Surface Plasmons in Highly-doped Graphene

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Abstract

The opto-electronic properties of graphene can be tuned by varying its charge carrier density *via* an applied voltage, surface chemical functionalization or interlayer intercalation. Although the former methods offer advantages for many applications, the carrier concentrations (*n)* that can be achieved with their use are limited to values corresponding to approximately $\sim 10^{13}$ cm^{-2} using conventional methods and $n \leq 4X10^{14}$ cm^{-2} by using other methods such as ionic-liquid or solid polymer electrolyte gating[1-3]. Interlayer intercalation, however, has been shown to allow for significantly higher carrier concentrations, $n > 5X10^{14}$ cm^{-2}, opening the way for experimental studies of the opto-electronic properties of graphene in an unprecedented energy regime[1,4]. Here, we show that highly-doped, FeCl3-intercalated graphene exhibits unique opto-electronic behaviour. For instance, we show that surface plasmons, i.e. collective oscillations of charged carriers, in this system can be coherently excited with propagation lengths significantly longer than any other non-encapsulated graphene system reported to-date. µ-Raman Spectroscopy, scattering-Scanning Near Field Microscopy (s-SNOM) and nano-Fourier Transform Infrared (nano-FTIR) Spectroscopy were used to study plasmonic behavior which provided valuable insight into the physics governing such phenomena in graphene. Of particular interest for this work are intrinsic electron-phonon interactions in graphene as, in principle, a better understanding of such phenomena may lead to the electronic control of crystal lattice vibrations for the development of future applications. As such, near-field imaging was used to observe unconventional behavior near the frequency of the intrinsic optical phonon and a model describing this phenomenon will be discussed.

References

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