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Review

Experimental results and theoretical model to describe angular dependence of light scattering by monolayer of nematic droplets

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ABSTRACT

Light scattering by a monolayer of bipolar nematic droplets encapsulated in polymer film is examined both experimentally and theoretically. A method for the simulation of the angular distribution of scattered light is based on the anomalous diffraction and interference approximations taking into account the director configuration within liquid crystal droplets and their bipolar axes orientation. The director configuration in nematic droplets is calculated using the relaxation method of the free energy minimization. The characteristics of the sample, including distribution of droplet sizes and shape anisometry, are measured in details. The experimental results and theoretical data agree closely with each other.

Contents

1. Introduction

The ensemble of optically anisotropic particles is not a trivial object for the evaluation of its light scattering characteristics [1]. This issue becomes even more complicated if to consider liquid crystal (LC) droplets [2–7], for example, polymer-dispersed liquid crystal (PDLC) films because orientation structure within the droplets is commonly inhomogeneous. Configuration of LC director (a unit vector **n** characterizing preferred molecular orientation for a local volume in a droplet) can be rather complicated [2,3,7]. Consecutive development of special simulation techniques by many

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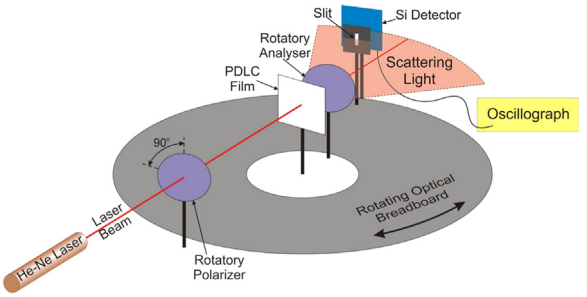

Fig. 1. Scheme of the setup to measure intensity of scattered light.

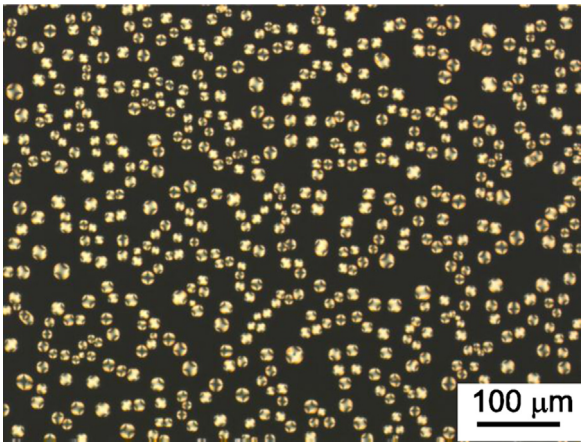

Fig. 2. Microphotograph of the film in the crossed polarizers. The size of the area is 700×520 μm. Polarizers (they are not shown) are oriented along the photo edges.

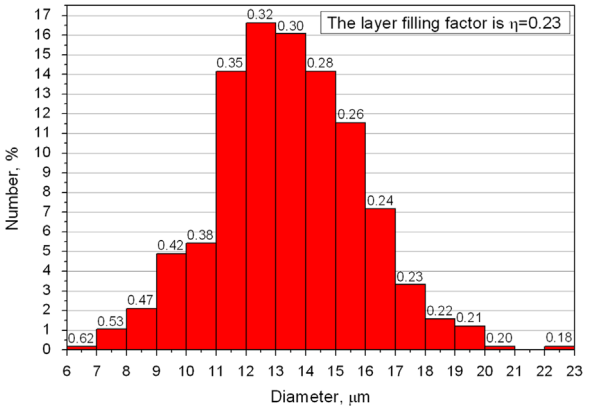

Fig. 3. Distribution of droplet diameters in the film plane. The axes ratios of droplets are indicated above the columns.

research groups (see, for instance, the lists of some of them in [6,7]) allows now calculating adequately the light scattering pictures for actual LC dispersions.

In this paper, we perform comparison of the theoretical estimations and experimental data on angular distribution of light scattered by a PDLC film with monolayer of bipolar nematic droplets. This theoretical approach takes into account distributions of droplet in size and shape anisotropy, orientation of droplets, and director configuration in

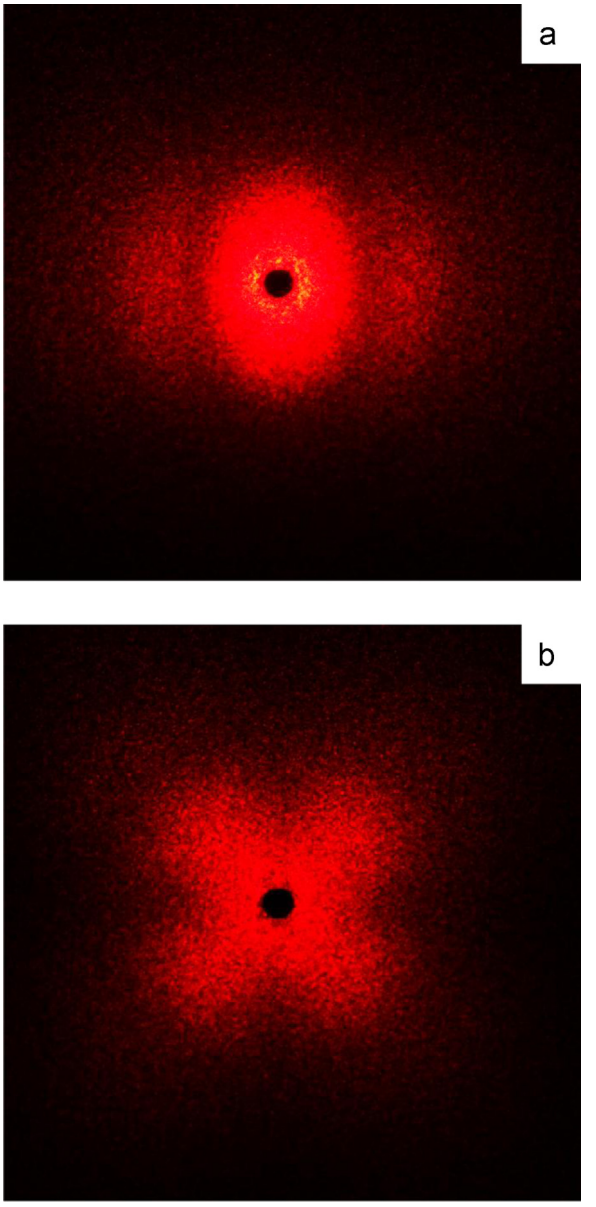

Fig. 4. Photographs of scattering patterns for geometry of parallel (a) and crossed (b) polarizer and analyzer. The laser beam passing straightforward is shaded. Exposure time for the crossed polarizers is more than that for the parallel ones.

LC droplets. The last is calculated using the relaxation method of the elastic energy minimization [2,3].

2. Materials and sample preparation

The samples have been made based on nematic liquid crystal 4-n-pentyl-4′-cyanobiphenyl (5CB) dispersed in polyvinylbutyral (PVB). Weight ratio of the components was 5CB: PVB=53:47. Solvent induced phase separation (SIPS) method using the ethyl alcohol as a common solvent was applied to prepare the samples. Heterogeneous films of polymer-dispersed liquid crystal were formed on the