

Enhancement of pretilt angle using blending polyimide

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Abstract

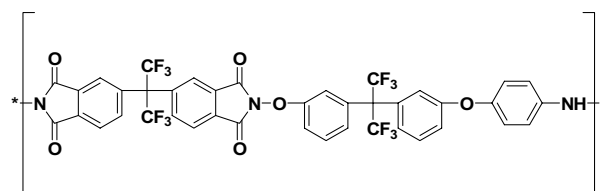
Photo-alignment layer which contains cinnamate is difficult to generate pretilt angle of liquid crystals. In order to enhance pretilt angle, blending poly (amic acid) between containing fluorine poly (amic acid) and 1,2,3,4-cyclobutanetetracarboxylic dianhydride (CBDA) / 3,5-diaminobenzyl alcohol (DBA) were used. For photoreaction, cinnamate was conjugated by interfacial reaction with blending polyimide

1. Introduction

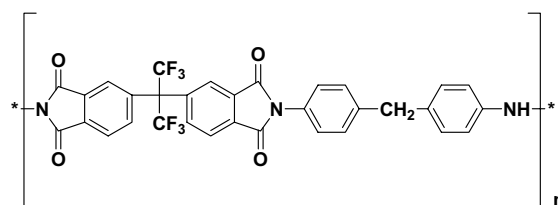
The successful operation of liquid crystal display (LCD) is required uniform alignment of liquid crystals (LCs). The surface alignment of LCs is one of the most important research subjects in manufacturing of LCDs. Rubbing method is the most effective method for uniform alignment of LCs. However, during rubbing on substrate which is coated alignment layer, some problems are occurred such as dust, static charge and scratches of the surface. In order to overcome those crucial problems, many alignment methods are appeared and studied. Photo-alignment method is the most prominent candidate to replace rubbing method due to defect free and simple process. Various photo-reactive materials were introduced and studied for photo-alignment methods [1-4]. The cinnamate moiety has a good potential ability for photo-alignment layer. But photo-alignment layer containing cinnamate moiety is hard to control pretilt angle [5]. Pretilt angle of LC alignment layer which is used cinnamate moiety was showed under the 1 degree. Low pretilt angle is brought about disclination. The pretilt angle is important parameter for image quality of LCDs [6-7]. Fluorine is helpful to generate the pretilt angle due to their low surface tension [7-8]. In this study, we have introduced blending poly (amic acid) between 4,4'-(hexafluoroisopropylidene)diphthalic anhydride (6FDA) / 2,2-bis[4-(4-aminophenoxy)phenyl] (HF-BAPP) and 1,2,3,4-cyclobutanetetracarboxylic dianhydride (CBDA) / 3,5-diaminobenzyl alcohol (DBA), 6FDA / 4-(4-aminobenzyl)benzeneamine (MDA) and CBDA / DBA. Photo reactive moiety was conjugated to alignment layer by interfacial reaction. Conjugation was demonstrated by change of surface polarity. The Fabry-Perot eliminated orthogonal polarization interferometric method is used to measure the pretilt angle.

2. Experimental

The molecular structures of two kinds of fluorine containing polyimide are shown in scheme 1.



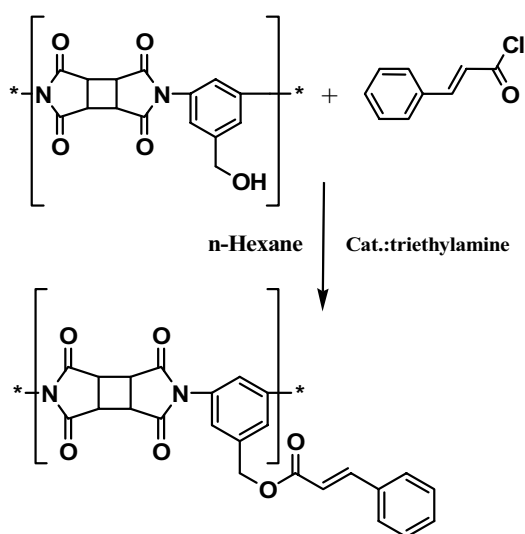
(a) 6FDA / HF-BAPP



(b) 6FDA / MDA

Scheme 1. The molecular structure of fluorine containing polyimide (a) 4,4'-(hexafluoroisopropylidene)diphthalic anhydride (6FDA) / 2,2-bis[4-(4-aminophenoxy)phenyl] (HF-BAPP) (b) 6FDA / 4-(4-aminobenzyl)benzeneamine (MDA)

These fluorinated polyimides were obtained from KRICT and blended with CBDA / DBA. The blending polyamic acid was coated on indium-tin-oxide (ITO) coated glass substrate with spin coater (MIDAS Model spin1200D). The polyamic acid film was pre-baked on temperature-controlled hot plate at 70°C for 10min. And then the substrates were hard-baked in the oven at 230°C for 30 minutes to convert polyamic acid to polyimide. In order to conjugate photo-reactive moiety, cinnamoylchloride was reacted with surface of polyimide film. Scheme 2 shows the synthesis route of CBDA / 3,5-diaminobenzyl cinnamate (DBC).



