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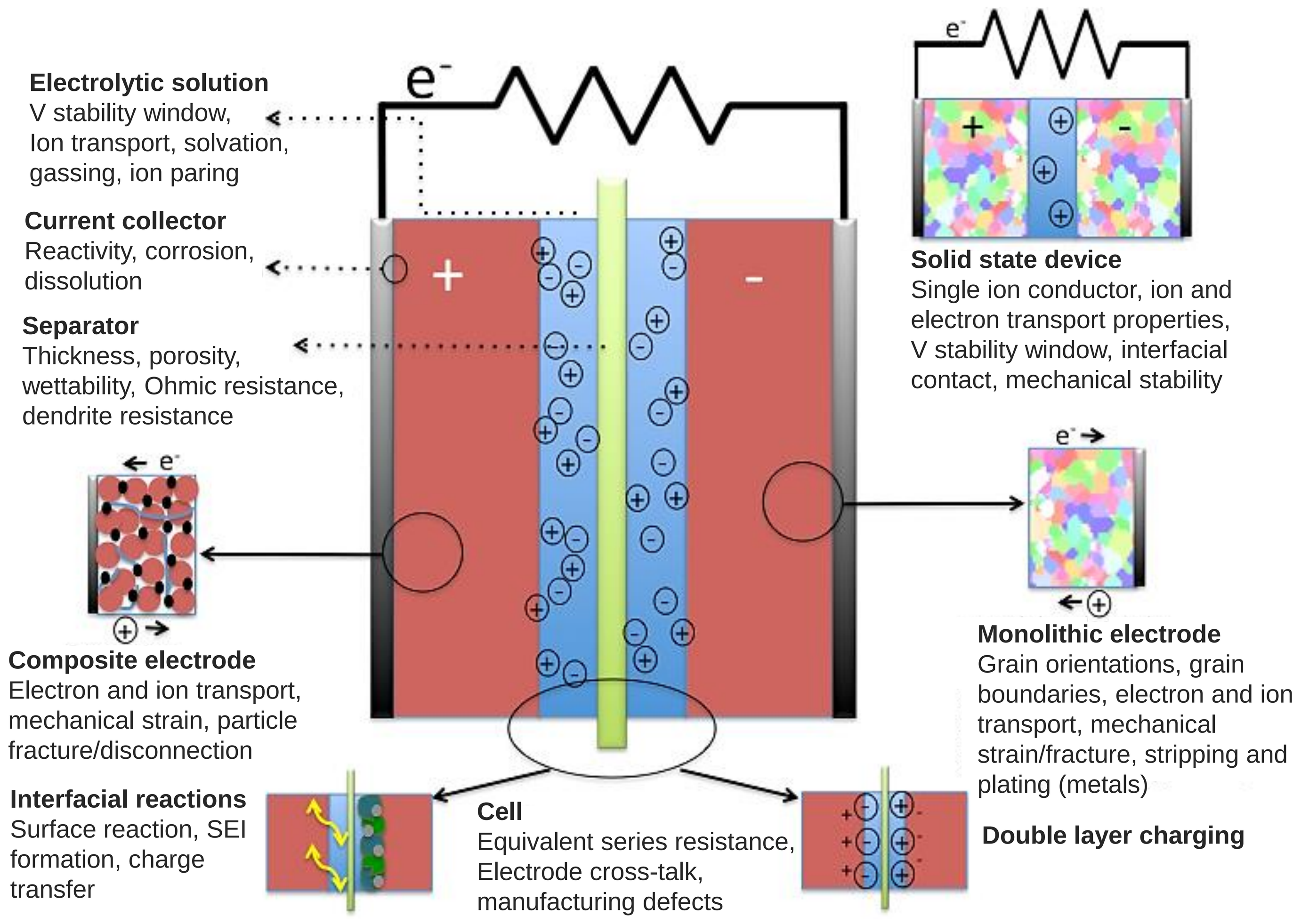
The Feng Lin Lab: Solid-State Materials Electrochemistry for Energy Sciences

