Mean-inner and Space Charge Potentials in Oxides

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Abstract

The mean inner potential (MIP) of a material is the volume averaged electrostatic (Coulomb) potential between bulk and vacuum. Thus, it is a fundamental material property, which depends on composition and structure. However, MIP measurements are lacking for a wide range of materials due to experimental challenges. I will present a methodology using off-axis electron holography (OAEH) to measure the MIP, demonstrated on α-Al_2O_3 sapphire.

Charge distribution in nanoscale granular oxides results in the formation of a space charge potential (SCP), which then determines functional properties. Explanations for this phenomenon are reported though quantitative experimental evidence is indirect. I will show direct measurements of the SCP in nanoscale non-stoichiometric granular magnesium aluminate spinel (MAS, $MgAl_2O_4$) using OAEH and Electron Energy-Loss Spectroscopy. Thus, the effect of MAS composition, grain size, and applied electric field during annealing on the SCP is examined. We demonstrate that regardless of grain size, excess Mg^{+2} or Al^{+3} cations resides in the vicinity of grain-boundaries of Mg- and Al-rich MAS, respectively. We then discuss the role of grain size on the SCP, especially when comparable to the Debye length. Furthermore, applying a moderate electric field during annealing modifies lattice ordering.

Short Biography

Amit Kohn is an Associate Professor at the Department of Materials Science and Engineering at Tel Aviv University since 2015. Amit's research projects are in the field of magnetic and electronic materials used for information storage devices. The contribution of the research is to relate between structure and composition of these materials to the magneto-transport properties of the devices. The objective is therefore to improve on, or design new so-called 'spin-electronic' devices.
Structural and chemical characterization is mostly achieved by analytical transmission electron microscopy, which probes the properties of the materials at the nanoscale and up to the atomic level. In addition, Amit applies and develops Lorentz electron microscopy and electron holography in order to image magnetic and electrostatic fields in materials and devices at the nanometer scale.
Professor Kohn holds a Ph.D. in Materials Engineering from the Technion – I. I. T.. He was a Royal Academy of Engineering Research Fellow at the Materials Department, University of Oxford followed by a faculty position at Ben-Gurion University of the Negev.