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Impurity state and variable range hopping conduction in graphene SANG-ZI LIANG, JORGE O. SOFO, Department of Physics, the Pennsylvania State University — The variable range hopping (VRH) theory is widely accepted as explaining the temperature dependence of the conductivity of doped semiconductors. However, as formulated for exponentially localized impurity states, it does not necessarily apply in the case of graphene with covalently attached impurities. We analyze the localization of impurity states in graphene using the nearest neighbor tight-binding model of an adatom-graphene system with Green's function perturbation methods. The impurity states in graphene are characterized as resonant states in the band continuum and both low energy approximations and numerical evaluation of the Green's functions indicate that the amplitude of the wave function decays as a power law with exponents depending on sublattice, direction, and the impurity species. We revisit the VRH theory in view of this result and find that considering only the overlap and energy difference of the impurity states, the conductivity obeys a power law of the temperature with an exponent related to the localization of the wave function. Other factors that were ignored in the original VRH are included due to the weaker temperature dependence, which contribute an additional exponent. We show that this relationship is in agreement with available experimental results.

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