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Author

Ju L. Geng BS. Horng J. Girit C. Martin M. Hao Z. Bechtel HA. Liang XG. Zettl A. Shen YR. Wang F.

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Graphene plasmonics for tunable terahertz metamaterials

Source

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Abstract

Plasmons describe collective oscillations of electrons. They have a fundamental role in the dynamic responses of electron systems and form the basis of research into optical metamaterials(1-3). Plasmons of two-dimensional massless electrons, as present in graphene, show unusual behaviour(4-7) that enables new tunable plasmonic metamaterials(8-10) and, potentially, optoelectronic applications in the terahertz frequency range(8,9,11,12). Here we explore plasmon excitations in engineered graphene microribbon arrays. We demonstrate that graphene plasmon resonances can be tuned over a broad terahertz frequency range by changing micro-ribbon width and in situ electrostatic doping. The ribbon width and carrier doping dependences of graphene plasmon frequency demonstrate power-law behaviour characteristic of two-dimensional massless Dirac electrons(4-6). The plasmon resonances have remarkably large oscillator strengths, resulting in prominent room-temperature optical absorption peaks. In comparison, plasmon absorption in a conventional two-dimensional electron gas was observed only at 4.2 K (refs 13,14). The results represent afirst look at light-plasmon coupling in graphene and point to potential graphene-based terahertz metamaterials.