Chiral selective plasmonic metasurface

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Abstract

A chiral plasmonic absorber using lightning-shaped nanostructures was demonstrated to achieve spectrally selective chiral in the visible region. The absorption can reach up to 84% for RCP and the circular dichroism (CD) is ~30% at the wavelength of 640 nm.

1. Introduction

Chirality is a fundamental and universal characterization of natural molecules and artificial metamaterials, which has different optical property for right-handed circular polarization (RCP) or left-handed circular polarization (LCP). Recently, the plasmonic metasurfaces with chirality absorber has been widely studied, and the design are including Z-shaped [1], L-shaped [2] and η-shaped chiral structures [3] , which have the applications, such as absorption filters, hot-electron collection devices, and so on.

2. Results and discussion

Figure 1(a) shows the schematic configuration of the designed Z-shaped structures (gold) on the top of the silicon dioxide spacer (SiO_2), underneath which is a layer of metallic reflector (gold) and the substrate (glass). Due to the thick gold backplane in this design, the transmission can be neglected. The geometric parameters used in this simulation are $h_1 = h_2 = 50$ nm, $h_3 = 200$ nm, the period in x direction is 300 nm and in y direction is 400 nm. The width of the line is 50 nm for the lightning-shaped structures. We fabricated the proposed metasurface design, and the scanning electron microscope (SEM) image is shown in Fig. 1(b).

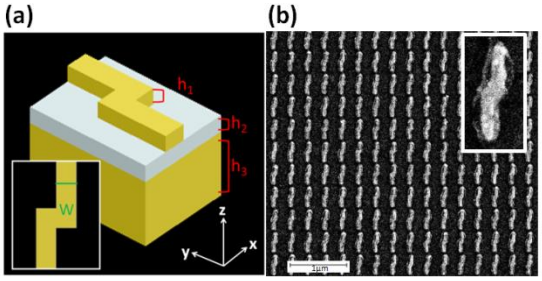

Figure 1. (a) Schematic view of lightning-shaped plasmonic nanostructures and (b) scanning electron microscopy images of the fabricated periodic pattern (scale bar: 1 μm).

We observed that at the 640 nm and 735 nm nearby, there are the obvious absorption for RCP, but no large quantity absorption for LCP in Fig. 2(a).

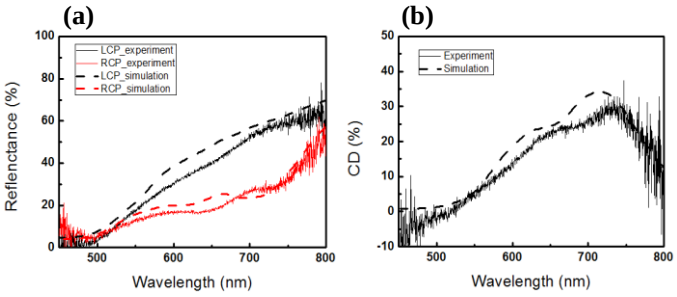

Figure 2. (a) Experimental (solid curve) and simulated (dash) results of the reflectance spectra under LCP (black) and RCP (red) normal incidence, and (b) the circular dichroism ($CD = A_{Rcp} - A_{LCP}$).

3. Conclusion

In summary, the anisotropy of the lightning-shaped structure can produce the phase difference and transform the linear polarization state into its orthogonal one. This phase difference will lead to destructive interference and constructive interference for RCP and LCP, respectively; which can produce different absorption characteristic and result in chiral response. The CD ~30% can be achieved. (Fig. 2(b)) This lightning-shaped structure can be applied to selective absorption filters or emitters.

References

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