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Research Article

ALIGNMENT OF LIQUID CRYSTALSON LB FILMS OF STEARIC ACID

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ABSTRACT

We formed the Langmuir monolayer of stearic acid at the air-water (A-W) interface. The Langmuir-Blodgett (LB) films were deposited on solid substrates at different surface pressures. The liquid crystal cells were prepared over such LB films. We found that these cells exhibit a tendency to align in planar orientation for the liquid crystal. We found that the liquid crystal alignment improves in cells prepared with substrates deposited at higher surface pressure like 25mN/m. We present the results on the liquid crystal alignment as a function of number of layers of LB films deposited on the substrates at various surface pressures. We propose that LB films of stearic acid can be used as an aligning agent for liquid crystals.

INTRODUCTION

Liquid crystal displays play a major role in the display based electronic devices. Liquid crystals are orientationally ordered fluids whose average direction of orientation can be manipulated with application of electric and magnetic fields(De Gennes,1993; Chandrasekhar,1992). However to obtain a uniformly oriented liquid crystal displays, the substrates are generally pretreated with some polymide and unidirectionally rubbed (Bahadur, 1990) Most often the shelf life of these polymides is less than a year and their curing temperatures are very high ~250^{o}C. For applications based on substrates which cannot withstand such high temperatures one needs aligning agents which can be cured at low temperatures. Stearic acid because of its bifunctional character, with a polar head group that can be attached to metal cations and a nonpolar chain that confers solubility in organic solvents. The stearic acid forms a stable Langmuir monolayer at the air-water (AW) interface (Gaines,1966; Gupta RK, 2012).We have formed the Langmuir monolayer of stearic acid at AW interface and formed the Langmuir-Blodgett (LB)films to the solid substrates at various target surface pressures. We have observed the liquid crystal cells made out of such substrates exhibit the tendency towards planar alignment of liquid crystals. Liquid crystal cells exhibiting uniform orientational alignment over large areas are required in most deviceapplications.

MATERIALS AND METHODS

A solution of stearic acid (Sigma-Aldrich) in HPLC grade chlorofromof concentration 1mg/ml was prepared. The solution of stearic acid was spread using a micro syringe (Hamilton) on the Millipore Milli-Q water having resistivity ≥18.2 MΩ-cm.The LB technique was employed to transfer monolayer and multilayers of the stearic acid onto hydrophilic substrates at different target surface pressures. The hydrophilic (HPL) substrates were prepared by boiling the microscopic glass slides in piranha solution (3:1, conc. H_2SO_4: H_2O_2) for 15 minutes and rinsed successively with Millipore water, absolute alcohol and acetone solvents. The substrates were then dried by blowing hot air at 70ºC. The glass substrates were immersed in the sub phase (water) prior to spreading the solution. The monolayer is gradually compressed using the moveable barrier to reduce the area per molecule. The target pressure of the LB film deposited was 5mN/m, 15mN/m & 25mN/m. After obtaining the target pressure, the monolayer was equilibrated for about 5-10 min. Different number of layers (5, 10 15 and 25) of stearic acid was transferred. Surface pressure- area per molecule (π-A) isotherm was obtained by compressing the monolayer at the A-W interface in a Langmuir trough (LB2004DC, Apex Instruments). The compression speed was maintained at 20 mm/min. Liquid crystal cells were prepared using such substrates deposited with LB films fabricated under the above mentioned conditions. Two substrates that are coated simultaneously with same number of layers at a given surface pressure are placed one above the other in such a manner that their deposition directions remain parallel to each other. Cells with thickness spacer ~5 μm are prepared

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and cured at ~70 C. A nematic liquid crystal at room temperature is filled in these cells through capillary action. Such liquid crystal filled cells are observed under a polarizing optical microscope (OLYMPUS BX51). Due to the birefringence of liquid crystals, in the planar cells, where the molecules lie parallel to the plane of the polarizer, exhibit colored texture and the appearance of the sample changes as the sample is rotated between crossed polarizers. On the other hand, the homeotropic state, where the long axes of the liquid crystal molecules are oriented perpendicular to the planes of the polarizer, looks uniformly dark. We have captured the images of the LC cells prepared using different surface pressures and various number of layers.

RESULTS

The surface pressure –area per molecule isotherm of stearic acid at AW interface is shown in Figure 1. The monolayer exhibits gas, liquid expanded and liquid condensed phase.

