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Title: Graphene and its unconventional plasmon properties: A combined theoretical and experimental study

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Plasmonics, which is based on using the electronic plasmon resonance of metals to seamlessly incorporate optical signals in electronic devices, is one of the current approaches being studied in the electronic industry to obtain smaller, faster and more energy-efficient devices. We have experimental evidence (using a scanning transmission electron microscope and electron energy-loss spectroscopy) that indicates that in monolayer graphene, plasmon could be enhanced under the presence of substitutional impurities and that the enhancement is atomically localized at the impurities sites. The experiments also show that graphene presents interband transitions that can be mapped at the atomic scale using electron energy-loss spectrum imaging. Both experiments contradict the conventional picture of the spatial delocalization of plasmons and interband transitions. We will explain the experimental results by using first-principles calculations within a density functional theoretical framework. Our observations open up exciting possibilities for designing atomic scale optoelectronic and plasmonic devices by assembling single atoms on monolayer graphene sheets.