Tunnel Manganese Oxides for Lithium-Ion and Sodium-Ion Batteries

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Abstract: Intercalation reactions lie at the heart of the operation mechanism of lithium-ion battery, which remains the most widely used energy storage device to power portable electronics and electric cars. Intercalation is usually a reversible process that involves the introduction of a guest species into empty crystallographic sites without major modification of the overall original host structure. The growing demand for electrochemical energy storage raises economic issues related to the limited supply of lithium, which is a principal operational unit in rechargeable lithium-ion batteries widely used as a power source in many applications. As the result, the research shifted towards exploring electrochemical systems that operate due to reversible intercalation reactions of more abundant and thus cheaper charge carrying ions, such as sodium and magnesium, often called beyond lithium ions (BLI). Materials with layered and tunnel crystal structures have been proven to be the most reliable hosts that provide highest performance in both lithium-ion batteries and BLI electrochemical systems. I will discuss our work related to the synthesis and electrochemical performance of manganese oxide nanowires with tunnel crystal structures. This materials display a controlled variation in tunnel size and shape which can be used for tunable ions intercalation. By matching the tunnel size of the host manganese oxide material with the radius of specific charge-carrying ions, it is possible to create efficient electrodes for intercalation-based energy storage systems, such as Li-ion and Na-ion batteries. To understand electrochemically correlated physical, structural and mechanical properties of single nanowire electrodes we utilize a unique TEM-compatible on-chip platform. Nanowire of the active battery material is assembled on the platform using dielectrophoresis (DEP). In this configuration individual nanowire can be separately probed for electrical transport and structural/mechanical property measurements.

About the Speaker: Dr. Ekaterina Pomerantseva is the Anne Stevens Assistant Professor at the Department of Materials Science and Engineering at Drexel University. She received a B.S. degree in Materials Science in 2000 and a M.S. degree in Chemistry and Materials Science in 2003 from Lomonosov Moscow State University, a M.S. degree in Biochemistry in 2005 from McGill University, and a Ph.D. degree in Solid-State Chemistry in 2007 from Lomonosov Moscow State University. She was a postdoctoral fellow with Professor Linda Nazar at the University of Waterloo, Canada in 2009-2010. After that she worked as a postdoctoral research associate in the MEMS Sensors and Actuators Laboratory (MSAL) led by Professor Reza Ghodssi at the University of Maryland in 2010-2013. She has published 39 journal papers. Her research interests lie in the development and characterization of novel nanostructured materials, systems and architectures for batteries and supercapacitors with the aim to better understand electrochemical energy storage at nanoscale.

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