Slippery Interfaces
–Low driving voltage and ultra-fast switching for DH-FLC mode-

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We have designed the slippery interfaces in the homeotropic ferroelectric (SmC*) liquid crystals for the DH-FLC mode as walls wetted on the electrodes in the in-plane switching cell (Fig.1), and success to reduce the driving voltage keeping the ultra-fast response (<100μsec). Slippery interface provides us the following three big advantages for the efficiency of the light bulbs of flat panel application. (1) Driving voltage can be drastically reduced (1~2 order <1~2V/μm)(Fig.2). (2) Response time for the fast component does not decelerate and keeps the same speed as that of the original material (<100 μsec). (3) The speed of recovery to the black state can be accelerated by applying a short pulse with negative sign of the voltage (<100 μsec almost same as rise-up time)(Fig.3). This is because the electrically induced polar order of C-director become large by the strong modulation of the distribution of C-director due to easiness of helix unwinding or rewinding motion with slippery interfaces.

Slippery interfaces are successfully introduced by the phase separation between SmC* and isotropic liquid (I) due to immiscibility of the additional dopant (Fig.1). We choose the prototype of the dopant as azo dye molecules, because the light induced trans-cis isomerization strongly modify the miscibility of azo dye to liquid crystal. Then we can clearly demonstrate the roles of the slippery interfaces on the switching behaviour of SmC* in the in-plane switching (IPS) cell in comparison with before and after UV illumination.

Key role of the slippery interface is to lubricate both dynamics in the intra helix C-director rotation and the inter helix motion. Namely, slippery interfaces even promote pitch change motions. We can easy to identify these fact from the difference of the lateral motion of Cano's wedge for unwinding or rewinding of the helix, and confirmed by colour shift of the selective reflection (photonic) band by image intensified spectrometer. It is important that correct understanding for coupled dynamics of the two modes of C-director motion, both in the intra and inter helix motions. Nevertheless, the lubrication of the inter helix motion by the slippery interfaces provides the strong enhancement of the electric field induced birefringence, the response function of the SmC* become to be complicated which coupled with the slow inter helix mode (~few msec) due to collectiveness of hydrodynamic modes. However, it can be overcome by suitable design of waveform of driving voltage.

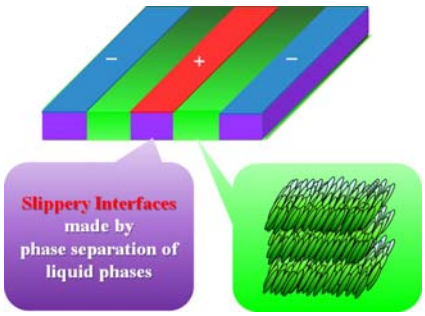

Fig.1 Schematic representation of the "Slippery interface on SmC* phase in IPS cell.

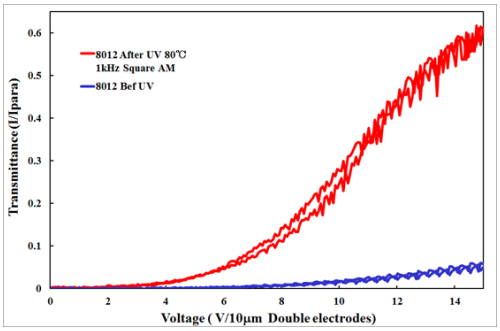

Fig.2 Applied voltage dependence of transmitted light intensity without (blue) and with slippery interfaces (red).

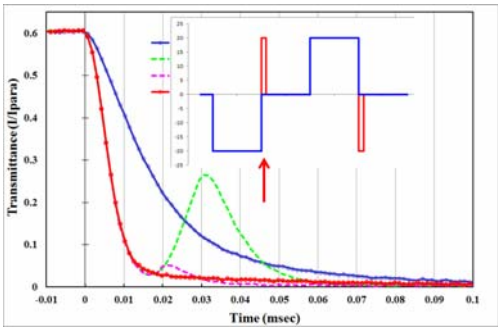

Fig.3 Acceleration for the recovery to black-state by applying the short negative pulse (blue to red).