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Thermoelectric properties of metal / excitonic insulator junctions[1]

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The excitonic insulator (EI) is a paradigma of a strongly correlated semiconductor whose ground state is dramatically renormalized by electron-hole interaction [1]. Here we propose that its unusual physical properties may be uncovered by making a junction with a metal, as well as that the EI / metal junction is a promising thermoelectric device. We first theoretically consider the class of mixed-valent EIs with high dielectric constants, such as SmB_6 and Sm_2Se_3, whose ground states may be regarded as a condensate of d electron and f hole pairs. If an overlayer of rare-earth atoms differing from the EI bulk is placed at the junction interface, then high values of the figure of merit ZT can be reached at low temperature [2]. This is due to the strong dependence of the transmission coefficient on the energy. In the case of the EI with dispersive bands [3], we are able to address the coherence properties of the ground state. We predict that the thermal and electrical transport across the junction shall exhibit high resistance behavior and low entropy production, distinct from a junction of a metal and a normal semiconductor [4]. At small electrical bias and low temperature, exciton flow dominates over the free charges, substantially increasing the electrical and thermal interface resistance. The rate of entropy production is low due to the coherent and dissipationless character of exciton flow, which is analogous to the supercurrent flowing through a metal / superconductor junction.

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[1] This work is done in collaboration with L. J. Sham.