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Industrial scale MeV Ion-beam analysis for battery development and quality assurance

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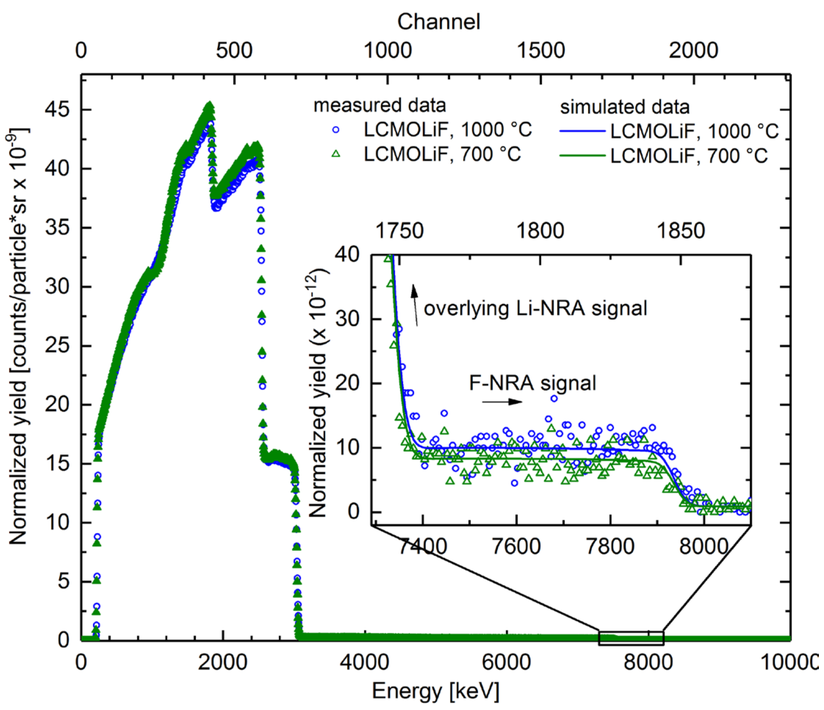
Motivation

- Batteries contain elements over a wide range of atomic numbers and concentrations
- Lithium ion batteries are the dominant battery type, but Li is difficult to measure
- For research: elemental mapping with high spatial resolution and quantification is needed
- For Industry: high accuracy quantification and throughput are required

Method

Ion beam analysis with MeV Ions (IBA)

- Several sub-methods (PIXE, PIGE, NRA, RBS)
- Seconds to minutes of analysis time per point
- Percent range accuracy
- Calibration free and non-destructive
- ≥1 µm spot sizes and ≥10 nm depth resolution

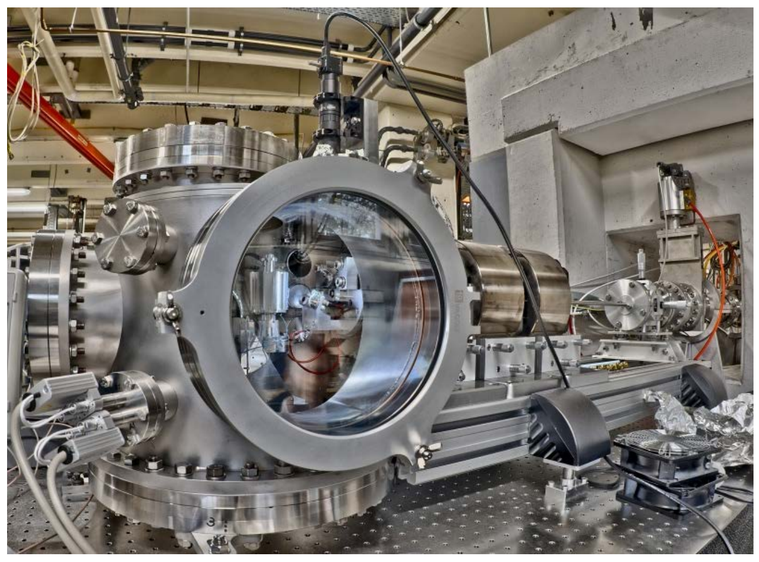


LCMO spectrum example [1]

Devices

Optimized for battery applications [2]

- Analysis in vacuum (picture) or air/atmosphere
- Analysis of liquids, solids, powders, thin films
- Software for device, measurement and analysis

