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Utilizing beams of energetic ions for measurements of kinetics in materials on the atomic scale

Tuesday, September 23, 2025 11:00 AM (30 minutes)

Recent developments of keV and MeV ion beam analytical tools for in-situ and in-operando characterization of a number of material systems with high relevance for energy-related applications will be presented. The ion-beam based characterization was complemented by atom probe tomography, X-ray diffraction and transmission electron microscopy.

We performed high-resolution depth profiling of Li and O in thin film batteries using primary beams of He and Li at energies up to 10 MeV. By recording transmitted particles in coincidence, we could observe reversible transport of Li and quantify the material transport during charging and discharging of the battery stack [1][2][3].

Oxidized rare-earth metal hydrides can feature reversible photochromism at ambient conditions with huge potential for passive regulation of energy flow. To better understand the nature of the photochromic effect, we combined ion beam analysis with in-situ reactive growth and oxidation [4]. From this work and further complementary studies, a dual-phase nature is proposed and the photochromism is related to high residual stress levels in the films [5].

We furthermore explored the potential of ion beam analytical techniques capable of directly and indirectly sensing hydrogen in real space at a true atomic length scale. As a result, we succeeded to probe the specific lattice location and vibrational amplitude of H in crystalline matrices, specifically investigating V-based thin films and Fe/V superlattices as model systems for studying effects of proximity and dimensionality [6][7].

References:
[1] V. Mathayan et al., Appl. Phys. Lett. (2020)
[2] V. Mathayan et al., Mat. Today Energy (2021)
[3] V. Mathayan et al., J. Appl. Phys. (2021)
[4] K. Kantre et al., Scr. Mat. (2020)
[5] M. Hans et al., Adv. Opt. Mat. (2020)
[6] K. Komander et al., Phys. Rev. Lett. (2021)
[7] D. Moldarev et al., Phys. Rev. Mat. (2025)

Author: PRIMETZHOFER, Daniel (Uppsala University)

Presenter: PRIMETZHOFER, Daniel (Uppsala University)

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