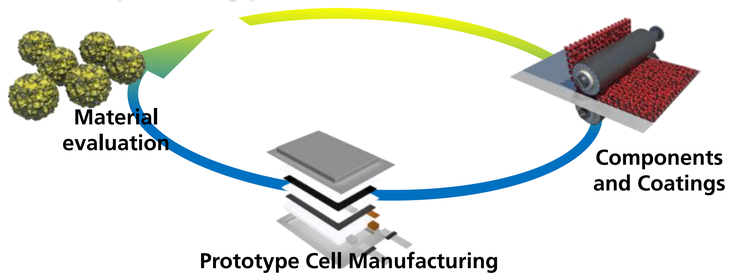
Recent Developments on Material, Components, and Processing for Thiophosphate-based All-Solid-State-Batteries

Felix Hippauf*, Sahin Cangaz, S. Poetke, M. Fiedler, L. Bloi, Benjamin Schumm, Susanne Doerfler, Holger Althues, Stefan Kaskel
Business Unit Chemical Surface and Reaction Technology, Fraunhofer Institute for Material and Beam Technology, 01277 Dresden, Germany

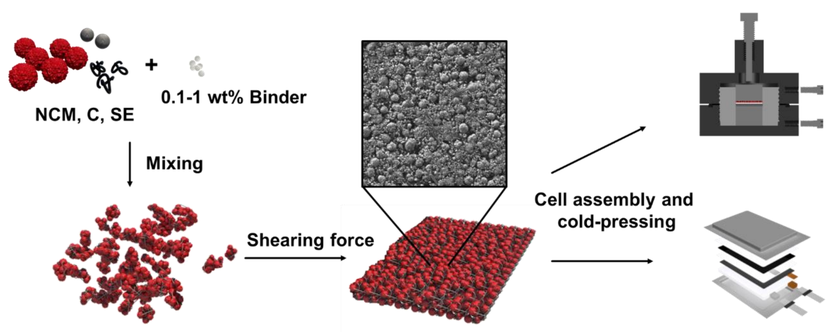
Motivation

- ASSB provides potential for high energy cells
- Solid interfaces promise stable cycling
- Material development and evaluation under relevant conditions in prototype cells



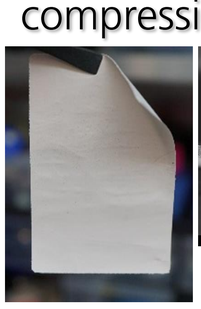
Challenges

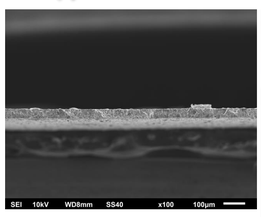
- Safety risks and volume change of Li-metal anode → particle based anodes
- Solvent-free electrode fabrication



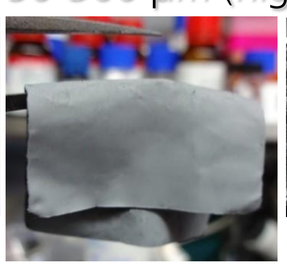
DryTraec® for ASSB Cathodes

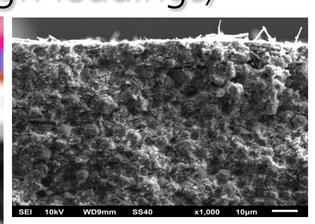
- Preparation of thin and free-standing SE-layers and cathodes via solvent-free process
- Current thickness: SE ~ 50 µm (30 µm after compression), Cathode 50-300 µm (high loadings)





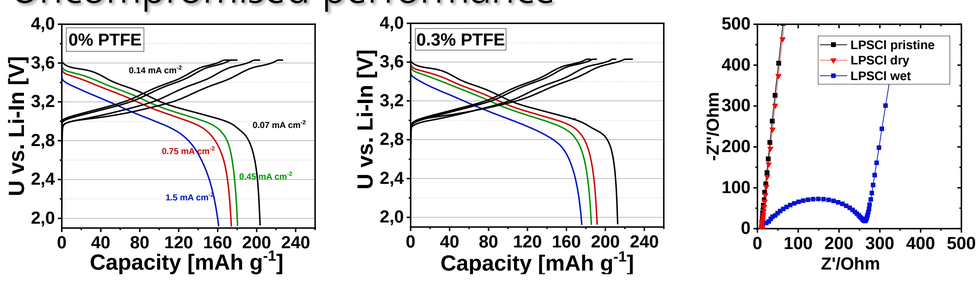
- Li_6PS_5Cl Layer



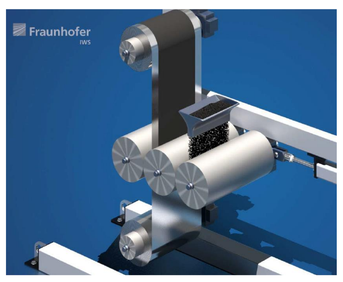


- NMC cathode

- Uncompromised performance



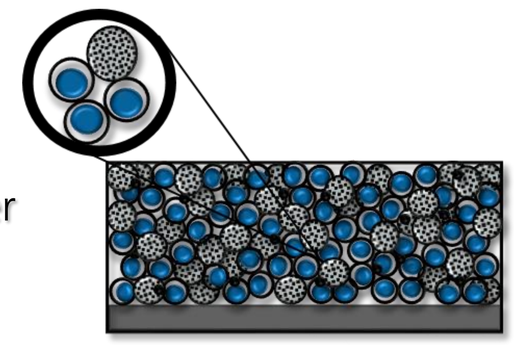
- Successful transfer from manual to calender process (DryTraec®)



