

56.2: A New Production of the Large size TFT-panel by "LC-Dropping Method"

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Abstract

We have been manufacturing the STN-panel with an original "LC-Dropping method" from 1984. LC-Dropping method eliminates the hole (LC injection hole) which infuses LC in the cell. This paper presents the development of the "LC-Dropping method" in order to manufacture the large size TFT-panel. And we can reduce the injection time of the LC substantially.

1. Introduction

Recently, the demand for the large size TFT-panel for the monitor of the TV and PC is growing. In the conventional LC-Injection method, production time becomes long, if LC-panel size enlarges. This time, the LC-Dropping method is developed which we can produce in a short time without regard to panel size.

Figure 1 compares the LC-Dropping method with the conventional LC-Injection method. The process of the LC-Dropping method is; ①dropping LC on the substrate, ②aligning a pair of substrate in vacuum, ③hardening sealant with UV. The LC-Dropping method is able to shorten the production time of the LC-panel, because LC is filled in the panel before combining a pair of substrate. The LC-Dropping method is 5minutes for filling 22 inches TFT-panel with the LC. On the contrast the conventional LC-Injection method requires 20hours.

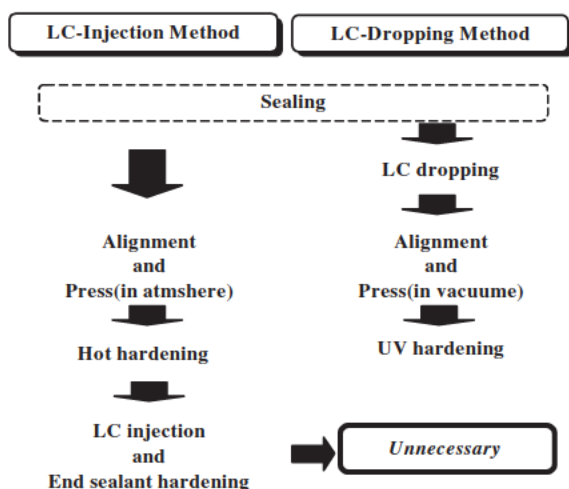


Figure 1. LC-Dropping method and LC-Injection method

In the LC-Dropping method, the sealant is hardened with UV after the LC was filled in the panel. Therefore, the LC contacts with unhardening sealant. In order to avoid the LC solving the

sealant, we selected the UV sealant which is able to harden in the short period at the low temperature.

The TFT-panel needs the higher voltage holding ratio than the STN-panel. When we produce the TFT-panel by the LC-Dropping method, we must care the voltage holding ratio. Because the voltage holding ratio is closely relation to the purity of the LC. As the purity is influenced by the LC degraded by the UV or the LC solves the sealant. In order to develop the LC-Dropping method into the large size TFT-panel from STN-panel, we improved the UV sealant and UV hardening process.

2. Subject

The voltage holding ratio influenced the characteristic of the TFT panel very much. If the voltage hold rate decreases, the contrast and flicker become worse.

The voltage hold rate is decided on the kind and the quantity of the ion in liquid crystal. In the LC-Dropping method, the kind and the quantity of the ion in liquid crystal demand on the component of the sealant, and the UV irradiation condition.

First, we examined the voltage holding ratio with the sealant which is used for the STN-panel. As a result, a sufficient voltage holding ratio was not obtained. We analyzed the LC of this panel, and the photoinitiator which is the component of the sealant was detected.

We examined the influence between solubility and voltage holding ratio about various kinds of the photoinitiators. And, we selected the most suitable photoinitiator for the LC-Dropping method.

2.1 Photoinitiator

We examined the solubility of the photoinitiator into the LC. In Table 1, we summarized the molecular weight and the melting point of the photoinitiators which I examined.

The kind of photoinitiator	Molecular weight	Melting point
acetophenon A	, QDS	, TO•
acetophenon B	, QW0	Liquid
benzoin A	, FV0	, TO•
benzoin B	, QIT	, W0•
benzoin C	, QW0	, LT•

Table 1. Molecular weight, and melting point of the photoinitiator

We mixed 5 kinds of the photoinitiators into the LC at 5wt%. Next, we filtered them after 10 minutes. We measured the

concentration of the photoinitiator in LC. Figure 2 shows the concentration of 5 kinds of the photoinitiators.

The solubility of the photoinitiator is not demanded on the kind, molecular weight, and the melting point. And we confirmed that the LC solved the all photoinitiators.

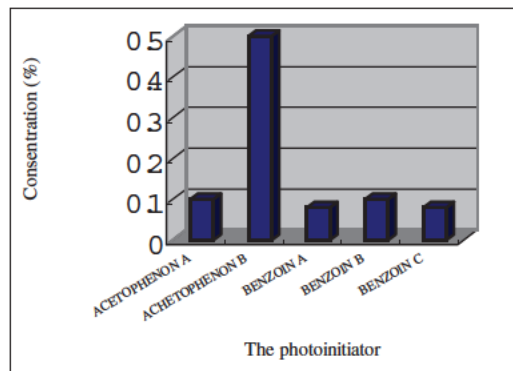


Figure 2. Solency of the photoinitiator

Next, we examined the influence of the photoinitiator about voltage hold rate. We measured the voltage hold rate of the LC which is melted the photoinitiator. Figure 3 shows the voltage hold rate of the LC which is melted the photoinitiator.

