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Modulation doping and energy filtering in two-dimensional, dichalcogenides: Moving toward flexible thermoelectrics with a ZT ~ 1

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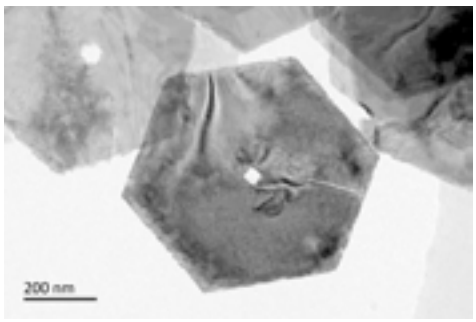
Two-dimensional systems, with simply connected topologies, have been synthesized in dichalcogenides. Such materials present novel opportunities in heterogeneous conduction. This talk will demonstrate a phase coherent, metal dopant added to reactive edges of these low-dimensional dichalcogenide system that dramatically alters the conduction behavior of such materials in unexpected ways. Temperature dependent conductivity suggests that local band bending across the interface acts as an energy filter for carrier injection. Further, significant decoupling between the electrical conductivity and Seebeck coefficient is observed in films of these platelettes, leading to surprisingly high power factors. A fivefold/eightfold increase in thermoelectric figure of merit (ZT) and power factor (PF) is seen over pure Bi2Te3 platelettes with the addition of Ag/Cu respectively, with the correlate being the barrier height at the platelette edge. This yields a ZT of 0.39 for Ag-doped Bi2Te3 and 0.6 for Cu-doped Bi2Te3, both at room temperature. The ZT is further increased to 0.93 at 470 K in the Cu case. First principles band structure calculations show that the electronics of the semiconductor-metal interfaces are quite different for edge and facial configurations, suggesting that the site of metal dopant plays an important role in the enhanced thermoelectric performance.



Biography

Carroll received his PhD from Wesleyan University in Connecticut and did his postdoctoral work at the University of Pennsylvania. He also served as a staff scientist at the Max-Planck-Institut für Metallforschung in Stuttgart before moving first to Clemson University then to Wake Forest University where he became Director of the Nanotechnology Center. Dr. Carroll has published more than 300 papers in reputed journals (h = 60), holds more than 30 patents, and serves on the editorial board of several academic journals.

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