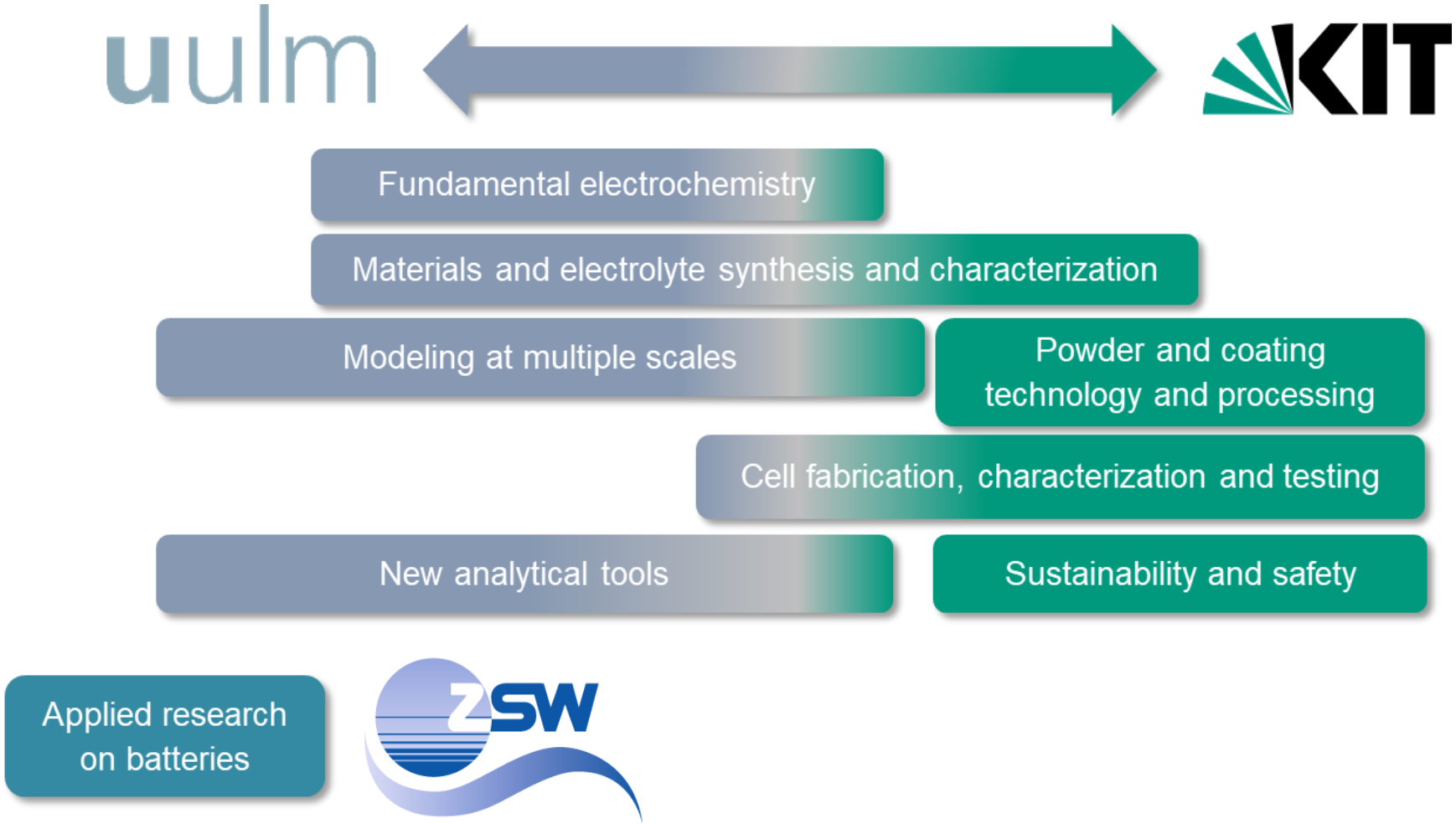
CELEST

CENTER FOR ELECTROCHEMICAL
ENERGY STORAGE
ULM & KARLSRUHE

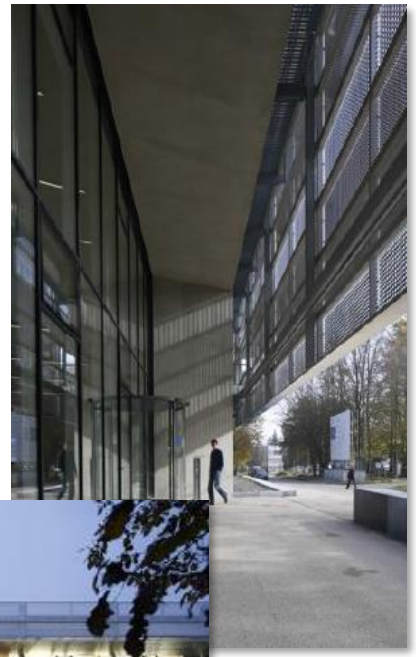
Form Integrated Energy
HannoverMesse
03.04.2019

Complementary expertise at Ulm and Karlsruhe



Helmholtz-Institute Ulm (HIU)

Helmholtz Institute Ulm
Electrochemical Energy Storage



Foundation: 1.1.2011	
Employees	128
PIs	23
New professors	3
Annual Budget	6 Mio. EUR

Mission: Applied-oriented basic research on new storage principles and related materials

