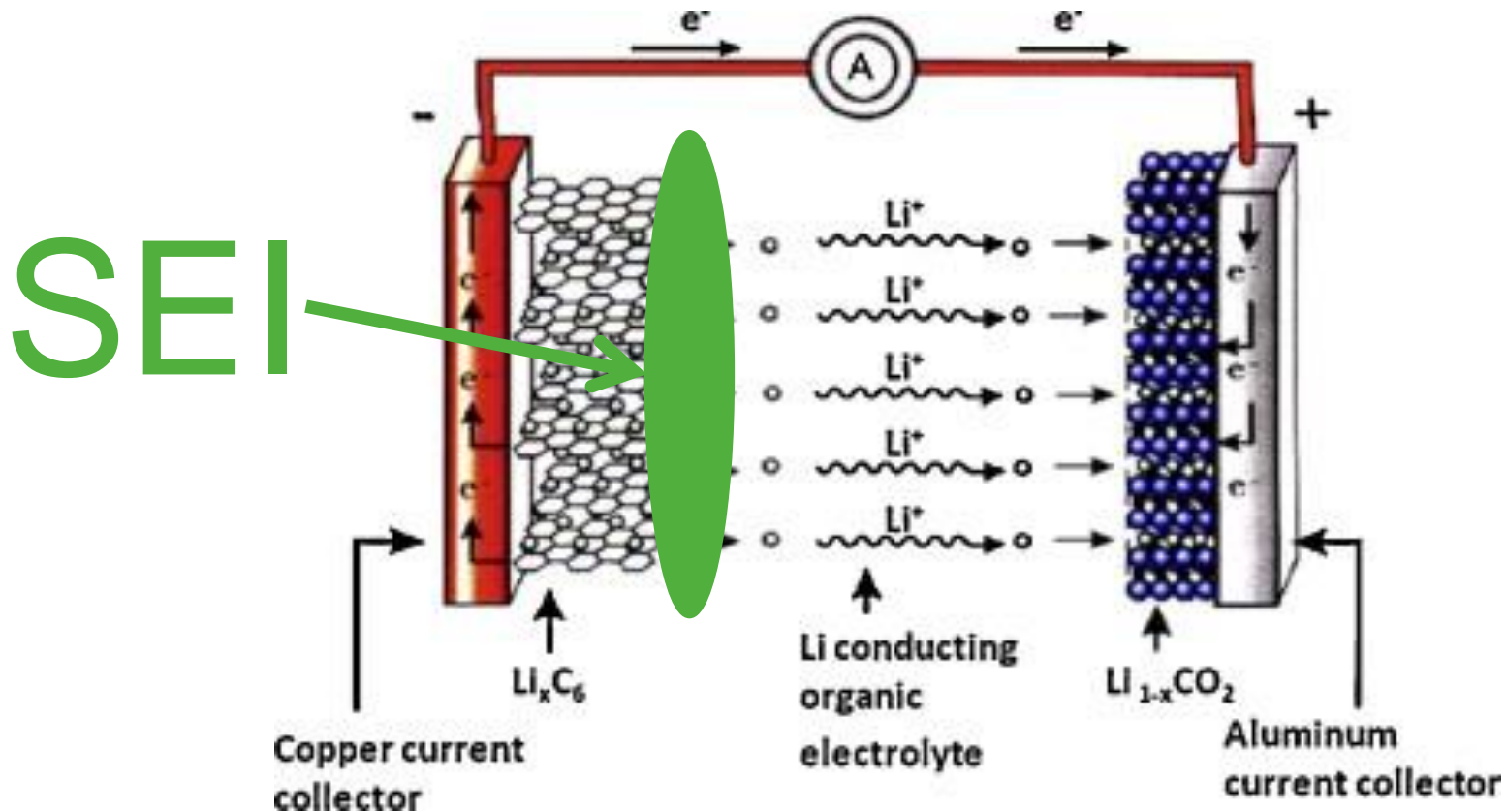
*Harris et al., Chem. Phys. Lett. 485, 265 (2010).
 ** Goodenough and Kim, Chem. Materials (2010)

