Substrates Fastening Technique for Pixel Isolated Liquid Crystal mode

Ji-Hong Bae[1], Se-Jin Jang[1], Hong Choi[2], Sang-Il Kim[4] and Jae-Hoon Kim[1,2,3,*]

[1]Department of Information Display Engineering, Hanyang University,
[2]Research Institute of Information Display, Hanyang University,
[3]Deartment of Electronics and Computer Engineering, Hanyang University
17 Haengdang-Dong, Seongdong-Gu, Seoul, 133-791, Korea
[4]Samsung Electronics, LCD R&D Center, Yongin-City, Gyeonggi-Do, Korea

Abstract

To realize the flexible LCDs, the stabilized technique of cell-gap is an essential prerequisite with the mechanical reliability. The pixel-isolated liquid crystal (PILC) mode maximizes the stabilization of cell-gap against the external shocks and deformations. But, the utility of this structure is extremely limited because of the substrates bonding process. We propose the simple fastening substrates technique by using agarose based on PILC structure. Also, this technique has a deep potential for application of the roll-to-roll process for the flexible LCDs.

1. Introduction

In side of bonding process for the flexible LC display, the distortion phenomenon according to expanding of the size of substrate, the cohesion technology of pixel by pixel is certainly required instead of the exterior seal line. PILC mode [1] has the superior advantages against the problem of stabilization which is happened when soft substrate is used. But, the formation of the additional alignment layer is impossible because polymer layer is formed on the top substrate by using phase separated composite organic film (PSCOF) [2] that is the phase separation of liquid crystal and polymer to attach the two substrates. So, PILC structure is limited the LC optical mode if PSCOF method is used in bonding process. The micro contact method on the PILC structure induces the defects due to low viscosity of UV bonding polymer. From this reason, bonding polymer is not fixed on the polymer wall and inflows into the sub-pixels. So, this bonding method is impossible to use in the roll-to-roll process based on the liquid crystal dropping because it is not stable on reacting with LCs.

2. Experimental

We fabricated the micro-structure to keep the cell-gap on the substrate. The roll-to-roll process is useful to adopt LC dropping method. It is necessary to stabilize bonding polymer on the formed micro-structure and to control the viscosity freely. So we proposed to use agarose that has liquid and gel property according of temperature.

Fig. 1 shows schematically illustrate the proposed bonding technique by using the agarose based on micro-structure. Fig. 1(a) is the micro-contact process of the bonding material that is composites of agarose and UV epoxy. Fig. 1(b) shows the image of the characteristics that the proposed bonding layer doesn't react with LCs. Fig. 1(c) illustrates the bonding process after putting the top substrate. The stabilization of bonding layer against the external pressure and impact is the most important in this process.

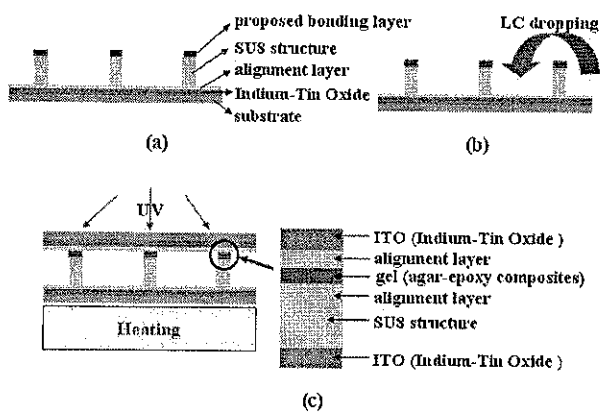


Figure 1. Schematic illustration for fabricating the flexible LCD: (a) the micro-contact process of proposed bonding material, (b) LC dropping process, (c) the bonding process by the condition of the temperature and the exposed time from ultraviolet.

The used agarose is high-gel-strength type (Gel point(1.5%): 36.0℃ ± 1.5℃, Remelt point(1.5%): 88.0℃ ± 1.5℃, Gel strength(1%) ≥ 1200gm/㎠, Gel strength(1.5%) ≥ 2500gm/㎠, Moisture ≤ 7%). SK-9 (SUMMER OPTICAL) is used by the bonding polymer. We added EDTA (ethylenediamime-tetraacetic) to the mixture of distilled water and agarose of powder pattern. The role of EDTA helps so that bonding polymer may be scattered well. The initial muddy mixture is changed by the clear state when this mixture boil until 150℃ after mixing the bonding polymer (SK-9). We coated by spin speed 6500rpm for 50sec on the glass (3 ㎝ by 3 ㎝) surface after the mixture cools until 60℃.

We transcribe by the micro-contact method the formed bonding layer on the glass surface to the top of the PILC structure. The bonding layer is existed by gel state in the top of stabilized structure. We covered a top substrate after dropping LCs. To attach two substrate, we set the temperature and the exposed time from ultraviolet (UV) in the condition that is considered the remelting temperature of agarose.