Karlsruhe Institute of Technology

ulm university universität ulm

ZSW

CELEST
CENTER FOR ELECTROCHEMICAL ENERGY STORAGE ULM & KARLSRUHE

Cooperative research platform

www.celest.de

29 institutes
45 working groups

RESEARCH · TEACHING · DEVELOPMENT · TECHNOLOGY TRANSFER

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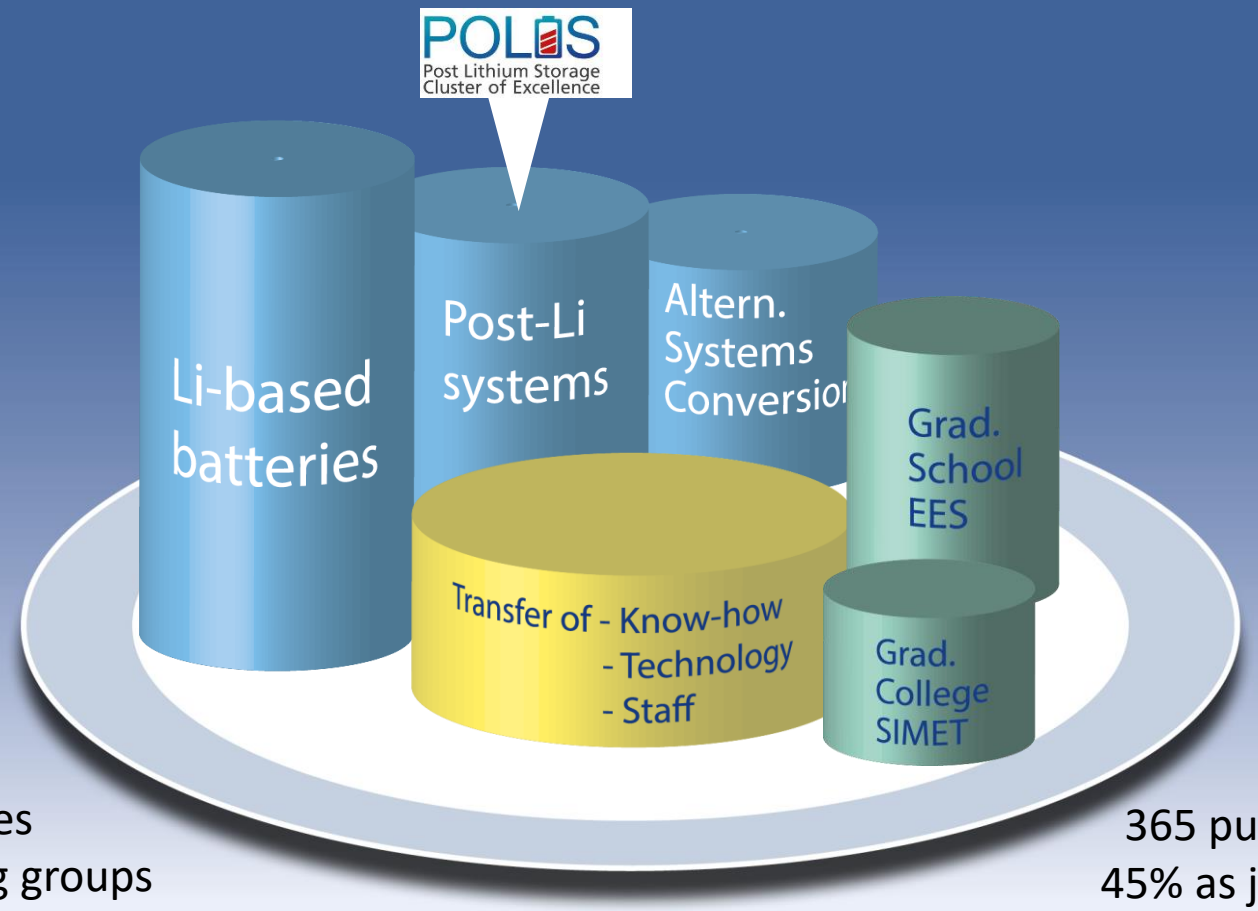

29 institutes
45 working groups

365 publications / 2018
45% as joint publications

RESEARCH · TEACHING · DEVELOPMENT · TECHNOLOGY TRANSFER

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Examples from the work of the platform

