Asymmetric transmission as a generic property of periodically structured interfaces

E Plum, V A Fedotov and N I Zheludev

Optoelectronics Research Centre & Centre for Nanostructured Photonic Metamaterials
University of Southampton, UK

We demonstrate experimentally for the first time that directionally asymmetric transmission can arise from oblique incidence onto any lossy, periodically structured interface.

The phenomenon arises from extrinsic 2D chirality of the experimental arrangement and even occurs for arrays of the most symmetric meta-molecules, see figures 1 (a) and (b). Being dependent on the mutual orientation of metamaterial and incident beam, the asymmetric transmission effect demonstrated here is inherently tunable and it can even be switched off, see figure 1 (c). It will be shown that the tunable transmission asymmetry is necessarily accompanied by tunable directional asymmetries in reflection and absorption, opening up an opportunity to develop novel directionally asymmetric and polarization sensitive devices. Furthermore, an overview will be given over the underlying physics and fundamental limits of the directionally asymmetric phenomena.

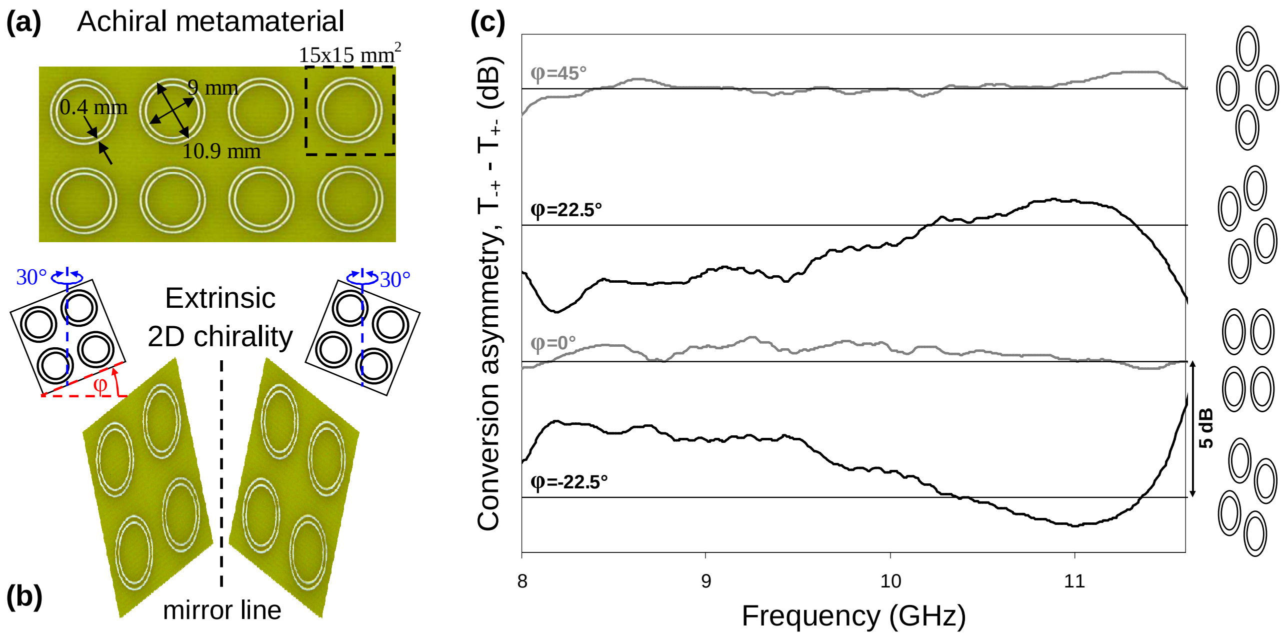

Figure 1: (a) Highly symmetric, achiral metamaterial. (b) Extrinsic 2D chirality: At oblique incidence, the metamaterial's projection onto the plane normal to the direction of incidence becomes different from its mirror image and therefore 2D-chiral. (c) Tunable asymmetric transmission due to extrinsic 2D chirality: Asymmetric transmission of circularly polarized waves results from different right-to-left T_{-+} and left-to-right T_{+-} circular polarization conversion efficiencies. This conversion asymmetry, $T_{-+} - T_{+-}$, is controlled by the metamaterial orientation φ. Insets show the metamaterial pattern projected onto the plane normal to the incidence direction.