



# Dynamics of lithium-distribution in 18650-type lithium-ion batteries during electrochemical cycling

D. Petz<sup>[a,b]</sup>, P. Müller-Buschbaum<sup>[a,b]</sup>, A. Senyshyn<sup>[a]</sup>

[a]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Lichtenbergstr. 1, 85748 Garching, Germany [b]Lehrstuhl für Funktionelle Materialien, Physik-Department, Technische Universität München, James-Frank-Straße 1, 85748 Garching, Germany

# Aim

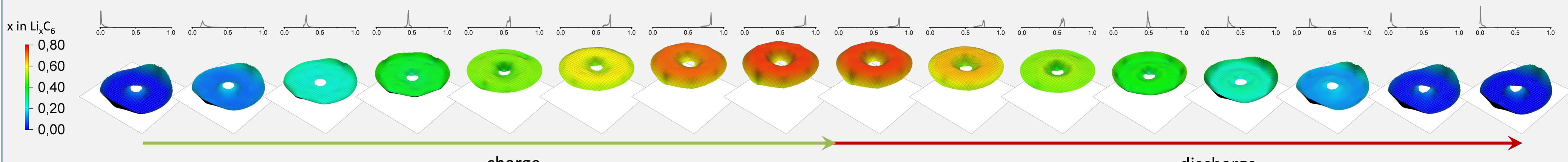
- 1. Non-destructive studies of lithium distribution in the interior of a cylindertype Li-ion cell
- 2. Monitoring the uniformity of the graphite lithiation in a high-power  $\text{Li}_{x}\text{FePO}_{4}|\text{C }18650\text{-type}$  lithium-ion battery vs. cell charging/discharging using spatially-resolved neutron powder diffraction
- 3. Probing the lithium distribution in a  $\text{Li}_x\text{FePO}_4 \mid \text{C}$  cylinder-type lithium-ion battery on  $\mu\text{m}$ -scale in fully charged state using X-ray diffraction

## Results

Methods

#### Lithium distribution in the graphite anode during cell charge/discharge monitored with mm-sized spatial resolution:

- 1. Discharged state: higher lithiation towards the centre pin and cell housing in comparison to the middle of the electrode stripe wound around the center pin
- 2. Charged state: "Inverted" lithium distribution, behaviour opposite to the discharged state with higher lithium content in the middle of the electrode spiral
- Non-uniform distributions will certainly affect cycling stability, aging characteristics, heterogeneity, safety and lifetime



charge

## X-Ray diffraction Spatially-resolved neutron powder diffraction P02.1 @ DESY beam stop transmitted beam cell housing radial collimator diffracted beam center pin gauge volume positive tab incident neutron negative tab sample slits High-energy synchrotron, Neutron, $\lambda$ =1.5482 Å λ=0.20708 Å '+' electrode '-' electrode - Al\Fe\Cu — Al\Fe\Cu

## Lithiation of the Li<sub>x</sub>FePO<sub>4</sub> cathode and the graphite anode in fully charged state on μm-scale (X-ray diffraction):

Lithiation of the cathode is generally more uniform along the electrode stripe at the separator side compared to the current collector side

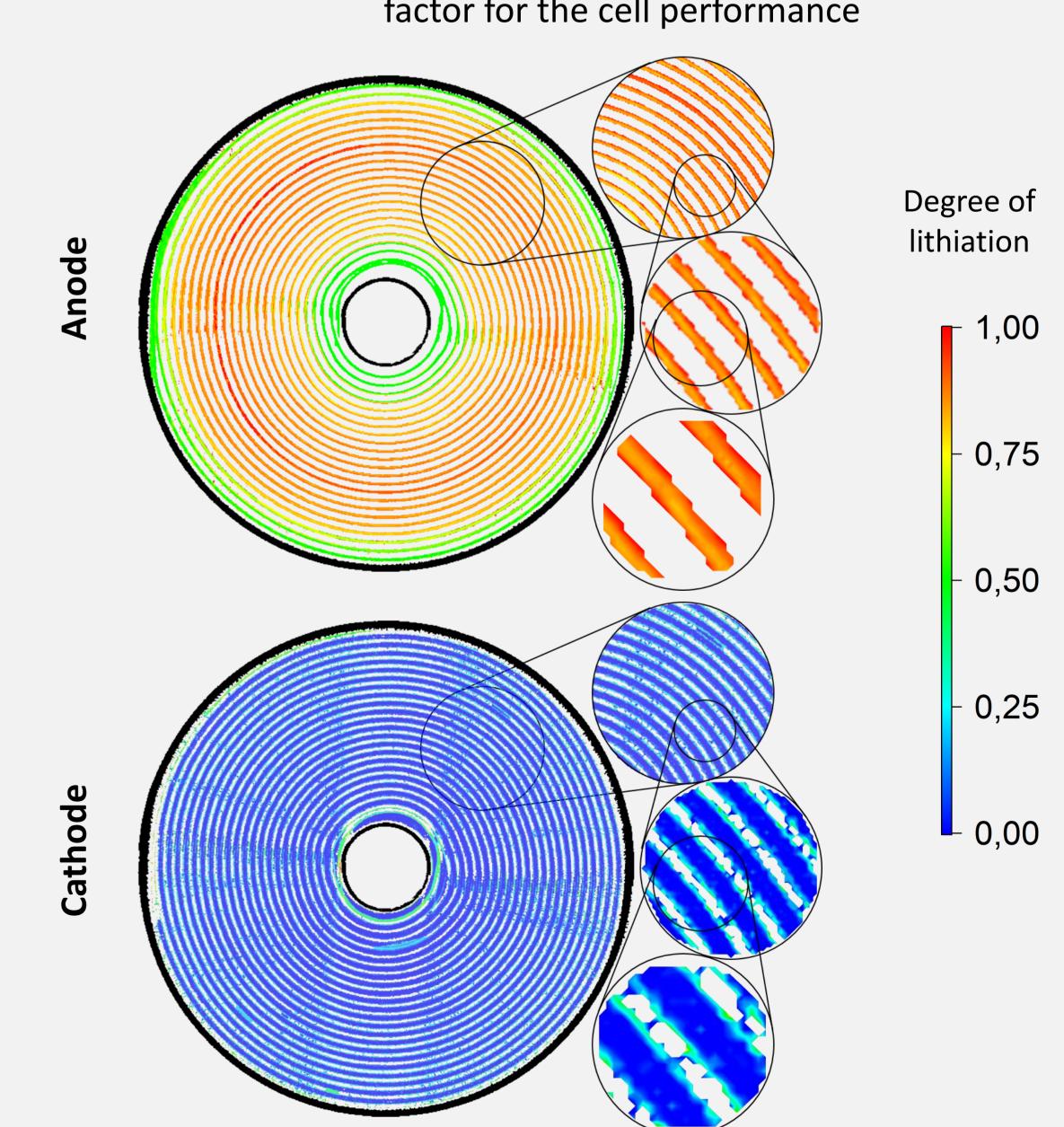
**Material distribution** 

Steel — Aluminum — Li<sub>x</sub>FePO<sub>4</sub> (cathode)

Separator

Li<sub>x</sub>C<sub>6</sub> (anode) — Copper

→ The optimization of lithium gradient through the electrode thickness is crucial factor for the cell performance



## Literature

**Contact:** 

Petz, D., et al., Lithium distribution and transfer in high-power 18650-type Li-ion cells at multiple length scales. Energy Storage Materials, 2021. **41**: p. 546-553.

n cells at

Angle  $2\theta$ , deg.

Angle  $2\theta$ , deg.