Next-generation Battery Materials

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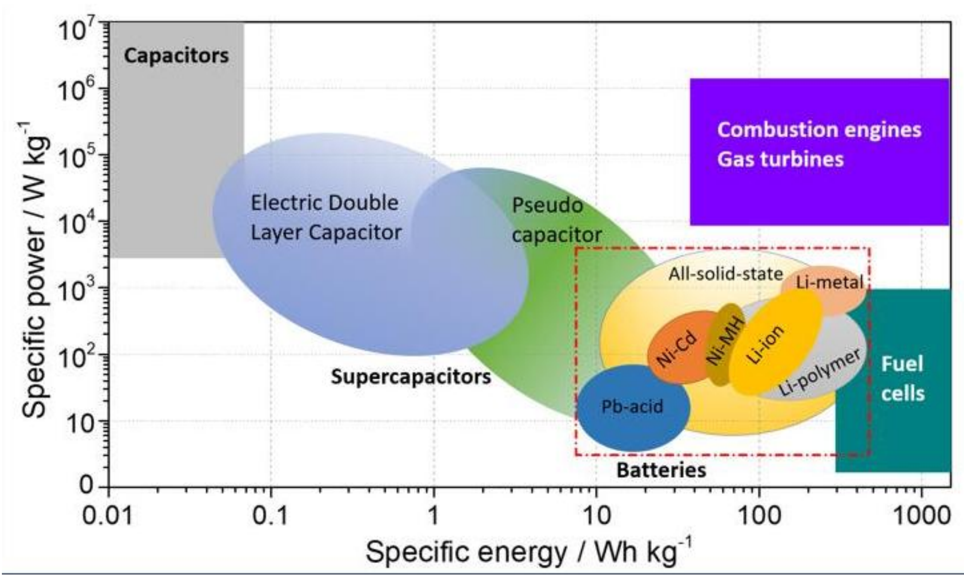
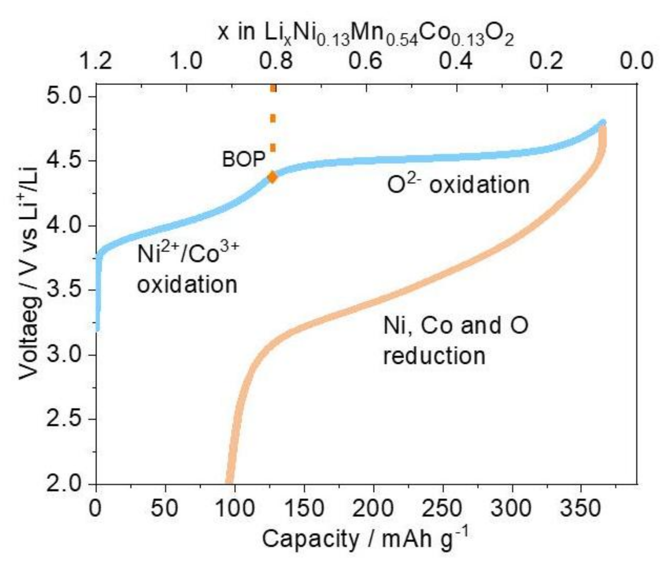
Research Summary

Our research aims to develop next-generation energy storage and conversion materials to enable technologies addressing energy and climate challenges.

We are particularly interested in battery materials, such as layered metal oxides and polyanion cathodes. Anionic-redox layered oxides, such as $Li_{1.2}[Ni_{0.13}Mn_{0.54}Co_{0.13}]O_2$ are considered the next-generation cathodes with capacities beyond 250 mAh g^{-1} resulting from the cationic and anionic (O^{2-}) redox reaction.



