Supporting Information

Details Regarding the Mechanism of Writing Scattering States

In all its simplicity of realization, we are dealing with a rather complex phenomenon. To understand it, we shall proceed from the fact that the domain formation takes place for the light wavelength and polarization corresponding to the (cholesteric liquid crystal) CLC's bandgap mode only. The superposition of the incident CP beam with the beam reflected from the CLC gives rise to a spiral standing wave wherein the effective polarization is linear rotating along the propagation axis of the beams (*z*-axis), Figure S1. Indeed, consider right-hand circular polarized (RHCP) beams of equal amplitude counter-propagating along *z*-axis:

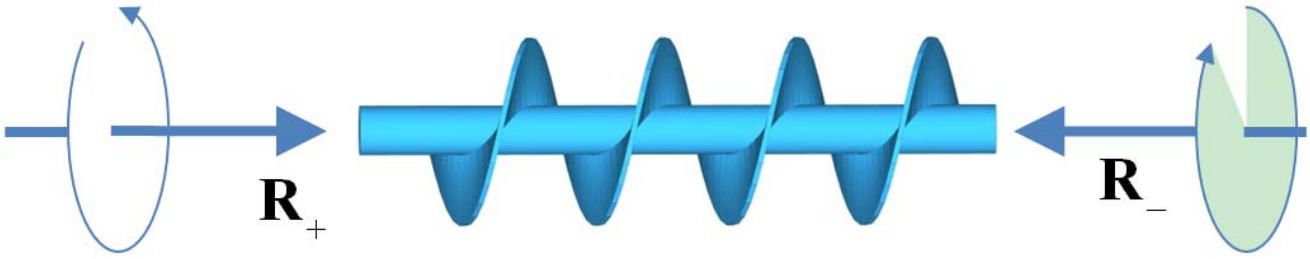
$$E_i = \frac{1}{2}\exp(ikz)\begin{bmatrix}1\\-i\end{bmatrix},\ E_r = \frac{1}{2}\exp(-ikz)\begin{bmatrix}1\\i\end{bmatrix} \tag{1}$$

here $k = 2\pi/\lambda$ is the wave vector; λ, the light wavelength, and the total intensity in the beams is equal to 1, $|E_+|^2 + |E_-|^2 = 1$. Superposition of those beams,

$$E = E_+ + E_- = \begin{bmatrix}\cos(kz)\\ \sin(kz)\end{bmatrix} \tag{2}$$

presents a spiral orientation pattern with the polarization angle α rotating in space, $\alpha = kz$.

Figure S1. Schematic of a spiral standing wave generated in the overlap region of counter-propagating circular polarized beams of same handedness.



The photosensitive alignment layer of the CLC cell, being only a few nanometers thin, is actually subject to effectively linear polarized beam in case of normal incidence or to a polarization modulation pattern across the layer if the cell is tilted with respect to the propagation direction of the beam and thus intersects the standing wave at different points along the *z*-axis. A schematic comparison of exposure to linear and bandgap mode CP light is shown in Figure S2.

Figure S2. Frustrated photoalignment of a cholesteric liquid crystal (CLC) in a spiral standing wave: (**a**) linear polarized beam incident on CLC; (**b**) the initial alignment condition at the photosensitive layer; (**c**) completion of transformation of the orientation state by the LP incident beam; (**d**) linear polarization obtained due to formation of a standing wave; and (**e**) reorientation causing domains in the CLC and loss of reflected left-handed circularly polarized (LHCP) light.