Karlsruhe Institute of Technology

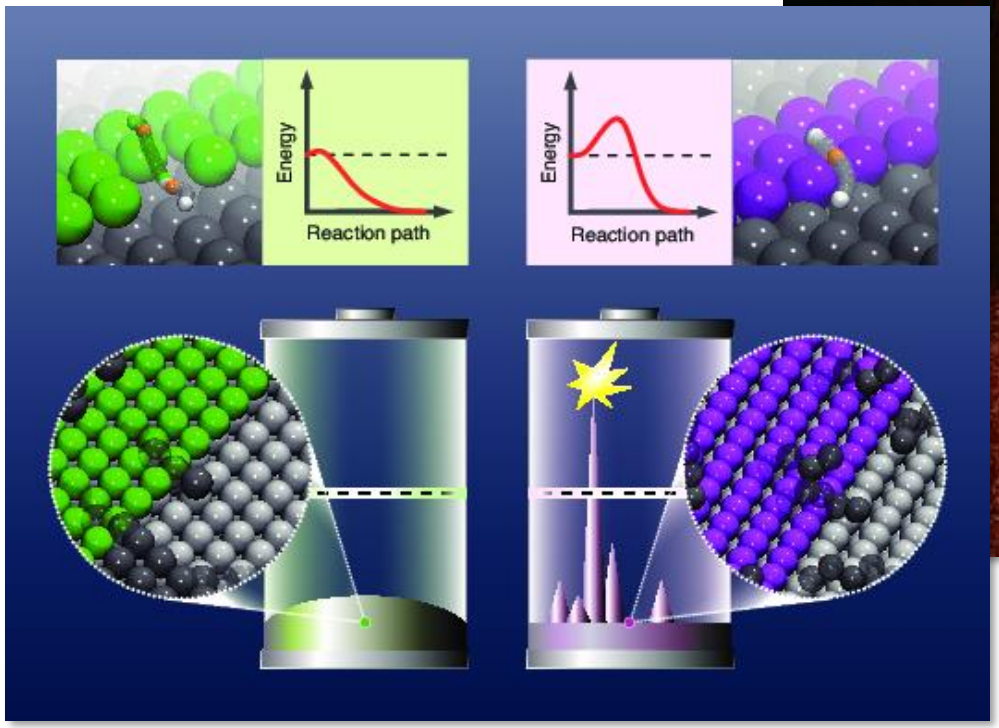
ulm university universität ulm

ZSW

Safety of Li Ion Batteries – Dendrite growth

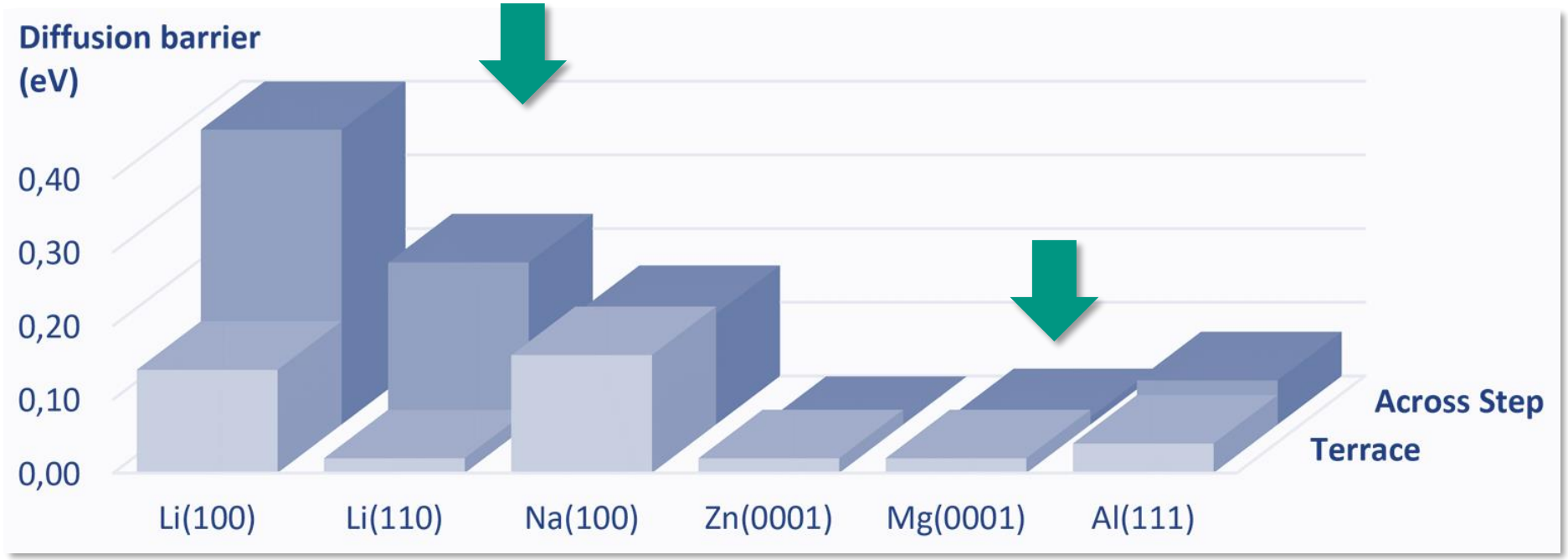
Li and Na exhibit dendrite growth, Mg does not.

Is growth and element-specific diffusion intimately linked?



Reasons for dendrite growth

Li and Na exhibit dendrite growth, Mg does not.

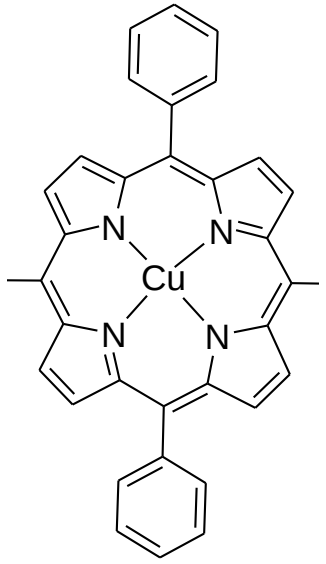


M. Jäckle, A. Groß, *et al.*, Energy Environ. Sci. (2018)

Correlation between height of self-diffusion barriers and dendrite growth

Example – Organic electrode materials based on porphyrins

A new class of highly conjugated porphyrin complex enabling high performance of rechargeable batteries



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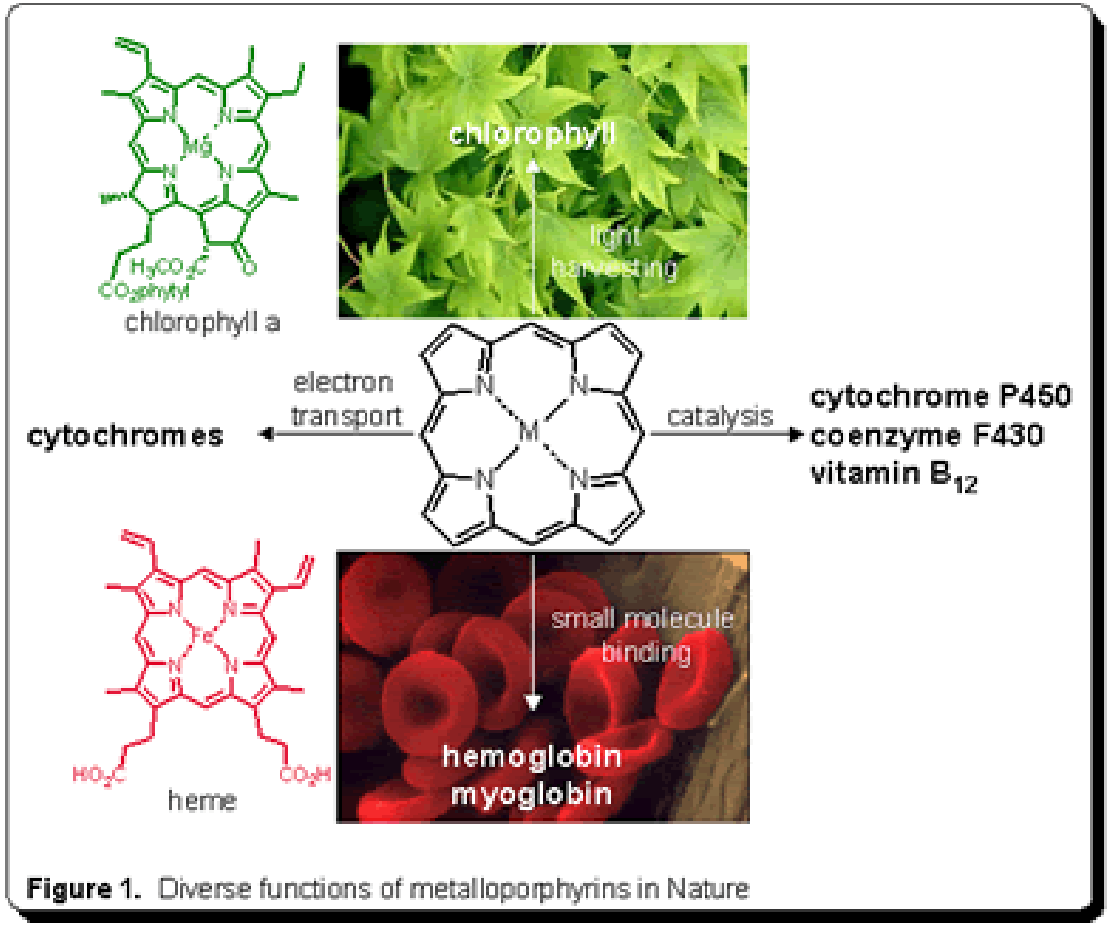
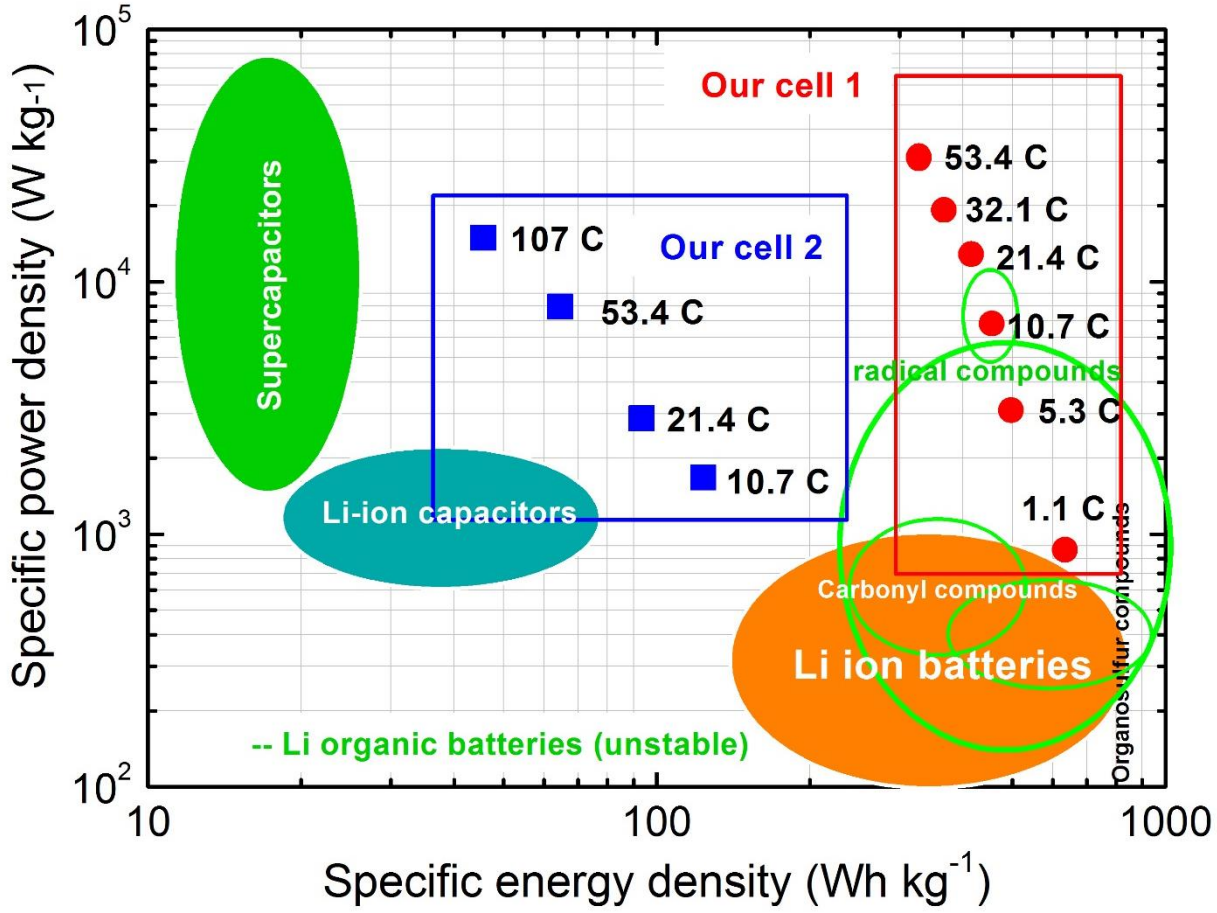


