Graphene for THz Beam-Scanning Reflectarrays

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Graphene is a monatomic layer of carbon atoms arranged in a honeycomb lattice, which has attracted tremendous interest thanks to its unique electrical and mechanical properties. The complex conductivity of graphene allows the propagation of plasmonic slow-wave modes at Terahertz (THz) frequencies, and can be dynamically controlled via a perpendicular bias electric field.

The use of these exceptional properties to implement controllable reflective cells at THz and their subsequent use in THz beam-scanning reflectarrays (see Fig. 1) is proposed here.

A square graphene patch has been designed using a grounded 30-µm SiO_2 substrate, as shown in Fig. 1(b), including the DC biasing for electronic control. In conventional reflectarray elements made of good conductors such as copper, the patch resonates when its length is in the order of a half wavelength in the effective dielectric media. In the case of the proposed patch the resonance occurs at much smaller sizes, which is due to the aforementioned slow-wave propagation associated with the plasmonic mode.

Once the reflectarray element has been accurately characterized, a whole beam-scanning reflectarray antenna has been designed, taking into account the mutual coupling between adjacent elements and the angle of incidence of the wave incoming from the THz source. Fig. 1(c) shows a beam scanned in the elevation plane. Very promising performance has been obtained in terms of dynamic phase range, efficiency, suppression of grating lobes, low cross-polar component and bandwidth, demonstrating the feasibility of using graphene in the development of future applications for free-space wave propagation control, at THz.

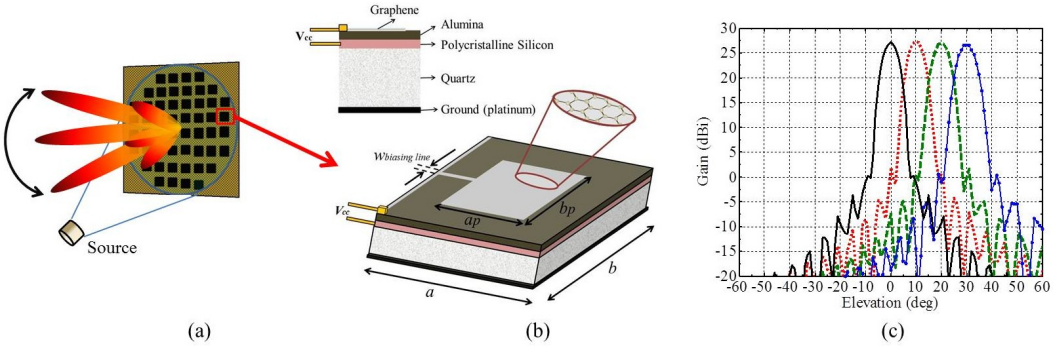

Fig. 1 Proposed reconfigurable-beam reflectarray antenna based on patches made of graphene. (a) Antenna architecture. (b) Multilayer elementary reflective cell, including biasing. (c) Expected radiation patterns for the beam-scanned antenna.