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# In Situ Studies of Electrochemical Reactions at Atomic Resolutions

## ABSTRACT:

Electrodes in rechargeable batteries undergo complex electrochemically-driven phase transformations upon driving Li ions into their structure. Such phase transitions in turn affect the reversibility and stability of the battery. This presentation gives an overview of the PI's research program on in-situ transmission electron microscopy (TEM) of battery materials. In-situ TEM has been shown to be a very powerful technique in shedding light to some of the mysteries in electrochemical performance of new materials. Various anode materials including SnO<sub>2</sub>, MnO<sub>2</sub>, ZnSb were subjected to lithiation process and the transport of Li ions was visualized within their atomic structure. For SnO<sub>2</sub> nanowires, it was observed that the Li ion transport results in local strain development preferably along (200) or (020) plans and [001] crystallographic directions. The lithiation behavior in the presence of twin boundary defects was completely different compared to pristine state with no twin boundary defect. We showed that twin boundaries in general provide a more accessible pathway for Li ion transport. Anisotropic plastic deformation was also observed along [010] directions of MnO<sub>2</sub> nanowires. .



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Reza Shahbazian-Yassar is an associate professor of Mechanical Engineering at the University of Illinois at Chicago. He received his PhD (with honor) in Materials Science from Washington State University in Pullman, WA, in Dec 2005. Prior to joining Michigan Tech, he was a post-doctoral research fellow at the Center for Advanced Vehicular Systems at Mississippi State University under the supervision of Mark Horstemeyer. He also worked at the Division of Materials Research under the supervision of Hasso Weiland at Alcoa Technical Center in Pittsburgh, PA. He was the recipient of 2014 Summer Faculty Fellow from Air Force Research Laboratory and received the Young Leaders Awards from TMS in 2015. He has published more than 80 journal papers and 4 book chapters. He is the current Materials Science Director for Midwest Microscopy Society, a member of Steering Committee for ASME NanoEngineering for Energy Committee, and the former chair of the Advanced Characterization, Testing, and Simulation (ACTS) Committee at The Materials Society (TMS). He is also a member of Editorial Board for Journal of Nanotechnology and Smart Materials (JNSM) and Metallurgical and Materials Transactions A (MMA).