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Infrared nano-imaging and nano-spectroscopy of graphene plasmons

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Graphene plasmons, which are collective oscillations of Dirac fermions in graphene, are of broad interests in both fundamental research and technological applications. In this talk, we present first nano-imaging and nano-spectroscopy studies of graphene plasmons using scattering-type scanning near-field optical microscope –a unique technique allowing efficient excitation and high-resolution imaging of graphene plasmons. With this technique, we were able to show that common graphene/SiO2/Si back-gated structure support propagating surface plasmons in the infrared frequencies. The observed plasmons are highly confined surface modes with a wavelength around 200nm that are conveniently tunable by the back gate voltages [Nature 487, 82–85 (2012)]. In addition, we performed nano-spectroscopy of graphene over a broad range of mid-infrared frequencies. Our spectroscopy results provide evidence of strong coupling between graphene plasmons and SiO2 optical phonons [Nano Lett. 11(11), 4701-4705 (2011)]. Finally, we were able to map and characterize various types of line defects inside CVD graphene film by exploring real space patterns of propagating surface plasmons. These line defects, including cracks, wrinkles, and even grain boundaries, trigger distinct plasmonic features due to plasmon interference. Further modeling and analysis unveiled unique electronic properties associated with these line defects.