Overview

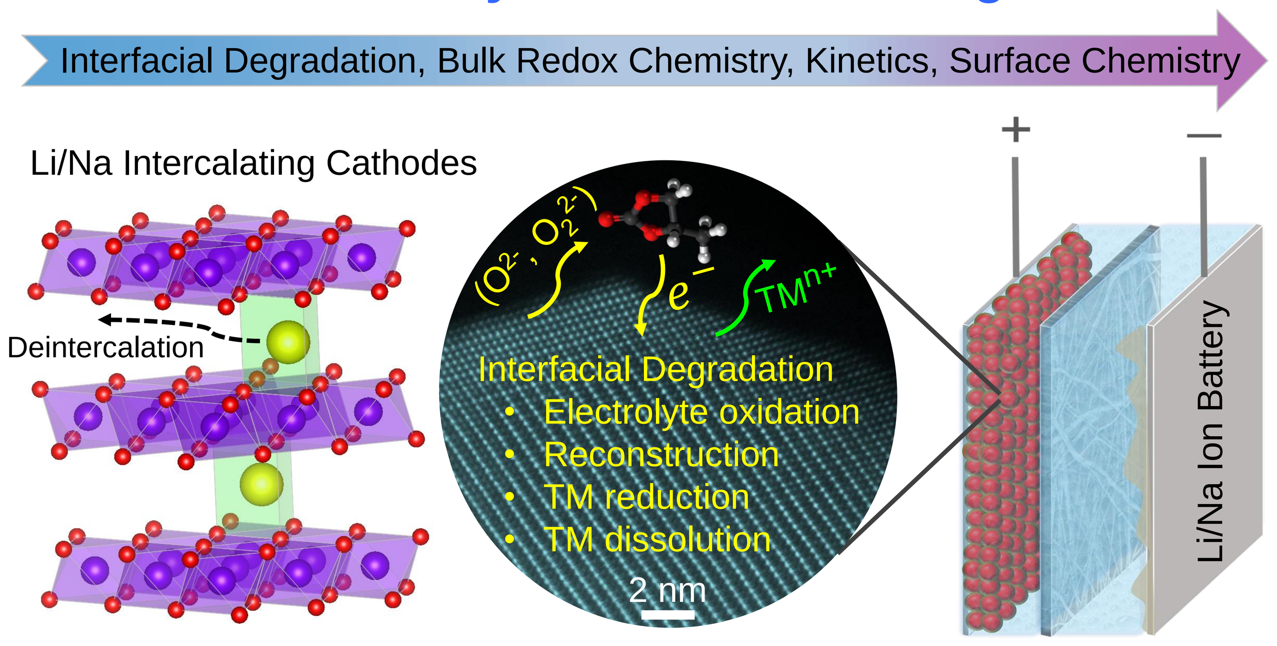
Our research team focuses on resolving one of the most longstanding challenges in materials electrochemistry regarding redox active solids: how does the mesoscale chemical distribution influence redox reactions at all length scales? Through manipulating the thermodynamics and kinetics of the intercalation chemistry, our goal is to develop unprecedented experimental methodologies and establish novel design principles to enhance the electrochemical and optical properties of ion-intercalating solids for **energy storage**, **catalysis**, and **dynamic thin films**. To accelerate the materials discovery, we develop an integral analytical program to study materials dynamics using synchrotron X-ray and electron techniques.

Keywords: Li^+/Na^+ Batteries, Catalysis, Inorganic Chemistry, Materials Science, Synchrotron X-ray Spectroscopy & Imaging

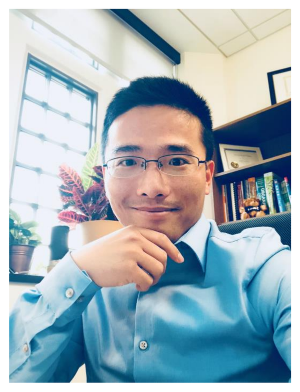


The goal is to achieve unprecedented control of materials properties for energy applications and to contribute to the fundamental progress of solid-state materials electrochemistry.