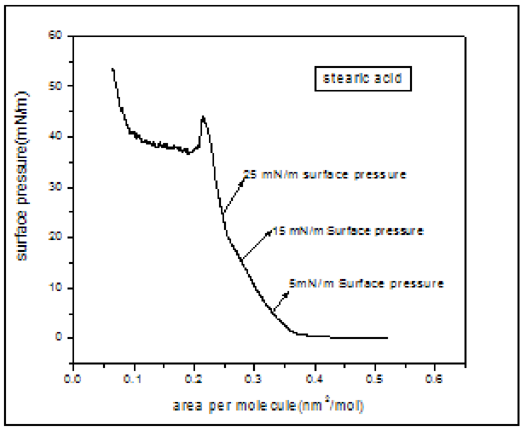

Figure 1: Surface pressure – area per molecule isotherm of stearic acid monolayer at the air-water interface. The LB films were deposited on substrates at the target surface pressure 5mN/m, 15mN/m & 25mN/M (indicated by the arrows)

The LB films weredeposited at5mN/m,15mN/m and 25mN/ m. The liquid crystal cells prepared using such LB films shows interesting results. We obtained a homeotropic alignment of the liquid crystals when the cell was prepared using the 5 layers of LB films deposited ata surface pressure of 5mN/m (Figure 2(a)).With increasing number of layers (*i.e.*10, 15, and 20)at 5 mN/m, the liquid crystal molecules tend towards planar alignment (Figures 2(b)-2(d)).The liquid crystal cells prepared over LB films deposited atsurface pressures 15mN/m and 25mN/m with increase in number of layers shows a better tendency towards planar alignment (Figures 3 & 4). The area of the monodomains liquid crystal sample appears to be increasing with increasing in target surface pressure.

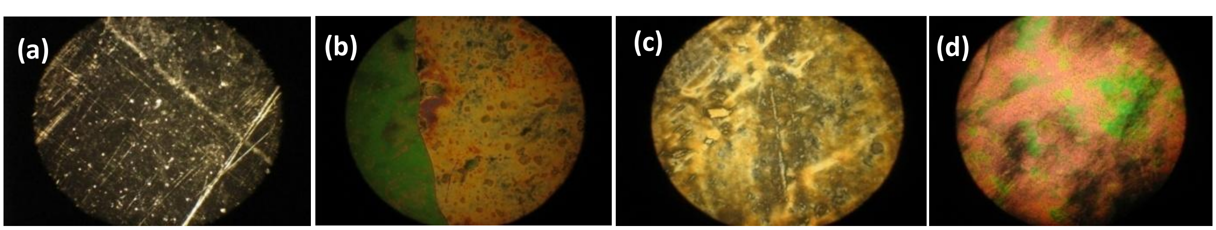

Figure 2: Photo micrograph of liquid crystal cell prepared using substrates deposited at surface pressure of 5mN/m. (a) 5 layers (b) 10 layers (c) 15 layers (d) 20 layers. Liquid crystal cells are between crossed polarizer's

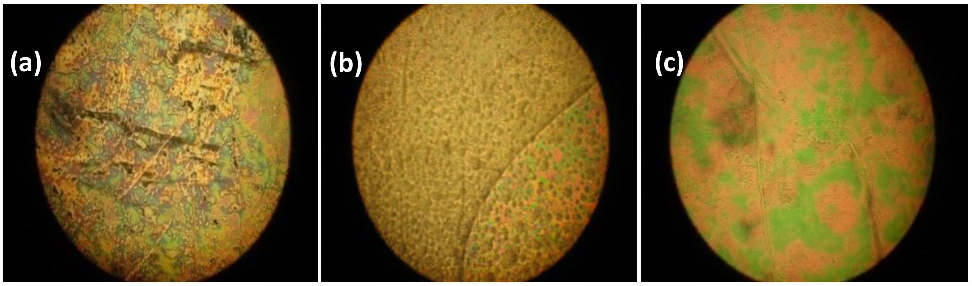

Figure 3: Photo micrograph of liquid crystal cell prepared using substrates deposited at surface pressure of 15mN/m. (a) 5 layers (b) 10 layers (c) 20 layers. Liquid crystal cells are between crossed polarizers

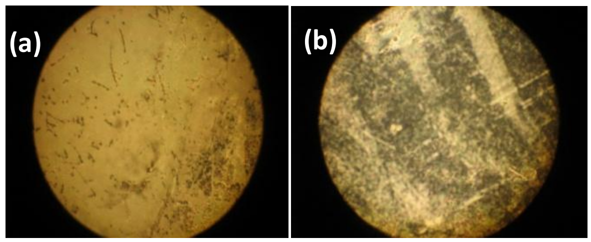

Figure 4: Photo micrograph of liquid crystal cell prepared using substrates deposited at surface pressure of 25mN/m; 10 layers. Liquid crystal cells are between crossed polarizers. (a) with direction of deposition at an angle of 30 with respect to the polarizer (b) with direction of deposition parallel to the polarizer

Hence, we propose the stearic acid layers deposited at substrate can be used as aligning agent in fabricating liquid crystal cells. This method will be useful for substrates which cannot with stand high temperatures.

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