Welcome to the EUFN Workshop 2022
Abstract Submission

Please select your presentation preference

X *Oral presentation*

☐ *Poster presentation*

• Please convert your abstract as PDF document and send it to:

robert.winkler@felmi-zfe.at

• For easier handling, please write EUFN 2022 Abstract in the subject.
• For your convenience, you can check the tag DELIVERY RECEIPT in your email program.

fibTOF: The strength of SIMS capabilities on FIB-SEM microscopes

Lex Pillatsch*, James Whitby and Janos Metzger

TOFWERK AG, Schorenstrasse 39, CH-3645, Thun, Switzerland
* corresponding author email: lex.pillatsch@tofwerk.com

The combination of a FIB-SEM microscope with a mass analyzer provides a cost-effective route to high spatial resolution chemical imaging using secondary ion mass spectrometry (FIB-SIMS) [1]. The high mass resolving power, together with the ability to collect information about all elements simultaneously, has made the use of time-of-flight mass analyzers popular for this purpose, especially in the field of materials science. Because information about all mass to charge ratios is collected, retrospective analysis of the data sets can allow for new insights into local elemental distributions and correlations without repeating the measurement. FIB-SIMS is based on the direct measurement of the sputtered ions. The yields of secondary ions are in general high for positive ions from alkali metals and, also for negative ions from halogens. This is especially true for lithium and fluorine, which can be difficult to map by other techniques. FIB-SIMS is therefore a technique well placed to support research of current and next-generation rechargeable battery materials (e.g., for lithium ion, sodium ion and fluoride ion batteries).

The correct identification of the sputtered ions is mandatory for the characterization of the material properties. Knowledge about the possible sample composition is required for the data interpretation. A high mass resolving power is essential to resolve molecules from elements at the same atomic mass unit. Molecular fragments containing the element of interest can confirm the correct elemental identification.

FIB-SIMS is thus a powerful technique that can complement other characterization methods (electrochemical, XRD, SEM imaging, or XPS). Having the specimen within the vacuum chamber of a FIB-SEM microscope means that a fresh (not oxidized) surface can be prepared, although the use of a cryostage and grazing incidence FIB beam may be necessary to get the best quality surface when using Ga+ primary (FIB) ions [3].

Recent results from rechargeable battery materials recorded by the fibTOF and methods for the correct data interpretation will be presented.

References

[1] L. Pillatsch, F. Östlund, J. Michler "FIBSIMS: A review of secondary ion mass spectrometry for analytical dual beam focused ion beam instruments" Progress in Crystal Growth and Characterization of Materials, Volume 65, Issue 1, February 2019, Pages 1-19. https://doi.org/10.1016/j.pcrysgrow.2018.10.001

[2] J. Sastre, M. H. Futscher, L. Pompizi, A. Aribia, A. Priebe, J. Overbeck, M. Stiefel, A. N. Tiwari, Y. E. Romanyuk "Blocking lithium dendrite growth in solid-state batteries with an ultrathin amorphous Li-La-Zr-O solid electrolyte" Communications Materials, Vol. 2, pp. 1–10 (2021) https://www.nature.com/articles/s43246-021-00177-4

[3] Lee, J. Z. et al. "Cryogenic focused ion beam characterization of lithium metal anodes". ACS Energy Lett. 4, 489–493 (2019). https://doi.org/10.1021/acsenergylett.8b02381

[4] Ch. Jiao, L. Pillatsch, J. Mulders, D. Wall "Three-Dimensional Time-of-Flight Secondary Ion Mass Spectrometry and DualBeam FIB/SEM Imaging of Lithium-ion Battery Cathode", Microscopy and Microanalysis, Vol. 25(S2), pp. 876-877 (2019) https://doi.org/10.1017/S1431927619005117

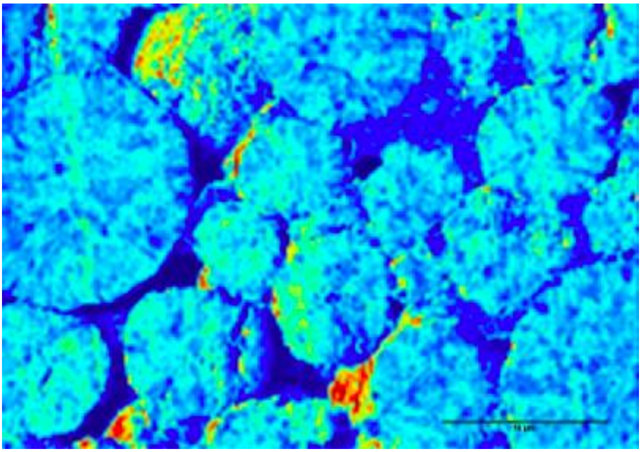

Figure 1: Lithium distribution in a $LiNi_xMn_yCo_{1-x-y}O_2$ (NMC) cathode, from [4].