SYTS 1: Thermoelectric and Spincaloric Transport in Nanostructures

Time: Wednesday 9:30–12:00 Location: H1

Invited Talk SYTS 1.1 Wed 9:30 H1
Transport in Old and New Thermoelectric Materials — •David Singh — Oak Ridge National Laboratory, USA

Thermoelectric performance is a multiply contra-indicated property of matter. For example, it requires (1) high thermopower and high electrical conductivity, (2) high electrical conductivity and low thermal conductivity and (3) low thermal conductivity and high melting point. The keys to progress are finding an optimal balance and finding ways of using complex electronic and phononic structures to avoid the counter-indications mentioned above. In this talk, I discuss some of the issues involved in the context of recent results. These include the surprising doping dependence of the thermopower in PbTe and PbSe, and the interplay between acoustic and optical phonons in PbTe. Certain new materials as well as new concepts based on low dimensional electronic structures are discussed.

Invited Talk SYTS 1.2 Wed 10:00 H1
Binary oxide structures as model systems for thermoelectric transport — •Peter J. Klar and Christian Heiliger — I. Physikalisches Institut, Justus-Liebig-Universität

The binary oxides ZnO or the different phases of the Cu-O system can be considered to a large extent as semiconductors and can be fabricated by various techniques ranging from rf-sputtering to molecular beam epitaxy. Controlled doping to vary the free carrier concentration as well as alloying are feasible in the usual way. Standard semiconductor technologies can be employed to fabricate nano and microstructures. Thus, different morphologies can be achieved even for bulk material and micro and nanostructures can be prepared in a controlled way. A thorough understanding of the bulk thermoelectric properties of these oxides forms the basis of studying the various types of nano and microstructured samples. To obtain an understanding of the influence of grain boundaries, interfaces, and phase segregation on the thermoelectric transport, local and global properties need to be studied by experiment and to be analyzed by multi-scale theoretical models. Several examples of our approach will be presented.

Invited Talk SYTS 1.3 Wed 10:30 H1
Functional oxides films: from single crystals to polycrystalline substrates — •Wilfrid Prellier — Laboratoire CRISMAT, ENSICAEN, CNRS, 6 Bd Mal Juin, F-14050 Caen Cedex, France

Complex oxides represent a class of materials with several of exiting properties including magnetism, superconductivity or multiferroics. Thus, there are interesting for both fundamental research and applications. Using epitaxial strain, it is also possible in a thin film to modify the electronic properties as compare to bulk materials. While usually, the material is deposited on a single crystal to achieve the perfect epitaxy, it is also possible to synthesise the film on other type of substrate. In the first case, the film can be also be made artificially using the superlattices approach. In this talk, I will present recent results on superconductor superlattices [1,2] as well as our recent developed approach on thermoelectric films grown on a polycrystalline ceramic sample.[3] At the end, it will provide insight into current perspectives and future trends of functional oxide thin films.

[1]*P. Boullay et al., Phys. Rev. B 83, 125403 (2011). [2]*D. Di Castro et al, Phys. Rev. B 86, 134524 (2012). [3] *D. Pravarthana et al., submitted (2012)

Invited Talk SYTS 1.4 Wed 11:00 H1
The Planar Nernst Effect and the Search for Thermal Spin Currents in Ferromagnetic Metals — •Barry Zink — University of Denver, Denver, Colorado, USA

In recent years some groups have reported that a pure spin current can be generated simply by applying a thermal gradient to a ferromagnetic material. This effect, called the spin Seebeck effect (SSE), has generated tremendous interest in the interaction of heat, charge and spin in ferromagnetic systems. In this talk we will present our recent measurements of thermoelectric and thermomagnetic effects in thin film metallic ferromagnets made using a micromachined thermal isolation platform that removes potentially confounding effects introduced by a highly thermally conductive bulk substrate. The main result is the observation of a transverse thermopower, called the planar Nernst effect (PNE). Measurements of the field-dependent (traditional) Seebeck effect and anisotropic magnetoresistance (AMR) confirm that the PNE is caused by spin-dependent scattering. This PNE should therefore be present in any attempted measurement of the SSE in a metal system where spin-dependent scattering of electrons occurs. Furthermore our “zero substrate" experiment shows no signal with the symmetry of the SSE, suggesting that the presence of the substrate is required to cause such a signal. This work was performed in collaboration with A. D. Avery, and M. R. Pufall, and supported by the US NSF CAREER award (DMR-0847796)

Invited Talk SYTS 1.5 Wed 11:30 H1
Tunneling magneto thermopower in magnetic tunnel junction nanopillars — Niklas Liebing[1], Santiago Serrano-Guisan[1,2], Patryk Krzysteczko[1], Karsten Rott[3], Günter Reiss[3], Jürgen Langer[4], Berthold Ocker[4], and •Hans Werner Schumacher[1] — [1]PTB, Braunschweig, Germany — [2]INL, Braga, Portugal — [3]U. Bielefeld, Bielefeld, Germany — [4]Singulus AG, Kahl am Main, Germany

Magneto-thermoelectric properties of magnetic nanostructures have attracted a broad attention over the last years. However only recenly first studies of the magneto-thermoelectric properties of magnetic tunnelling junctions (MTJ) have been published. These studies included the prediction [1] and experimental observation [2-4] of tunnelling magneto thermo power (TMTP). In this talk we will discuss our recent results on TMTP of CoFeB/MgO/CoFeB MTJ nanopillars [3]. For TMTP measurements the thermally induced voltage V_T across the MTJ is measured as function of magnetic field. The thermopower signal V_T scales linearly with the temperature gradient and reveals a similar spin dependence as the TMR. We observe a spin-dependent change of the Seebeck coefficient of up to 0.2 mV/K and a correspondingly large TMTP ratio of up to 90 per cent. This might enable future spin-caloritronics applications of CoFeB/MgO/CoFeB based MTJs. [1] M. Czerner et al. Phys. Rev. B 83, 132405 (2011), [2] M. Walter et al., Nature Mat. 10, 742 (2011), [3] N. Liebing et al. PRL 107, 177201 (2011), [4] W. Lin et al., Nat. Comm. 3, 744 (2012).