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DOI: 10.3969/j.issn.1003-501X.2017.01.009

Anomalous scattering-induced circular dichroism in continuously shaped metasurface

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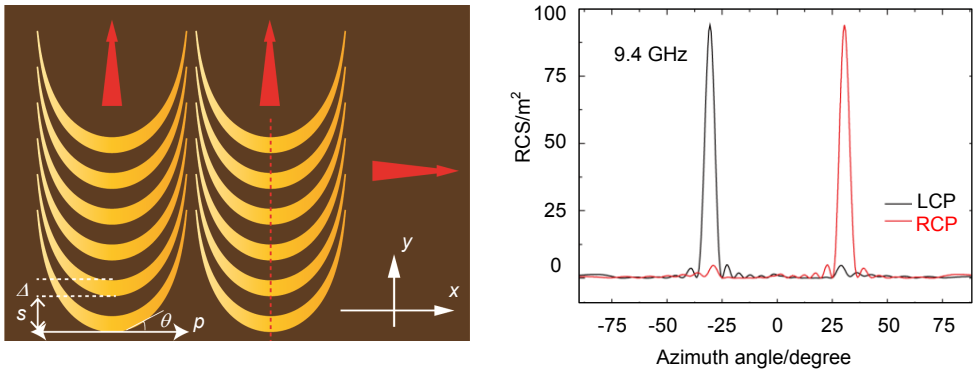

Continuous metasurface composed of catenary arrays and the anomalous scattering.

Abstract: Circular dichroism (CD) is helpful in providing useful knowledge about the structure of biological macromolecules. However, CD generated by intrinsic chiral materials is always too weak so it is inefficient to probe the micro-structure of biological molecules. To enhance the CD signal, chiral metamaterials composed of artificial meta-atoms with controllable chirality, have been developed in the past few years. Besides chiral metamaterials, recent theoretical and experimental results have shown that planar metasurfaces can also lead to CD at oblique incidence. In principle, both absorption and scattering of circularly polarized light contribute to CD. Nevertheless, scattering of incident left and right circularly polarized light can be an important contribution to the CD of the molecules, whose dimensions are greater than 1/20 of the incident wavelength. Therefore, abnormal scattering will induce a considerable CD.

In general, abnormal scattering has been developed in anisotropic and inhomogeneous metasurfaces, where spin-orbit interaction occurs and results in handedness-dependent scattering. The most direct method to introduce the spin-orbit interaction is utilization of the anisotropic meta-atoms with different orientations. Although expected phase modulation for wave-front manipulation can be infinitely approximated by several levels of quantified phase shifts, discontinuous nature inevitably degrades the overall performance of metasurfaces due to the induced phase noise to the scattering fields. Meanwhile, discrete system is not electrically conductive, thus it is difficult to obtain simultaneous electric and optical functionality.

In order to overcome the shortages above, a novel metasurface composed of continuous meta-atoms, i.e., metallic catenary structures is developed. The main difference of the proposed metasurface with those consisting of the discrete meta-atoms array is that the wavefront engineering accuracy is significantly improved because of their nearly infinite small "pixel" size, which may motivate the anomalous scattering-induced CD. As an experimental proof, a metamirror composed of continuously shaped metasurface, dielectric space and ground reflection is fabricated by PCB technology. The anomalous scattering properties are characterized by the RCS reduction at microwave band. Both simulation and experimental results demonstrate the anomalous scattering-induced CD in the proposed continuously shaped metasurface.

Keywords: scattering engineering; circular dichroism; continuously shaped metasurface

Citation: Tan Xuehai. Anomalous scattering-induced circular dichroism in continuously shaped metasurface[J]. *Opto-Electronic Engineering*, 2017, **44**(1): 87-91.

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