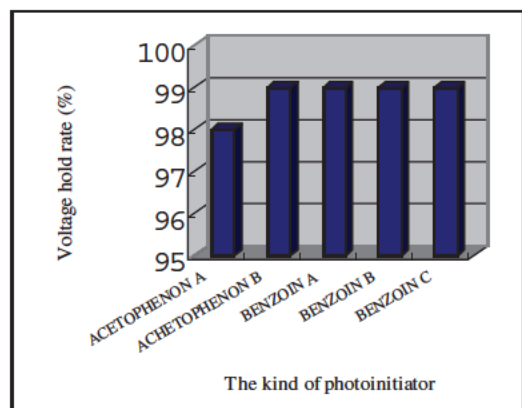


Figure 3. The voltage holding ratio of the LC which solves the photoinitiator

The photoinitiator does not influence the voltage holding ratio. We irradiated the UV to their LC-panels, and we measured the change of the voltage holding ratio. With the condition of UV, the wavelength range is above 310nm, and irradiation energy is 5000mJ/cm². We cut the wavelength under 310nm, because the LC absorbs the wavelength under 310nm. Figure 4 shows the changing ratio of the voltage holding ratio around the UV irradiation.

The voltage holding ratio of the LC which solved acetophenon type decreases around UV irradiation. We consider acetophenon type separates by UV. Especially, absorption of acetophenon type is larger than the other photoinitiator.

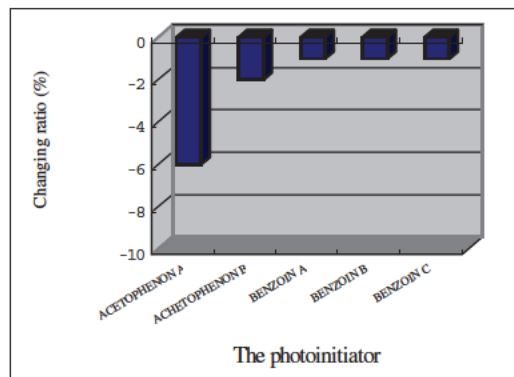


Figure 4. The changing ratio of the voltage holding ratio around UV irradiation

And, acetophenon type does not restore its original state. But benzoin type restores its original state, if benzoin type does not react some molecules in the LC. Figure 5 shows the photo reaction model of acetophenon type and benzoin type.

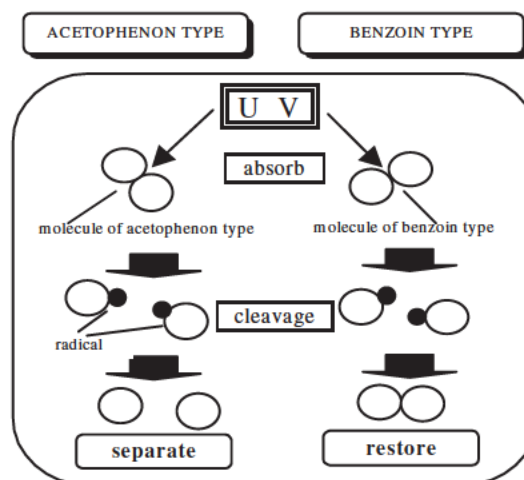


Figure 5. The photo reaction model of acetophenon type and benzoin type

The difference between acetophenon A-type and B-type is ionicity of the molecule. The voltage holding ratio of the LC which solved acetophenon A-type is worse than B-type, because ionicity of the acetophenon A-type is stronger than B-type.

Now, we confirmed that the photoinitiator of the benzoin type is better in order to produce the TFT-panel by the "LC-Dropping method".

2.2 UV hardening process

When the sealant is harenig by UV, the visible area is masked. But, UV is irradiated to the LC in order to leak from the mask. Figure 6 shows the model of the UV hardening process.

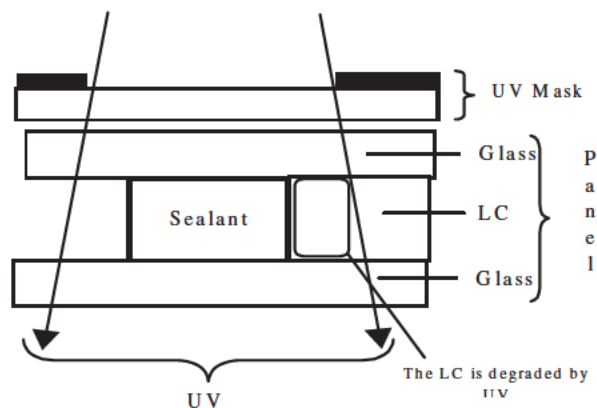


Figure 6. The model of the UV hardening process

We must cut the wavelength under 310nm in order to do not damage the LC. But the absorption wavelength range of the photoinitiator and the LC is same. The sealant is less than hardened by UV. If the sealant is not hardened enough polymerization, the quality of the LC-panel is down. Because some components of the sealant (origomer or monomer) is melted in the LC.

