A Geometric Structure for Uniform Bend Transition in a pi cell

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Abstract

A novel geometric solution for uniform bend transition in a pi cell has proposed. In order to obtain the uniform bend transition, we applied hybrid domain structure to the edge of a LC cell by using ion-beam alignment method. As a result, we confirmed that the uniform bend transition has arisen from the edge to the center. From the proposed structure, we expect that the reliable and uniform bend transition can be achieved in the pi cell.

1. Introduction

A pi cell has good properties for device applications such as fast response time and intrinsic wide viewing angle characteristics [1-2]. These advantages are suitable to next generation display units and TV application compared with conventional liquid crystal display modes such as TN mode or STN mode.

In general, the director configuration of the pi cell starts from the splay state by parallel rubbing. By applying a voltage, the director configuration goes to the bend state from splay state.

Since the derived optical switching is between the bend state, it is always necessary to apply an initial voltage to make the LC configuration transition from the splay to the bend state. Because of topological inequivalence between bend and splay state, however, some of the pixels sometimes never go to bend state even after bias voltage has applied. Therefore, to obtain uniform bend pixel distribution in a pi cell is an practical issue point for the pi cell improvement [3-4]. Figure 1 shows non-uniform bend pixel distribution.

In the previous papers, several LC geometric schemes for the uniform bend transition have been discussed [3]. In this method, there were no falling off characteristics optically. But they still have non-uniform bend pixel distribution.

Uchida proposed two methods to solve the non-uniform bend distribution in the pi cell [3-4]. First, they proposed to apply high voltages to the pi cell. However, this method was not appropriated for TFT cell because very high voltage may break TFT cell. Another method was to form a structure which has a twist state in the center of the each pixel. However, twist LC configuration in the center of the bend cell may reduce the optical characteristics. Therefore, in order to block the light leakage of the cell extra-masking process to be able to hide twist state in the cell is needed. Otherwise, this process brings about low aperture ratio.

In this paper we propose a LC structure which can exhibit uniform bend transition by applying hybrid domain structure to the edge of the each cell.

