Presentation

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Multi-physics analysis of hybrid graphene/semiconductor plasmonic terahertz sources (Conference Presentation)

Mona Nafari (/profile/mona.nafari-4013329), Gregory R. Aizin, Josep M. Jornet (/profile/Josep-Miquel.Jornet-4006060)

Author Affiliations + ()

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Abstract

Wireless data rates have doubled every eighteen months for the last three decades. Following this trend, Terabit-per-second links will become a reality within the next five years. In this context, Terahertz (THz) band (0.1-10 THz) communication is envisioned as a key technology of the next decade. Despite major progress towards developing THz sources, compact signal generators above 1 THz able to efficiently work at room temperature are still missing. Recently, the use of hybrid graphene/semiconductor high-electron-mobility transistors (HEMT) has been proposed as a way to generate Surface Plasmon Polariton (SPP) waves at THz frequencies. Compact size, room-temperature operation and tunability of the graphene layer, in addition to possibility for large scale integration, motivate the exploration of this approach. In this paper, a simulation model of hybrid graphene/semiconductor HEMT-based THz sources is developed. More specifically, first, the necessary conditions for the so-called Dyakonov-Shur instability to arise within the HEMT channel are derived, and the impact of imperfect boundary conditions is analyzed. Second, the required conditions for coupling between a confined plasma wave in the HEMT channel and a SPP wave in graphene are derived, by starting from the coupling analysis between two 2DEG. Multi-physics simulation are conducted by integrating the hydrodynamic equations for the description of the HEMT device with Maxwell's equations for SPP modeling. Extensive results are provided to analyze the impact of different design elements on the THz signal source. This work will guide the experimental fabrication and characterization of the devices.

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