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Tailoring electronic and phononic properties at nanoscale for higher thermoelectric efficiency

The current research scenario for alternative energy sources is primarily focused on the reduction of dependency on fossil fuels, so that the harmful effects of greenhouse gases can be minimized. Thermoelectricity can contribute to this area of research by waste heat utilization for electric power generation and thus the reduction in CO_2 emission. The efficiency of a thermoelectric material is defined by a dimensionless parameter thermoelectric figure of merit $ZT=S^2\sigma T/\kappa$,where, T, Δ and Δ are the absolute temperature, electrical conductivity and thermal conductivity, respectively, and S is the See-beck coefficient or thermo-power, which is defined as $\Delta V/\Delta T$, i.e., the voltage that develops across a sample with a temperature gradient of 1 K. High ZT requires an unusual type of material: a good electrical conductor with high thermo-power, but low thermal conductivity, i.e. it must scatter phonons (to minimize lattice contribution to thermal conductivity) without troubling the transport of charge carriers, i.e., ceramic and metallic behaviors are combined to a single material system. Due to the strong interdependency of the parameters S, σ andκ. The reduction of thermal conductivity without deteriorating electrical conductivity is a challenging task. Structuring material systems to the nano-dimension scale can facilitate the tailoring of phononic transport independently or quasi –independently of electronic transport and thus the manifold enhancement of ZT. The focus of the present talk is to discuss the different approaches for tailoring electronic and phononic properties in nano-structured materials at different length-scales leading to the enhancement of ZT.

Biography

Biplab Paul has obtained his PhD in 2011 from Indian Institute of Technology Kharagpur, India, where he initiated a new line of research in the area of thermoelectric. In 2011, he joined Universitat Autonoma de Barcelona, Spain, where he led another research line in the area of thermal rectification for practical realization of thermal diode. Presently, he is working in Linköping University, Sweden since 2012. His extensive studies in Linköping University have created a new research line in the area of flexible thermoelectric.

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