



MESOSCOPIC MEASUREMENTS OF THERMOELECTRIC MATERIAL

Celine Slam (Vikram Deshpande)
Department of Physics & Astronomy

Power plants extract only 30 to 40% of usable energy from fuel and lose the rest of energy in the form of unusable heat [1]. Recovering this wasted heat will dramatically change the consumption of limited energy sources, such as petroleum and coal, leading to a sustainable society.

Thermoelectric materials, which reliably and renewably convert heat into electricity, are promising for recovering wasted heat, as they do not produce carbon emissions and do not require complicated mechanical systems. Electricity is generated at the interface of a thermoelectric material applying a temperature gradient across the substrate. For a thermoelectric to be efficient it must have a high figure of merit (ZT), expressed as $ZT = \frac{S^2\sigma T}{\kappa}$, where S is the Seebeck coefficient, σ the electrical conductivity, and κ the thermal conductivity. To optimize ZT , the Seebeck coefficient and electrical conductivity must be increased, while the thermal conductivity lowered. Commercially available thermoelectric materials exhibit a high ZT of around 1.5, [2], however they are toxic and costly. Metal-organic frameworks (MOFs), a new candidate for thermoelectrics, are inexpensive and non-toxic. MOFs are a favorable material because of their intrinsic porosity, which lowers their thermal conductivity. In general, MOFs have poor ZT values because of their low electrical conductivity. However, copper-benzenehexathiol (Cu-BHT) exhibits an unusually high electrical conductivity for MOFs. As such, we have measured electrical and thermal conductivity of Cu-BHT. We have found Cu-BHT's periodic, one nanometer pore size, effectively scatters phonons, contributing to its intrinsic low thermal conductivity, while conducting electrons. In future work we will focus on optimizing the ZT of Cu-BHT, by chemical doping.

[1] Annual Electric Utility Data – EIA-906/920/923 Data File. (2018). Retrieved July 3, 2018, from <https://www.eia.gov/electricity/data/eia923/>

[2] Yamashita, O., Tomiyoshi, S., & Makita, K. (2003). Bismuth telluride compounds with high thermoelectric figures of merit. *Journal of Applied Physics*, 93(1), 368-374.
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