3. Results and Discussion

We observed that the transcribed bonding layer to the top of PILC structure is very uniform and clear. After dropping LCs, the bonding layer doesn't react with LCs. And, the remainder polymer doesn't exist into the pixel because the bonding layer keeps to the gel state. Fig. 2 shows the microscopic images of the fabricated ECB sample by the proposed bonding material. It shows the normal driving that is not influenced to bonding polymer. Fig. 3 shows the attached result of two substrates with Field Emission Scanning Electron Microscope.

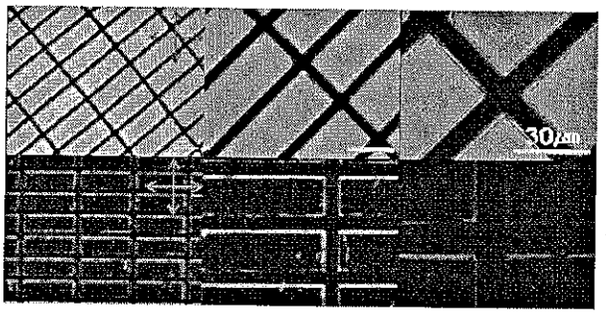
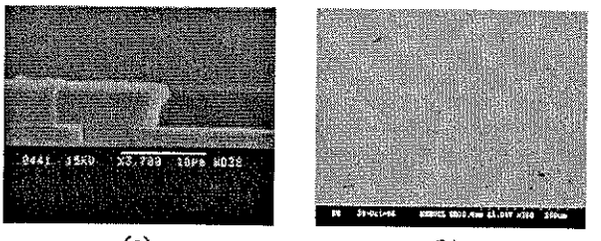


Figure 2. Microscopic images of the fabricated samples.



(a) (b)

Figure 3. The observation of attached sample by FEM (Field Emission Scanning Electron Microscopy): (a) the strong bonding state, (b) top substrate after separating two substrates

We observed the strong bonding state of two substrates in fig. 3(a). Fig. 3(b) shows the plucked bonding layer to the top substrate when two substrates is separated. We measured that the thickness of bonding layer is 138 ㎚ with alpha-step

