

Soft Matter Exercise - Chapter 2: Liquid Crystals

1. Liquid Crystals

What are the differences between thermotropic and lyotropic liquid crystals?

2. Structure

What does “short range order” mean? How does that compare to the structure of a crystal and how does it compare to that of a liquid?

3. Thermodynamics

The entropy decreases if a liquid transitions into a nematic phase. Why can the nematic phase of certain compounds, such as 5 CB, nevertheless be stable within a certain temperature range?

4. Quarter-Wave Plate

A thin slab of a nematic liquid crystal is held between two parallel glass plates for use as a quarter-wave plate with a 488 nm laser. If the liquid crystal has a birefringence of $\Delta n = 22$, how thick does the liquid crystal slab need to be for it to act as a quarter-wave plate?

5. Birefringence

Which of the following liquid crystal samples are birefringent?

- a. homeotropically aligned nematic phase
- b. planar-aligned smectic A phase
- c. cholesteric phase
- d. isotropic phase of a discotic material

6. Twisted Nematic Liquid Crystal

You must design a twisted nematic display using a nematic liquid crystal with elastic constants $K_1 = 5.3 \times 10^{-12}$ N, $K_2 = 2.2 \times 10^{-12}$ N, $K_3 = 7.45 \times 10^{-12}$ N, and $\Delta\epsilon = 0.7\epsilon_0$. The distance between the plates is 10 μm .

- a. What is the switching voltage?
- b. How could you reduce the switching voltage?