Graphene-based THz reconfigurable metasurfaces biased by electric and magnetic fields

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Metasurfaces are planar devices, based on periodic or quasi-periodic bi-dimensional arrays of elements (cells), capable of manipulating impinging EM waves in ways not usually encountered in nature. When a tuneable 2D-material like graphene is added to the cells, the resulting metasurfaces can be easily reconfigured, being able for instance to steer the reflected waves or to strongly affect their amplitude.

We present first a terahertz reflectarray metasurface that uses electrically biased graphene as active element to achieve beam steering and phase control. Then, we demonstrate that magnetostatic-biased graphene can be included in adequately designed metasurfaces to control the frequency of magneto-plasmonic resonances and to strongly enhance the Faraday rotation effect in the terahertz range. Indeed, by combining electric and magnetic bias, it is possible to create graphene-based metasurfaces able to control the angle and amplitude of reflected waves in a tunable THz frequency range.

Our simulations agree very well with the experimental results in all the tested cases, thus fully confirming our design strategies.

In conclusion, these preliminary results pave the way to the creation of versatile reconfigurable devices in the THz and optical ranges, including reflectarrays, beam shaping modules, switches, phase and amplitude modulators and useful non-reciprocal devices like isolators.