Lithium-Ion Batteries: Electrochemical Cell

negative electrode
discharge: **anode**

separator

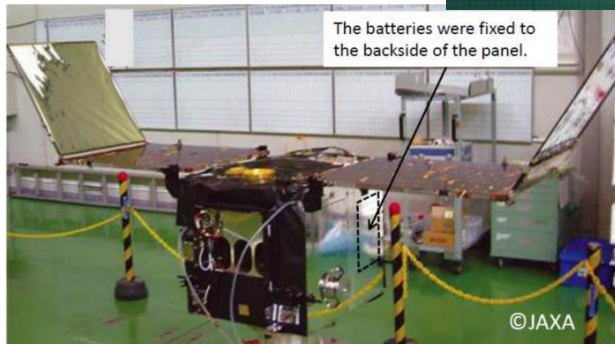
positive electrode
discharge: **cathode**



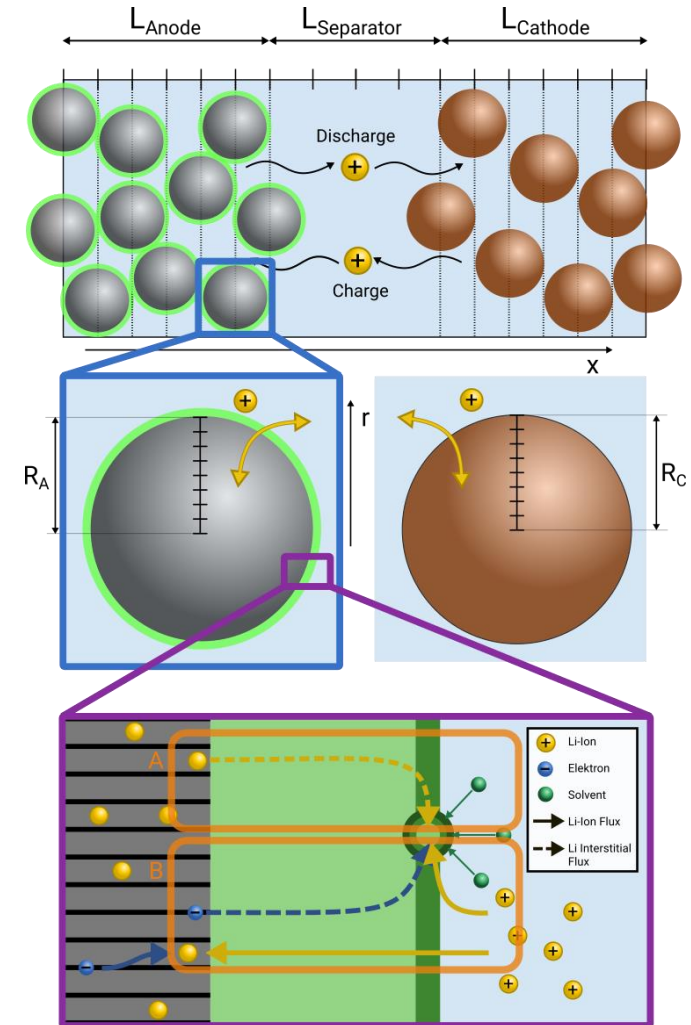
Simulation of Satellite In-Flight Data

Battery Datasets

- Cycle data from 12 years



Japan Aerospace Exploration Agency (JAXA) provided the battery data of satellite REIMEI



