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Refractory Metal Oxide Electrodes for Lithium-Ion Batteries

Oxide compounds of early transition metals, also referred to as refractory metal oxides, have reemerged as fast-charging electrode materials capable of multi-electron redox at low voltage. These compounds often crystallize in structurally very interesting variants such as the Wadsley–Roth compounds whose structures are obtained by appropriate crystallographic shear of the ReO_3 structure.

The first part of this talk will be a tutorial on this fascinating (and large) materials class. In the second part, I will describe the research being carried out in our group on the use of these materials as electrodes. A number of these oxides display multielectron redox as observed through X-ray absorption spectroscopy and X-ray photoelectron spectroscopy, and rapid charge/discharge with lithium. Some of them also display an insulator-to-metal transition upon lithium insertion, as suggested by a number of complementary techniques. Chemical tuning of the structures results in significant changes in the electrochemistry and kinetics of lithium insertion in the structure, pointing to larger implications for the use of these compounds, including the crystallographic shear phases, as fast-charging electrode materials.

Ram Seshadri is the Fred and Linda R. Wudl Professor of Materials Science, and a Distinguished Professor at the University of California Santa Barbara, in the Materials Department and the Department of Chemistry and Biochemistry. He received his PhD in Solid State Chemistry in 1995 from the Indian Institute of Science, working under the guidance of Professor C. N. R. Rao FRS. After some years as a postdoctoral fellow in Europe, returned to Bangalore as an Assistant Professor in 1999. He moved to UC Santa Barbara in 2002, where he currently serves as Director of the Materials Research Laboratory: A National Science Foundation Materials Research Science and Engineering Center (NSF-MRSEC). His research, embodied in close to 400 publications, addresses the topic of structure-property relations in crystalline inorganic materials, with a focus on materials for energy applications. He is a Fellow of the Royal Society of Chemistry, the American Physical Society, and the American Association for the Advancement of Science. He serves as the Associate Editor of Annual Reviews of Materials Research (on the Committee since 2008), and as an Associate Editor of Chemistry of Materials (since 2015).