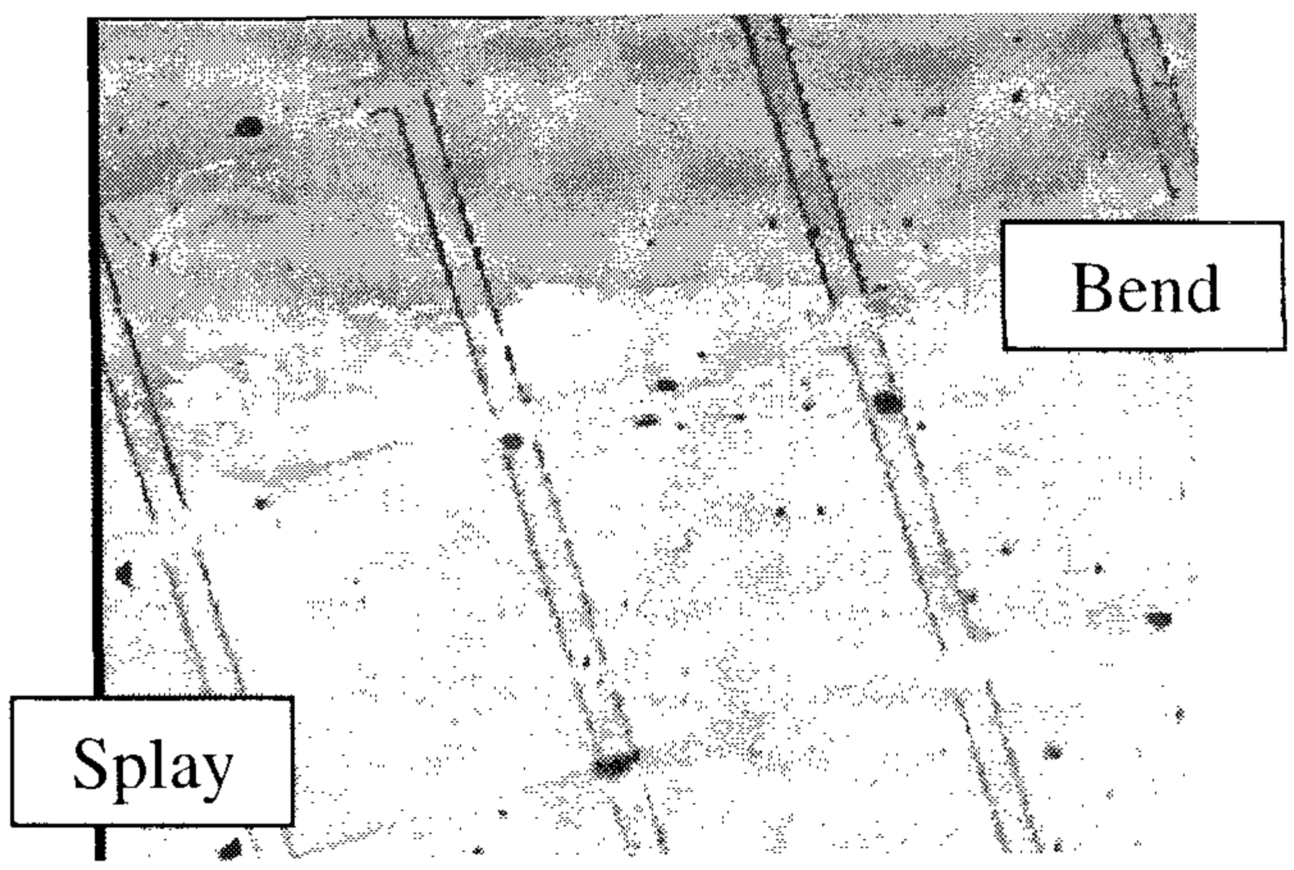


Figure 1. Non-uniform bend pixel distribution (pixel size: 300㎛ x 300㎛)

2. Transition property of the pi cell

When no voltage is applied, the pi cell is in the splay state, and the molecules are aligned along the rubbing direction. In geometry, when a voltage is applied to the cell, it goes to the bend state. In the case of the transition, since the splay and the bend states are topologically different from each other, transformation between the splay state and the bend state inevitably accompanies with bend nucleus. And then domain growth of the bend state should take place. Conventional pi cell never go to bend state without bend transition core even after bias voltage has applied because of topological inequivalence between splay and bend state. To obtain uniform transition from splay to bend state, bend transition core must be essential. The proposed method is to make hybrid domain structure to the edge of the each pixel. As a result, because of topological equivalence between hybrid and bend states, hybrid state first transforms to the bend state, so that it cause the uniform bend pixel distribution

3. Experiment and Results

In this experiment, in order to obtain a sufficient retardation in the bend state, the MLC 6265-000(E. Merck) with Δn of 0.2106 at 550nm wavelength were used. And the cell gap was controlled by using spacer of 4.2㎛.

Table 1. Ion beam expose condition

Parameter	Condition
Ion-beam voltage	250eV
Ion-beam current	10mA
Incidence angle	> 20°
Exposed time	10 sec

The alignment layer of the top glass substrate was coated by spin coating SE-3140(Nissan Chemical Co.) which is homogeneous alignment material. The bottom glass substrate was coated by spin coating AL00010(JSR) , which is vertical alignment material. To make a hybrid domain structure in the boundary of LC cell, we exposed the ion-beam on the center of the bottom alignment layer [5-6]. The exposed ion beam condition is shown in Table 1. Figure 2 shows the

