Study of lithium-ion battery aging using laser-induced XUV spectroscopy (LIXS)

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Laser-induced XUV spectroscopy (LIXS) [1] is an emerging technique for elemental mapping. In comparison to conventional laser-induced breakdown spectroscopy in UV-vis (LIBS), it has a higher precision and wider dynamic range, and it is well suited for the quantification light elements like lithium and fluorine. Further it can spot oxidation states. The XUV spectra are produced at a very early stage of the plasma formation. Therefore, effects from plasma evolution on the reproducibility can be neglected. It has been shown, that high-precision elemental quantification in precursor materials for lithium-ion batteries (LIBs) can be performed using LIXS.[2] Based on these results, LIXS mapping was used to investigate aging processes in LIBs. Different cathode materials with varying compositions of fluorine containing polymer binders were compared at different stages of aging. Due to effects comparable to X-ray photoelectron spectroscopy but in reverse, monitoring of changes in the oxidation state is envisioned, which makes information about the chemical environment of the observed elements accessible. The combination of elemental distribution and structural information leads to a better understanding of aging processes in LIBs, and the development of more sustainable and safe batteries.

[1] Bleiner, D.; Qu, D.; Kraft, K.; Shlyakhtun, O. Laser-induced XUV spectroscopy (LIXS): From fundamentals to application for high-precision LIBS. *Spectrochim. Acta, Part B* **2023**, *204*, 106668. DOI: https://doi.org/10.1016/j.sab.2023.106668.
[2] Qu, D.; Ohannessian, N.; Wyder, C.; Trottmann, M.; Wichser, A.; Lippert, T.; Bleiner, D. High-precision mapping of fluorine and lithium in energy materials by means of laser-induced XUV spectroscopy (LIXS). *Spectrochim. Acta, Part B* **2021**, *181*, 106214. DOI: https://doi.org/10.1016/j.sab.2021.106214.