1. Surface Chemistry of Ion Intercalating Solids



We study electrochemical interfaces to enable a path towards precisely tuning local chemical environments and to eliminate undesired interfacial reactions that are responsible for performance degradation in Li-ion and Na-ion batteries.
Scientists: Dr. Linqin Mu, Momi Rahman, Zhijie Yang, Yuxin Zhang, Crystal Waters, Mingyu Yuan, Tianyi Liu



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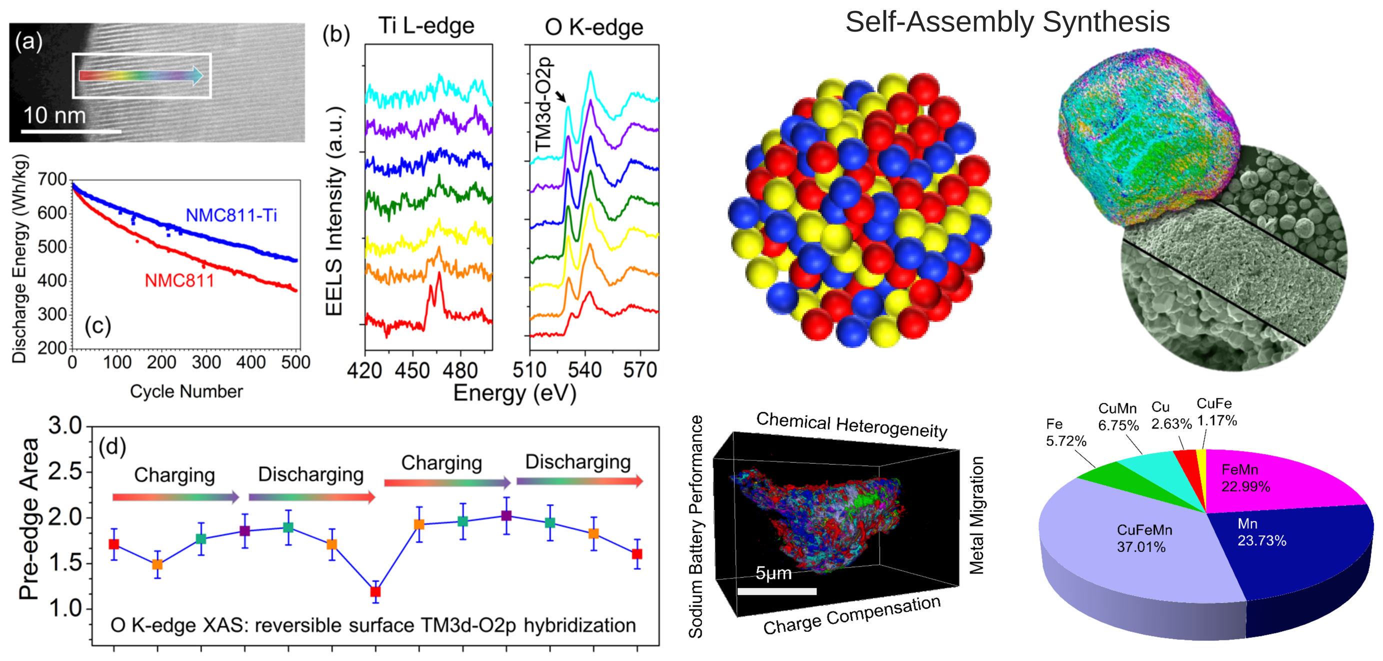
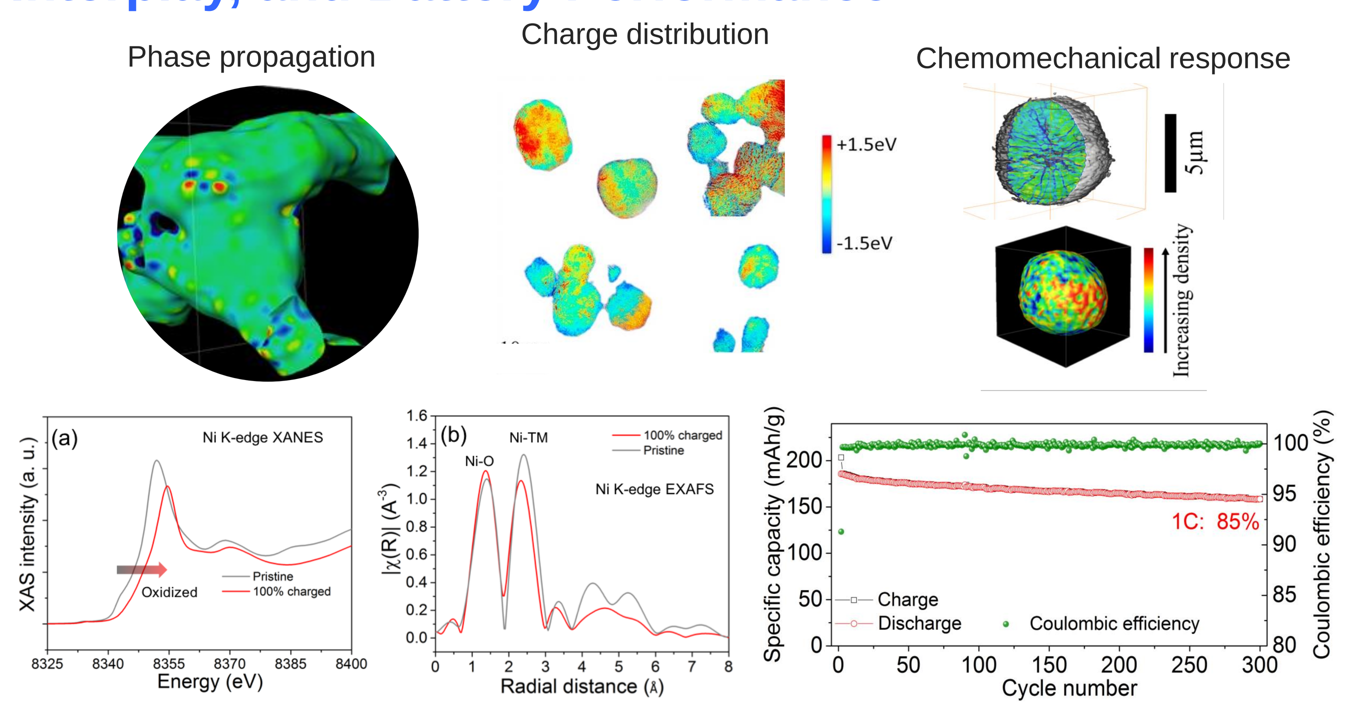
Poster made in February 2019

