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–Photons for Energy - Complementary Analytics

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New high performance materials like CoRe alloys which can improve the efficiency of gas turbines and Lithium ion batteries as energy storage device in electric vehicles or even large scale electric storage device combined with photovoltaic energy sources are just two examples of new materials which could help to solve the energy problem and reduce the worldwide CO2 pollution.

X-ray diffraction is a powerful technique to analyze such materials on the atomic level to obtain complementary informations which are not accessible with neutron scattering measurements.

In this poster we will present three examples which demonstrate the capability of this technique. We will show the correlation of the variation in the crystallographic structure of the elements of CoRe-TaC alloys exposed to high temperatures or in battery pouch cells directly with the amount of Lithium incorporated in the cathode or the anode.

The first example shows the development of a new sample stage to measure thin pouchbag batteries in transmission setup using Mo radiation. This allows to measure a LiNMC (LiNi0.33Mn0.33Co0.33O2) //graphite battery in operando and shows that it is possible to follow the structural changes due to the de-intercalation of Lithium simultaneously on the anode (graphite) and cathode (LiNMC) during charging and discharging with high speed and sufficient resolution. (Project ExZellTUM)

In the second example, we compare fresh and aged pouch cells of LiFePO4/C chemistry to understand cell degradation. With in-operando XRD during cell cycling, we demonstrate differences in the structural evolution of crystalline phases in these cells. In the cathode of the fully discharged aged cell, weight fraction of LiFePO4 has reduced whereas the FePO4 weight fraction has increased. In the anode of the fully charged aged cell, the weight fraction of the LiC6 phase has reduced. These changes are directly related to the loss of electrochemically active Li due to cell aging. (Project EEBatt)
The third example focuses on the formation and stability of Tantalum Carbide precipitates in Co-Re base superalloys. These precipitates are considered to be the main strengthening phase of the material and have a strong impact on the mechanical and thermal properties of the material. The alloys are exposed to temperatures up to 1500°C which severely changes the alloy's structure. The martensitic transformation of Co-Re matrix in fcc and hcp phase influences the TaC stability and is investigated by XRD.
The Poster will be completed by an overview about the current lab equipment, the techniques which are provided by the lab and a statistic about the usage of the lab.

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