Figure 1. Diverse functions of metalloporphyrins in Nature

Hemocyanin-derived
(Molluscs, Arthropoda)
4 electron transfer from 16 to 20 π electrons; OCV vs. Li: 3.0 V

Ragone Plot

Cell 1: Li/$LiPF_6$/**CuDEPP** (as cathode)

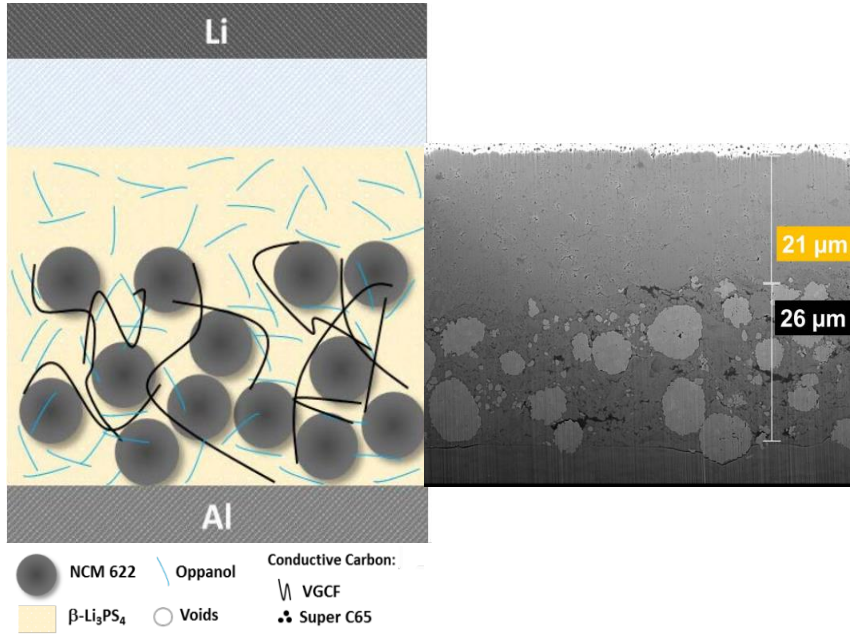


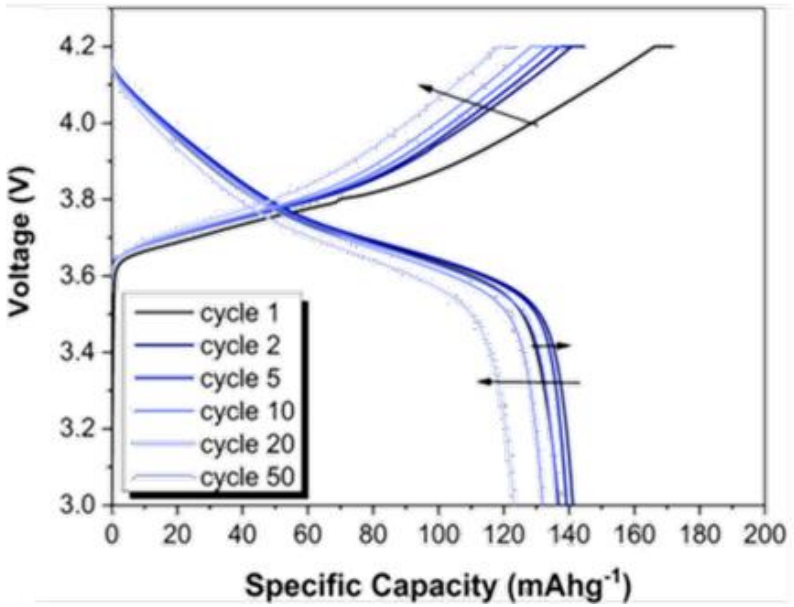
Power density measured up to 30 kW/kg

- Capacity of a Li ion battery
- Rate of a supercapacitor

Solid-State Batteries – Fast Production

All-solid-state, Li-metal batteries employing sulfidic electrolyte and NCM cathode