2. Decoupling Multiscale Electrochemistry in Intercalating Battery Cathode Materials



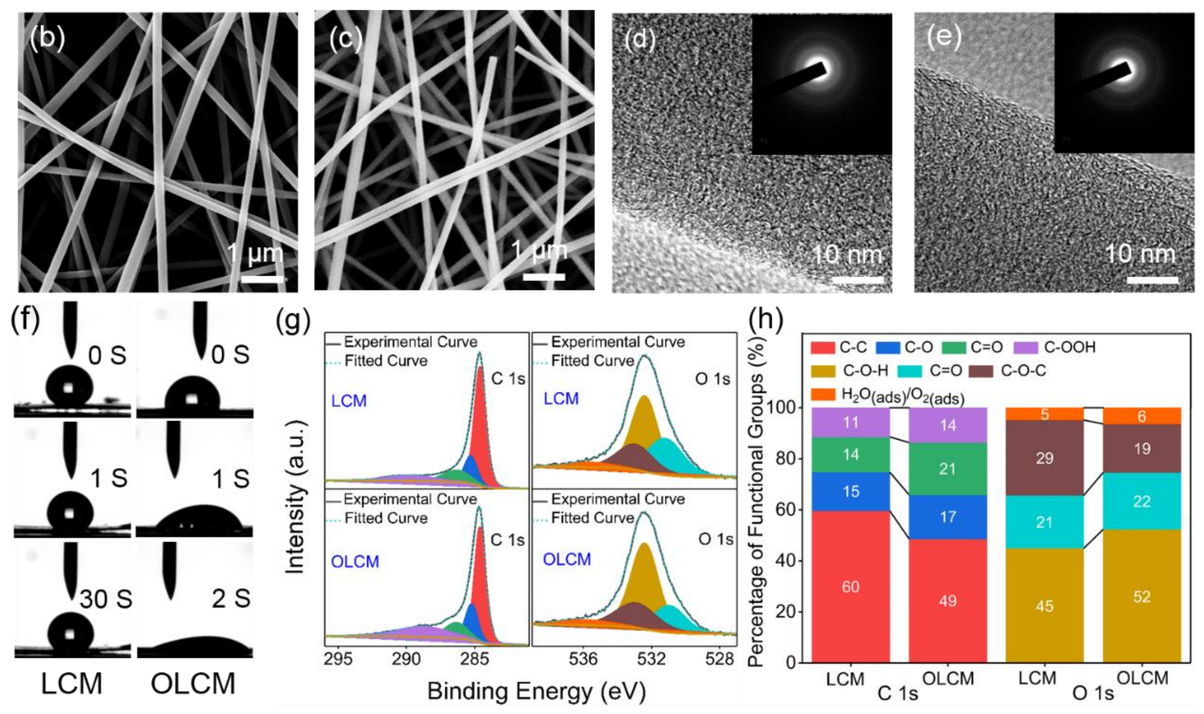
Engineering the three-dimensional distribution of metal cations in electrode particles can take advantage of the depth-dependent charging mechanisms thus empowering superior battery performance (energy/power density and cycle life in Li-ion and Na-ion batteries).
Scientists: Dr. Linqin Mu, Momi Rahman, Yuxin Zhang, Dr. Dong Hou