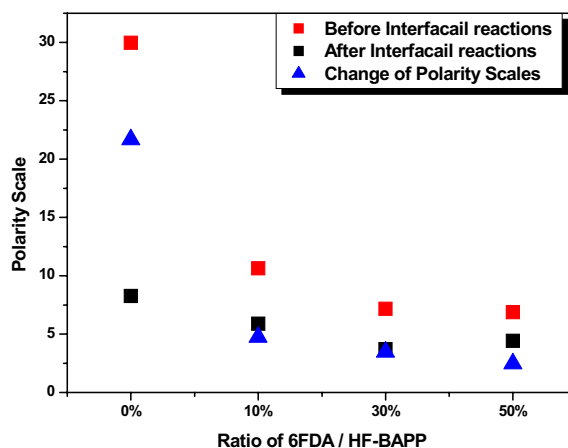
Scheme 2. Synthesis route of CBDA / DBC from CBDA / DBA

Surface polarity of alignment layer was calculated by measuring contact angle. Linear UV light was irradiated for 20min by 200W super pressure short arc mercury lamp. The liquid crystal was obtained from Merck (E-7 TN liquid crystal), and used as it was. The pretilt angle of LC cell was measured by Fabry-Perot eliminated orthogonal polarization interferometric method using Sesimlcd PAMS-200. The microimage of LC cell was shown Nikon ECLIPSE E600 POL.

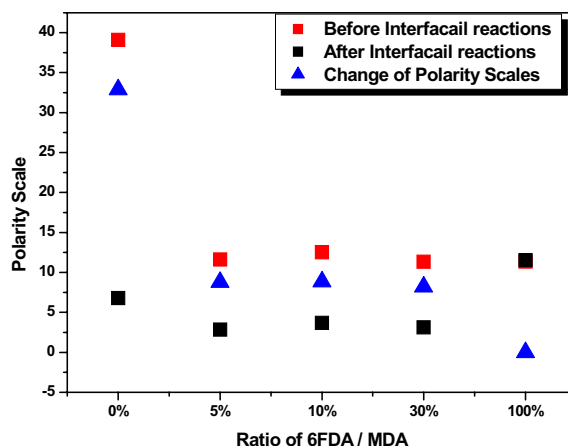
3. Results and discussion

Surface polarity of blended PIs coated substrates were measured and calculated. Figure 1 show the surface polarity and change of surface polarity between before and after interfacial reaction. The surface polarity was quite decreased as add fluorinated polyimide. This suggests that adding

fluorine can generate different interaction. The change of surface polarity can demonstrate that cinnamate moiety was attached on the surface of the CBDA / DBA by reaction with chloride and O-H.




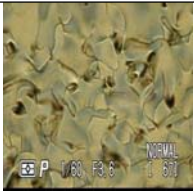
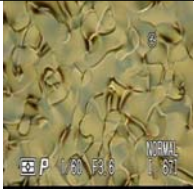
(a)



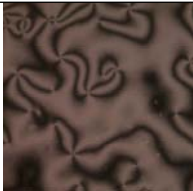

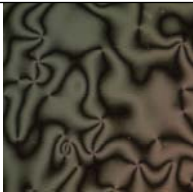
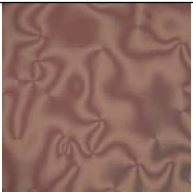
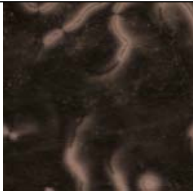
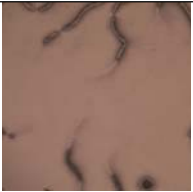
(b)

Figure 1. The surface polarity calculated from contact angle, (a) CBDA / DBA and 6FDA / HF-BAPP, (b) CBDA / DBA and 6FDA / MDA

Figure 2 shows the microscopy images of the parallel LC cell coated with different ratio of 6FDA / HF-BAPP and 6FDA / MDA, respectively. The breakdown of LC alignment quality was clearly observed in using blended PIs. But, as shown figure 3, LC cell of using CBDA / DBA has good image quality and high pretilt angle about 7.2° in result of measuring pretilt angle.

Ratio of fluorinated PI	
1 wt%	
2 wt%	
5 wt%	

(a)

Ratio of fluorinated PI	Black	Gray
1 wt%		
2 wt%		
5 wt%		

(b)

Figure 2. The microscopic photographs of LC cell using blended PIs (a) CBDA / DBA and 6FDA / HF-BAPP, (b) CBDA / DBA and 6FDA / MDA

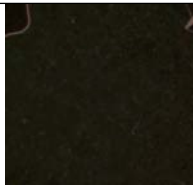
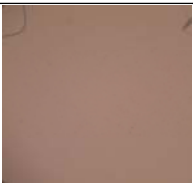
	Black	Gray
CBDA / DBA		

Figure 3. The microscopic photographs of LC cell using CBDA / DBA

4. Summary

The polyimide containing photo-reactive cinnamate as a side chain was synthesized by interfacial reaction. In the previous work, fluorine containing photo-alignment layer can generate pretilt angle from 0°C to 90°C [7-8]. But, in the blended photo-alignment layer, fluorine did not affect to enhance pretilt angle and has different interaction to LC comparison with cinnamate. In this study, we showed good LC alignment quality and high pretilt angle about 7.2°C using photo-alignment layer through the interfacial reaction. We hope our interfacial reaction can contribute to improvement of photo-alignment layer.

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5. References

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