Electrolyte and electrode layers produced by solvent-cast coating and calendaring (i.e., fast component and cell production)

Very promising cycling performance

M. Keller, T. Ates, S. Passerini, Patent application " Process for Manufacturing a Layered Lithium Cells with Solid-State Electrolyte" (# 102018205299.9 on 09.04.2018)
T. Ates, M. Keller, J. Kulisch, T. Adermann, S. Passerini, *Energy Storage Materials*, revised version submitted.

Research Pilot Line (Forschungspilotanlage, FPL) at ZSW

Largest pilot fabrication line for battery cells in Europe

Coater for double-side coated electrodes

Assembly, electrolyte filling and formation of cells at FPL

Active collaborations and leadership

Examples of recent activities

CELEST

FestBatt

E-MAGIC BATTERY COMMUNITY

LiRichFCC

Li-EcoSafe

Entwicklung kostengünstiger und sicherer Lithium-Ionen-Batterien

- Vom Material bis zur Betriebsstrategie -

ProZell
Kompetenzcluster zur Batteriezellproduktion

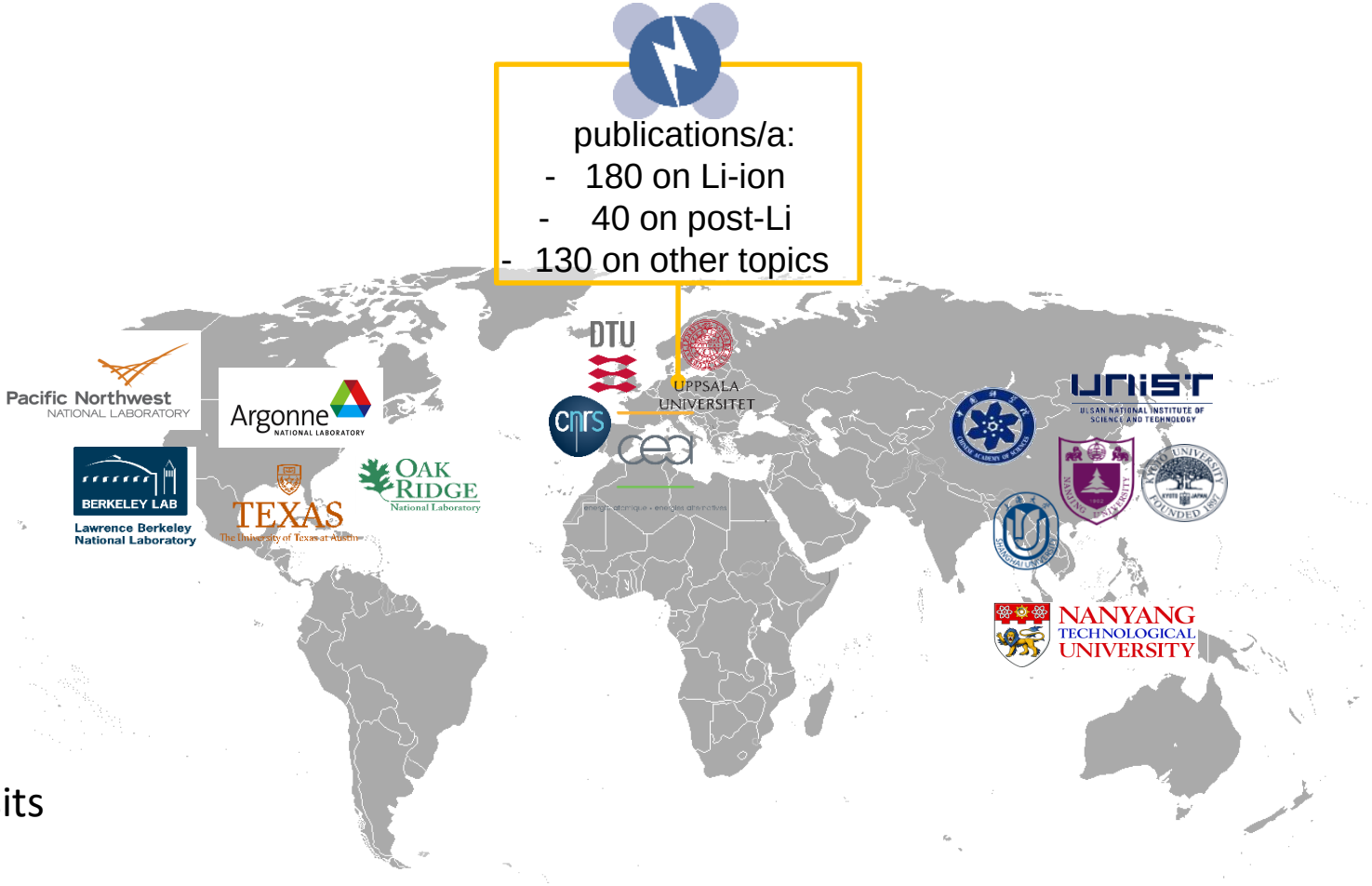
Fast Storage BW II – Energiespeicher der nächsten Generation

KIT Karlsruhe Institute of Technology

ulm university universität ulm

ZSW

Position in International Context



Internationalization

MoUs with:

ANL, NTU, DTU, CEA, UNIST,…

- joint projects
- joint publications
- joint patent applications
- student/staff exchange/visits

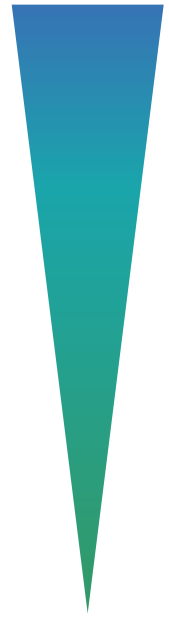
Unique approach of CELEST, integrating the entire research & development line

Already established strategic collaborations with industry

- BASF (KIT/BASF Joint Battery and Electrochemistry Laboratory 'BELLA')
- SCHAEFFLER (Schaeffler Hub for Advanced Research 'SHARE' at KIT)
- BOSCH
- Steinbeis Transfer Center
- Continental
- VOLTABOX
- ….
- bilateral projects

Industry cooperations and technology transfer

- Joint research projects with external funding
- Cooperation- and license agreements
- Order contracts (full costs)
- Licensing of existing and protected know-how



Contact: m.fichtner@kit.edu

POLiS
Post Lithium Storage
Cluster of Excellence

Energy Storage beyond Lithium

New storage concepts for a sustainable future

Joint proposal of UUlm and KIT

Helmut Ehrenberg, Maximilian Fichtner, Axel Groß

Storage of renewable energy is necessary, e.g. with batteries

(i2.wp.com)

stationary / home

(www.bauen.de)

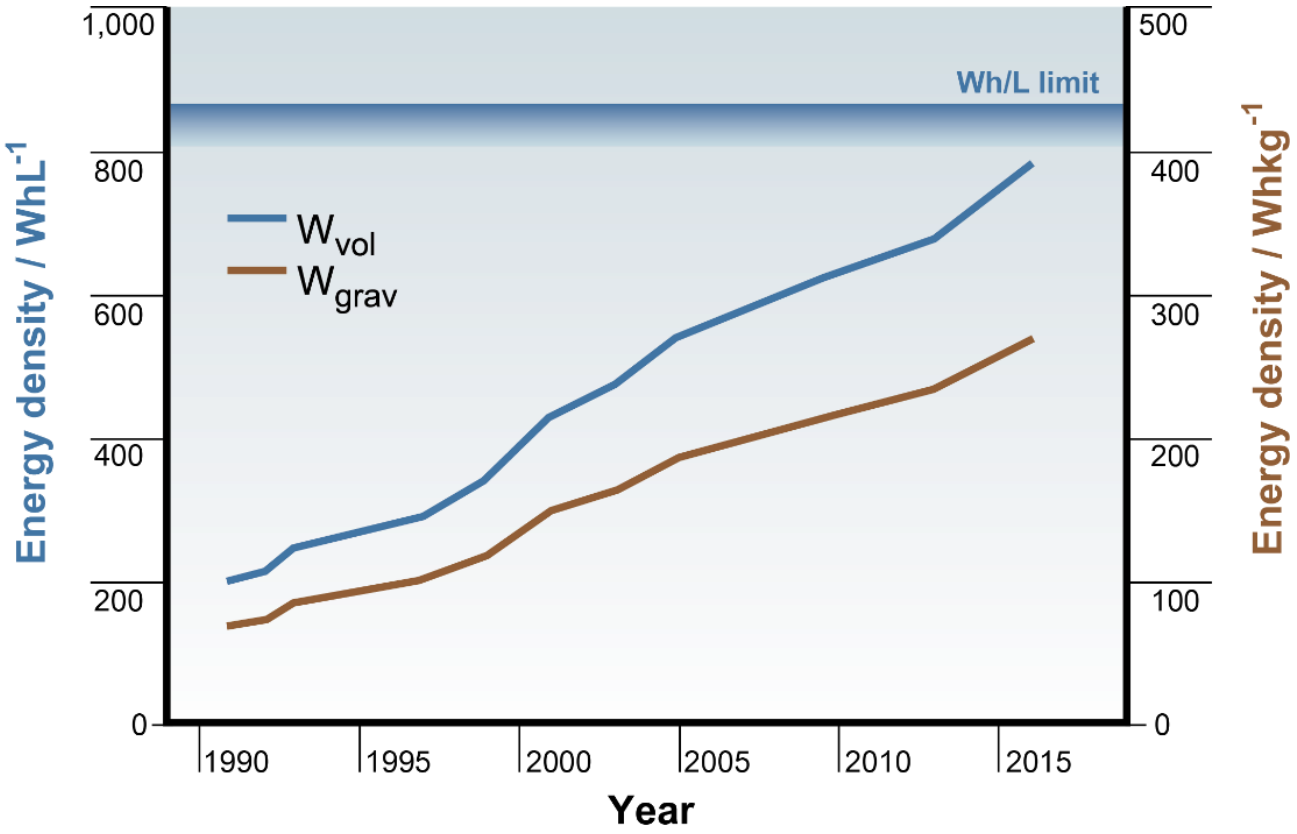
portable

(www.hp.com)

mobile

(www.catchuk.org)

Present Day Energy Storage in Batteries



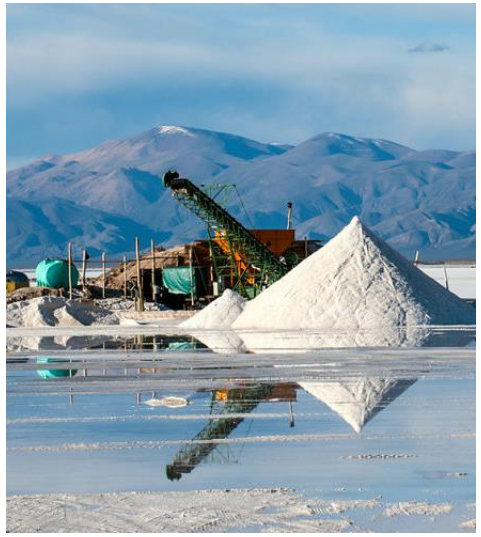
J. Janek, **W. G. Zeier**, *Nat. Energy* (2016)

Li ion batteries (LIBs): efficient energy storage system in terms of energy and power density, reliability and cyclability

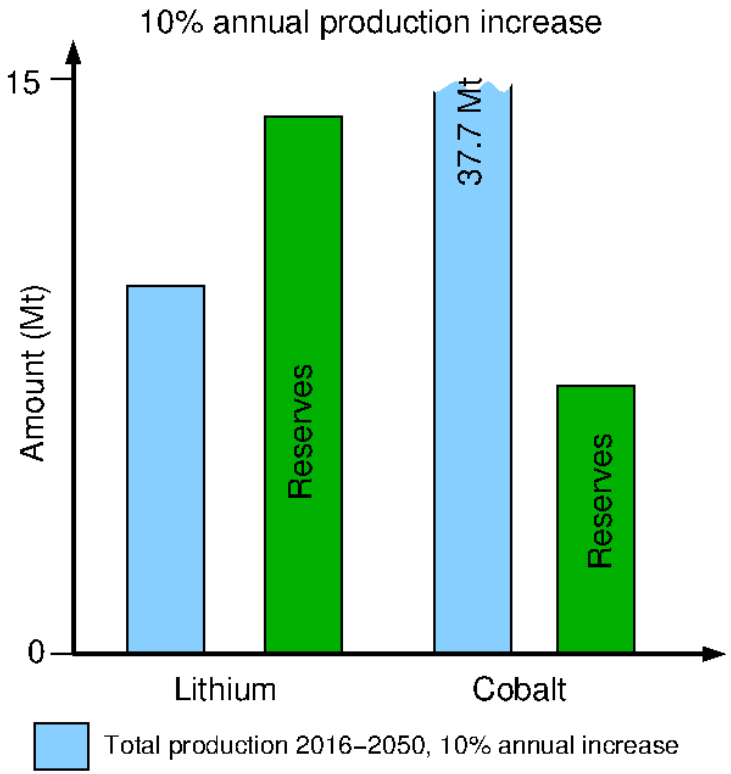
Energy density of conventional LIBs will soon reach its limits!

Sustainability aspects with respect to lithium and cobalt reserves

Lithium



Production and reserves

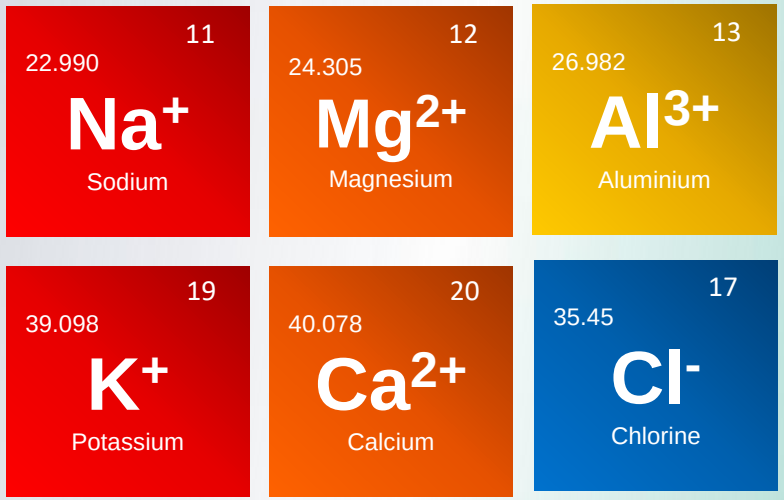


Cobalt

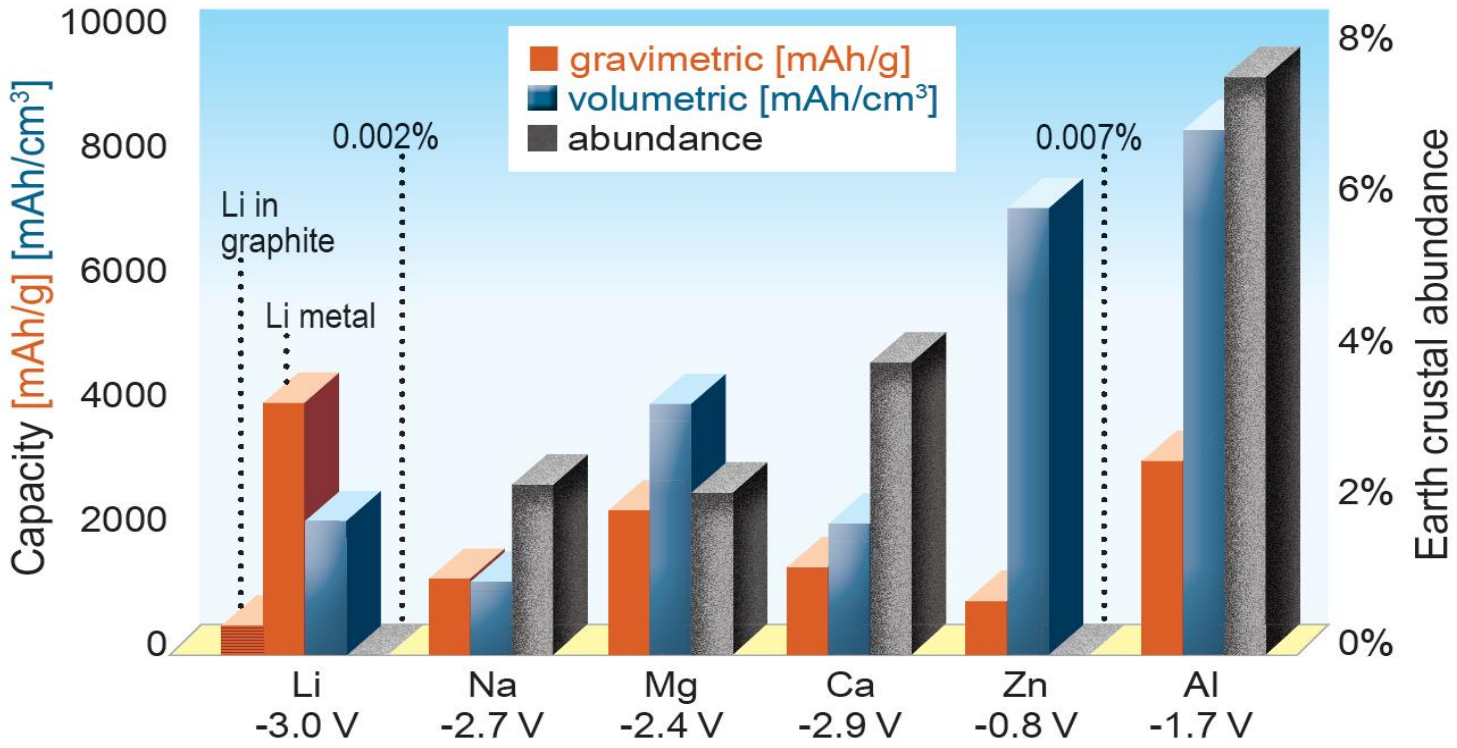
C. Vaalma, **D. Buchholz**, **M. Weil**, **S. Passerini**, *Nat. Rev. Mats.* (2018)

There are substantial supply risks for lithium and cobalt.

