SUPPORTING INFORMATION

Extrinsic chirality tailors Stokes parameters in simple asymmetric metasurfaces

Emilija Petronijevic,[a,*] Tiziana Cesca,[b] Carlo Scian,[b] Giovanni Mattei,[b] Roberto Li Voti,[a] Concita Sibilia[a] and Alessandro Belardini[a]

[a.] Department SBAI, Sapienza University of Roma, Via A. Scarpa 14, I-00161 Rome, Italy. E-mail: emilija.petronijevic@uniroma1.it
[b.] University of Padova, Department of Physics and Astronomy, NanoStructures Group, via Marzolo 8, I-35131 Padova, Italy.

1. Polarization-resolved chiro-optical spectroscopy

To define the input polarization state, the first linear polarizer (LP) was kept in the horizontal position, and the first quarter- wave plate (QWP) is rotated; QWP angles of -45°, 0° and +45° correspond to LCP, p and RCP polarized light, respectively. The sample was facing the incident light from the metasurface side, and the total intensity was detected by a photo-diode (PD).

To resolve Stokes parameters, a QWP and a LP were put into the transmitted beam path before the PD, and four combinations of their orientations were measured; ϕ_{QWP} is the QWP fast axis angle w.r.t. vertical axis, while ϕ_{LP} is the LP angle w.r.t. horizontal axis. In the first three measurement, ϕ_{QWP}=0°, while the LP acquires angles ϕ_{LP}=0° (horizontal), ϕ_{LP}=45° (diagonal) and ϕ_{LP}=90° (vertical); these three measurements give intensities I_1, I_2 and I_3, respectively. In the fourth measurement, I_4 gives the transmitted intensity for $\phi_{QWP}=\phi_{LP}$=45°. Finally, Stokes parameters are obtained as: $S0 = I_1 + I_3$, $S1 = I_1 - I_3$, $S2 = S0 - 2I_4$, $S3 = 2I_2 - S0$. Parameters S_1, S_2 and S_3 in the main manuscript are obtained by normalizing parameters $S1$, $S2$ and $S3$ by $S0$.

2. Numerical modelling of asymmetric metasurfaces

We performed extensive numerical simulations by means of a commercial-grade numerical package in Lumerical, Ansys. Lumerical solves Maxwell's equations by 3D Finite Difference Time Domain (FDTD) method on a discrete spatial and temporal grid. The simulation domain is defined by a unit cell with Bloch boundary conditions in x- and y- directions, and perfectly matching layers in the z-direction, see Fig. 1c in the main manuscript. The xy plane spans $a\sqrt{3}$ and a in the x- and y-direction, respectively, where $a = 522nm$ is given by the initial nanosphere diameter in nanosphere lithography. The metasurface consists of polystyrene nanosphere with diameter of 370 nm, covered by a 50 nm thick golden asymmetric shell, and standing on a semi-infinite glass substrate (see Fig. 1b in the main manuscript). To account for the low in-plane chirality, the shell is tilted around the vertical axis for angle 30° with respect to the y-direction. The metasurface is excited from the top (air) side, with a broadband plane-wave source. Since we investigate oblique incidence up to 40°, a special care is needed to remove the wavelength dependence on the injection angle: a Broadband Fixed Angle Source Technique (BFAST). Therefore, two BFAST sources with properly shifted phases model circular polarizations, while one BFAST source models linear p polarization. The incidence plane is defined as in the experiment; note that under normal incidence, linearly polarized source has electric field oscillating perpendicular to the in-plane asymmetry vector $\vec{s}$. The FDTD region is meshed with accuracy of 4. The absorption per unit volume is calculated by measuring both electric field and complex refractive index in the "pabs_adv" analysis group. The best fit of the model was done by comparing the zeroth order of the simulated transmitted field in a broad spectral and incidence angle range to the experimental results (Fig. 2 of the main manuscript). This model was then applied to study the absorption (Fig. 3 of the main manuscript, and Fig. S1), and the electric field vector of the transmitted beam (Fig. S2).

