Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter

Thursday, July 20th , 2017 – 2:00 p.m.

CFEL Seminar room I-II (Bldg. 99)

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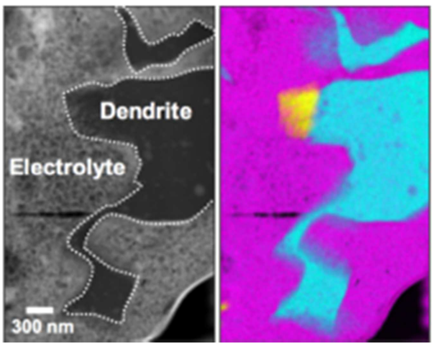
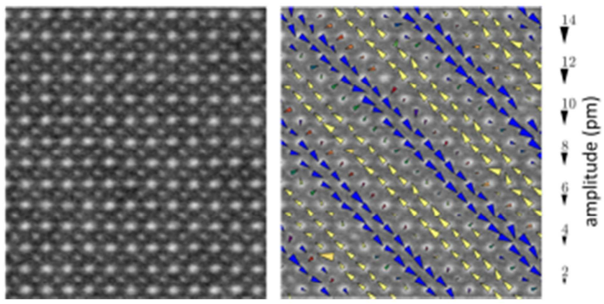
New frontiers in cryo-electron microscopy: From Probing Low Temperature Electronic Phases to Processes at Liquid/Solid Interfaces

Spectroscopic mapping by STEM/EELS has proven to be a powerful technique for determining the structure, chemistry and bonding of interfaces, reconstructions, and defects. So far, most efforts in the physical sciences have focused on room temperature measurements where atomic resolution mapping of composition and bonding has been demonstrated [1-3]. For many materials, including those that exhibit electronic and structural phase transitions below room temperature and systems that involve liquid/solid interfaces, STEM/EELS measurements at low temperature are required. Operating close to liquid nitrogen temperature gives access to a range of emergent electronic states in solid materials and allows us to study processes at liquid/solid interfaces immobilized by rapid freezing [4,5].



Here, we will discuss our approach to study two processes at the anode-electrolyte interface in lithium metal batteries (LMBs), uneven deposition of lithium metal leading to dendrite growth and the breakdown of electrolyte to form a “solid-electrolyte interphase” (SEI) layer, processes which result in capacity fade and safety hazards. By combining cryo-STEM/EELS with cryo-FIB lift out [5], we provide nanoscale compositional information about intact SEI layers in cycled LMBs and track local bonding states at interfaces, leading to new insights into SEI and dendrite formation (*Figure left*).

We will further demonstrate cryo-STEM imaging at sub-Å resolution and atomic tracking with picometer precision in charge-ordered manganites. Using this technique, we measure transverse, displacive lattice modulations of the cations, distinct from existing manganite charge-order models and reveal temperature-dependent inhomogeneities in the stipe order such as shear deformations and topological defects, and the emergence of phase coherence well below T_c (*Figure right*). Correlating the atomic level structure and electronic properties at cryogenic temperatures is an important step in realizing the goal of understanding and controlling emergent phenomena in these materials.



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References

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Host: R. J. Dwayne Miller