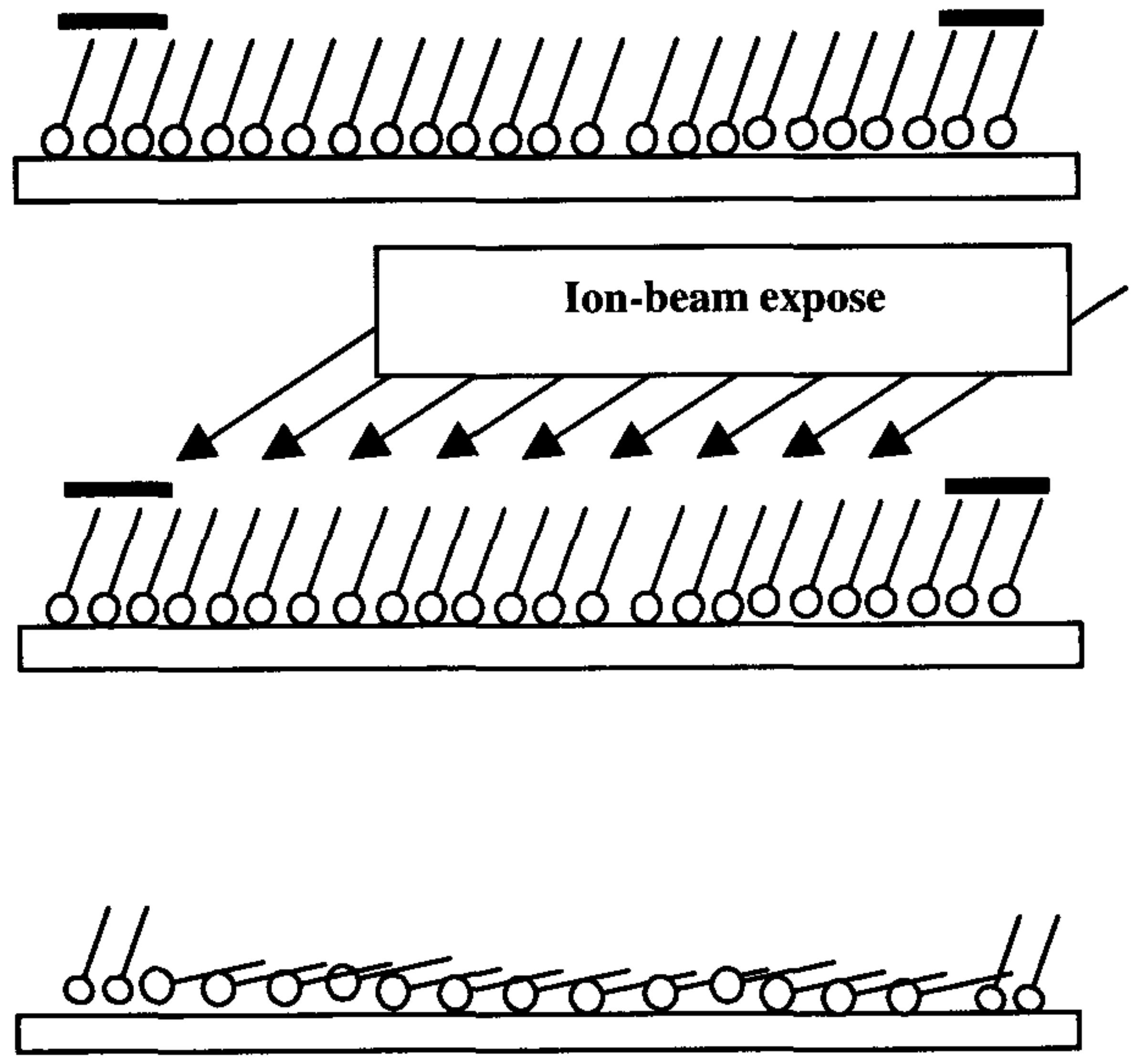


Figure 2. Ion beam expose method

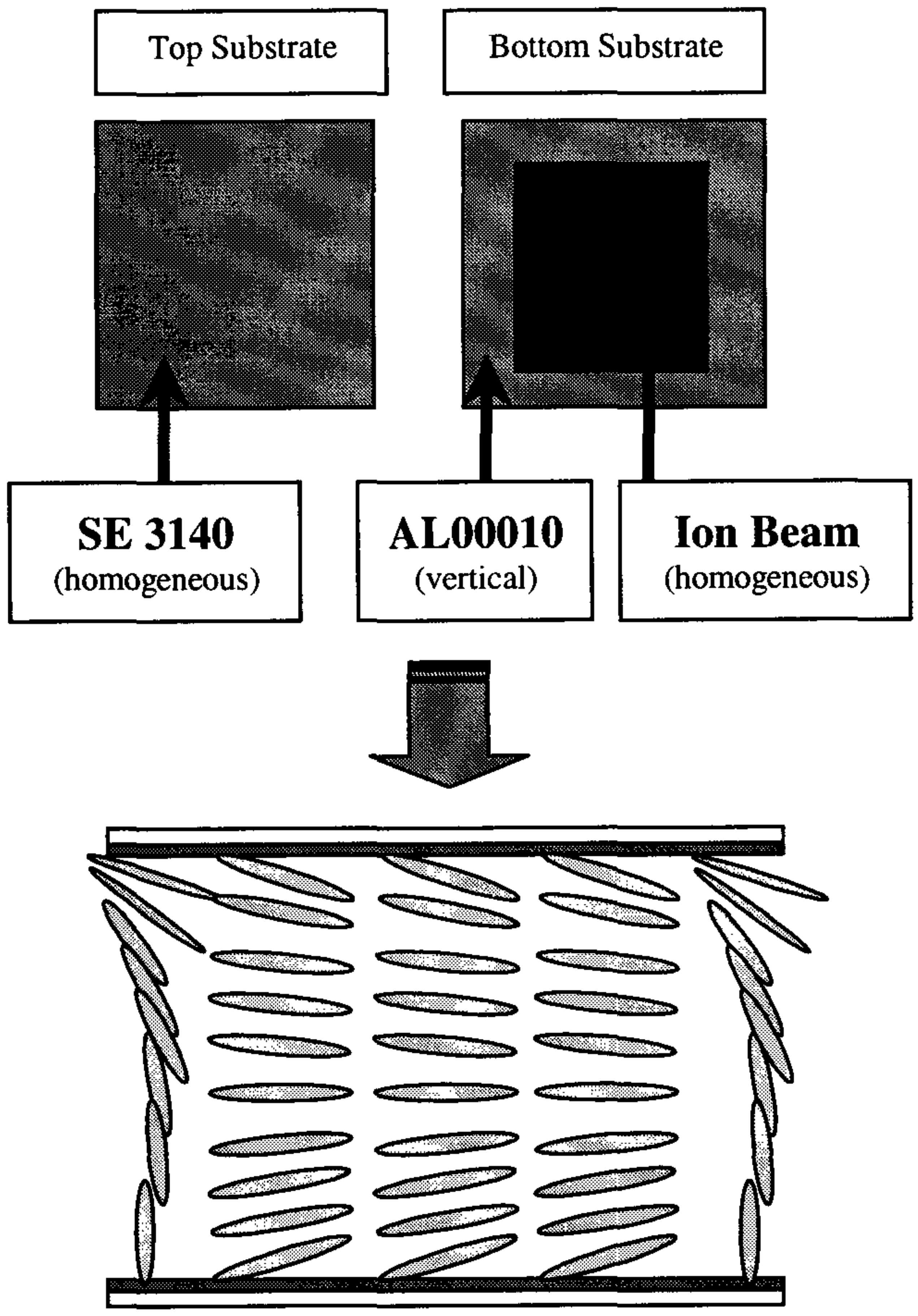


Figure 3. Initial alignment configuration of proposed hybrid domain structure

alignment of the bottom substrate exposed by the ion beam.

Figure 3 shows the initial alignment configuration of the proposed hybrid domain structure. The bulk and boundary of the LC cell become the splay and hybrid configurations respectively. Figure 4 shows the initial state of the domain edge which is the edge of between the splay and the hybrid state.

When a voltage is applied to the LC cell, bend transition has arisen from the edge between splay and hybrid domain to the center. Figure 5 shows the spread of bend transition from the edge to the center after 4V is applied to LC cell. Figure 5 (a) is a picture with 4V, Fig. 5 (b) is a picture after 7 sec and Fig. 5 (c) is a picture after 27 sec and Fig. 5 (d) shows the complete bend transition.

