Canalization of surface plasmon polaritons on a graphene sheet with a perturbed ground plane

E. Forati[(1)], G. W. Hanson[*(1)], A. B. Yakovlev[(2)], A. Alù [(3)]

(1) University of Wisconsin-Milwaukee, Milwaukee, WI 53211, USA
(2) University of Mississippi, Oxford, MS, 38677, USA
(3) University of Texas at Austin, Austin, TX 78712, USA
*E-mail: george@uwm.edu

Canalization of surface plasmon polaritons (SPPs) on a layer of suspended graphene is investigated. In the canalization regime (*Phys. Rev. B. vol. 71, pp. 193105, 2005*), spatial harmonics propagate with the same phase velocity. One application of canalization is in sub-wavelength imaging to overcome the diffraction limit. It is shown that a graphene sheet with anisotropic conductivity can provide a canalization regime with the phase velocity of spatial harmonics being equal to the phase velocity in free space. The anisotropic conductivity is derived by tuning the isofrequency contours for SPPs. Similar to the layered perfect lens introduced in (*J. Mod. Optics*, vol. 50, pp. 1419-1430, 2003), a composite graphene sheet consisting of strips having complex conductivities with alternating positive and negative imaginary parts provides the anisotropic effective conductivity which is essential for canalization.

The desired conductivity profile on graphene can be implemented using a fixed voltage bias between the graphene sheet and a perturbed ground plane, similar to (*Science,* vol. 332, no. 6035, pp. 1291-1294, 2011). Two different geometries (rectangular and triangular perturbations) for the perturbed ground plane are proposed, providing the desired effective anisotropic conductivity profile.

For the rectangular perturbation, a static analysis (with a zeroth-order approximation) is performed to find the surface charge density (and therefore the complex surface conductivity) distribution on the graphene sheet (similar to *arXiv:1306.3138*). For both rectangular and triangular perturbations, the exact conductivity distributions are found numerically using a commercial package (COMSOL). Full-wave simulation results (CST) confirm successful canalization provided by the proposed perturbed ground planes.