Copper Ion Novel Thermoelectric Materials

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Solid-state thermoelectric (TE) technology uses electrons or holes as the working fluid for heat pumping and power generation and offers the prospect for novel thermal-to-electrical energy conversion technology that could lead to significant energy savings by generating electricity from waste industrial heat. The key to the development of advanced TE technologies is to find highly efficient TE materials. In current commercial materials, the zTs are limited to values around unity. Recently, several novel concepts have been proposed to enhance the efficiency of TE materials and laboratory results suggest that high zT values can be realized in several families of bulk materials. In this presentation, we report a new high efficiency thermoelectric material $Cu_{2-x}Se$, that reaches zT above 1.5 at 1000 K, among the highest values for any bulk materials. The Se atoms in $Cu_{2-x}Se$ form a rigid FCC lattice providing a crystalline pathway for semiconducting electrons, while the copper ions are highly disordered around the Se sublattice and are superionic with liquid-like mobility. This extraordinary 'liquid-like' behavior of copper ions around a crystalline sublattice of Se in $Cu_{2-x}Se$ results in intrinsically very low lattice thermal conductivity that enables high zT in this otherwise simple semiconductor. This unusual combination of properties leads to an ideal thermoelectric material within the concept of 'phonon-liquid electron-crystal'.

References:

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Keywords: Thermoelectric materials, phonon-liquid electron-crystal, $Cu_{2-x}Se$, liquid-like behavior

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