High thermoelectric performance of p-type solution processed SnTe nanocomposite through band engineering

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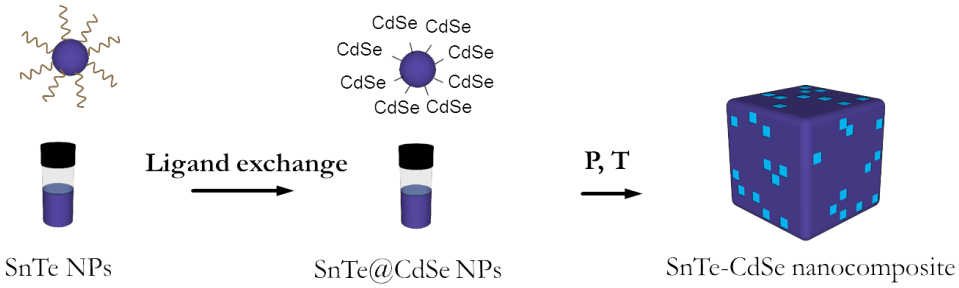
The bottom-up assembly of semiconductor colloidal nanoparticles into macroscopic multi-compound materials is a particularly versatile methodology to precisely design thermoelectric materials. Beyond the control over crystal domain size, shape, crystal phase and composition during nanoparticle synthesis, solution-processed nanoparticles allow an exquisite surface engineering, which provides additional means to modulate transport properties. The exchange of native surface organic ligands by short inorganic molecules can be envisioned as carriers of foreign ions, which may diffuse to the nanoparticle lattice to tune the type and concentration of majority carriers or to modify the electronic band structure.

Herein, we report the thermoelectric performance of consolidated surface modify SnTe nanoparticles. CdSe complexes were selected as ligands to suppress the excess of holes arising from the intrinsically large number of Sn vacancies, to converge the light- and heavy- bands, and to generate nanoinclusions of a secondary phase to further reduce the lattice thermal conductivity. The SnTe-CdSe nanocomposites produced allowed us to obtain figures of merit up to 1.3 at 850 K, which is, to the best of our knowledge, the highest thermoelectric figure of merit reported for Sn-based solution processed chalcogenides, and comparable to the highest figure of merit stated for SnTe.