3. Phase Transformations, Defects, Chemomechanical Interplay, and Battery Performance



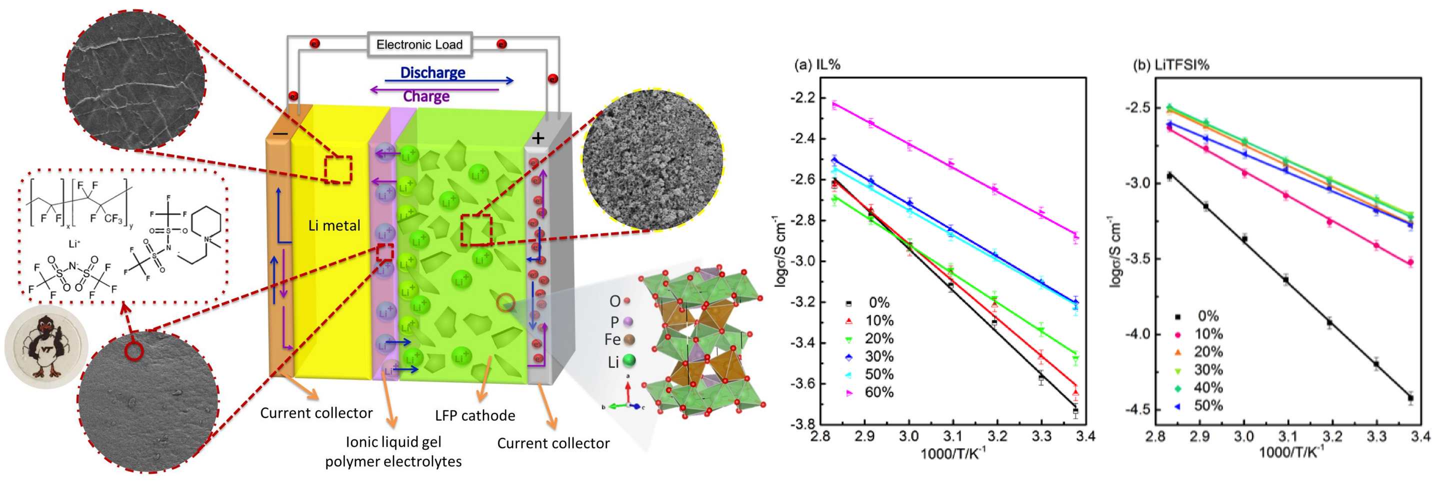
Our goal is to understand the defect inception, accumulation, and growth at the interface or within the grains, and the defect-microstructure-performance relationship in ion intercalating solids using the synchrotron X-ray analysis, electrochemical methods, and data mining.
Scientists: Zhengrui Xu, Dr. Dong Hou, Dr. Linqin Mu, Huabin Sun

4. Stable, High Capacity Anodes for Li and Na Metal Batteries



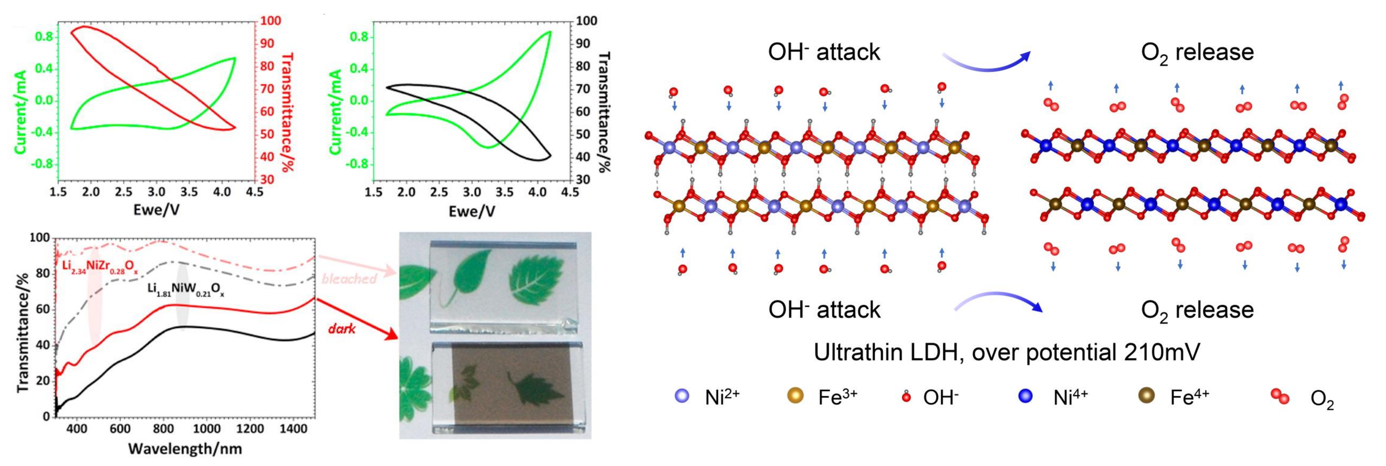
We design functional-gradient composite metal anodes and new electrolytes that offer a protected host for redox reactions and a stable interphase against metal anode consumption. Applying this method will potentially enable high current density, high areal capacity, and fast-charging all-solid-state batteries.
Scientists: David Kautz, Lei Tao