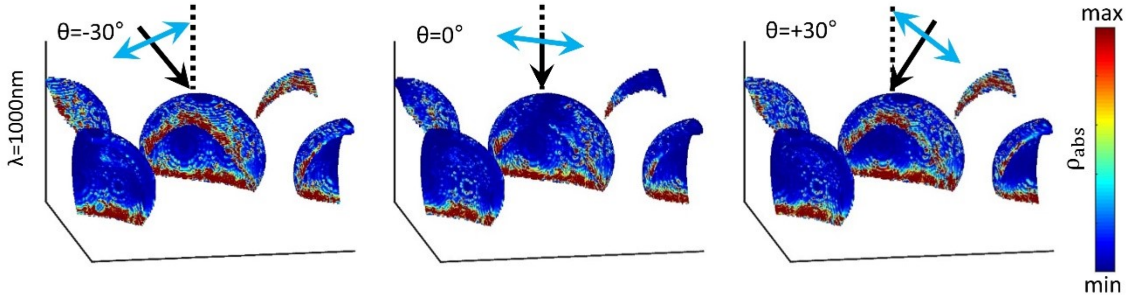

Figure S1 Absorption density distribution for p-polarized excitation at 1000 nm, at ∓30° and normal incidence.

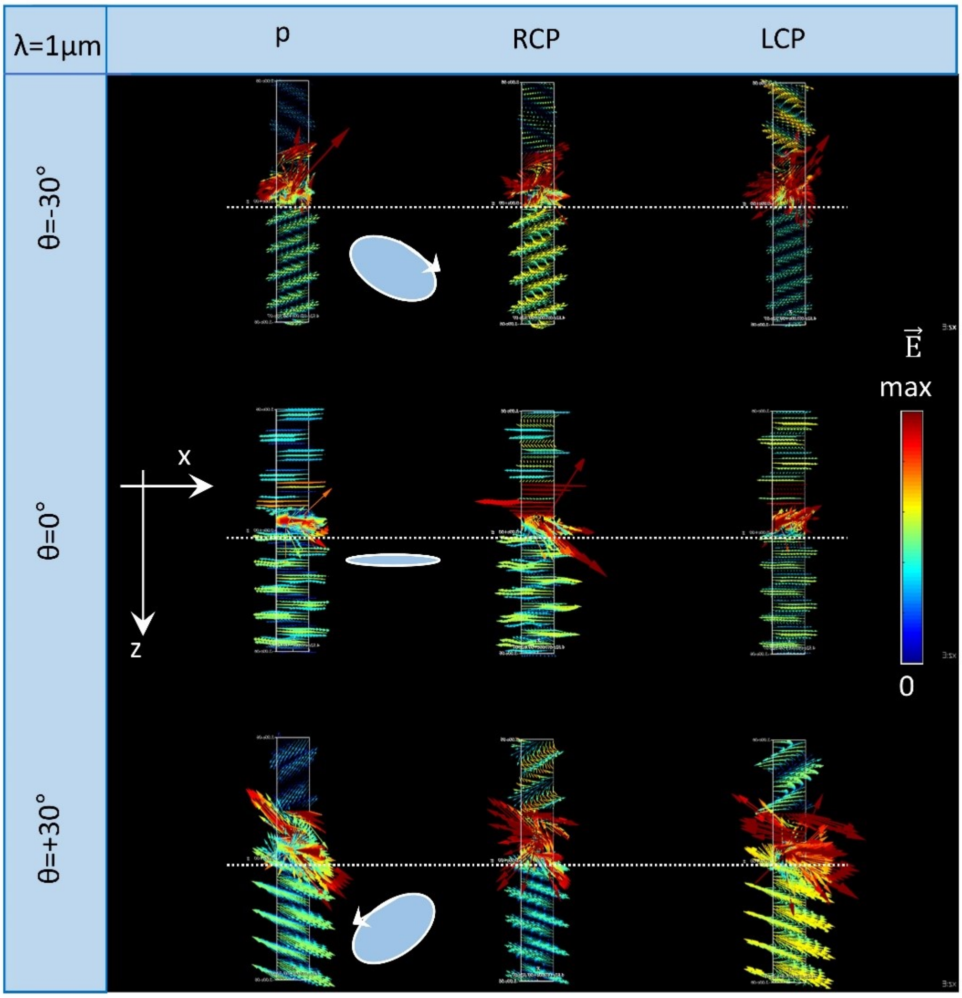

Figure S2 Electric field vector behaviour in the xz plane, excited at wavelength of 1 μm, with p, LCP or RCP polarization, under normal incidence or θ=±30°. The xz monitor shows propagation from +3 μm to +-3 μm, and the white dashed lines represent glass substrate. As in the experiment, the field is incident from the top (negative z-direction) and it is strongly enhanced in the near-field around the metasurface. Sketches for p-polarized excitation correspond to the experimentally measured handedness of the elliptically polarized transmitted beam.