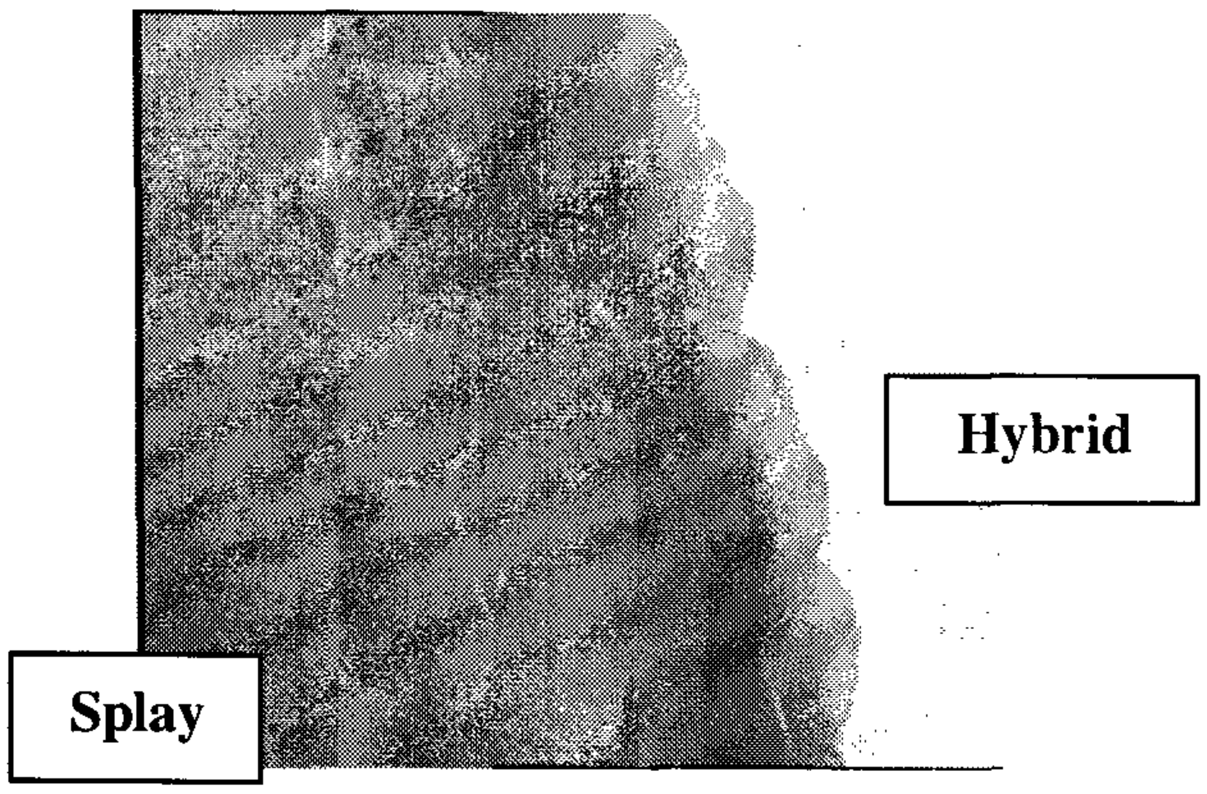
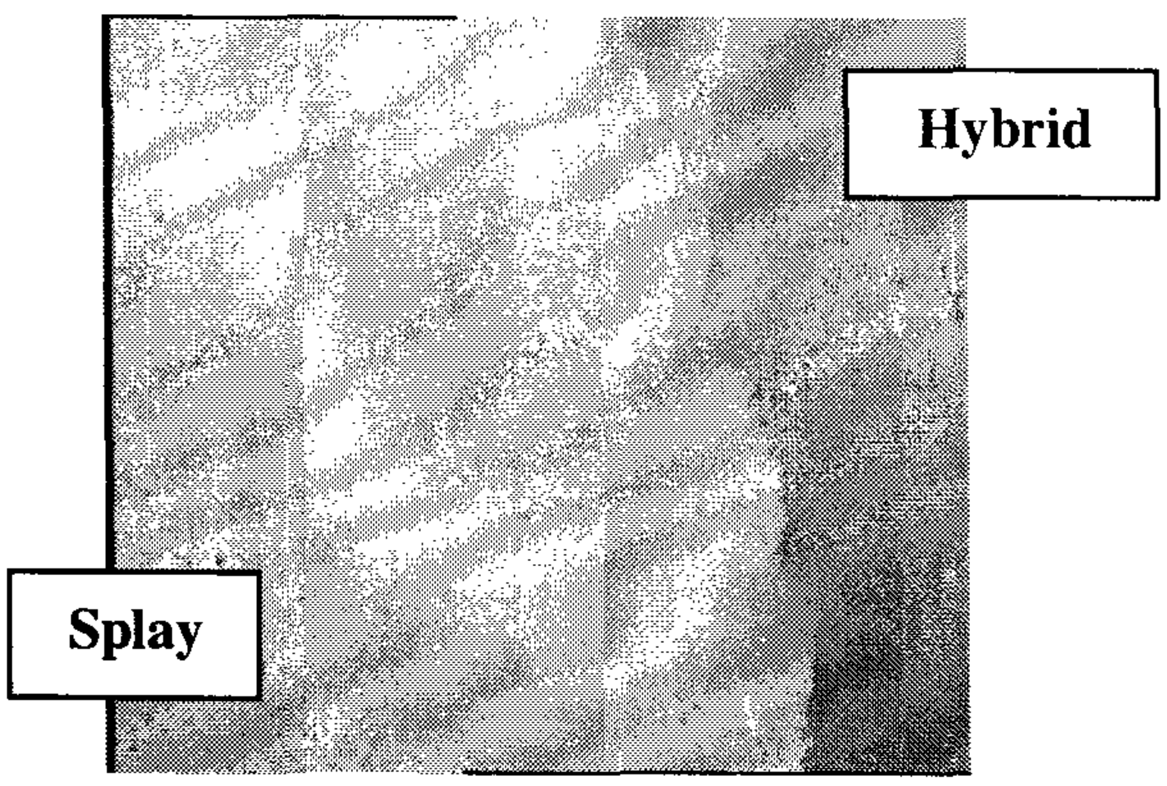
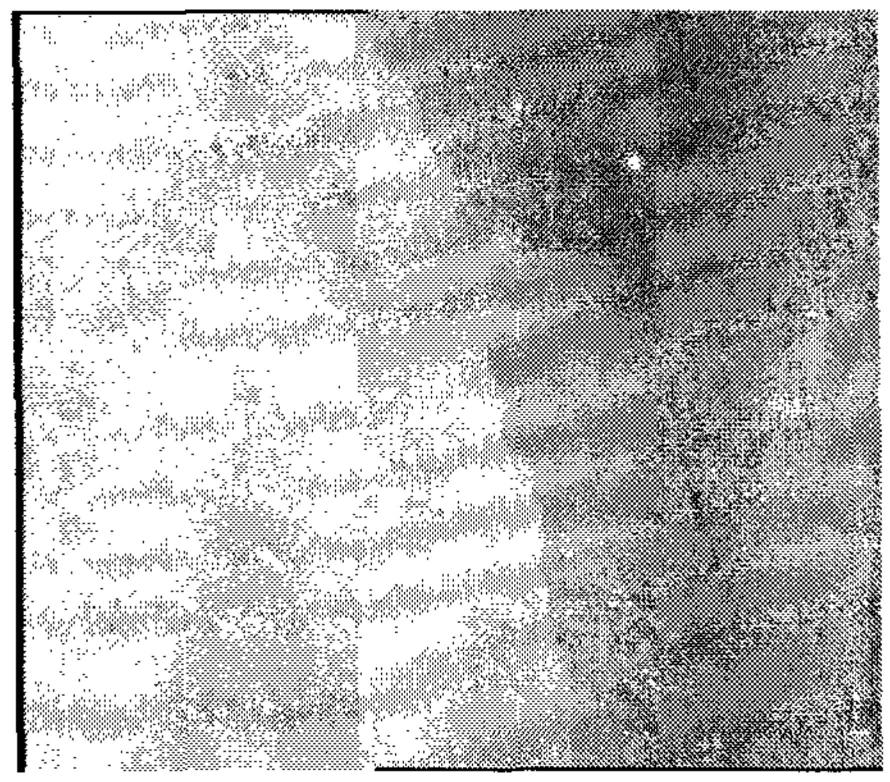


