Birefringence of Nematic Phase [pln73]

Birefringence is an optical effect characterizing anisotropic transmission of light. The refractive index depends on the polarization of light traveling through a birefringent material in a given direction.

In a nematic liquid crystal the anisotropy is caused by the orientational order of rod-like molecules. The orientational order is marked by a unit vector $\mathbf{n}$, named director.

The birefringence of nematics is characterized by the difference of refractive index for light polarized parallel or perpendicular to the director:

$$\Delta n \doteq n_{\parallel} - n_{\perp}.$$

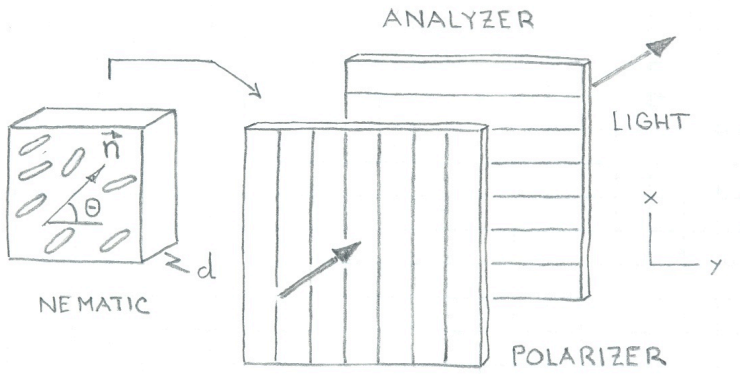
Traveling light waves of wavelength λ and one or the other linear polarization thus acquire a phase difference when traversing a nematic film of width d:

$$\Delta\phi = \frac{2\pi}{\lambda} d\Delta n.$$

Polarized optical microscopy (POM) is a powerful technique for the visualization and characterization of liquid crystal phases.

Intensity of light emerging from setup with nematic film between crossed polarizers [pex2]:

$$I \propto \sin^2(2\theta) \sin^2\left(\frac{\pi d}{\lambda}\Delta n\right).$$



[extracted from Hirst 2013]