The optimization of new alignment films in the TNLC for low image-sticking

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Abstract

We introduce a new copolymer alignment film made by bridge-building structure. It is a better film to decrease the image-sticking level in LCD displays. It is noted that the image-sticking was decreased by preventing ion mixing between inter-layers through high hardness. We have investigated the electrical characteristics such as pretilt angle, Residual DC, VHR by changing cure temperature and process delay time conditions of the new alignment film. In this paper, we have investigated the solution for the deep-rooted image defect and incidentally got a contrast ratio improvement by high anchoring force and hardness elevation through the new copolymer alignment film.

1. Introduction

Although mechanical rubbing process has many deep-rooted problems, rubbed polyimide films on substrate are widely used for aligning LC molecules along the rubbing direction with a certain pretilt angle in the fabrication of liquid crystal(LC) devices because it is short, simple LC alignment process, and can be applied to a large area at low cost[1]. Although the process is simple, it has large effects on the image quality and reliability of the LCDs. Unevenness in the rubbing process causes alignment defects. These defects harm the optical characteristics of the LCDs, because the LCDs use the light modulation phenomena that depend on the LC's alignment. Not only the rubbing itself, but also the alignment materials affect the quality of the LCD's. Polyimide films are still key factors directly controlling the arrangement of LC molecules to specific direction and has used the dominant material due to its stability and superior electric characteristics[2][3]. In addition to the alignment properties, the electrical characteristics of the alignment material that affect the image quality are important for display devices. The alignment materials for display products are selected by evaluating such electrical characteristics as the voltage holding ratio, the residual DC, image sticking time and common level shift. These electrical properties are seen in the flicker and image sticking characteristics of the LCD panels. It is commonly understood that residual DC has some relation with image sticking. The so-called image sticking or image retention of a long time addressed display area is a severe problem regarding the image quality in high information content active matrix displays[4].

RDC phenomenon can be explained with the interfacial polarization and electric potential by adsorbed ions on the LC-alignment layer interface.

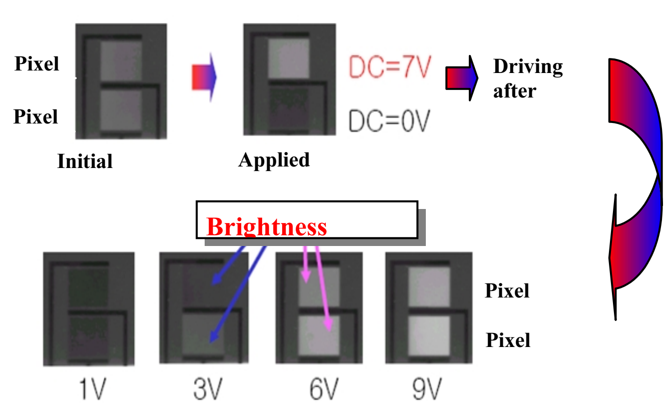


FIG.1. Image sticking display

FIG.1 shows that ion impurities in LCs or alignment films generate internal fields by interfacial polarization when applied DC voltage for long hours and then though it is applied OFF voltage it remains display image. So, we need new alignment film for image sticking prevention and low RDC.

In this paper, we will introduce the new copolymer alignment films made by bridge-building structure to decrease image-sticking problem and will introduce its physicochemical characteristics. Also theoretical analysis and experimental results are given in this paper.

2. Experimental configurations

New alignment films AL22620 is consisted of S.C 6.0%, Coefficient of viscosity 26mpa• s, layer hardness 2H(JIS-K5400), reflective index 1.62(633nm), permittivity 4.49(t:300nm), specific resistance $1.8x10^{14}$, solvent furtherance γ-BL(68), NMP(17), BC:15, surface energy 51dyn/cm, and water <1.0%, NA,K,Fe,Cu <0.5ppm.(By JSR CO.)

AL22620 is created by the compounds of polyamic acid and soluble polyimide. Polyamic acid(PA) is made of the polymerization of tetracarboxylic dianhydride and diamine compound and then from its imidization chemically by catalyst makes soluble polyimide (PI).

