Decoupling the electrical conductivity and Seebeck coefficient in Bi_2Te_3/polycarbazole composite

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Power generation and heating/cooling applications can be achieved through thermoelectric materials. However, the figure of merit (zT) which is directly related to the efficiency in thermoelectric materials remains low for most conventional bulk materials. During the last decade, many efforts were made to lower the thermal conductivity of the thermoelectric materials without affecting the electrical conductivity and the Seebeck coefficient by addition of intrinsically conductive polymers (ICP). The overall results found in such composites were the successful reduction of the thermal conductivity accompanied by a reduction of the electrical conductivity. This effect is due to the electronic component present in the thermal conductivity. In addition, in most thermoelectric materials the electrical conductivity is linked to the Seebeck coefficient in such manner that when one increases the other decreases and vice-versa.

In his work, we synthesized a 3,6-polycarbazole polymer (PCz) and used it to make Bi_2Te_3 composite. Thermoelectric measurements show a constant value in both thermal conductivity and Seebeck coefficient with the incremental addition of PCz. A good maximum power factor value of 648 $\mu W\ m^{-1}\ K^{-2}$ is reached for hybrid materials charged at 90% v/v content for Bi_2Te_3/PBz composite. The measured thermal conductivity is in the range of 0.5 $W\ m^{-1}\ K^{-1}$, which gives a zT at room temperature of 0.379, which is the highest, found for Bi_2Te_3/ICP composite to the best of our knowledge.