5. Flexible, Stretchable, and Transparent Superionic Polymer Solid Electrolytes



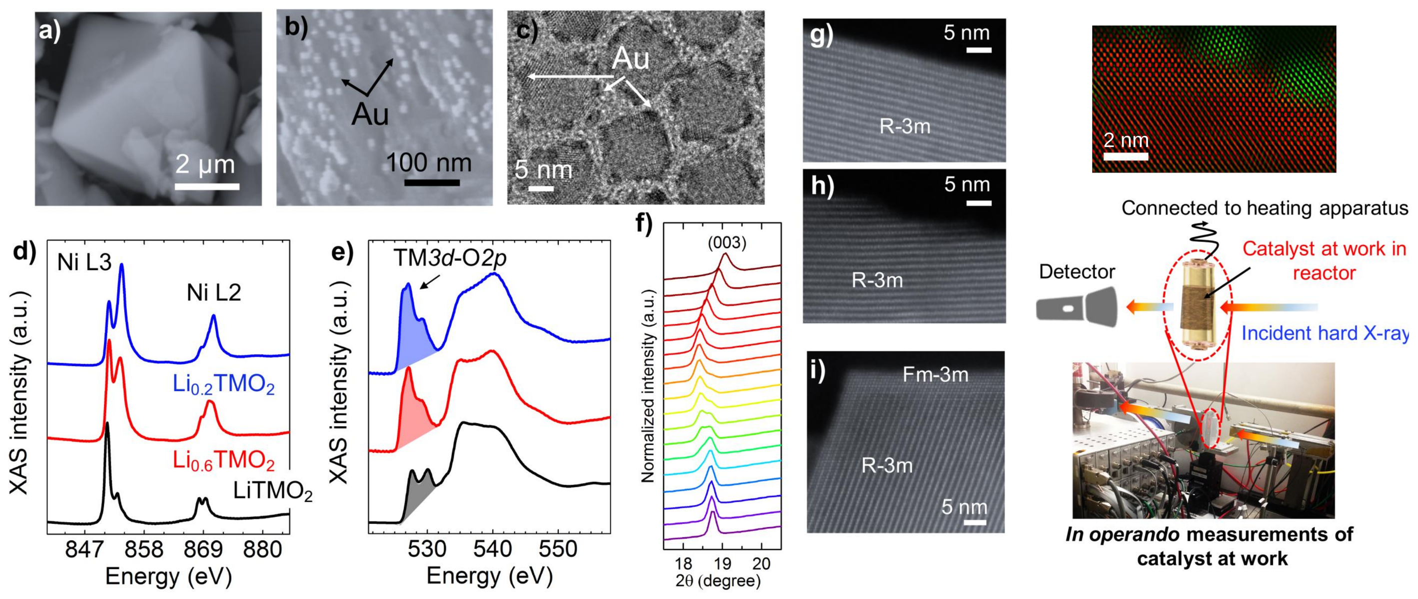
The flexible, stretchable, and transparent characteristics open up a completely new playground that will support next-generation wearable electronics, fast charging batteries, and flexible dynamic glass technologies.
Scientists: Tianyi Liu, Mingyu Yuan

6. Rapid Switching Electroactive Thin Films for Dynamic Glass and Electrocatalysis



Our materials platform will enable fast charge transfer for rapid switching electrochemical devices, aligning with the frontier challenges in electrocatalysis and dynamic glass.
Scientists: Stephanie Spence, Anyang Hu, Chunguang Kuai

7. Continuously Tunable Metal Oxides as the Modular Platform to Support Catalysts



We apply our recent discovery of the continuously tunable electronic and crystal structures in some inorganic materials to create high-performance supported metal catalysts.
Scientists: Chunguang Kuai, Crystal Waters, Stephanie Spence

We thank our sponsors for supporting our research and education:
NSF-DMR-Ceramics
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We thank national laboratories for the highest-level materials characterization: