Electronic Supplementary Material (ESI) for Nanoscale.

Giant and Broadband Circular Asymmetric Transmission Based on Two Cascading Polarization Conversion Cavities

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Supplementary Information

I. Influence of permittivity of metallic materials

The simulation results for metallic materials of silver, gold and aluminium are presented in Fig. S1. The curves of the three metals are quite similar, but the maximum magnitude and corresponding wavelength are varies with each other. Among them, silver has the best performance, and the maximum Δ_{cir} can reach 0.87 at 1.55μm. As for gold, the maximum Δ_{cir} is 0.73 at 1.62μm. While with aluminium as the metallic materials, though the maximum Δ_{cir} is less than silver (Δ_{cir}=0.76, λ=1.39μm), but the blocking effect for the RCP waves in backward propagation is enhanced (minimum transmittance can be reduced to 0.02).

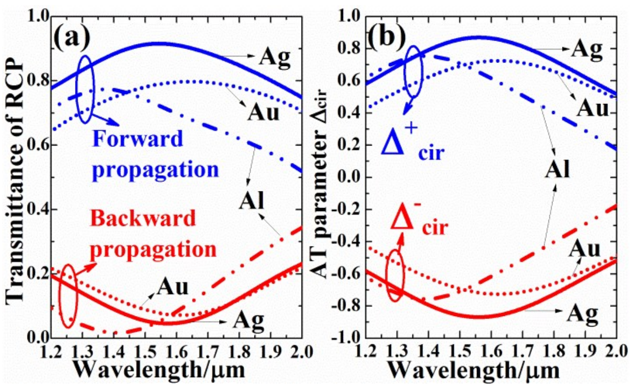

Fig. S1 (a) Total transmittance for a RCP waves in forward (*+z*) and backward (*-z*) propagation (b) asymmetric transmission parameter for circular polarized waves Δ_{cir} of the designed metamaterial. Silver (solid line), gold (short dot) and aluminium (dash dot dot) are used as the metallic materials of the metamaterials. The permittivity values of gold and aluminium given by Palik[1] are used in the simulations. The parameters of the metamaterial are as follows, *p*=320 nm, *t*=50 nm, *lw*=40nm, *ls*=60nm, *hs*=90nm, *ws*=30nm, *ϑ*=45° and *d*=150nm**.**

II. AT sensitivity to the incident angle

The asymmetric transmission parameters Δ_{cir} and transmittance curves with different incident angles are illustrated in Fig. S2. As shown in Fig. S2(a), the transmittance curves with incident angle of 10° and 20° nearly maintain almost the same transmittance as the case of normal incidence, except for slight magnitude changes and dips/peaks at 1.47μm. Under normal incidence, the electric field distributions in the two parts of metallic S-shaped structures are symmetrical, while become unsymmetrical under oblique incidence. In the other words, the symmetry of the S-shaped is broken when the incident angle not equal to zero. Thus, similar with the planer asymmetrically split rings under normal incidence, circular polarized incident waves will excite a strongly scattering electric dipole-like current mode (strong polarization conversion) or a weakly scattering magnetic mode (conversion minimum), which contribute to the dips/peaks in the transmittance curves[2]. As shown in Fig. S2(b), when the incident angle is less than 5°, the influence of the incident angle is nearly ignorable and the curves of AT parameter almost coincide with each other. And when the incident angle is increased to 30°, the AT parameter at 1.55μm is only decreased to 0.84, and the maximum decrease of AT parameter is only 0.1 if the dip mentioned above is not taken into consideration.

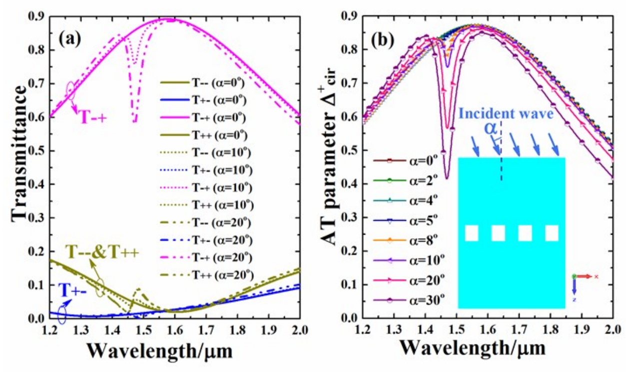

Fig. S2 (a) Transmittance curves of the proposed metamaterials with incident angle α of 0° (solid line), 10° (short dot) and 20° (dash dot dot) (b) asymmetric transmission parameters Δ_{cir} with different incident angles. The parameters of the metamaterial are as Fig. S1**.**

References

1. A. D. Rakic, A. B. Djurisic, J. M. Elazar and M. L. Majewski, *Appl Optics*, 1998, **37**, 5271-5283.
2. E. Plum, V. A. Fedotov and N. I. Zheludev, *Appl Phys Lett*, 2009, **94**, 131901.