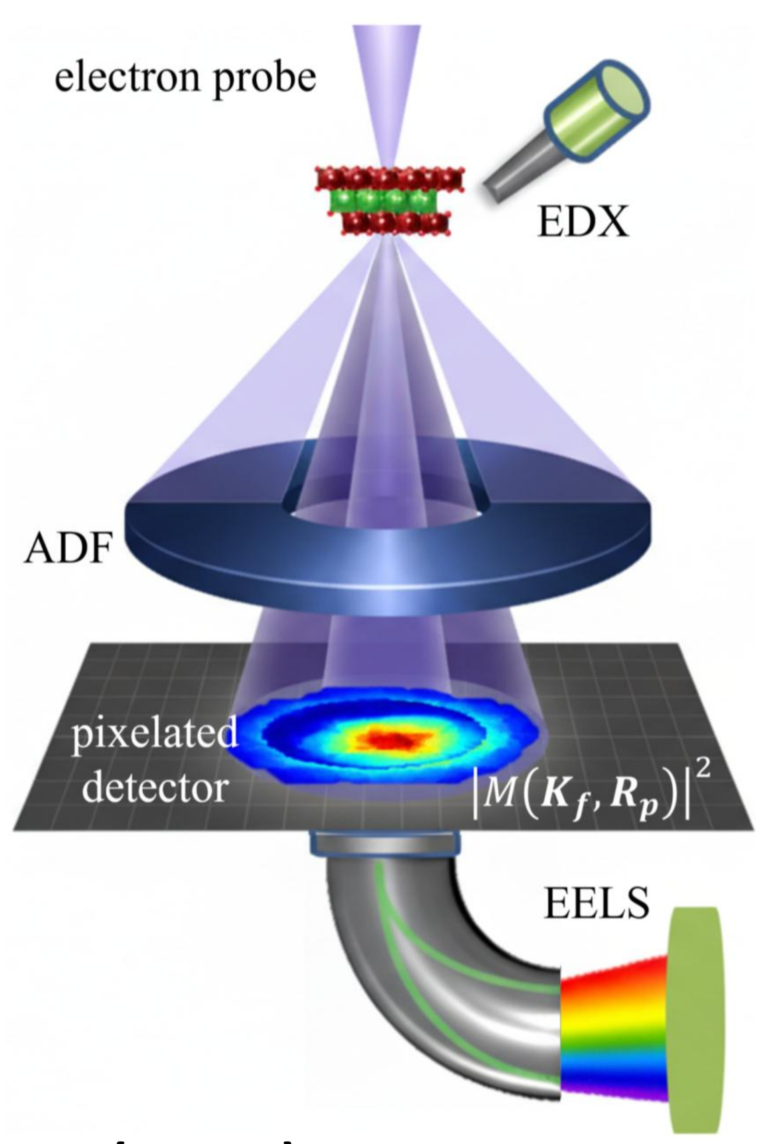


Advanced Material Characterization

Our group has expertise in developing and applying advanced characterization methodologies to understand the materials from atomic scale and advancing material synthesis to improve device performance.

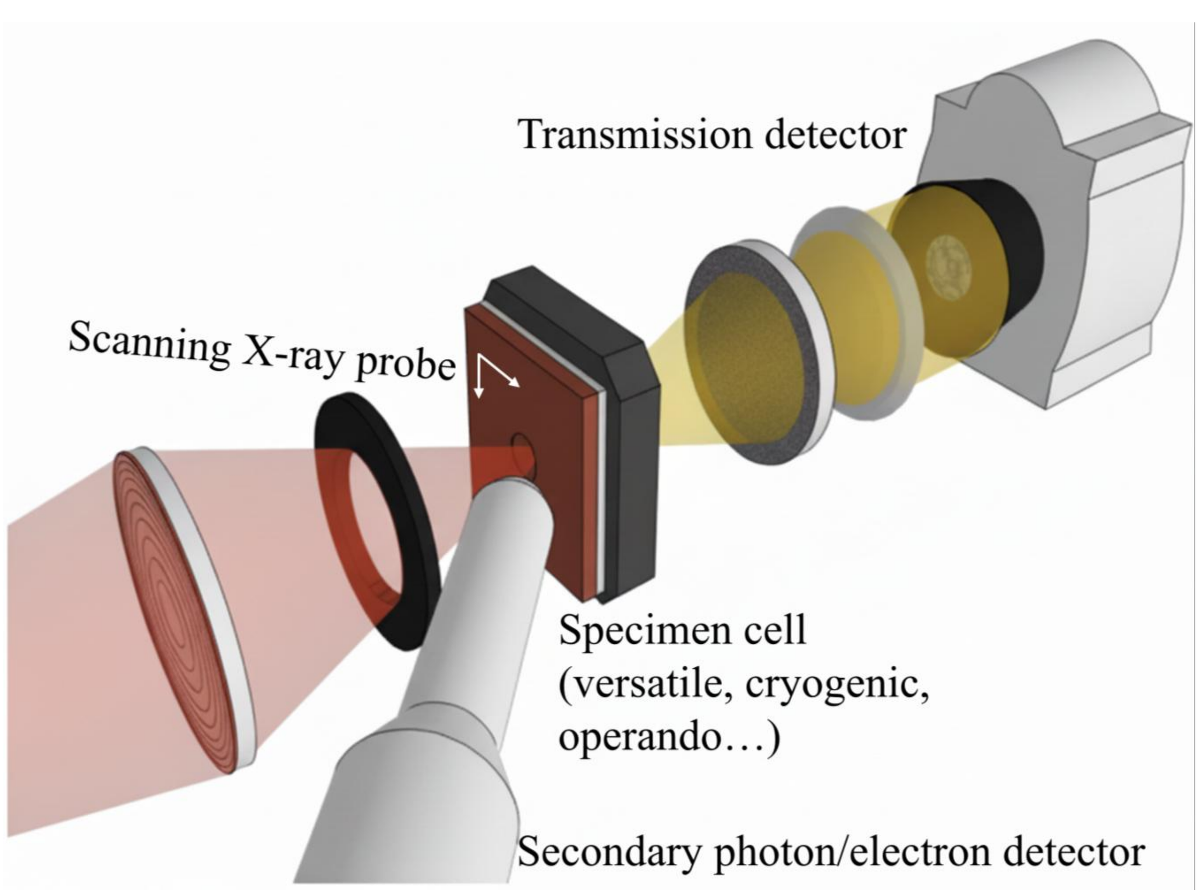
Scanning Transmission Electron Microscopy (STEM):

