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Optimized Third Harmonic THz Generation from Graphene in a Parallel Plate Waveguide

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Graphene as a zero-bandgap two-dimensional semiconductor with a linear electron band dispersion near the Dirac points has potential to exhibit very interesting nonlinear optical properties [1]. In particular, third harmonic generation of terahertz (THz) radiation should occur both due to the nonlinear relationship between the crystal momentum and the current density, and due to the interaction between interband and intraband parts of the current densities due to the vanishing bandgap [2]. In this work, we investigate THz nonlinear response of graphene situated inside a parallel plate waveguide (PPW). The graphene is contained in a PPW to increase the interaction time between THz radiation and graphene which, offers the potential to generate a larger third harmonic field.

In this work, we employ a Green function approach to solve for the generated third harmonic field in the PPW, inducing self-consistently the loss to the graphene at the fundamental and third harmonic. We optimize the plate separation and Fermi energy of the graphene to obtain phase matching and low loss, and thereby maximize third harmonic generation. We find that the best phase matching is obtained between the $TE1$ mode at the fundamental and the $TH3$ mode at the third harmonic.

References

[1] S. A. Mikhailov, Phys. Rev. Lett. **105** ,097401 (2010).

[2] I. Al-Naib, J. E. Sipe, M. M. Dignam, Phys. Rev. B **90** , 245423 (2015).

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