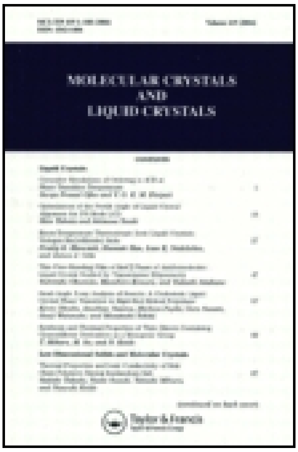

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A Simple Method to Prepare Polymer Dispersed Liquid Crystals

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A SIMPLE METHOD TO PREPARE POLYMER DISPERSED LIQUID CRYSTALS

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Abstract A simple method of dispersing nematics in poly (vinyl alcohol) and other polymers is presented. This method may be used for fundamental studies of different dispersed nematic materials.

Keywords: nematics, polymers, polymer-dispersed-liquid-crystal displays

INTRODUCTION

The polymer-dispersed-liquid-crystals (PDLC) have some interesting properties and they have been widely studied recently[1-5]. There are different methods of preparing these systems[6]. The aim of our studies was to obtain a simple method of PDLC preparing suitable for studies of physical properties of dispersed nematic liquid crystals. The method used for preparing thermosensitive displays containing cholesteric liquid crystals has been adopted[7].

EXPERIMENTAL

As the base polymeric material poly(vinyl alcohol)-PVA was preferably used but similar procedures can be used for the other polymers (water insoluble, either for instance poly(vinyl acetate or poly(acrylic) varnish). PVA with molecular mass about 60000-80000 and hydrolysis degree 85-90 (preferably PA-18 obtained from Shin-Etsu Chem.Co.and Winakol from POCh) has been dissolved in distilled water up to the concentration about 20 per cent by weight. To this solution the mixture of ethanol and acetone (5:1 vol.) has been added in equal volume. Then the curing (H_3BO_3 - 2-8% bw.) and in some cases plastification(sorbitole - 2-6% bw.) agents have been added. For the purpose of increasing elasticity of the obtained layers formaldehyde was added, which in presence of a mineral acid, e.g. H_3BO_3, converted PVA to poly (vinyl formate) partly and on the other hand decreased the viscosity of the solution which was convenient from point of view of subsequent procedures.

A nematic liquid crystal has been added to the above solution from 3 to 30 per cent by weight. Then the mixture has been mechanically homogeneized by the laboratory homogeneizer in a hermetic vessel which allowed to remove air (to prevent bubbling because air bubbles are difficult to remove from the colloid layer before total curing). The time of homogeneizing was from 60 to 300 sec. and the stirrer rotational speed was from 6000 to 15000 r.p.m. The suspension obtained in this way was deposited on a glass sheet with ITO conducting layer and polymeric spacers 12μm thick and 2 mm wide glued to the two parallel edges of a sheet. After 20 minutes at the temperature 60 centigrades and relative humidity 60 per cent the cover glass sheet with ITO layer was deposited on PVA layer which acted as a glue. The excess of PDLC was removed during a lamination process between two rollers. The thickness of the obtained cell was nearly equal to the distance thickness.

The obtained cells have been heated for 2 hours at the temperature of 80 centigrades. After this treatment the cell was ready to be studied.

The PVAc layers were prepared by the similar method from saturated ethanol solution of Movilite K-70 (obtained from Hoechst GmBH) without plastification however. As the nematic material the mixtures of cyclohexylphenylisothiocyanates were used, mainly hexylcyclohexylphenylisothiocyanate doped by (2-methyl)butylcyclohexylphenylisothiocyanate and Merck ZLI-2457 mixture.

The dispersions of nematics in polymeric materials have been studied with a microscope. It was found that the droplets of nematic had nearly spherical shape with diameter depending on solution viscosity and homogeneization time and velocity. For instance a mentioned PVA solution doped by 5% bw. of H_3BO_3 and 6% bw. of sorbitole had a diameter of the majority of droplets from 1-2 μm for homogeneization velocity 15000 r.p.m. to preferably 6-8 m for velocity 6000 r.p.m.

It is worth to mention that the obtained dispersions of studied nematics were much more time-stable than the cholesteric esters dispersions. For the 3 per cent bw. concentration of nematic the dispersion was stable for about a week without a sedimentation or a coalescence of the droplets.The details of these studies will be published separately[8].

The electrooptical response of the obtained layers has been studied. A sinusoidal external voltage with frequency 50 Hz has been applied. The measurements set-up was standard for LCD studies. All measurements were done for normal incidence of light beam. For the 12 μm thick PDLCD layers with droplets diameter 2-3 μm the threshold voltage was about 20 V. The transmission in on-state reached a saturation at about 45 V and the total response time was about 20 msec for the latter value. For layers thicker than 100 μm no electro-optical response has been observed for voltages up to 100 Volts. The optical contrast value was of order 10. The obtained cells were stable for a minimum of several months.

In the case of PVAc layers the electrooptical response has not been observed for voltages up to 100 Volts. It is probably due border conditions of nematic droplets which caused non-convenient molecular arrangement of liquid crystal in this polymer. This effect is probably caused by low elasticity of PVAc. The details oh these studies will be published elsewhere[8].

CONCLUSIONS

1. The proposed method is applicable to different polymeric materials and enables optical and electrooptical studies of dispersed nematics. It allows to study PDLC obtained in low-temperature conditions.

2. The main disadvantage of this method is time-consuming preparation of cells and for this reason it may be applied for fundamental studies only, for instance as standard method of LC material studies.

3. The properties of a film-forming polymer are a critical factor and may cause total collapse of electrooptical response.

4. The liquid crystal dispersion properties and so the electrooptical parameters of obtained PDLC depend on viscosity of the polymer solution, polymer-LC border conditions, and preparation parameters (velocity and time of stirring). By changing these factors one can effectively change the droplet diameter and electrooptical properties of PDLC.

5. A solvent used to obtain a polymer solution should not dissolve a liquid crystal mixture, because effect of this kind may introduce uncontrollable changes of colloid parameters.

6. For water soluble polymers the concentrated solutions give better results because water evaporation does not cause formation of a cured polymer layer on the top of a sample.

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