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Nano-plasmonic phenomena in graphene

The term “plasmonics” often carries an applied connotation owing to remarkable successes in controlling and manipulating light at the nanoscale in artificial structures. Infrared nano-spectroscopy and nano-imaging experiments on graphene carried out in our group [Nano Lett. 11, 4701 (2011)] have uncovered a rich variety of plasmonic effects that may enable application not attainable through metal-based plasmonics. Among these, the tunability of the plasmonic response via electrostatic gating is a major forte of graphene. Applications aside, the nano-scale exploration of surface plasmons offered an entirely new perspective on fundamental physics behind electronic phenomena in graphene. For example, by direct infrared imaging of plasmonic standing waves we were able to quantify the electronic losses in graphene [Nature 487, 82 (2012)]. This latter result highlights the important role of many body effects that were not anticipated theoretically. By examining the sub picosecond dynamics of plasmons in a setting of a unique pump-probe nano-spectroscopy apparatus we were able to discriminate between the roles of several photo-induced processes in mono-layer and few layer graphene. Remarkably, infrared photo-excitation enables ultra-fast control of plasmons with the efficiency rivaling that of electrostatic gating.

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