New Developments for In-Situ and Operando TEM Experimentation

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As in-situ transmission electron microscopy (TEM) is becoming more readily available throughout the scientific community, the needs and wants of the community expand as well. This presentation will focus on a series of new in-situ TEM sample holders that expand the horizons of in-situ TEM experimentation. This new suite of electrical, mechanical, and temperature controllable sample holders include: a liquid-electrochemical TEM holder that can, for the first time, match bulk scale electrochemistry data, a biasing manipulator holder for sample manipulation and site-specific probing, an air-free transfer holder for protecting air-sensitive samples, a heating and biasing holder that allows heating while measuring electrical properties, and a cryo-biasing holder that allows fine electrical measurements at cryogenic temperatures.

We will present recent works performed using these products in research fields such as electrochemistry, batteries, 2D material fabrication, and low-temperature devices. Most importantly, we will present our liquid electrochemistry holder's ability to match bulk scale electrochemistry data inside a TEM. We will show nano battery setup and charge/discharge behavior in individual nanoelectrodes. We also show an example of our holder heating a MoS_2 sample to 1000°C, resulting in well-segregated MoS_x quantum dot particles. Finally, we will discuss a constant current experiment performed on a nanowire at cryogenic temperatures.