Sustainable charge carriers in batteries without lithium



Post-Li Systems

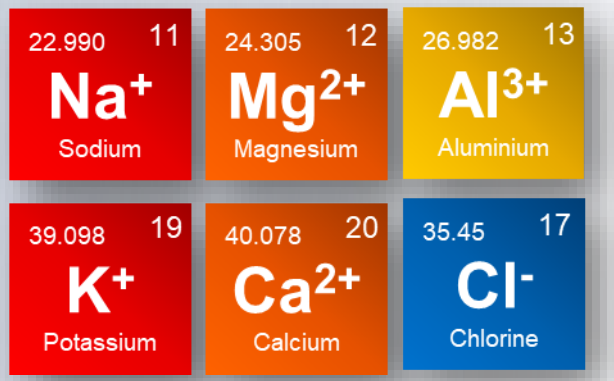


G.A. Elia, et int., **S. Passerini**, R. Hahn, *Adv. Mater.* (2016)

Post-Li systems are not only earth-abundant, but also may offer comparable or improved properties compared to LIBs.

Challenges and Goals

Alternative charge carriers

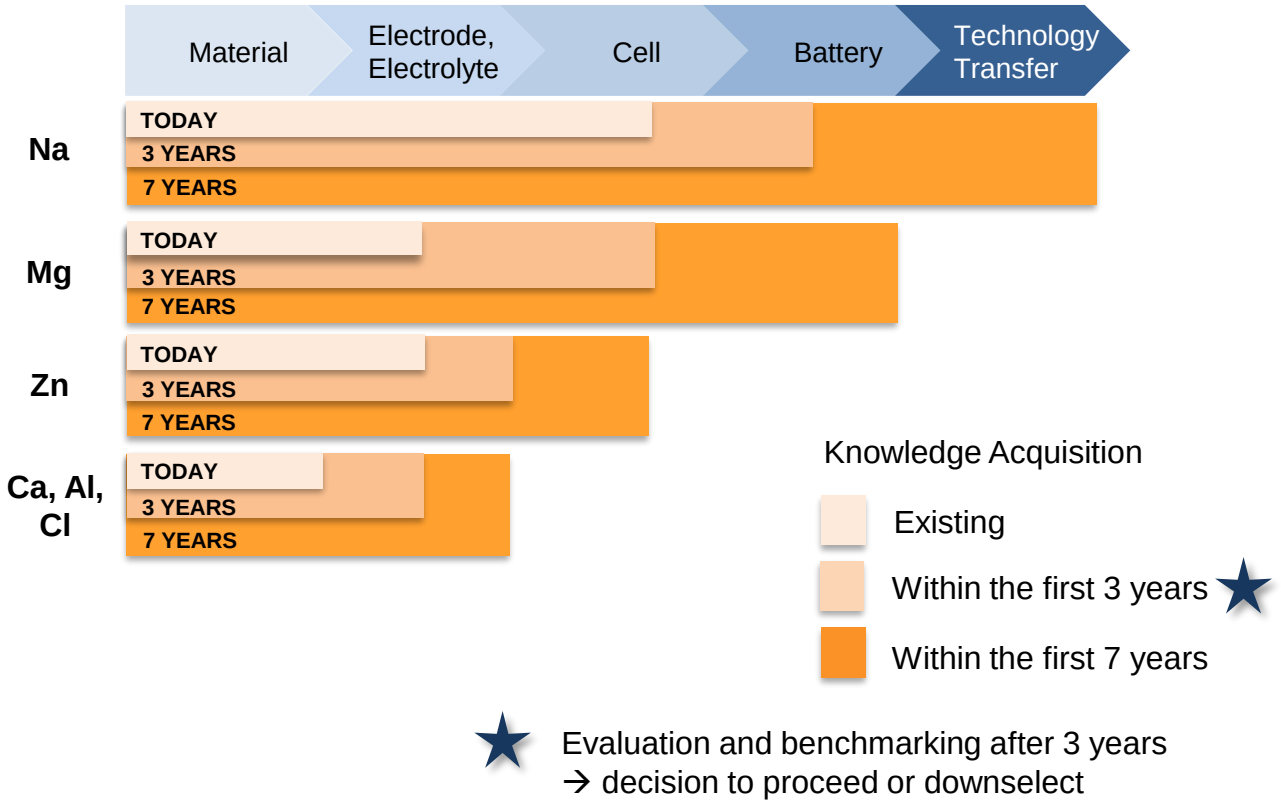


Post-Li systems require:

- New anode materials
- New cathode materials
- New electrolytes
- New engineering-concepts

The overall objective of the Cluster of Excellence is to lay the scientific and technological foundation for a new generation of post-Li electrochemical energy storage systems for stationary and mobile applications which overcome the limitations of current battery technology.

Progress in Different Battery Chemistries



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Thank you!

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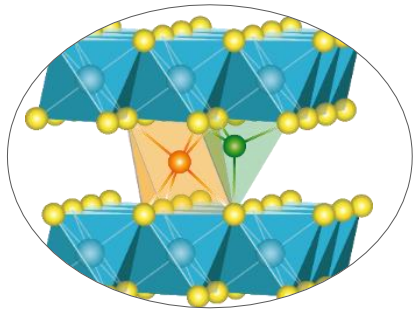
ULM & KARLSRUHE

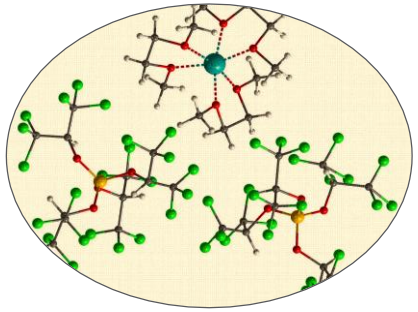
Karlsruhe Institute of Technology
ulm university
universität ulm
ZSW

Research Program Overview

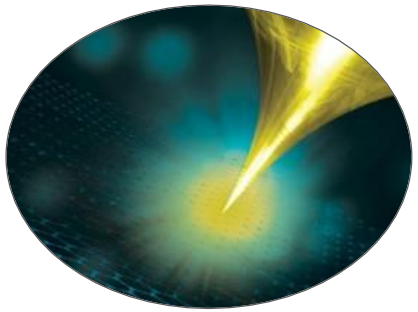
Electrode Materials
RU A



Electrolytes
RU B



Interfaces
RU C



Integration and Sustainable Cell Engineering
RU D

- Basic elements of the research & development chain
- Addressing the grand challenges in post-Li batteries
- Benefit from the interdisciplinarity of the Cluster
- Theoretical modelling ↔ Model systems ↔ Laboratory cells
- Facilitates work on fundamental topics of overarching nature