Graphene-Based Plasmonic Arrays for Dynamic Light Bending

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Abstract

Plasmonic arrays based on patterned graphene allow long-lived plasmonic resonances, strong light-matter interaction and dynamic tunability. These features pave the way to unprecedented applications in the spectral regions from low-terahertz to mid-infrared. In this contribution, the possibility of utilizing reflective-type graphene arrays for dynamic light bending is discussed. The basic working principle relies on manipulating the spatial variations of the phase-shifts of the reflected beam, achieved through optimizing the size of the array elements and gate-tuning of the plasmonic resonance. Fig. 1(a) shows the conceptual principle. Based on experimentally feasible designs, accurate electromagnetic simulations show that it is possible to bend the impinging beam over a wide range of angular directions.
It is well known that the complex conductivity of graphene can be modeled through the Kubo formalism [1] which depends, among other parameters, on the chemical potential (μ_c) and the relaxation time (τ). The value of μ_c can be controlled by chemically doping graphene or by applying an external electrostatic field. While in the former case the value of μ_c is fixed, in the latter case the conductivity of graphene can be dynamically controlled allowing, for instance, adjusting the phase of the reflection coefficient along the surface of the array. On the other hand, τ is somehow a measure of the graphene quality dependent on the fabrication process.
Two kinds of topologies for the elementary cell forming the reflective-type array are used: square patches [2] and ribbons [3]. In the first case a periodic array formed by equally-sized patches is optimized and the dynamic phase-shift in reflection is produced by varying the chemical potential in graphene. In the second case, an aperiodic array with optimized widths is designed and at the same time the chemical potential (μ_c) is varied for producing the desired phase profile.
The obtained results are very promising, demonstrating the possibility of efficiently bending the beam towards the desired spatial direction, when the graphene is properly patterned and a simple biasing is implemented. An example of the resulting bent beam, when a laser-beam illuminates the plasmonic structure is shown in Fig. 1(b).

References

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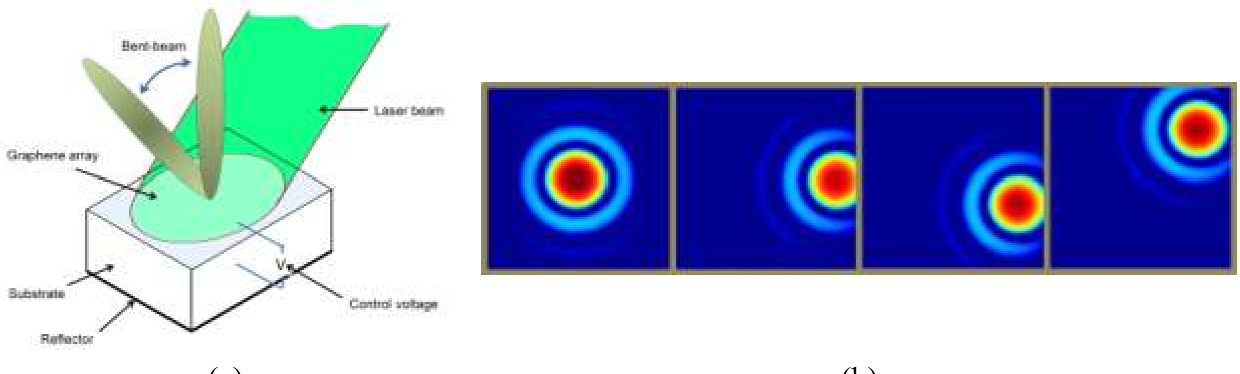
Figures



(a) (b)

: Fig. 1 Proposed reflective-type array based on graphene for ligth bending. (a) Architecture of the whole structure. (b) Some examples of the spatial ligth bending.

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