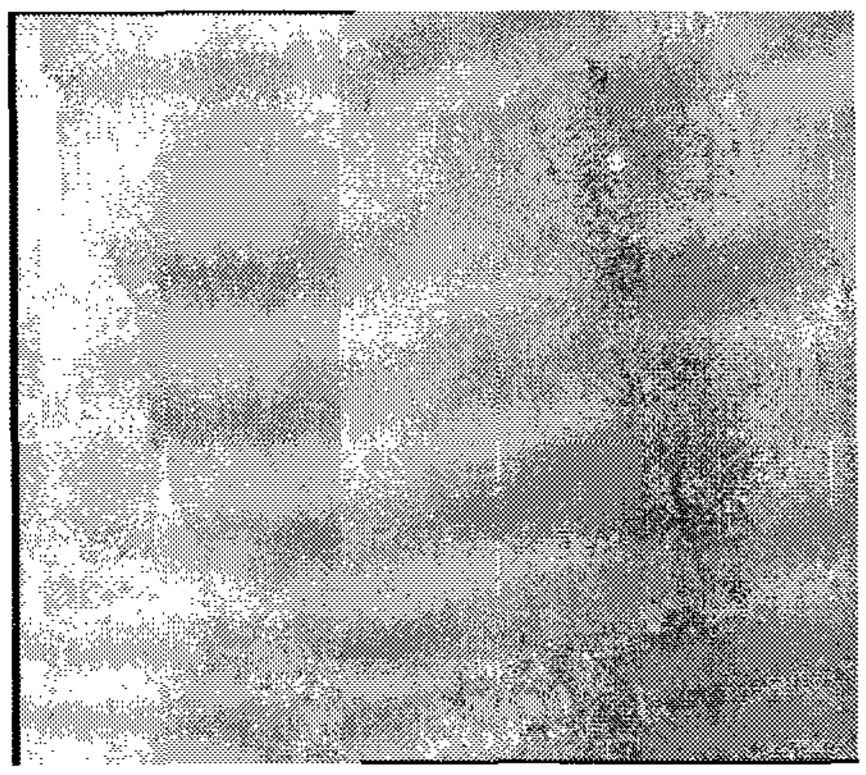
Figure 4. initial state of between splay domain and hybrid domain