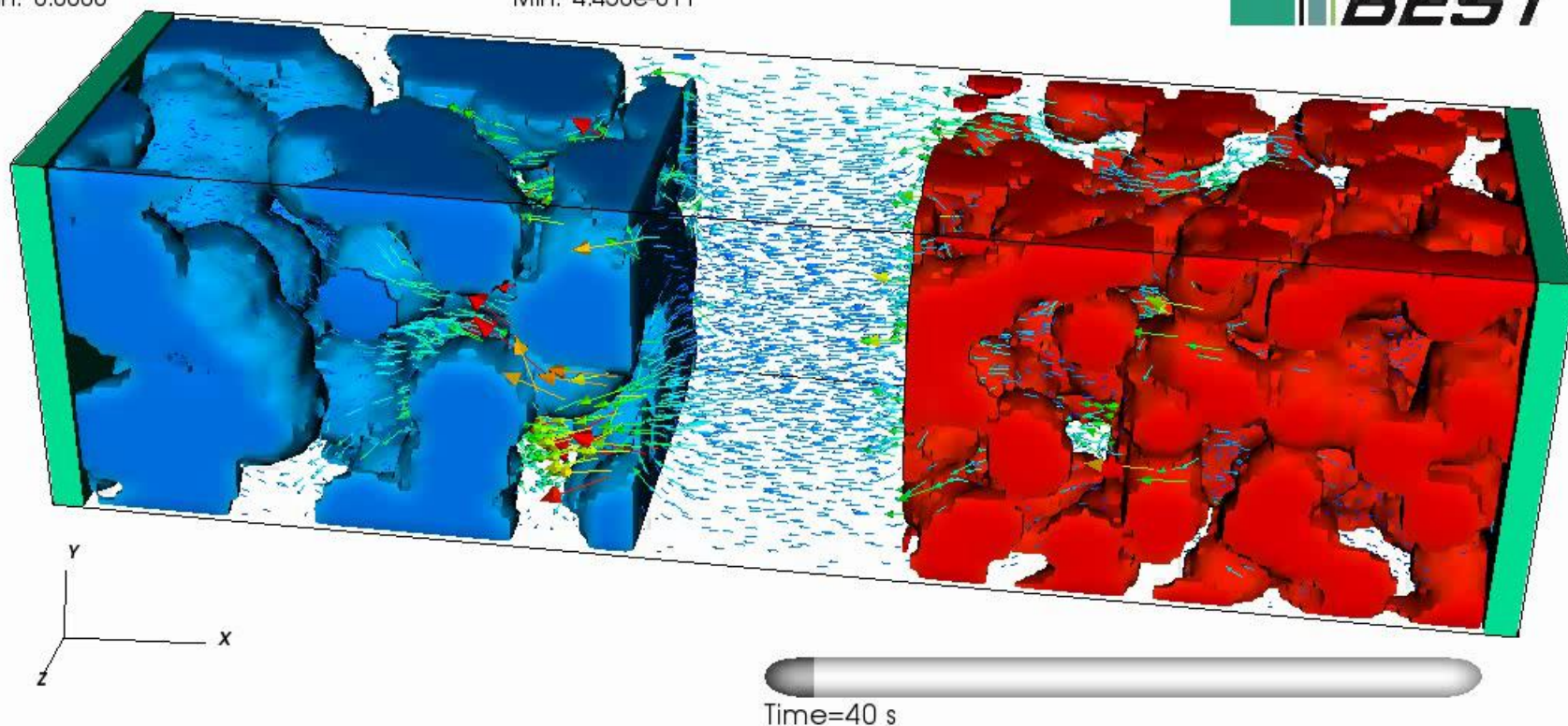
Micro-Structure Resolved 3D Model

Pseudocolor
Var: concentration

Max: 0.02066
Min: 0.0000

Vector
Var: current density

Max: 0.1902
Min: 4.450e-011



Thank you for your attention!



Bundesministerium
für Bildung
und Forschung

DFG


CELEST


DLR

Contact Details

PD Dr. Birger Horstmann
Group Leader: Theory of Electrochemical Systems
German Aerospace Center (**DLR**), Institute for Engineering Thermodynamics
Helmholtz Institute Ulm for Electrochemical Energy Storage (**HIU**)
Helmholtzstraße 11
89077 Ulm

www.hiu-batteries.de
www.dlr.de/tt

Email: birger.horstmann@dlr.de
Phone: 0711 6862 8254