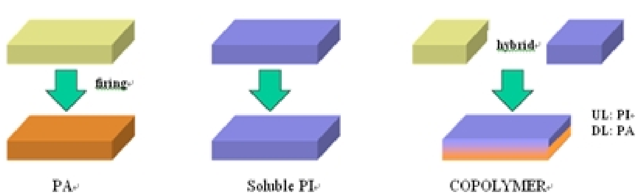


FIG.2 Hybridized Copolymer Platform

We initially approached to three assumptions about image-sticking generation factor. One is LCs(MDA-05-4157, MDA-05-4225) in itself and we supposed that there is image-sticking occurrence possibility by charge localization of high polar single by LCs in Voff. Another is ion impurities generating from alignment film(AL22620 by JSR, SE-7492 by Nissan). And the third is something of interaction between LCs and alignment films. We progressed LC split test of 4 classes whether any factor is the nearest cause.

FIG.3 shows the polar single of each LC and LC split test result. As shown in the Fig. 3(b), in image-sticking occurrence alignment film interrelationship is the main factor with liquid crystal test independently.

Furtherance and properties of matter data of two alignment films are the same as seen in a table.1. As table.1, AL-22620 was high alignment film density by bridge-building structure and it induced low image-sticking by preventing ion impurities mixing from lower layer through high film density and kept low Residual DC through ion injection prevention from LC layer.

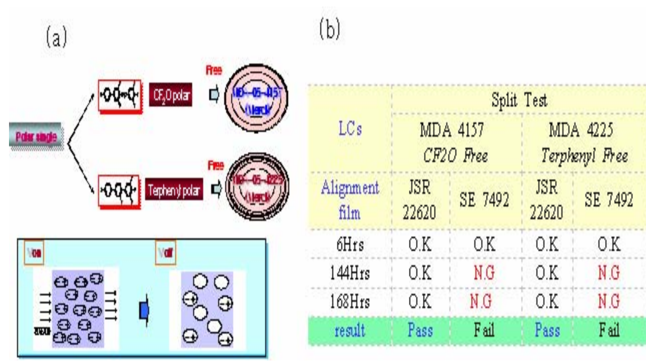


Fig. 3. 2 Polar single of each LC and LC split test

TABLE 1. Alignment film furtherance comparison

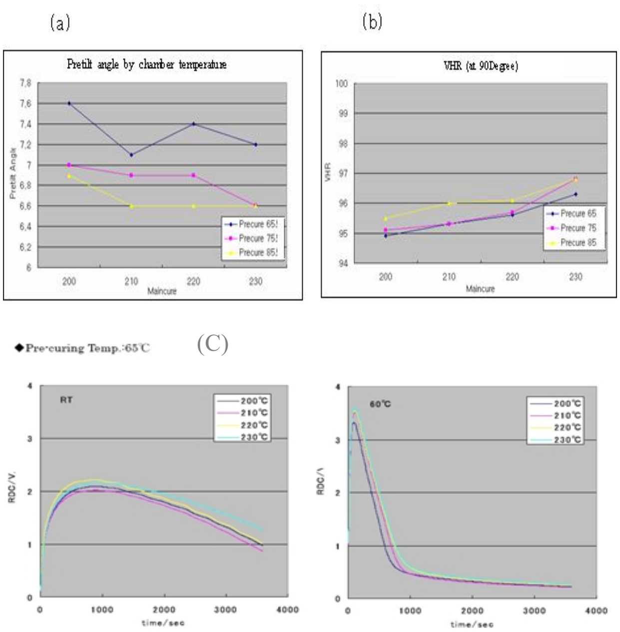
	SE-7492(Nissan)	AL-22620(JSR)
Concept	PI + PAA Blend	PI + PAA Copolymer Bridge-building structure
Molecular weight	18000*	30000*
Solid Content	5%, 6%	6%
Solvent Furtherance	BL(66)NMP(17)BC(12)*	BL(68)NMP(17)BC(15)*
Viscosity	24m Pas	26m Pas
Pretilt angle	3 - 5.5	3.5 - 6
Surface Energy	42.8 dyn/Cm * 48 dyn/Cm *	51 dyn/Cm *
Retractive index	1.62	1.62(633,600)
Permitivity	3.8	4.49(3.00)
Hardness	3H	2H

2-1. Pretilt angle, Residual DC, VHR by changing cure temperature

we measured the electrical characteristics about the new alignment film. Cure temperature was divided into precure and maincure for high imidization and hardening of alignment film. Precure temperature was measured dividing into each 65, 75, 85 degrees, and maincure temperature was measured dividing into 200, 210, 220, 230 degrees. As shown in the FIG.4 (a) when cure temperatue rises, tendency which pretilt angle decreases is seen. As shown in the FIG.4 (b) We measured VHRs by cure temperature on same conditions and knew that VHR rises as temperature rises. Finally, rising of cure temperature drives an increase of the imidization and VHR, but it decrease pretilt angle by deforming polyimide's backbone structure[5]. Also, in maincure temperature 230 degrees neighborhood polarity suddenly increases because molecular weight is decreased by side chain's dissolution.

