Study about the Reverse Tilt Domain in Chiral Hybrid In-Plane Switching mode

Soo In Jo,[1] Young-Eun Kang,[1] June-Kyu Park,[1] You-Jin Lee,[2] Kyeong-Hyeon Kim,[3] Jeong Wook Heo,[3] Joo-Hong Seo,[3] Jae-Hoon Kim,[1,2] Chang-Jae Yu[1,2,*]

[1] *Department of Electronics and Computer Engineering, Hanyang University, Seoul 133-791, Korea,*
[2] *Department of Information Display Engineering, Hanyang University, Seoul 133-791, Korea,*
[3] *Advanced Development Team, LCD business, Samsung Electronics, Asan, Chungnam 366-741, Korea*

We have proposed a liquid crystal (LC) display mode, namely chiral hybrid in-plane switching (CH-IPS) mode which has high transmittance and excellent dark state using the in-plane switching electrodes [1]. The layer structure with planar alignment layer and vertical alignment layer enable to generate the normally white state by hybrid twisted nematic structure at initial state. And, in-plane field makes the dark state under the crossed polarizers. However, as we reported, the CH-IPS mode has a reverse domain problem which was expected to reverse twist domain [2]. In this paper, we will study about the reverse tilt domain problem by the numerical calculation of the free energy at the surface and bulk area. And, experimental result using the numerical calculation result will be presented.

Figure 1 shows the reverse domain problems of the CH-IPS mode by changing the pretilt angle of the planar layer without external electric field. The major and minor domains are arranged in LC panel and it decrease the optical characteristics. In contrast to our expectation, those kind of domain is merely seen in the chiral dopant added system. And also, in numerical calculation result, the energy barrier between the reverse twist domain and intended domain is sufficiently large to overcome.

Therefore, we change our expectation by defining those kinds of LC domain with reverse tilt domain. We calculate the free energy calculation result of the reverse tilt domain system by changing the pretilt angle of the planar layer and anchoring energy. In reverse tilt domain system, free energy of the bulk region is same and symmetric between two domains. If we added the surface anchoring energy effect, the barrier between the two states are increased by changing the polar anchoring energy. And, large pretilt angle at the planar substrate shows the stable state due to the low free energy. To confirm this calculated result, we adopt those parameters, pretilt angle and anchoring energy, in experiment and reverse domain was removed.

As a result, we find that the pretilt angle and polar anchoring energy are important parameter to control the defect free structure in CH-IPS mode by the numerical calculation. And we confirm this expectation by the experimental result.

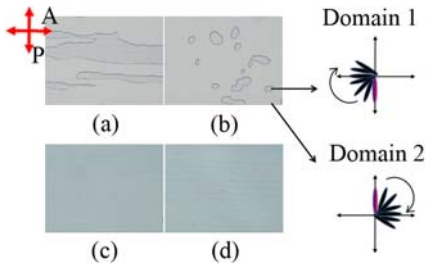

Figure 1. The configuration of domain at pretilt angle (a) 2°, (b) 5°, (c) 8° and (d) 10°

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* corresponding author; E-mail: cjyu@hanyang.ac.kr