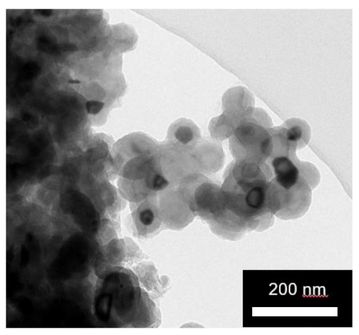
Li-free Anode Concepts

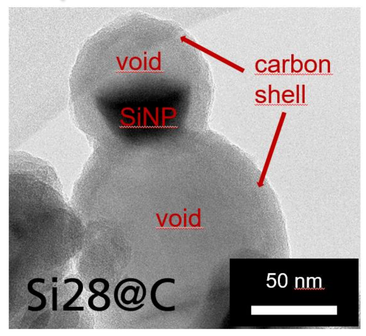
Si-C Composites

- Compensation of vol. changes by carbon shell
- SEI formation only at outer surface
- No prelithiation required



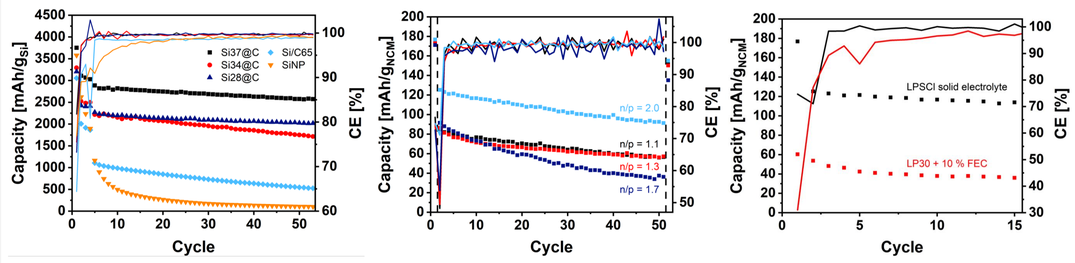
- Different Si contents possible





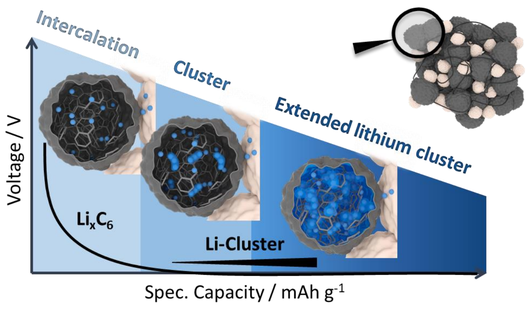
Label	Si [%]
Si28@C	28.21
Si34@C	34.45
Si37@C	36.86

- Enhanced electrochemical performance of Si-C half-cells
- Higher initial coulombic efficiency (ICE) and higher initial discharge capacity of SE full cell

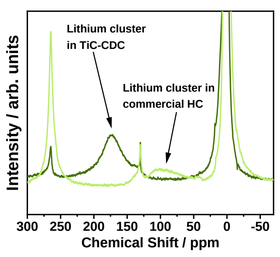


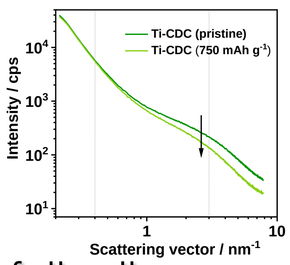
Porous Carbon Anodes

- Proof-of-Concept for Li-cluster deposition in porous carbons
- Solid electrolyte prevents extensive SEI formation

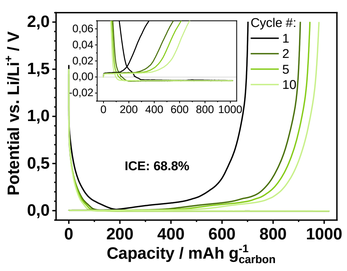


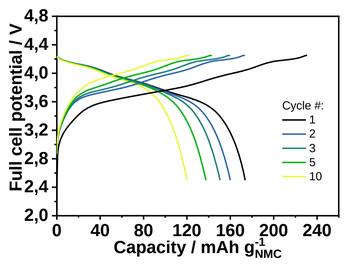
- MAS ^{7}Li-NMR proves existence of extended Li-clusters in TiC-CDC
- loss of porosity due to pore filling suggested by SAXS





- Demonstration in half and full cells





This work has received funding from the Federal Ministry of Education and Research (BMBF)

SPONSORED BY THE
Federal Ministry of Education and Research
ClusterBatt
TECHNISCHE UNIVERSITÄT DRESDEN
FEST BATT
Europäische Union
Europa fördert Sachsen. ESF Europäischer Sozialfonds
Diese Maßnahme wird mitfinanziert durch Steuermittel auf Grundlage des von den Abgeordneten des Sächsischen Landtags beschlossenen Haushaltes.
Project number: 100340676