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Nonlinear optical response in narrow graphene nanoribbons[1]

FARHAD KARIMI, IRENA KNEZEVIC, University of Wisconsin-Madison — We present an iterative method to calculate the nonlinear optical response of armchair graphene nanoribbons (aGNRs) and zigzag graphene nanoribbons (zGNRs) while including the effects of dissipation. In contrast to methods that calculate the nonlinear response in the ballistic (dissipation-free) regime, here we obtain the nonlinear response of an electronic system to an external electromagnetic field while interacting with a dissipative environment (to second order). We use a self-consistent-field approach within a Markovian master-equation formalism (SCF-MMEF) coupled with full-wave electromagnetic equations, and we solve the master equation iteratively to obtain the higher-order response functions. We employ the SCF-MMEF to calculate the nonlinear conductance and susceptibility, as well as to calculate the dependence of the plasmon dispersion and plasmon propagation length on the intensity of the electromagnetic field in GNRs. The electron scattering mechanisms included in this work are scattering with intrinsic phonons, ionized impurities, surface optical phonons, and line-edge roughness. Unlike in wide GNRs, where ionized-impurity scattering dominates dissipation, in ultra-narrow nanoribbons on polar substrates optical-phonon scattering and ionized-impurity scattering are equally prominent.

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