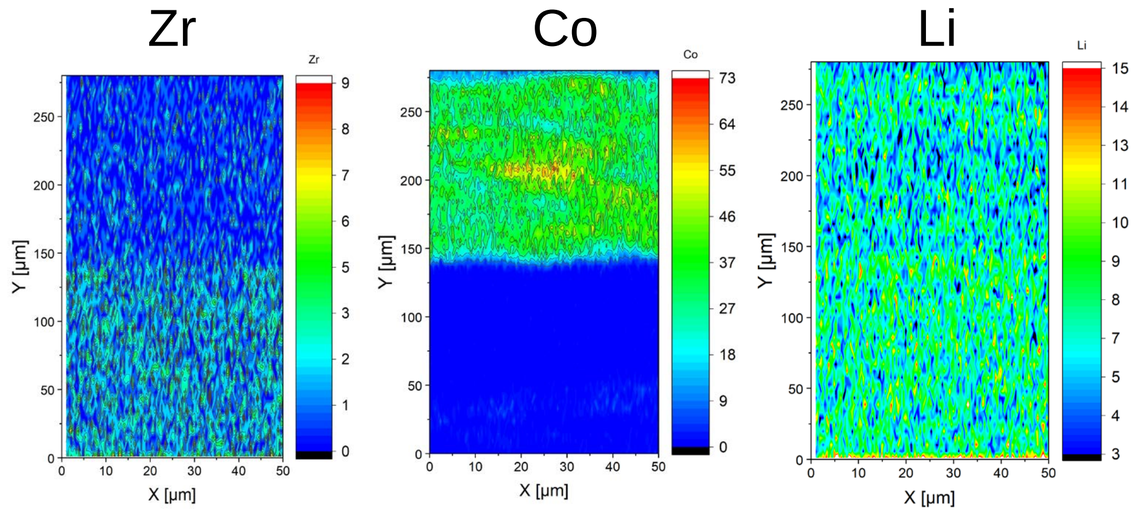


Results

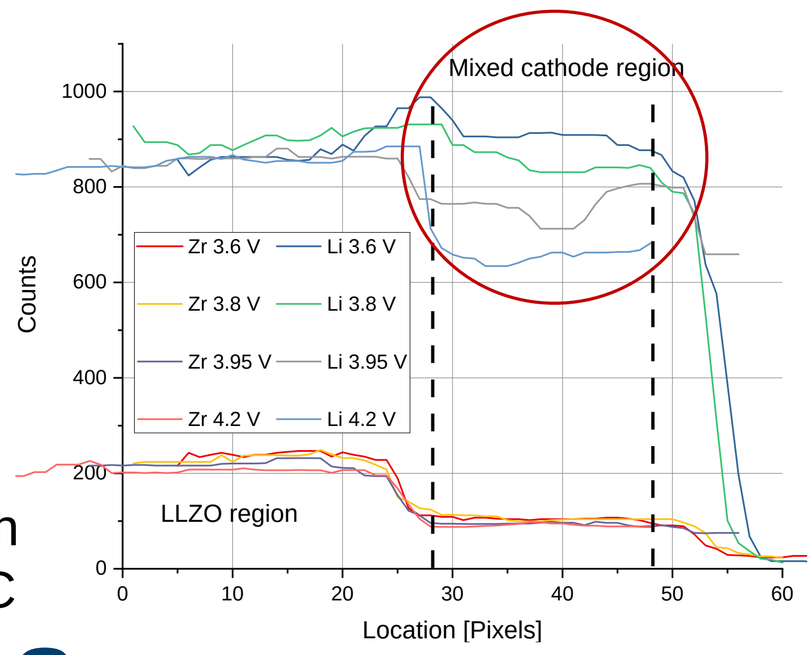
Fluorine sintering additives [1]

- Added LiF for improved sintering of LCMO
- Sintering at different temperatures
- Final F content analysed by NRA in agreement with admixed amount (no evaporation)

LCO-ASB analysis during charging [3]



- MEEP and LLZO based all-solid-state batteries
- Cell layers visible
- SoC measured by lithium-% in LCO agrees with OCV based SoC



Summary

- Ion beam analysis combines mapping and quantification with high throughput and accuracy
- Proof-of principles exist for F and B doping, lithium migration during cycling, structural analysis, stoichiometry analysis, Li and Na cells, …
- Start-up to be founded

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[1] Solid State Ionics 320, 2018, 378-386, doi.org/10.1016/j.ssi.2018.03.026
[2] Patent WO002019219103A1, S. Moeller et al.
[3] S. Moeller et al., 2020, submitted to Journal of Power Sources

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