Dynamical Cross effect in chiral liquid crystals

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Liquid Crystal (LC) films composed of chiral compounds are known to exhibit a unidirectional molecular rotation under transmembrane thermal, ionic or mass current, which is understood as thermomechanical, electromechanical and chemi-mechanical coupling between the unconjugate flows and forces. We have investigated the coherent molecular precession in ultrathin chiral LC films driven by transmembrane gas flow, as a typical cross coupling showing that the precession speed is linear to the gas flow rate and the rotational direction is reversed by the inversion of the flow direction and the molecular chirality. As the sources that cause the unidirectional molecular motion, we suggest that there are two, one is macroscopic helical structure and the other is microscopic molecular propeller, the intersection of which can be sometimes observed as the rotational switching. If we can manipulate the torques with different origins, it may be possible to control the molecular rotation effectively.

Recently, we also found that the transmembrane gas flow should induce not only the molecular precession but also the unidirectional hydrodynamic flow in the films. Depending on the LC elasticity, viscosity and boundary condition, the crossover between the two flows can be observed. We expect the dynamical properties of chiral liquid crystals may be used for new LC applications.

References:
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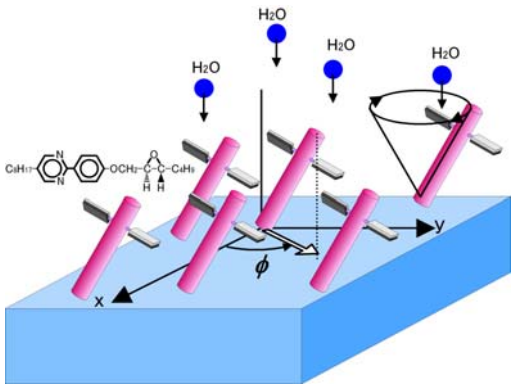

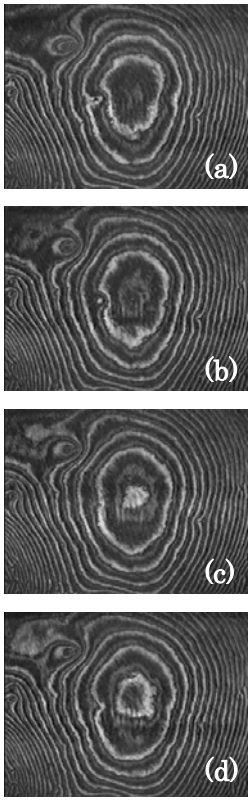

Figures: (top) Schematic drawing of a chiral LC monolayer under transmembrane water vapor flow. (right) Images observed under polarizing microscope, which shows the coherent molecular precession in CCW direction.