Optical spin Hall effect in a tunable liquid crystal microcavity

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Recently, research on new spintronic and optoelectronic systems has gained great popularity. The devices that would explore the spin state of photons become of special interest as they provide a new degree of possible manipulation mechanisms by spin-to-orbital momentum conversion of photons.

In this communication we present a new kind of an active polarization converter [1] consisting of a microcavity filled with a nematic liquid crystal (LC). The properties of LC are controlled by external voltage (Fig.1a). This unique device operates in room temperature and explores giant values of TE-TM splitting that are smoothly tunable in range from -15.9 meV to 27.8 meV, an order of magnitude higher to values reported previously. One of the most interesting phenomena directly dependent on the TE-TM splitting in a cavity is the optical spin Hall effect. We show that thanks to the novel design and the unique possibility to tune the splitting even for zero incidence angle, we are able to observe not only typical quadrupole spin textures, but also never reported before patterns resembling: dipole, spin doughnuts and whirls (Fig.1b).

Our novel device allows to control the spin state of photon making a new building block for the next-generation of photonic spin Hall devices. Moreover, it can be easily integrated with light emitters (like various dopants: quantum dots, dyes, thin layers of transition metal dichalcogenides) for room-temperature strong light-matter coupling and lasing.

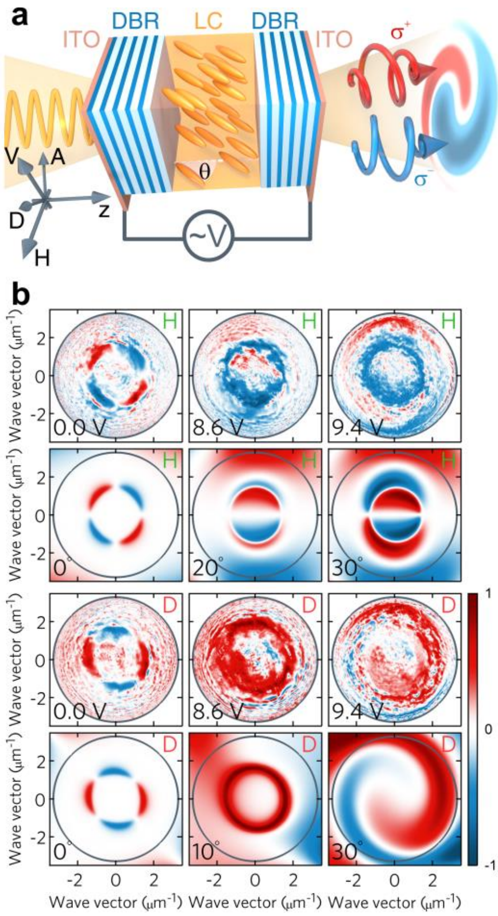

Fig. 1 (a) Scheme of the tunable liquid crystal microcavity. **(b) Degree of circular polarization ρ_C for liquid crystal microcavity for horizontal (H) and diagonal (D) polarization of incident light.** Experimental results **(first and third panel)** for different voltages applied to the electrodes constituting the outer layers of the structure for H polarization and for D polarization compared with model **(second and fourth panel)** for different average arrangement of LC molecules angles. Circles mark the areas available experimentally limited by numerical aperture of the objectives.

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[1] K. Lekenta, Tunable optical spin Hall effect in a liquid crystal microcavity. *Light Sci. Appl.* **7**, 74 (2018).