Nonreciprocal Nanoantennas Based on Time Modulation

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1. Extended Abstract

Nonreciprocal devices have attracted significant attention for applications in the protection of sensitive sources from strong external interferences and the design of full-duplex communication systems. A technique that has recently gathered significant interest for breaking reciprocity is spatiotemporal modulation, because it can lead to magnet-free nonreciprocal devices that are fully compatible with integrated circuit technology. So far, the majority of efforts in this direction have been concentrated on the realization of nonreciprocal devices for guided waves, including isolators and circulators. Furthermore, preliminary results have been presented in the design of nonreciprocal antennas, with applications in full-duplex systems and enhancing the efficiency of thermophotovoltaic systems. Such radiating systems were based on spatiotemporal modulation of leaky waves antennas, leading to long devices [1-2].

Here, we present nonreciprocal nanoantennas based on localized plasmonic resonances, which allow to significantly reduce the size. An example of such an antenna based on graphene and the approach of angular momentum biasing is presented in Fig. 1. It consists of three identical graphene patches symmetrically coupled to each other and modulated in time with signals of equal amplitudes and phase differences of 120 deg. This type of spatiotemporal modulation effectively imparts angular momentum to the structure, breaking the symmetry between right- and left-handed circularly polarized waves, and allows the antenna to receive right-handed waves but not left-handed ones. At the same time, when the antenna is used as an emitter it radiates left-handed waves, but not right-handed ones. By combining such a non-reciprocal antenna with a reciprocal metasurface that transmits waves of opposite circular polarizations to different directions, it is possible break Kirchhoff's law for the symmetry between absorption and thermal emission, which can allow to enhance the efficiency of thermal emitters [3]. In addition to the structure described above, in out talk we will present antennas based on Huygen's sources and dielectric nanoantennas, which can support nonreciprocal radiation/absorption without the need of additional metasurfaces.

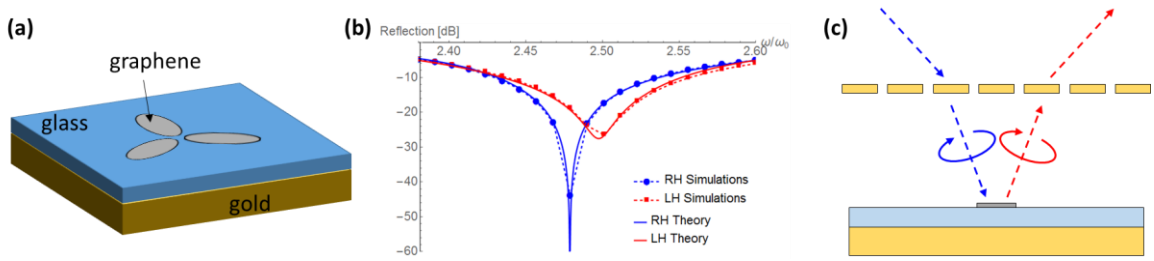

Figure 1. (a) Nonreciprocal nanoantenna based on graphene and angular momentum biasing through spatiotemporal modulation. (b) Receiving response of the antenna. (c) When the antenna is combined with a reciprocal metasurface, it is possible to achieve absorption and emission from different directions.

2. References

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