Modeling of plasmonic nanostructures for enhanced graphene-based photodetectors

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Graphene, due to its unique optical properties, offers great opportunities for light harvesting and photodetection in a wide spectrum from visible to THz [1,2]. In most of these applications graphene is the active layer for both light absorption and for electron-hole separation and transport, the latter being facilitated by both photovoltaic and photothermoelectric effects [3]. Given however the relatively low absorption efficiency of graphene (2.3% when suspended and even lower when on a substrate) structural variations such as decoration of graphene with quantum dots [4] or plasmonic nanoparticles [5] have been found necessary to enhance performance. Here, we theoretically explore how different combinations of localized and propagating plasmons, plasmonic gratings (Fig. 1), lattice resonances and Fabry-Perot resonances, with different plasmonic materials such as noble metals, highly doped semiconductors and transparent conductive oxides can be utilized to optimize the absorption performance and/or tunability from the visible to the mid-IR. Specifically, we look at how the plasmonic near-fields, multiple scattering, and interference individually contribute to the enhanced absorption, and how their cumulative effect can be spectrally tuned and maximized.

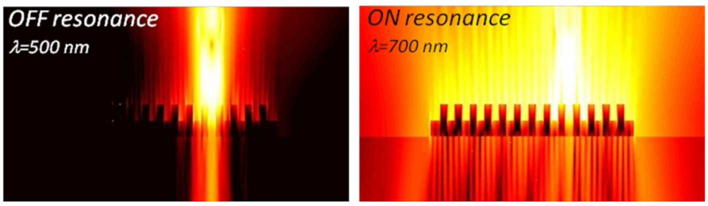

Figure 1: Field distribution of light scattering from a metallic grating

This work was funded by the EU Graphene Flagship (contract no.604391)

References

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