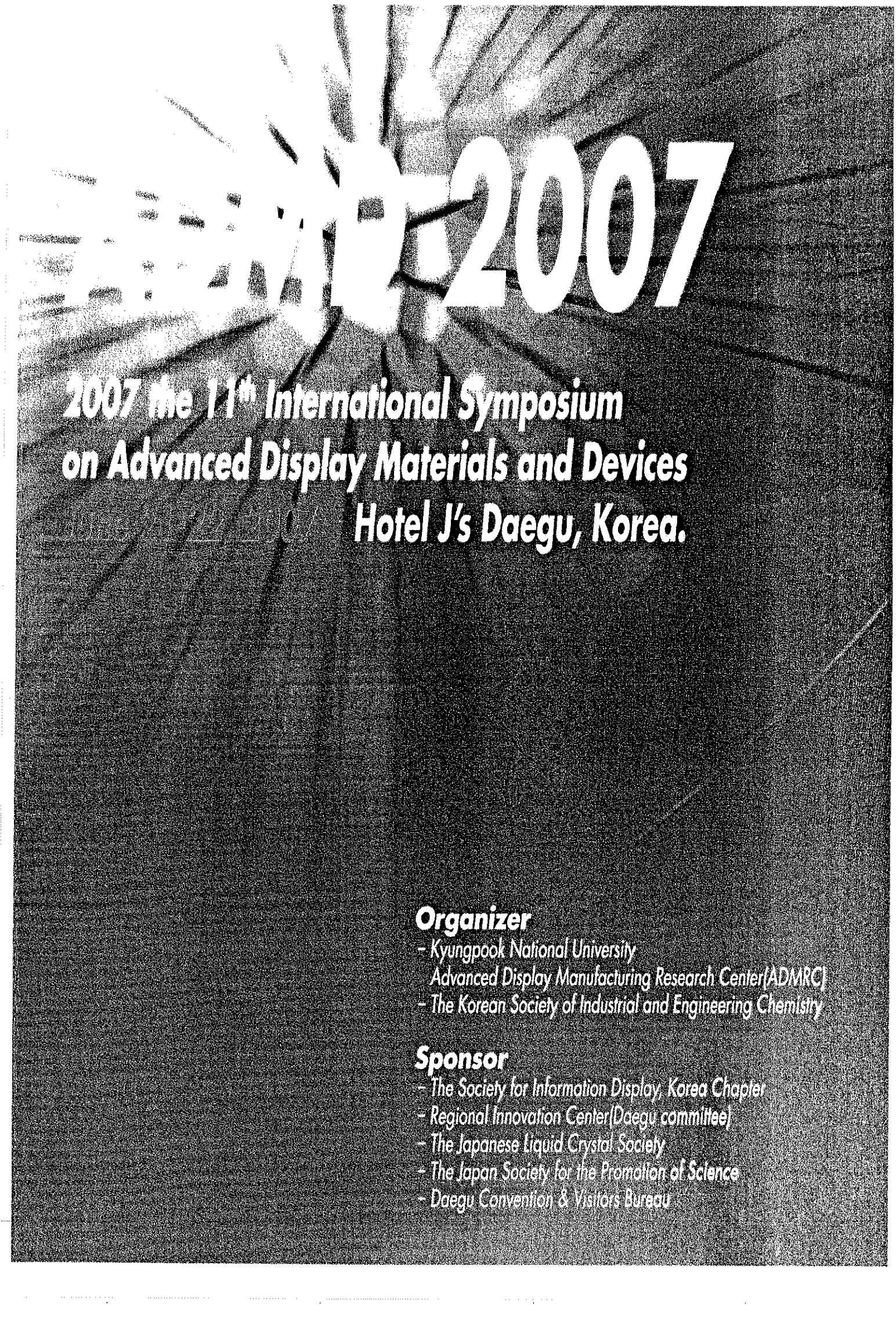
4. Conclusions

In summary, we can simultaneously obtain the characteristic of agarose which is change the state according to temperature and strong bonding property of UV epoxy by using agar-epoxy composites. This method can supplement the problem that adhesion materials on formed polymer wall were not fixed and fall to the each sub-pixel by the pressure of two substrates. Also, it is possible the LC dropping process because the proposed bonding layer does not react with liquid crystal. According to the suggested bonding technique, we can get the producible advantage that this process can produce through single processing because all manufacture processes are linked organically. It is accomplished the indicator of roll-to-roll process for flexible display by using simple micro-contact method.

5. References

[1] S.-J. Jang, J.-W. Jung, H.-R. Kim, M. Y. Jin and J.-H. Kim, *Jpn. J. Appl. Phys.*, **44**, pp6670-6673 (2005).

[2] J.-W. Jung, S.-K. Park, S.-B. Kwon and J.-H. Kim, *Jpn. J. Appl. Phys.*, **43**, pp4269-4272 (2004).


2007
2007 the 11th International Symposium
on Advanced Display Materials and Devices
Hotel J's Daegu, Korea.
Organizer
- Kyungpook National University
Advanced Display Manufacturing Research Center(ADMRC)
- The Korean Society of Industrial and Engineering Chemistry
Sponsor
- The Society for Information Display, Korea Chapter
- Regional Innovation Center(Daegu committee)
- The Japanese Liquid Crystal Society
- The Japan Society for the Promotion of Science
- Daegu Convention & Visitors Bureau

PI-20. Temperature Stability of Electro-Optic Properties of Polymer Dispersed Liquid Crystal with Different Crosslinking Agent in PN393 Base Pre-Polymer

Young-Seok No*, Jae Hong Kim, Chan-Wook Jeon
School of Display and Chemical Engineering, Yeongnam University

PI-21. Single substrate flexible LCD with enhanced stability using functional photopolymer structure

Kwang-Soo Bae[1], Yoonseuk Choi[2], Hak-Rin Kim[3], and Jae-Hoon Kim[1,2,4,*]
[1]Department of Information Display Engineering, Hanyang University
[2]Rearch Institute of Information Display, Hanyang University
[3]School of Electrical Engineering and Computer Science, Kyungpook National University, [4]Department of Electronics and Computer Engineering, Hanyang University

PI-22. Substrates Fastening Technique for Pixel Isolated Liquid Crystal mode

Ji-Hong Bae[1], Se-Jin Jang[1], Hong Choi[2], Sang-Il Kim[4] and Jae-Hoon Kim[1,2,3,*]
[1]Department of Information Display Engineering, Hanyang University,
[2]Research Institute of Information Display, Hanyang University,
[3]Deartment of Electronics and Computer Engineering, Hanyang University
[4]Samsung Electronics, LCD R&D Center

PI-23. New Materials for Organic Interdielectric Layer Patterning of TFT Array

Hyo-Jung Lee[1], Hong-Qing Wang[1], Dong - Ju Kim[1], Soon -Hak Kim[1], Lee - Soon Park*, Yun Su Lee[2], Gab Deuk Song[2], Suk-kyung Kim[2]
[1]Department of Chemical Engineering, Daegu University, Gyeongbuk, 712-714, Korea
[2]Advanced Display Manufacturing Research Center, Kyung pook National University, Daegu, 702-701, Korea