We experimented the photosensitizer in order to harden by the UV above 310nm. Figure 7 shows the absorption spectrum of the photoinitiator(benzoin type), the photosensitizer, and the LC.

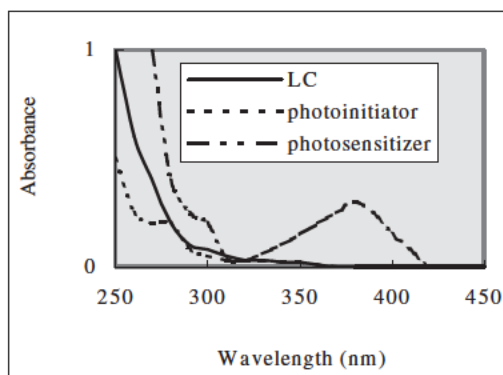


Figure 7. The absorption spectrum of the photoinitiator(benzoin type), the photosensitizer, and the LC

The absorption peak of the photosensitizer is 380nm. This time, we measured the degree of polymerization about 2 types of sealant. The sealant A concludes only the photoinitiator (benzoin type) and the photosensitizer, and the sealant B concludes the photoinitiator and the photosensitizer. The UV irradiation conditions are the illuminance is 20mw/cm², the sample temperature is about 40°C, and wavelength range is above 310nm. Figure 8 shows the degree of polymerization about 2 types of sealant.

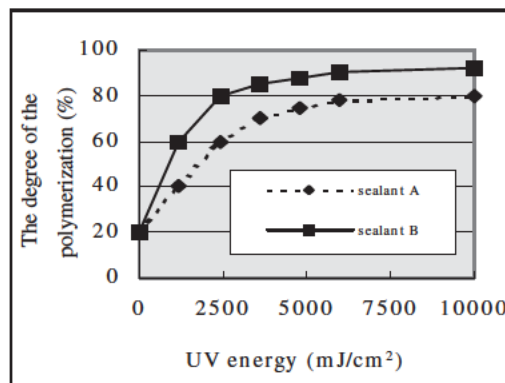


Figure 8. The degree of polymerization about 2 types of sealant

(The sealant A concludes only the photoinitiator (benzoin type), and the sealant B concludes the photoinitiator and the photosensitizer.)

The degree of the polymerization the both of the sealant A and B saturated above 6000mJ/cm². But the sealant B hardens better than the sealant A. And we confirmed the effect of the photosensitizer.

This time, we made the LC-panel with the sealant B by the LC-Dropping method. The UV irradiation conditions are the same as before. This LC-panel left for 100hours at 120 °C. And we measured the extraordinary orientation area of the LC, and the voltage holding ratio. Figure 9 shows the result.

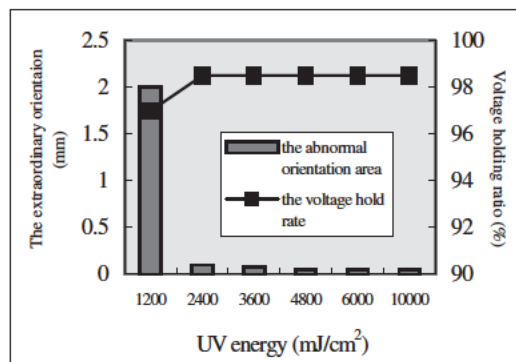


Figure 9. The extraordinary orientation area of the LC, and the voltage holding ratio about UV energy

We confirmed that the quality of the LC-panel is good if the degree of the polymerization is above 80%. If it is under 80%, the extraordinary orientation of the LC-molecule occurs, and the voltage holding ratio decreases in order to be solved the components of the sealant. If the sealant does not conclude the photosensitizer, we could not manufacture the TFT-panel.

3. Conclusion

We decided about the sealant composition. The characteristics of this sealant are

- (1) The photoinitiator is benzoin type.
- (2) The photosensitizer is concluded.

We manufactured 15 inches TFT-panel with this sealant by the LC-Dropping method. We could get uniformity and flicker-less TFT-panel.

Now, we are examining production of the "LC-Dropping method" for the large substrate. We confirmed 3 merits of the LC-Dropping method.

- (1) The LC can fill in the panel quick, and accurate.
- (2) The uniformity of the LC-panel gap stabilizes very much.

- (3) The accuracy of the alignment of the LC-panel is good.

From now on, the "LC-Dropping method" will need to produce various kinds of the TFT-panel, for example narrow gap (IPS), perpendicular orientation, and high quality.

4. References

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