- Annular Dark Field (ADF) imaging
- Electron Ptychography
- Scanning Nanobeam Electron Diffraction
- Energy dispersive X-ray Spectroscopy (EDX)
- Electron Energy Loss Spectroscopy (EELS)

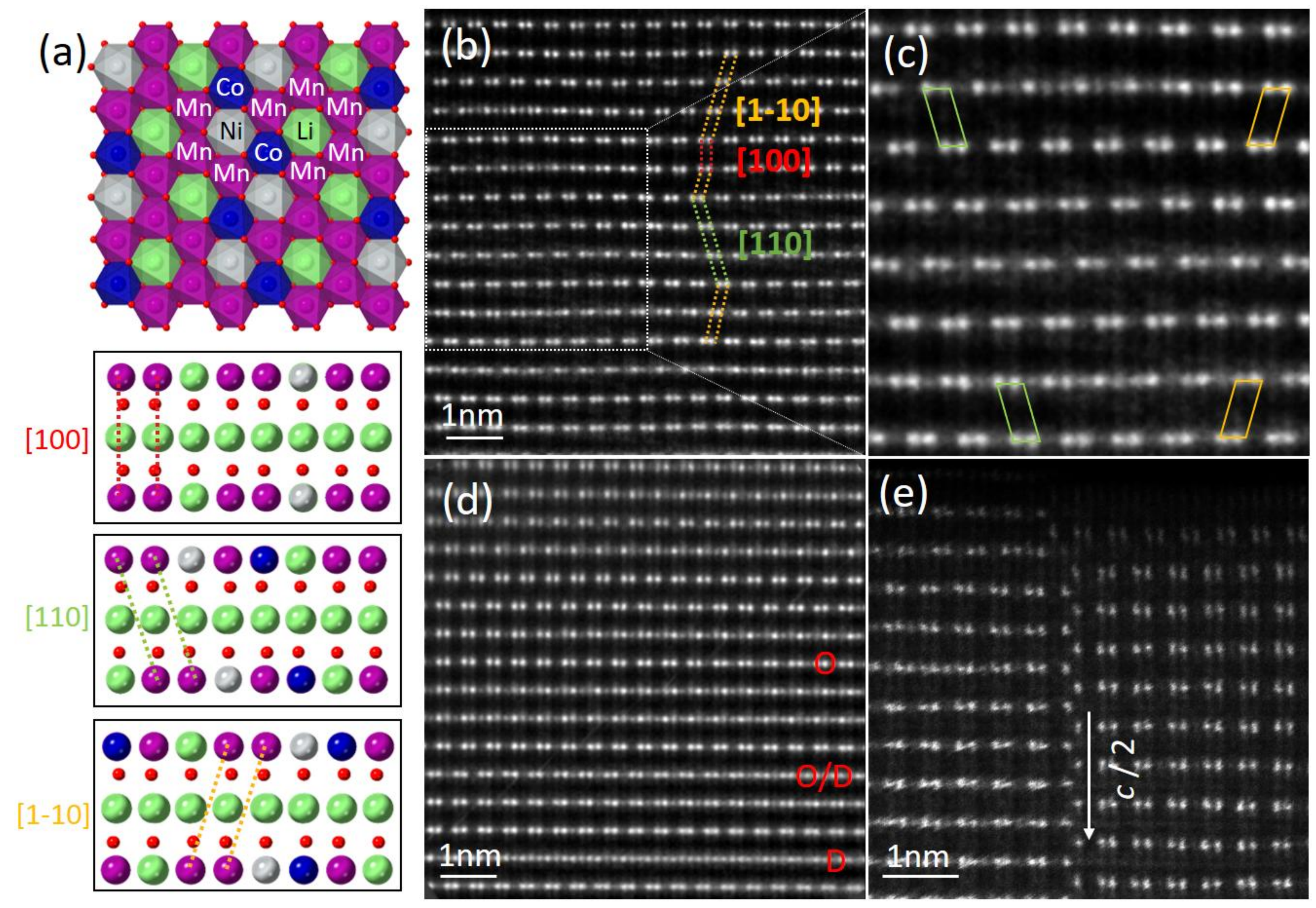


Scanning Transmission X-ray Microscopy (STXM):