Next, we measured Residual DC. We measured Relaxation time after applied each reverse polarity to Pattern (Black D.C 3V, White A.C) of D.C image-sticking area. As a result, D.C offset happened toward polarity direction that applied D.C. This means that D.C offset greatly happened as temperature is high about equal D.C voltage that applied, and we can presume that Image-sticking level difference by curing temperature is Residual DC offset difference.

In this way, the VHR, RDC is shown contradictory result in temperature. That is we can say that the most proper maincure temperature is required.



. Fig.4. Pretilt angle and VHR, Residual DC

2-2. Process delay time condition

We also tested how process delay time affects in image-sticking generation. We used the CHISSO liquid crystal and JSR-22620 alignment film. We divided maincure temperature by 200, 210, 220 degrees and each of test glasses assembled after holding until 5 hours after PI process. The result shows in FIG.5 and the degree of image-sticking can see that is serious as delay time is long. Y axis values of Fig.5 show degrees of after-image and as the figure is big, after-image is heavy.

Also, image-sticking is some profitable as manicure temperature is low, but have to consider the imidizaton rate and VHR and must keep maincure of proper temperature.

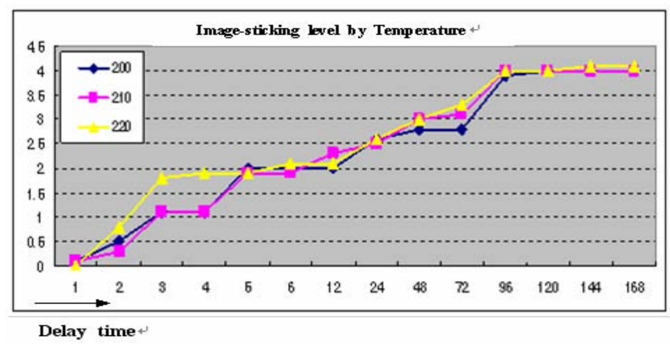


Fig.5. Image-sticking change by delay time

3. Results

FIG.6 shows the new copolymer alignment films made by bridge-building structure. The new copolymer alignment films made by bridge-building structure induced low image-sticking by preventing ion impurities mixing from lower layer through high film density and kept low Residual DC through ion injection prevention from LC layer.

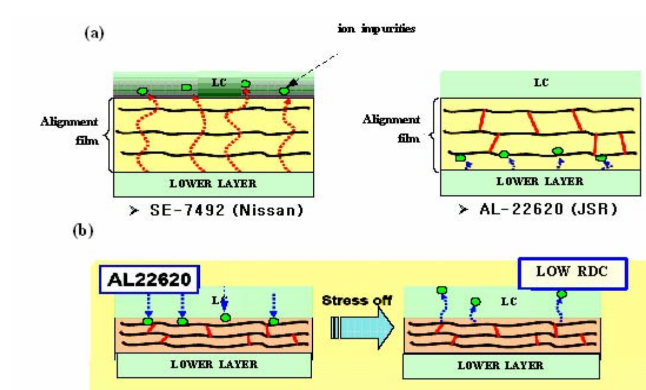


FIG.6. bridge-building structure

4.Conclusion

The mechanism of image-sticking generation has been studied for a long time, but it is not yet sufficiently understood in literature and is presuming that various kinds of factors have entangled. Such as adsorption and desorption phenomenon of charge by ion impurities of LCs or alignment film, pixel internal DC remains by TFT kick-back voltage, interaction between sealant of color filter and LCs.

One plain thing is that image-sticking is happening by difference of effective voltage that LCs react according to the applied voltage.

We investigated the pretilt angle, VHR, Residual DC by changing cure temperature and also correlation of Process delay time about alignment film. We want to obtain the high imidization, stable pretilt angle, high VHR, and low Residual DC in polyimde film. This is the optimized material for low image-sticking generation. So, we developed the new copolymer alignment films made by bridge-building structure. With result of above new alignment film of bridge-building structure that protect ion impurities is one important factor but, synthetic problems connected with image-sticking far complex. Addition study about this will be gone subsequentness.

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