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Thermionic energy conversion in carbon nanotube networks
CHEN LI, KEVIN PIPE, University of Michigan - Ann Arbor, KEVIN PIPE'S GROUP TEAM — We investigate whether efficient carrier ballistic transport in CNT networks can overcome the parasitic effects of high CNT thermal conductance to yield thermionic (TI) devices with high energy conversion efficiency and/or high cooling power density. We simulate semiconducting single-walled carbon nanotube (SWCNT) structures in which inter-tube junctions provide the necessary filtering of high-energy electrons. Using energy-dependent transmission functions, we compare the performances of various junction types in selective filtering, and then perform Monte Carlo (MC) simulations to study the subsequent relaxation of hot electrons within the SWCNTs. Finally, we examine the parasitic effects of high thermal conductance, accounting for reductions in phonon mean free path due to scattering at inter-tube junctions. The results of the junction transmission, MC, and phonon transport simulations suggest optimal CNT types, junction types, and inter-junction spacings that maximize energy conversion metrics such as efficiency and cooling power density. While certain aspects of electron transport and phonon transport in CNT networks remain unresolved, our simulations suggest that CNT-based networks show promise for TI energy conversion.

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