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Recent Advances on Graphene Leaky-Wave Antennas

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Graphene is a one-atom thick layer of carbon atoms arranged in a honeycomb lattice with unique physical and electromagnetic properties [1]. For antenna applications, graphene shows its best electromagnetic properties in the low THz frequency range, where its surface complex conductivity (which is known in closed analytical form [2]) exhibits moderate ohmic losses, and a reflectivity that can be externally controlled through the application of a bias voltage. In other words, graphene may allow for the design of antennas capable of dynamically controlling their beam features at a fixed frequency, avoiding the use of complex feeding systems as in phased arrays.

The pioneering idea of using graphene for realizing reconfigurable antennas was first proposed by J. Perruisseau-Carrier in 2012 [3]. That conference paper inspired most of the following works dealing with the analysis, design, and modeling of graphene leaky-wave antennas in the THz range (see, e.g., [4–7]).

One of the first examples of graphene leaky-wave antennas (LWAs) exploited the propagation of a surface plasmon polariton (SPP) over a periodically modulated graphene sheet [4]. The graphene surface conductivity was sinusoidally modulated over the direction of SPP propagation so as to convert the highly-confined *SPP slow wave* into a *fast radiating backward leaky-wave*. A suitable biasing scheme was designed to steer the beam from backfire to endfire at a fixed frequency around 2 THz. In spite of their high degree of reconfigurability, such kind of graphene LWAs are characterized by *limited radiation efficiencies*.

In this contribution, we review the advances in the field of graphene leaky-wave antennas, starting from the early examples based on plasmonic leaky waves [4] to the more recent *nonplasmonic leaky waves* [8], discussing advantages and disadvantages of both solutions from a rigorous theoretical viewpoint. The possible realization of these promising devices will be addressed from a realistic perspective, highlighting the fabrication issues related to both graphene and terahertz technologies that still hinder the first experimental validation of graphene LWAs.

References

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