The Effects of the Mean-Field Interaction on the Anderson Localization of Graphene Nanoribbons

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A generalized tight-binding (TB) model, which includes a mean-field Hubbard-$U$ and up to 3rd nearest-neighbor hopping terms, is applied to edge-disordered zigzag graphene nanoribbons in order to study spin-transport within the Landauer-Büttiker formalism. Edge-disorder is modeled by random perturbation of the on-site energy in the range $-E..E$ on all edge atoms, and the resulting Anderson localization lengths determined. We compared the Anderson localization lengths and spin-transport features obtained from the generalized model, an extended TB model (non-interacting) and the simplified TB model (1st nearest neighbor hopping only). Within the range $\pm E =0.5$ eV the Anderson localization length for a single spin was found to decrease by 86.4% with the introduction of the Hubbard-$U$ in the generalized model compared to the non-interacting models, whereas the opposite spin remained unchanged across all model types. For the range $\pm E =2.0$ eV the Anderson localization length for both spin types decreased by 71.4% and 76.2% in the generalized model when compared to the extended TB model, and 76.5% and 80.4% when compared to the simplified TB model.

$^1$Hancock et al. PRB 81, 245402 (2010).