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Skutterudite-based Thermoelectrics: Nano-composites and Device Development

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Thermoelectric (TE) conversion receives great attention as a prospective energy conversion technique with potential applications in the harvest of solar energy and the recovery of industrial exhausted heat. This talk will provide a review of some effective techniques for improving material performance through multi-level microstructure control and enhancing device efficiency through structure and electrode design, with focusing on the research of skutterudite-based materials in our laboratory.

A proven approach to elevate figure of merit (ZT) is via formation of nano-composites, in which extrinsic nano-phases are dispersed in grains and at grain boundaries. Acting as energy filter and phonon scattering center, nano phases contribute to both the increase of thermopower and the reduction of thermal conductivity without much degradation of electrical conductivity. The distribution of the extrinsic phases, including content, homogeneity and structures, are the key factors for the enhancement of ZT values. Several novel approaches including in-situ reaction, vapor-transportation and sol-gel process to prepare TE composites with dispersion of extrinsic nano particles have been developed.

The design and fabrication of TE device based on high performance skutterudite materials have also been carried out using Mo-based alloys as electrode. The interfacial microstructure of the skutterudite/electrode joints were found to affect the interfacial electrical resistivity, thermal resistivity, bonding strength, and therefore the device thermoelectric performance. Some novel processes for fabricating the joints have been developed. The reliability and life duration behavior of the TE device have also been studied with focusing on the microstructure evolution in accelerated service tests. Some criteria on the development of high performance devices using skutterudite materials will also be discussed.