- Soft & Hard X-rays Absorption Spectroscopy (XAS)
- Transmission XAS
- Electron Yield Mode
- Fluorescence Mode

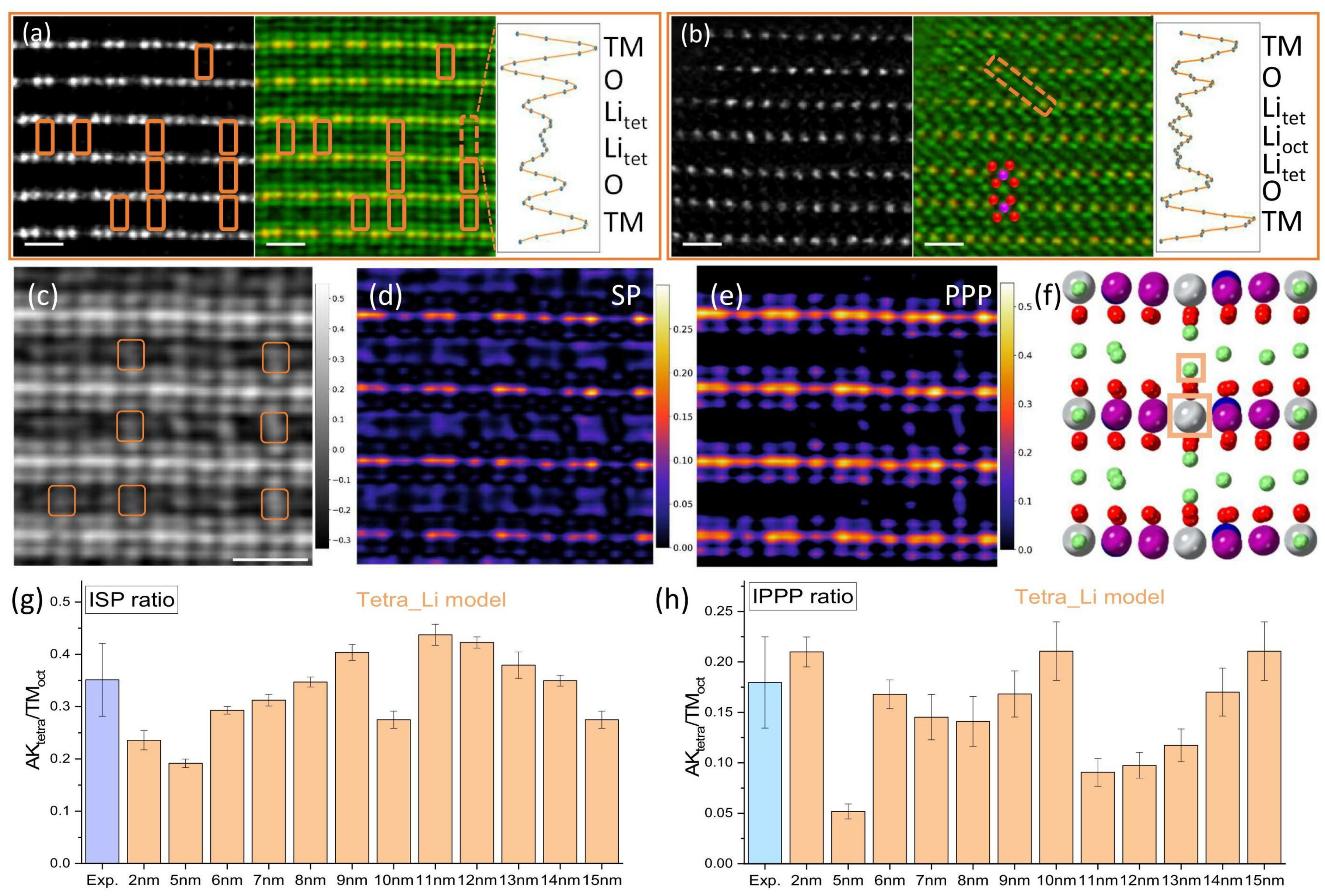


Transition Metal (TM) Layer Stacking Faults



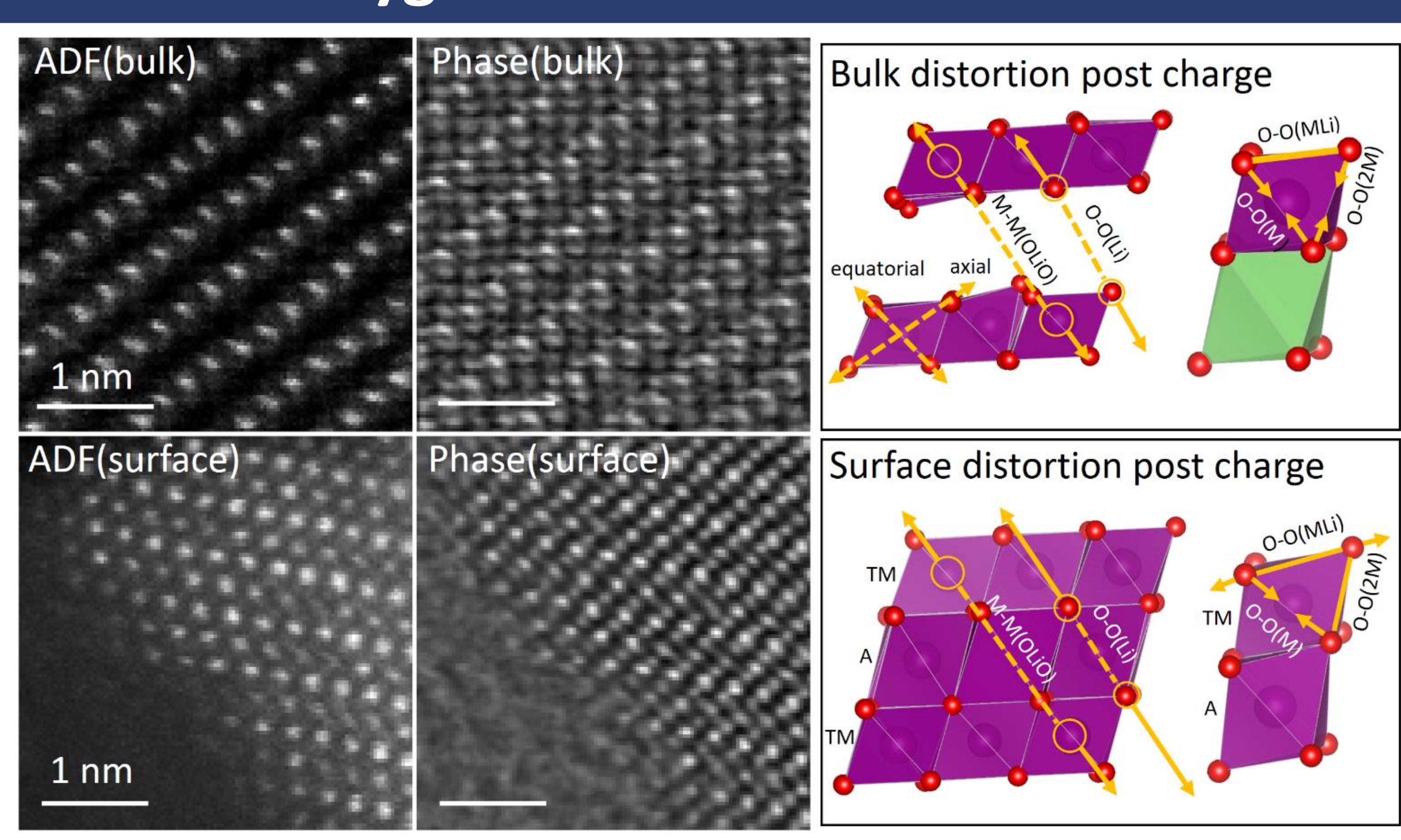
ADF imaging of $Li_{1.2}[Ni_{0.13}Mn_{0.54}Co_{0.13}]O_2$ showing inter-layer and intra-layer stacking faults with ordered and disordered contrast.

Lithium Diffusion Pathway



Ptychographic phase quantification demonstrates lithium diffusion from TM-layer to alkali layer through the tetrahedral sites of $Li_{1.2}[Ni_{0.13}Mn_{0.54}Co_{0.13}]O_2$.

Oxygen Sublattice Distortion



Imaging of oxygen sublattice and measuring $[TMO_6]$ octahedral distortion with pico-meter precision from bulk and surface.