

Metallic perovskites – Mn, Co and Ru based materials and their characterization

Jiri Hejtmanek

Institute of Physics, ASCR, Prague, Czech Republic

Abstract:

The material research of some complex Mn and Co based oxides is strongly motivated by their application potential to be used as chemically stable and efficient multifunctional materials. The promise is the use in high temperature thermoelectric battery or as chemical catalyst. This ambition, together with richness of $\text{Ln}_{1-x}\text{A}_x\text{MnO}_3$, $\text{Ln}_{1-x}\text{A}_x\text{CoO}_3$ ($\text{Ln} = \text{La}, \text{Y}, \text{rare-earth}$, $\text{A} = \text{alkaline -earth}$) and Na_xCoO_2 phase diagrams, offering e.g. spin-polarized metals, superconductors and multiferroics, intensified both the theoretical and experimental research. Nonetheless, despite the theoretical and experimental investigations, the unequivocal and concise physical background of their transport and magnetic properties remain still a matter of debate. This is namely due to a fact that spin, orbital and charge degree of freedom of valence electrons can sway the balance between the degenerate or localized behavior of conducting electrons, being primarily determined by the character of TM-O chemical bond and crystal structure. Concretizing for the case of $\text{Mn}^{3+}/\text{Mn}^{4+}$ perovskites, the possibility of minimizing the ground-state energy via ferromagnetic double-exchange, associated with degenerate carriers, competes with antiferromagnetic superexchange, conditioned by orbitally polarized and insulating charge ordered electronic states. In case of $\text{Co}^{3+}/\text{Co}^{4+}$ systems, the minute energy difference between the low-spin state ground-state with filled t_{2g} levels and empty e_g states, competing with magnetic one with filled e_g states, is likely at the origin of “exotic” charge carriers with both hole- and electron-like character. With respect to the high electrical conductivity, the role of spin degree of freedom in thermoelectric power and magnetic interactions the lecture will be completed by examples of simple and double Ru – based perovskites.

Contents:

Introduction

- crystal structure, M-I transition, Charge transfer vs Mot Hubbard insulator, history and prospects
- physical probes and experimental techniques
 - - electrical resistivity, diffusive transport vs. hopping conduction (polarons, disorder)
 - - thermoelectric power (diffusion and hopping)
 - - thermal conductivity and diffusivity (phonons and charge carriers)
 - - specific heat (low temperatures and phase transitions)

Materials and phenomena - experimental data:

- Manganite perovskites – orbitals and spin polarization (Pr-Sr-Mn-O, Sm-Ca-Mn-O, Bi-Sr-Mn-O), thermal conductivity, thermoelectric power and magnetism
- cobalt cubic and layered perovskites – spins state of cobalt (La-Y-Ca-Sr-CoO₃, Ca₃Co₄O₉ , thermal conductivity, thermoelectric power and magnetism, spin and orbital degree of freedom of charge carriers)
- 2D cobaltites- thermoelectric power and magnetism, thermal conductivity, spin and orbital degree of freedom of charge carriers
- Ru-perovskites – preliminary data and literature based assessment

Discussion

- interplay between transport, structure and magnetism