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Coupling of strongly localized graphene plasmons to molecular vibrations DAMON FARMER, IBM T.J. Watson Research Center, YILEI LI, Columbia Univ, HUGEN YAN, IBM T.J. Watson Research Center, XIANG MENG, Columbia Univ, WENJUAN ZHU, IBM T.J. Watson Research Center, RICHARD OSGOOD, TONY HEINZ, Columbia Univ, PHAEDON AVOURIS, IBM T.J. Watson Research Center — In this paper, we first present a determination of the out-of-plane confinement of the plasmons in graphene nanoribbons. Using light with a free-space wavelength of $\sim 6\mu$m, we excite plasmons in graphene nanoribbons that are ~ 100 nm wide. A red-shift in the plasmon frequency is induced by a thin layer of Poly (methyl methacrylate) (PMMA) adsorbed onto the nanoribbons surface due to dielectric screening effect. With increasing thickness of the PMMA layer, we observe a saturation of the frequency shift, from which we deduce an out-of-plane field plasmon field decay length of ~ 10 nm. The strongly confined plasmons in graphene produce significant enhancement of the field intensity. We show that this enhancement strengthens the coupling of graphene plasmon to vibrations in the PMMA molecules. The enhanced interaction is manifested through induced transparency in the graphene plasmon optical response when the plasmon and the vibrational frequencies are matched. We also show that this coupling is of an electromagnetic nature by comparing the evolution of the line shape as a function of the detuning of the two frequencies to simulations using the finite-difference time-domain method.

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