Molecular Crystals and Liquid Crystals
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl16

Observation of the Crystalline Nature of LB Monolayers of ω-Tricosenoic Acid

J. Staromlynska [a] , F. C. Saunders [a] , K. J. Harrison [a] & D. Tandy [a]
[a] Royal Signals and Radar Establishment, St Andrews Road, Great Malvern, Worcestershire
Version of record first published: 20 Apr 2011.

Mol. Cryst. Liq. Cryst. Vol. 102 (Letters), pp. 175-180
0140-6566/84/1026-0175$15.00/0

OBSERVATION OF THE CRYSTALLINE NATURE OF LB MONOLAYERS OF ω-TRICOSENOIC ACID

J. STAROMLYNSKA, F.C. SAUNDERS, K.J. HARRISON
AND D. TANDY
Royal Signals and Radar Establishment,
St Andrews Road, Great Malvern, Worcestershire

(Received for Publication August 1, 1984)

Some preliminary studies of monolayers of ω-acid using the liquid crystal characterisation technique have been carried out. Observations have revealed a crystalline nature to the films with the size of the crystalline domains varying between approximately 30 and 100 microns. In addition these crystallites were seen to form well defined patterns which are reminiscent of flow. Photographs are presented which illustrate these features.

INTRODUCTION

Past studies have indicated that Langmuir-Blodgett (LB) films are composed of crystalline regions or domains[1-4]. This crystallinity of the films has been probed by utilising the method of epitaxial growth[5] where it is thought that the structure of the initial layer can be extended to as great a thickness as required for any given characterisation technique. Using this growth method films have been produced for study by electron diffraction[5] and the first optical record of crystalline domains has been made on films of ω-tricosenoic acid approximately 100 layers thick[6]. To date there has been no direct observation of crystalline domains in a 1 layer LB film. In this letter we present some preliminary studies of monolayers of ω-acid using the previously reported liquid crystal imaging technique[7]. Two main features of the work are described - the observation of crystalline regions within the monolayer and the effect of substrate contamination upon film deposition.

EXPERIMENTAL

The LB films were deposited in a trough of the constant perimeter type under clean room conditions. The subphase water was passed through a deionisation system containing an activated carbon cartridge to remove organic contaminants and a 0.22 micron filter to remove dust.

The substrates for deposition were commercially available Indium Tin Oxide coated glass of resistivity 10-20 ohms/□ supplied by EEV Chelmsford, Essex. After cutting to a size of 75 mm by 12 mm the substrates were subjected to a rigorous cleaning procedure as outlined in a former publication[7].

Solutions of ω-acid were made up to a concentration of 0.2 $mgml^{-1}$ in Aristar grade chloroform and were spread on to the subphase using an all-glass syringe through a PTFE filter. The glass syringe and millipore were washed in chloroform before each use and the PTFE filter was changed regularly. After a 1 minute time lapse to allow for solvent evaporation the monolayers were compressed at $\sim 0.2 Å^2$ $molecule^{-1}$ sec^{-1} to a pressure of 30 dynes cm^{-1}. The substrates were immersed in the subphase before spreading and the monolayer was transferred on the upward movement of the substrate. The drawing speed was approximately 3 mm min^{-1}. All films were pulled within an hour of spreading the monolayer.

Examination of the samples using the liquid crystal was achieved by making the substrate supporting the film one of the plates of a liquid crystal cell as outlined previously[7]. The other plate of the cell was a glass slide treated with lecithin or a chrome complex to give homeotropic alignment at its surface. The liquid crystal used was E7 available from BDH Chemicals of Poole, Dorset. The samples were viewed in transmission between crossed polars using a Nikon Optiphot polarising microscope.

RESULTS

Examination of the monolayers at a low magnification revealed two main features: (1) the area of film close to the meniscus mark was generally of a poor quality, this being in agreement with our earlier observations and (2) the monolayer of ω-acid induced a uniform near homeotropic alignment of the liquid crystal. Superimposed on this homeotropic alignment was some background structure of a crystalline nature which seemed to follow a flow pattern ie the crystallites tended to be elongated in one direction. Figure 1 illustrates the uniform near homeotropic alignment with the background structure. Figure 2 is at an increased magnification and highlights the crystalline character of the film. The size of the crystalline like regions were variable ranging between $\sim$ 30 and 100 microns. The 'direction of flow' of the patterns tended to vary from sample to sample and also across the area of the film with the most common direction being parallel to the direction of pull. Within one sample and again from sample to sample the background structure changed character in that it appeared to be more pronounced in some cases than in others eg the structure is more pronounced in the sample of Figure 3 than the sample of Figure 2. The dark line at the top of the picture of Figure 3 is a scratch in the film.

Also present, but to a lesser degree, are features of approximately 1-10 microns in size which we previously christened 'crystallites'. These appear as small birefringent areas (white specks in photographs) which cannot be dispersed by squeezing or shearing the liquid crystal cell. The origin of these features has not yet been conclusively established. Two possibilities are that they are defects in the monolayer, or are small pinning sites for the liquid crystal arising from surface contamination of the film itself.

Figure 4 is a photograph of some surface contamination at the edge of the ITO coated glass prior to deposition of the LB film. Again the crystalline nature of the monolayer is apparent. The 'flow pattern' of the structure is also quite distinct and can be seen to contour the contamination. This contouring behaviour proved to be a general occurrence and was observed in several samples.

