Plasmonic resonances in the infrared spectra of nanostructured graphene

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Surface plasmons can be understood as electromagnetic waves bound to a surface between a conductor and insulator. In last two decades, they became one of the focal points in photonics due to their ability to support strong electromagnetic fields confined at the conductor-insulator interface well below the diffraction limit. Graphene has been seen as an interesting ground for plasmonics in the infrared (Jablan et al., 2009, Koppens et al., 2011) owing to its thinness which offers the possibility of changing its carrier density over several orders of magnitude by means of a gate voltage (Novoselov et al., 2004). While possible in theory, in practice plasmons in graphene are not expected at frequencies above mid-infrared (e.g. in the visible spectrum) due to the limited carrier concentration that can be generated by a gate voltage before the SiO_2 layer that supports graphene breaks down. The field of graphene plasmonics is currently receiving a lot of attention in the literature (Nikitin et al., 2012, Thongrattanasiri et al., 2012) because plasmonic resonances in nanostructured graphene provide means to electrically modulate the light transmission and reflection through the thin graphene layer (Ju et al., 2011).

In this theoretical study the experimentally relevant case of graphene on top of a few hundred nanometer thick SiO_2 layer on a doped silicon substrate is considered. The investigated structures include the array of graphene nanoribbons and graphene dots and antidots arranged in a rectangular lattice. The signature of plasmonic resonances in the infrared reflectance spectra and its dependence on carrier concentration and presence of few nanometer thick adsorbed water layer is discussed.

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