Nano-micro-porous skutterudites with 100% enhancement in ZT for high performance thermoelectricity

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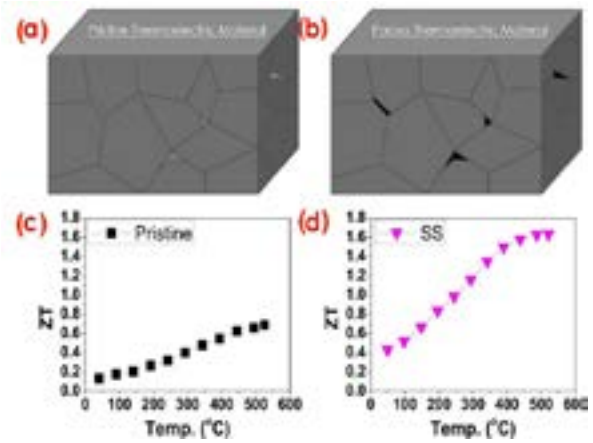
Increasing energy demands require new materials, e.g., thermoelectrics, for efficient energy conversion of fossil fuels. However, their low figure of merit (ZT) limits widespread applications. Nanostructuring has been an effective way of lowering the thermal conductivity. However, grain growth at elevated temperature is still a big concern, for otherwise expected to be long-lasting thermoelectric generators. Here, we report a porous architecture containing nano- to micrometer size irregularly shaped and randomly oriented pores, scattering a wide spectrum of phonons without employing the conventional rattling phenomenon. Lattice thermal conductivity reaches the phonon glass limit. Basically, a low melting phase was sintering with skutterudite powder. Later on, annealing under vacuum helped this low melting phase evaporate from the structure, leaving behind a mix of nano and micrometer sized pores. These pores interact with phonons and causing them to either slows down or dissipates, resulting in a very low thermal conductivity. On the other hand, electrons can pass through the dense part due to their ability to change path resulting in only a small drop in electrical conductivity. This design yields greater than 100% enhancement in ZT, as compared to the pristine sample. An unprecedented and very promising ZT of 1.6 is obtained for Co23.4Sb69.1Si1.5Te6.0 alloy, by far the highest ZT ever reported for un-filled skutterudites, with further benefits, i.e. rare-earth-free and improved oxidation resistance enabling simple processing.



Speaker Biography

Atta Ullah Khan has his expertise in phase equilibria, crystallography, thermoelectric materials and ceramics. He received his Ph.D in Physical Chemistry in 2011 from the University of Vienna, Austria. He has worked for three years as a postdoctoral fellow in National Institute for Materials Science (NIMS), Japan. Currently, he is working as a Postdoctoral Fellow in Department of Materials Science and Engineering, Rutgers, The State University of New Jersey, USA.

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