Infrared Beam-steering Using Mechanically Modulated Graphene Monolayer

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Abstract: We propose a graphene-based infrared beam-former based on the concept of surface leaky-wave. The excitation of infrared surface plasmon polaritons over an acoustically modulated one-atom-thick graphene monolayer is typically associated with intrinsically slow light.

THz antenna made of a graphene sheet with a high-density bias circuitry has been proposed to realize the beam-steering and beamforming of THz waves. Thanks to the tunability of graphene’s conductivity [1], the use of multiple-cascaded gates can modulate the surface reactance by biasing each gate with a given voltage [see Fig. (a)]. For no-bias condition, the graphene sheet generates a slow GSPP wave. When the gate-electrodes are conveniently biased, a “digitized” sinusoidal modulation can be applied to the surface reactance of graphene, introducing thus high-order spatial harmonics that can support a fast-wave-leaky-mode. Varying the modulation periods using different bias-setups lead to the steering of the THz beam over a wide range of scan-angles [see Fig. (b)].

![Graphene antenna diagram](image)

Figure (c) plots the effective GSPP wavelength for different Fermi energies, for a flat graphene sheet. It shows that GSPP are confined to the graphene surface and can be hardly excited. We overcome this problem using flexural elastic waves [2]. Figure (d) shows that the directivity of the antenna can be greatly enhanced by increasing the mobility of graphene, and thus lowering the associated plasmonic losses [3]. This antenna will result in fast switching of infrared or THz beams to various space channels, facilitating thus the integration of graphene-based plasmonic devices into applications such as switching, spatial multiplexing, or holography.