Defect-induced enhancement in the thermoelectric performance of freestanding graphene foams

P. Parajuli, P. Puneet, F. Liu, H. Behlow, A. M. Rao, *S. Bhattacharya, and R. Podila

Clemson Nanomaterials Institute, Department of Physics and Astronomy, Clemson University,

SC, USA

Abstract: Thermoelectric (TE) devices generally offer a simple and environmentally friendly solution for the direct conversion of heat to electricity. The performance of a TE material is gauged by the dimensionless figure of merit $ZT = S^2\sigma/\kappa$, where S is thermopower, σ is the electrical conductivity, and κ is the thermal conductivity. The material properties S, σ, and κ are closely inter-related, hence they must be decoupled to improve ZT. Here, we show that the presence of N-dopants breaks the electron-hole symmetry in graphene, leading to an increase in S, while extra carriers injected by the dopants improve σ. Specifically, we find that the enhancements in S and σ are dependent upon the N-doping configuration (viz., graphitic, pyridinic, or pyrrolic). [1] We experimentally measured TE properties of freestanding pristine and doped graphene foams, and fabricated single-leg freestanding N-doped graphene TE devices that show considerable increase in the heat-to-electricity conversion efficiency compared to pristine graphene.

Keywords: graphene foam, thermoelectric, graphitic, pyridinic, pyrrolic

[1] R. Podila, J. Chacón-Torres, J. T. Spear, T. Pichler, P. Ayala, and A.M. Rao, Appl. Phys. Lett. 101, 123108 (2012)