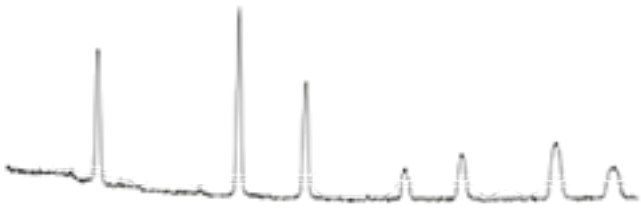

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Developments for 4D Neutron Depth Profiling at the N4DP Instrument

Thursday, 2 June 2022 11:35 (20 minutes)

Neutron Depth Profiling (NDP) is a non-destructive, isotope-specific, high-resolution nuclear analytical technique, which is often used to probe concentration profiles of lithium, boron, nitrogen, helium and several other light elements in different host materials. The N4DP instrument is located at the Prompt Gamma Activation Analysis (PGAA) facility of Heinz Maier-Leibnitz Zentrum (MLZ), which provides a cold neutron flux up to $5 \times 10^{10}\,\mathrm{s}^{-1}\mathrm{cm}^{-2}$. When a neutron is captured by a specific nuclide, charged particles with well-defined energies are emitted. The energy loss of the charged particles traveling through the host material is related to the depth of origin at a resolution level up to tens of nanometers.

We applied NDP to study the lithium-ion concentration gradient in energy storage systems, e.g. Li-ion batteries. Here, NDP reveals the evolution of immobilized lithium, which is one of the main causes of battery lifetime limitation. Furthermore, the status of the ongoing development towards 4D profiling is presented, where not only the concentration gradient, but also the lateral position of probes as well as its time evolution will be measured. For this, a highly segmented Si-based detector with 32×266 stripes, including integrated electronics, were tested. Using a camera-obscura geometry setup, we aim for lateral resolutions down to $100\mu\mathrm{m} \times 100\mu\mathrm{m}$ and highest time resolutions using a newly developed elliptical focussing neutron guide. This project is supported by the BMBF, Contract No. 05K16WO1, 05K19WO8.

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