Nano-plasmonic phenomena in graphene

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Infrared nano-spectroscopy and nano-imaging experiments have uncovered rich optical effects associated with the Dirac plasmons of graphene [*Nano Lett. 11, 4701 (2011)*]. We were able to directly image Dirac plasmons propagating over sub-micron distances [*Nature 487, 82 (2012)*]. We have succeeded in altering both the amplitude and wavelength of these plasmons by gate voltage in common graphene/SiO_2/Si back-gated structures. We investigated losses in graphene using scanning plasmon interferometry: by exploring real space profiles of plasmon standing waves formed between the tip of our nano-probe and edges of the samples. Plasmon dissipation quantified through this analysis is linked to the exotic electrodynamics of graphene [*Nature-Physics 4, 532 (2008), PRL 102, 037403 (2009)*]. Scanning plasmon interferometry has allowed us to visualize grain boundaries in CVD graphene. These experiments revealed that grain boundaries tend to form electronic barriers that impede both electrical transport and plasmon propagation. Our results attest to the feasibility of using electronic barriers to realize tunable plasmon reflectors. Finally, we have carried out pump-probe experiments probing ultra-fast dynamics of plasmons in exfoliated graphene with the nano-scale spatial resolution.