TIFR Centre for Interdisciplinary Sciences, Narsingi, Hyderabad 500075

Colloquium

Does nanotechnology really help, for higher thermal-electrical conversion efficiency, in thermoelectric materials?

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Abstract: The inter-conversion of thermal and electrical energy can be useful for many purposes such as waste heat recovery, body-heat powered biomedical devices, and temperature activated processes. Semiconductor materials exhibiting enhanced thermoelectric effects, such as the generation of voltage in response to a temperature gradient (the Seebeck effect) along with an optimized transduction of heat to electrical current, are especially suited for such applications. However, practically the thermal-electrical conversion efficiency had been quite low (<6%). Much excitement was then generated when it was proposed that the use of lower dimensional nanostructures such as quantum wells and nanowires could considerably boost, by an order of magnitude, the traditional thermoelectric material efficiencies. This was sought to be accomplished through electrical carrier confinement effects which enhances the Seebeck coefficient (S) and electrical conductivity (σ). In this talk, I will propose the existence of an optimal S leading to the maximization of the thermoelectric power factor (S2σ) in any material, at any temperature and for any given dimensionality. It will then be shown, through a critical comparison of the magnitude of the density of states (DOS) of the bulk and nanostructured forms for a variety of materials, e.g., Si, Bi2Te3, PbTe, and Si1-xGex, that there exists an optimal length scale only below which the S2σ is enhanced over the bulk value. It is then concluded that it is the increase in magnitude, and not the change of shape, of the DOS as most responsible for the increase of the power factor and the thermoelectric figure of merit (ZT). Our results lay the foundation for future research in the synthesis and characterization of nanostructured thermoelectric materials.

***Date*: Thursday, June 27th 2013**
***Time*: 04:00PM (Tea/Coffee at 03:30PM)**
***Venue*: Conference Hall, TCIS**

All are cordially invited