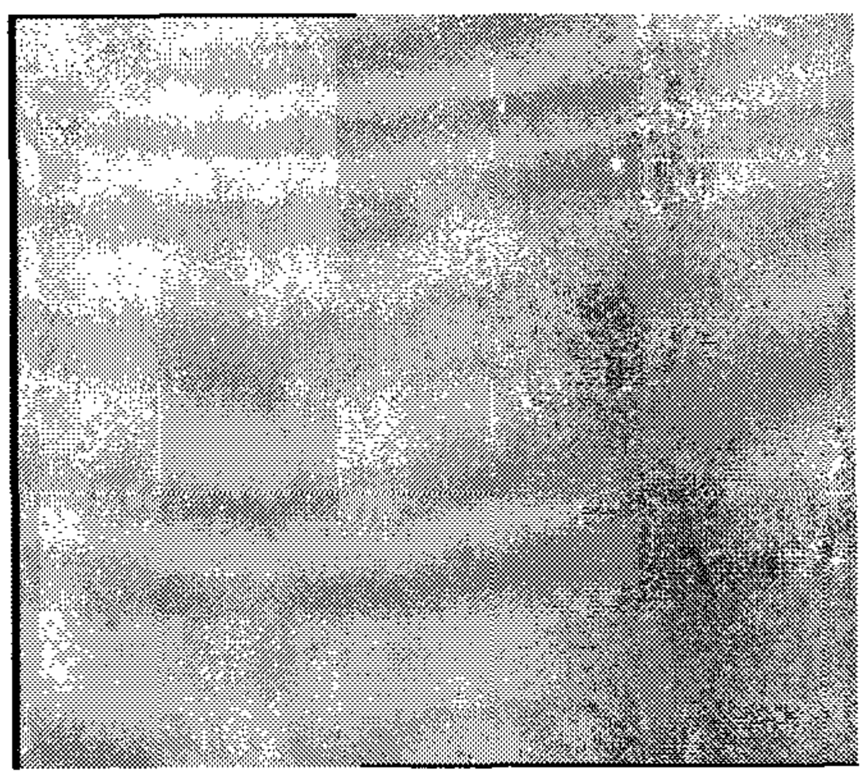
(a)



(b)



(c)



(d)

Figure 5. Spread of bend transition from the edge of between splay and hybrid domain to the center (applied 4V to LC cell) : (a) 0.1 sec after the voltage applied, (b) 7 sec later, (c) 27 sec later, (d) 35 sec later

In general, a conventional pi cell is applied high voltage of 12V or over so as to transform from splay to bend state [4, 7]. Transition time of the conventional pi cell with 2 x 3 ㎝ pixel size takes minimum 160sec after the voltage of 4V applied. However, in the case of the proposed pi cell the hybrid domain structure has short bend transition time and the reliable transition reliability even if low voltage is applied.

4. Conclusion

We propose a LC structure which can exhibit uniform bend transition by applying hybrid domain structure to the edge of the each cell. We confirmed that the bend transition has arisen from the edge to the center. The hybrid domain structured pi cell has fast bend transition time compared with the conventional pi cell.

5. Acknowledgement

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6. References

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