Conjugated polymer/layered inorganic nanocomposites: solution processable route to enhanced thermoelectric performance

KEVIN SEE, JEFFREY URBAN, The Molecular Foundry, Lawrence Berkeley National Lab, RACHEL SEGALMAN, Department of Chemical Engineering, University of California, Berkeley — In recent years, incorporation of nanostructuring has led to notable improvements in the performance of thermoelectric materials. At a given temperature $T$, the thermoelectric figure of merit $ZT$ is given by $\frac{S^2 \sigma T}{\kappa}$, where $S$ is the Seebeck coefficient, $\sigma$ the electrical conductivity and $\kappa$ the thermal conductivity. In most cases, improvement in $ZT$ through nanostructuring has been realized via reduction in thermal conductivity $\kappa$ rather than increases in the power factor $S^2\sigma$. Here we utilize solution-based intercalation chemistry to create layered inorganic/conjugated polymer nanocomposites with designed nanoscale interfaces engineered to enhance the power factor by energy filtering. The layered inorganic material $\text{Sb}_2\text{Te}_3$ was intercalated with poly(3-hexylthiophene), and the resulting composite material was cast into thin films from solution. The resulting devices exhibit Seebeck coefficients with two-fold enhancement over those reported for bulk $\text{Sb}_2\text{Te}_3$ with known conductivities for solution-processed films. These results demonstrate the promise of these novel intercalated materials for high performance solution processable thermoelectric materials.

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