Stability, Dewetting and Texture of Liquid Crystal Thin Films

Palash Dhara

Roll Number: 13CH91R04

Key words: Liquid Crystal, Thin films, Texture, Phase Transition, Dewetting

Abstract:

This thesis deals with fundamental and critical issues on stability and spontaneous instability of the Liquid Crystal (LC) thin films. Spin coating with a dilute solution of casting material may result in spontaneous rupturing of the solution layer, which leads to the in-situ dewetting during the spin coating itself. The in-situ spin dewetting is a very rapid and ultra-fast process and can be very useful to fabricate nano or mesoscale structures of 5CB LC at nematic state itself. In chapter 2, the morphological transition from spin dewetted droplets to the continuous film by changing the concentration (C_n) of 5CB solution on flat and topographically patterned substrates has been reported. Interestingly, periodicity (λ_D) and diameter (d_D) of the spin dewetted droplets gradually decrease with increasing C_n till the formation of the continuous film above the critical concentration ($C_n > C_n^*$). Alignment of droplets and brushes of continuous Schlieren texture is achieved on topographically patterned substrates. Thermally-induced phase transition from nematic (N) to isotropic (I) and I→N and dewetting of 5CB films on flat and topographically PMMA patterned substrates have been reported in the chapter 3. The as-cast textures and the dynamics of phase transition of 5CB films on the patterned substrates are strongly influenced by the underlying geometry of the substrates. Interestingly, while a reversible phase transition is observed for LC films coated on flat PMMA substrates, phase transition becomes irreversible on the patterned substrates. The stability and texture of LC films are strongly influenced by the molecular orientation or anchoring, which depends on the chemical and physical properties of the interface boundaries. In chapter 4, we report the influence of PMMA substrates properties on the texture, phase transition, and dewetting dynamics of LC thin films. UV-Ozone (UVO) exposure on PMMA substrates generates oxygen containing polar functional groups which enhance surface energy as well as wettability for 5CB on it. The consequence of that spin dewetting is suppressed and stability of the 5CB film is seen to be enhanced against the thermal dewetting on the modified substrates. The texture of LC films gradually changes on modified PMMA substrates as a function of UVO exposure time (t_E). In chapter 5, morphological evolution during phase separation and thermal annealing of an incompatible blend thin film of Poly(styrene) (PS) and 5CB have been encountered on flat and topographically patterned substrates. Interestingly, thermally dewetted droplets of PDLC form core-shell like morphology with PS rich phase at the core and 5CB rich domains accumulate at the periphery. While random phase-separated domains are obtained on flat substrates, aligned and alternate PS and 5CB domains are formed by guiding the phase separation process on topographically patterned substrates. In chapter 6, AFM tip-based nanolithography technique has been explored to fabricate arrays of periodic defect domains of 8CB (smectic liquid crystal) by surface modification of the film during the tapping mode of scanning. Significant miniaturization in size and physical alignment of defect domains are achieved on the 8CB films coated on the topographically patterned substrates. Finally, summary and future scope of works of the present research have been highlighted in chapter 7.