Circular dichroism in twisted resonator based chiral metamaterial

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An object is chiral if it cannot be overlapped with its mirror image. One of the manifestations of chirality in optics are chiral metamaterials, responsible for the appearance of optical activity and circular dichroism. These effects originate from polarization rotation which occurs because waves of the opposite handedness propagate with unequal phases and absorption rates through this kind of material [1].

Circular dichroism has an important role in applications of chiral metamaterials related to manipulation of circularly polarized waves. Nowadays, there is a need for development of devices relevant for terahertz and infrared technologies, in particular for spectroscopy, imaging and communications. Numerous designs of chiral resonant elements have been proposed until now, providing components for terahertz wave modulation, switching and sensing [2-4]. Similarly, chiral structures can enhance infrared signal of chiral molecules which enables detection of enantiomers of these molecules by measuring circular dichroism.

In this study, we performed numerical simulations of terahertz wave propagation through chiral metamaterial composed of twisted closed ring resonators [5]. In the absorption spectra, three resonances were distinguished as a result of the existence of electric dipoles and quadrupoles. By this design of resonator, high values of circular dichroism as well as strong local electric field enhancement are obtained. The most significant results are seen at first resonant frequency which appears as a consequence of the gap provided by twisting the ring resonator. Furthermore, we extended our research to infrared range by scaling the chiral resonator dimensions. Values of circular dichroism within this frequency range indicate different performance capabilities when comparing to the terahertz case. In addition, we examined the influence of losses in metal and dielectric on this quantity for both frequency ranges.

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