DS 32: Thermoelectric materials I (Focused session – Organizers: Meyer, Heiliger)

Time: Thursday 9:30–11:00 Location: H 2032

Invited Talk DS 32.1 Thu 9:30 H 2032

Tuning thermoelectric properties of oxides by the interplay between spin/charge/lattice — •Sylvie Hebert — Laboratoire CRISMAT UMR6508 CNRS et ENSICAEN

Following the discovery of a large thermopower in NaxCoO2 with x ~ 0.7 [I. Terasaki et al., PRB56, R12685 (1997)], the thermoelectric properties of oxides have been intensively investigated in the last 10 years. The presence of strong correlations in these materials could be a way to enhance the thermopower, and low dimensional structures could also be beneficial. Moreover, these materials present fascinating properties beyond thermoelectricity, as superconducting properties appearing in the hydrated phase with x ~ 0.3, showing the richness of their phase diagram.

For p type oxides, the most interesting materials are layered compounds deriving from NaxCoO2, with layers of edge shared CoO6 octahedra, with a mixed valency of Co3+ and Co4+ in low spin states located on a triangular lattice. Following these results, we have been investigating several families of oxides, p or n type, to better understand the interplay between the crystallographic structure, the different spin and valence states, and the thermopower. In this presentation, several examples will be presented emphasizing the relative influence of electronic correlations, and spin and orbital degeneracies in these oxides.

Invited Talk DS 32.2 Thu 10:00 H 2032

Oxide materials for high-temperature thermoelectrics — •Michitaka Ohtaki — Kyushu University, Fukuoka, Japan

Increasing energy demand in worldwide obviously requires more energy security options. Thermoelectric (TE) conversion is becoming more and more of vital importance for higher overall energy efficiency. However, conventional TE materials such as Bi2Te3 and PbTe based on Bi, Te, and Pb are unlikely to prevail for wide commercialization because of the toxicity, poor heat durability, and low abundance of the comprising elements, particularly for those containing Te. In terms of durability at high temperature in air, metal oxides are most attractive. Although strongly ionic characters and the light constituent element, oxygen, of metal oxides are obviously against the conventional guiding principles for higher ZT and hence metal oxides have been totally disregarded in the history of thermoelectrics until the early 1990s, several oxide materials such as CaMnO3, ZnO, SrTiO3, NaCoO2, and Ca3Co4O9 have been reported to actually show a promising thermoelectric performance [1,2]. In this paper, a landscape of oxide thermoelectric materials will be given with respect to the recent materials development based on analyses of the carrier mobility and the lattice thermal conductivity. Some strategies for selective phonon scattering for higher ZT in oxides will be given.

References [1] M. Ohtaki, K. Araki, K. Yamamoto, J. Electron. Mater., 38 1234 (2009). [2] N. V. Nong, N. Pryds, S. Linderoth, M. Ohtaki, Adv. Mater., 23, 2484 (2011).

Topical Talk DS 32.3 Thu 10:30 H 2032

Investigations of the thermal conductivity of thermoelectric thin films and nanostructures — •Friedemann Voelklein, Heiko Reith, Matthias Schmitt, and Daniel Huzel — RheinMain University of Applied Sciences Wiesbaden, Germany

The characterization of the thermal transport properties of thin films and nanostructures is important both for understanding of their transport mechanisms and for their technical applications. Thermal conductivity and diffusivity are crucial material parameters for the design of integrated devices, MEMS, sensors and actuators. The coefficient of performance of thermoelectric devices such as generators, coolers and sensors can be improved by an increase of thermoelectric efficiency z. Considerable decreases of thermal conductivity (and increases of z) can be observed in nanostructured thermoelectric materials due to finite size effects. Thus, nanowires and nanoscale materials are promising candidates for new thermoelectric devices with significantly increased thermoelectric coefficients of performance. Measurements of thermal conductivities of thin films and nanostructures are associated with various experimental problems. We report on methods for the characterization of thermal conductivity by using diagnostic microchips with suspended thin films and nanowires. Results of thermal conductivity measurements on thermoelectric thin films and nanostructures are discussed using finite size effects models.