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Graphene-based vdW heterostructure Induced High-efficiency Thermoelectric Devices. SHIJUN LIANG, LAY KEE ANG, Singapore University of Technology and Design — Thermoelectric material (TE) can convert the heat into electricity to provide green energy source and its performance is characterized by a figure of merit (ZT) parameter. Traditional TE materials only give ZT equal to around 1 at room temperature. But, it is believed that materials with ZT >3 will find wide applications at this low temperature range. Prior studies have implied that the interrelation between electric conductivity and lattice thermal conductivity renders the goal of engineering ZT of bulk materials to reach ZT >3. In this work, we propose a high-efficiency van del Waals (vdW) heterostructure-based thermionic device with graphene electrodes, which is able to harvest wasted heat (around 400K) based on the newly established thermionic emission law of graphene electrodes instead of Seebeck effect, to boost the efficiency of power generation over 10% around room temperature. The efficiency can be above 20% if the Schottky barrier height and cross-plane lattice thermal conductivity of transition metal dichacogenides (TMD) materials can be fine-engineered. As a refrigerator at 260 K, the efficiency is 50% to 80% of Carnot efficiency. Finally, we identify two TMD materials as the ideal candidates of graphene/TMD/graphene devices based on the state-of-art technology.

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