# RHEOLOGICAL METHOD TO INVESTIGATE PSEUDOLAYER COMPRESSION ELASTIC CONSTANT AND THE DYNAMICS OF THE TWIST-BEND NEMATIC LIQUID CRYSTAL

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## ABSTRACT

Liquid crystals are intermediate state of matter between completely ordered crystals and amorphous liquids. They exhibit both the liquid like and the solid like properties. The common liquid crystal phases are nematic (N), smectic-A (SmA) and cholesteric (N*) etc. Recently, some new nematic LCs with a nano and micro scale modulation of director such as twist-bend nematic (NTB) and splay nematic (NS) have been discovered. We study the flow behaviour of a twist-bend nematic (NTB) liquid crystal. It shows three distinct shear stress ($\sigma$) responses in a certain range of temperatures and shear rates ( $\dot{\gamma}$). In Region-I, $\sigma \sim \sqrt{\dot{\gamma}}$ [1], in region-II, the stress shows a plateau, characterised by a power law, $\sigma \sim \dot{\gamma}^{\alpha}$, where $\alpha \sim$ 0.1- 0.4 and in region-III, , $\sigma \sim \dot{\gamma}$. With increasing shear rate, $\sigma$ changes continuously from region-I to II, whereas it changes discontinuously with a hysteresis from region-II to III. In the plateau (region-II), we observe a dynamic stress fluctuations, exhibiting regular, periodic and quasiperiodic oscillations under the application of steady shear. The observed spatiotemporal dynamics in our experiments are close to those were predicted theoretically in sheared nematogenic fluids [2].

We study the rheological properties of NTB phase and compare the results with those of an ordinary SmA phase**.** Our results show that the structural rheology of NTB phase is strikingly similar to that of the ordinary smectic LCs. Analysing the shear response and adapting a simplied physical model for rheology of defect mediated lamellar systems we measure the pseudolayer compression elastic constant ($B_{eff}$) of NTB phase from the measurements of dynamic modulus G*(ω) [3, 4] **Fig(1(b)).** We find that $B_{eff}$ of the NTB phase increases with decreasing temperature as shown in **(Fig.1(c)),** and it follows a temperature dependence, $B_{eff} \sim (T_{TB} - T)^2$ as predicted by the recent coarse-grained elastic theory [5]. Thus our results provide a valuable test of the validity of the proposed theoretical models.This experiment also

offer new perspectives on NTB LCs and open unexplored aspects of the rheology of nematic LCs with nanoscale modulation of director.

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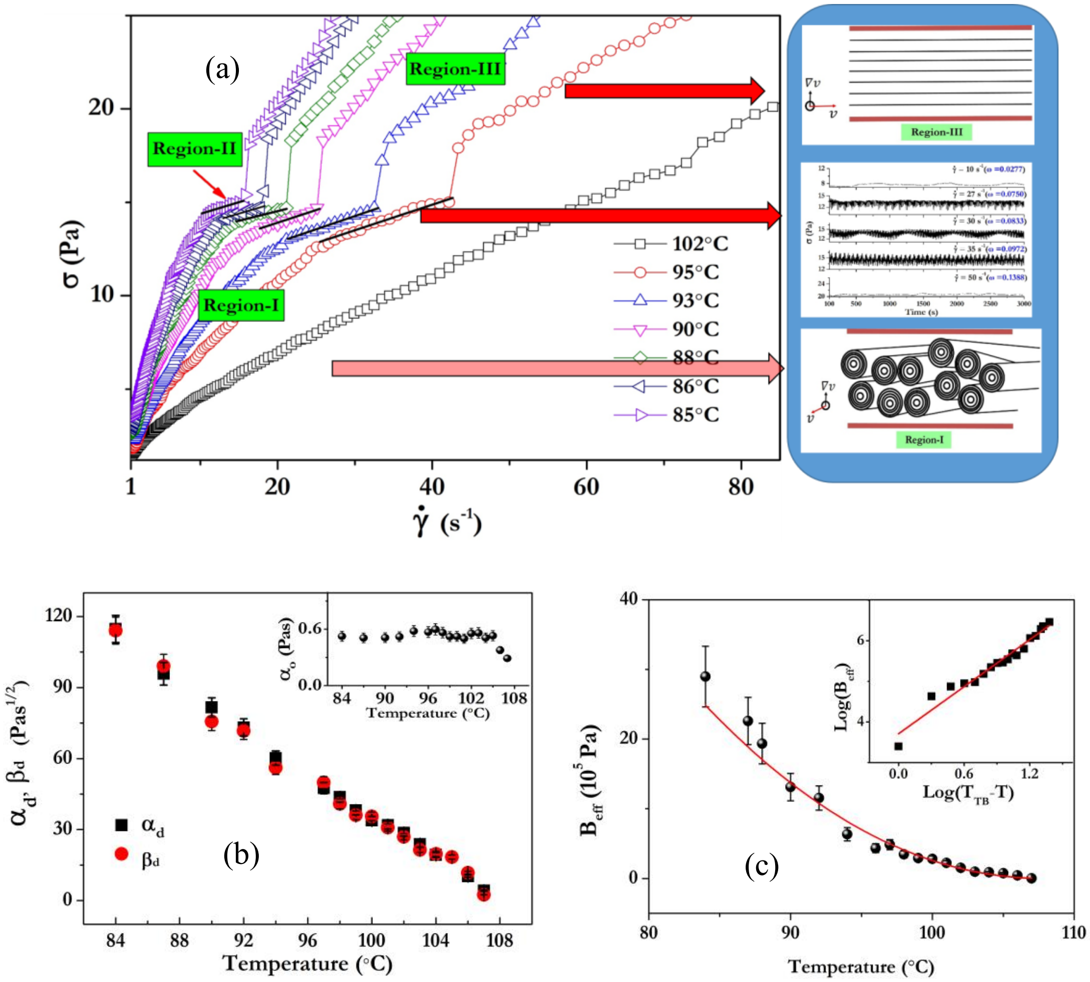


**Figure 1:** (a)The flow curve of NTB phase shows three distant regions (Region-1, Region-II, and region-III) and their corresponding schematic picture of layer alignment and dynamics (b) frequency dependent shear modulus is fitted to a simple theoretical model where the fitting parameters ($\alpha_d$ and $\beta_d$) with temperature inset $\alpha_0$ represents viscosity with respect to temperature (c) Temperature dependence of $B_{eff}$ inset the linear fit of of temperature dependence which agrees well with the coarse grain model of Dozov and Mayer [5] .

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