MAR15-2014-008796

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Nanoimaging and manipulation of plasmons in graphene

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A promising solution for active control of light on the nanometer scale are plasmons in graphene, which offer ultra-short wavelengths, long lifetimes, strong field confinement, and tuning possibilities by electrical gating [J. Chen, et al., Nature 487, 77 (2012); Z. Fei, et al., Nature 487, 82 (2012)]. The huge momentum mismatch between graphene plasmons and photons, however, presents a major technological challenge. Here, we present and discuss the coupling of incoming light into propagating graphene plasmons based on resonant optical antennas, constituting an essential step for the development of graphene plasmonic circuits [P. Alonso-González, et al., Science 344, 1369 (2014)]. By interferometric near-field microscopy we mapped the propagating plasmons launched by the antennas. Visualizing the plasmon wavefronts, the near-field images show how graphene plasmons can be focused by tailoring the antenna geometry, and how plasmon refraction can be achieved by spatially modulating the graphene conductivity. We further discuss the remarkably strong plasmon reflection at nanometer-size gaps in the graphene layer [J. Chen, et al., Nano Lett. 13, 6210 (2013)], and propose the coupling of light to graphene plasmons by compressing surface polaritons with tapered bulk materials [A.Y. Nikitin, et al, Nano Lett. 14, 2896 (2014)].