Enantiomeric-sensitive plasmons

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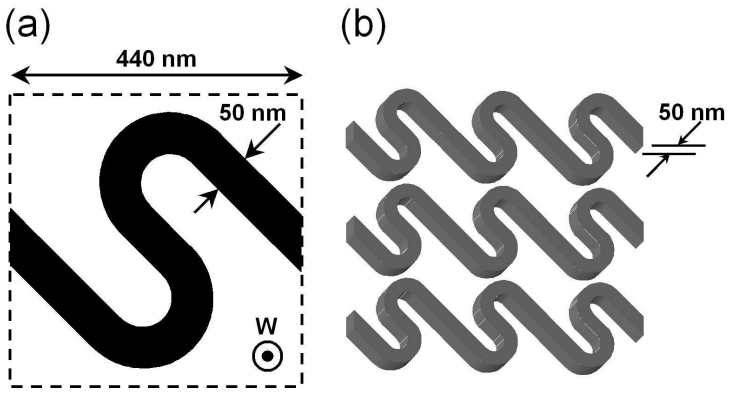
We show theoretically and experimentally that in the visible to near-IR part of the spectrum normal incidence transmission of circularly polarized light through a nano-structured anisotropic planar chiral metamaterial is asymmetric in the opposite directions. The new effect is fundamentally different from the conventional gyrotropy of bulk chiral media and Faraday effect. It has a resonance nature associated with a new type of excitation in the metal nano-structure: ***the enantiomeric sensitive plasmon***.



We observed that asymmetric transmission in a tilted "fish-scale" metal nano-structure of regular planar array of chiral aluminium nano-wire elements arranged on a lattice with 440nm x 440nm unit cell prepared by electron-beam lithography. The asymmetry, measured in the range from 500nm to 1700nm using a continuum laser source has a resonant nature linked to the enantiomeric sensitive excitation of plasmon in the metal nanostructure. Experimental results are compared and corroborate with detailed pseudo-spectral time domain (PSTD) numerical simulations.

A planar structure is said to be chiral (twisted) if it cannot be brought into congruence with its mirror image (reflected across a line in the plane of the structure) unless it is lifted off the plane. The asymmetric effect in some ways resembles the famous non-reciprocity of the Faraday effect in magnetized media but require no magnetic field for its observation and is fully complacent with the Lorentz reciprocity principle [1]. Both in the Faraday effect and in that produced by planar chirality, the transmission and retardation of a circularly polarized wave is different in opposite directions. In both cases the polarization eigenstates, i.e. polarization states conserved on propagation, are elliptical (circular). There are also essential differences between the two phenomena. The asymmetry of the Faraday Effect applies to the transmission and retardation of the *incident* circularly polarized wave itself, whereas the planar chirality effect leads to partial conversion of the incident wave into one of opposite handedness, and it is the efficiency of this *conversion* that is asymmetric for the opposite directions of propagation. The effect which we describe here is also radically different from conventional gyrotropy in 3D-chiral media (such as sugar solution or quartz), which is completely symmetric for the wave propagating in opposite directions.

1. A. V. Rogacheva, V. A. Fedotov, A. S. Schwanecke, and N. I. Zheludev, Phys. Rev. Lett. 97, 177401 (2006).