Master Thesis Projects available at the Max-Planck-Institute for Solid State Research, Stuttgart Department Prof. Joachim Maier

1. How to exploit conversion reactions for Li- or Na-based batteries?

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Batteries storing lithium or sodium typically work by inserting Li or Na into the crystal structure. In addition, there is significant storage possible by decomposing electroactive materials on massive storage. While the theoretical capacity is very high, the problem lies here in the reversibility of the process. The master thesis considers the possibility of increasing the reversibility by nanodispersing the electroactive masses in a conducting matrix. The master thesis will complement ongoing experimental and thermodynamic work on RuO_2 and MoS_2.

2. Hetero-interface effects in proton conducting ceramics

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Proton conducting ceramics are highly relevant materials for key technologies such as advanced energy conversion devices (proton-based solid oxide fuel cells) and hydrogen separation membranes. This master thesis project aims at exploring novel approaches for obtaining proton conductivity in barium zirconate ($BaZrO_3$), which belongs to the best proton conducting ceramics. Proton transport in the bulk of acceptor-doped barium zirconate (e.g. $Ba(Zr_{1-x}Y_x)O_{3-x/2}$) as a consequence of water incorporation is a well-known phenomenon. Here hydroxide ions are incorporated into oxygen vacancies formed by the doping, and protons attached to regular oxide ions. In this project, water incorporation and proton conductivity at hetero-interfaces via a novel "job sharing mechanism" will be investigated. Even though neither undoped $BaZrO_3$ nor acceptor-doped $Zr_{1-x}Y_xO_{2-x/2}$ (YSZ) will take up water, nanostructured composites of these phases are expected to do so at the $BaZrO_3$/YSZ interfaces by incorporating protons into $BaZrO_3$ and oxide ions into vacancies in YSZ. These ceramic composites will be prepared by wet-chemical methods followed by "spark plasma sintering", and investigated by impedance spectroscopy (as function of the water partial pressure, pH_2O, and temperature) and further complementary methods available in the institute (such as X-ray diffraction, electron microscopy, Raman spectroscopy).