Work is continuing at RSRE to investigate the dependence of the crystalline nature on transfer parameters and type of substrate.

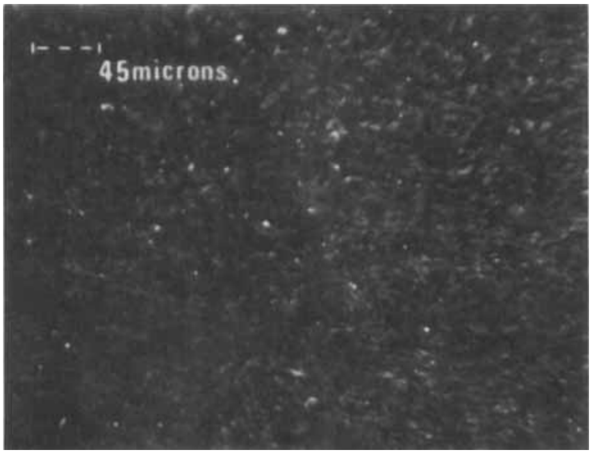

FIGURE 1 Photograph showing near homeotropic alignment plus background structure

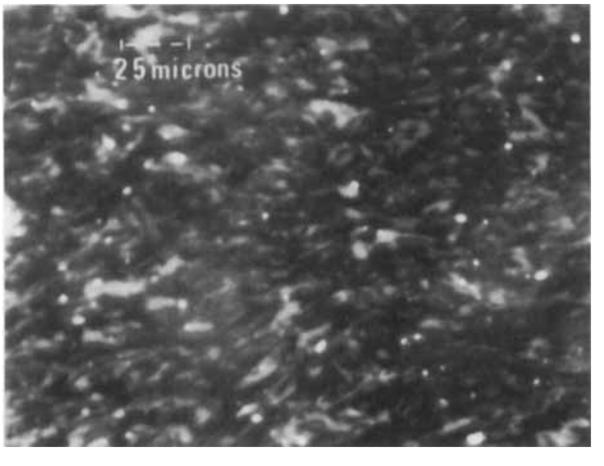

FIGURE 2 Increased magnification of FIGURE 1 highlighting crystalline nature of monolayer

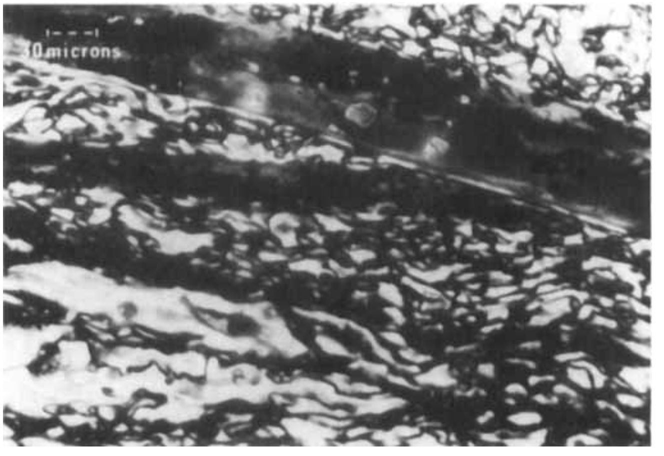

FIGURE 3 Photograph showing pronounced crystallinity plus a scratch in the film

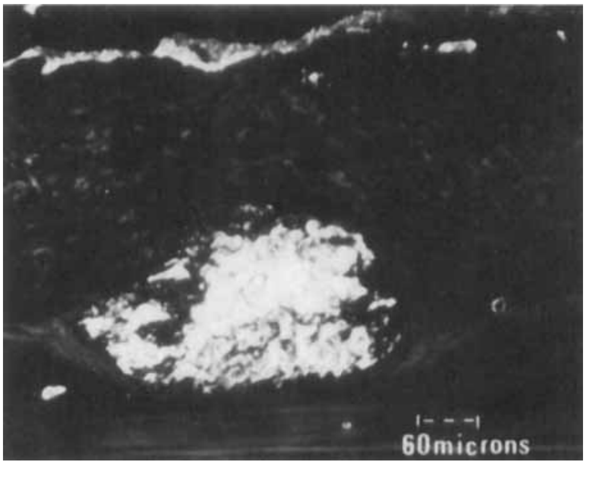

FIGURE 4 Illustration of 'contouring' behaviour round surface contamination

REFERENCES

1. G.L. Clark and P.W. Leppla, J. Am. Chem. Soc., 58, 2199 (1936).

2. D.L. Allara and J.D. Swalen, J. Phys. Chem., 86, 2700 (1982).

3. D.L. Germer and K.H. Storks, J. Chem. Phys., 6, 280 (1938).

4. G. Lieser, B. Tieke and G. Wegner, Thin Solid Films, 68, 77 (1980).

5. I.R. Peterson, G.J. Russell and G.G. Roberts, Thin Solid Films, 109 (1983).

6. I.R. Peterson, Thin Solid Films, to be published.

7. J. Staromlynska, F.C. Saunders and G.W. Smith, Mol. Cryst. and Liq. Cryst., to be published.