Slippery Interfaces

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Abstract: 1. "Principle & Design for slippery interface" We have invented the new principle to produce the slippery interfaces on the glass or plastic substprates, or even nano-interfaces embedded in the materials such as PSChBP. Slippery interfaces are created by the disorder effect. We designed and realized several models of self-organized slippery interfaces. For example, the localized impurities on the interface between liquid crystal and polymer thin films can weaken LC order near the interfaces. Then, the anchoring effect should be weakened, and molecular motion is greatly lubricated by the slippery interfaces.

2. "Materials & Characterization of slippery interface" We characterize the slippery interface by measuring the dynamics of the surface director $\boldsymbol{n}_s$ under rotational magnetic field, which is equal to the nematic director just on the slippery interface. We analyze magnetic field dependence of the response of $\boldsymbol{n}_s$ and evaluate the anchoring energy W and viscosity of surface director γ_s. Furthermore, the gliding phenomena, which is the movement of so-called easy axis $\boldsymbol{n}_h$, is also measured and discussed. Slippery behaviors can be explained based on states of the polymer thin films and should be dependent on visco-elastic behaviors of the polymer near the glass transition.

3. Application 1. "Slippery ferroelectric smectic C* (SmC*) phases" We applied the slippery interfaces to the homeotropic ferroelectric SmC* liquid crystals for the DH-FLC mode in the in-plane switching cell and succeeded in reducing to reduce the driving voltage drastically keeping the ultra-fast response. Figure 1 shows the performance of SmC* on the slippery interface. SmC* on the slippery interface can be driven by low driving voltage <~1.0V/μm as shown in Fig.1. The response time for the fast component does not decelerate and keeps the same speed as that of the original material (<100 μsec).

4. Application 2. "Slippery IPS nematic" We used the strong anchoring surface of polyimide for one of the inner surfaces of the glass substrates of a liquid crystal display cell, and used the slippery interface for the other. Driving voltage can be reduced and mode efficiency was also enhanced greatly due to the large rotation of the surface director on the slippery interface. We discuss quantitatively the reduction of the driving voltage and acceleration of the response time of several types of the slippery interfaces.

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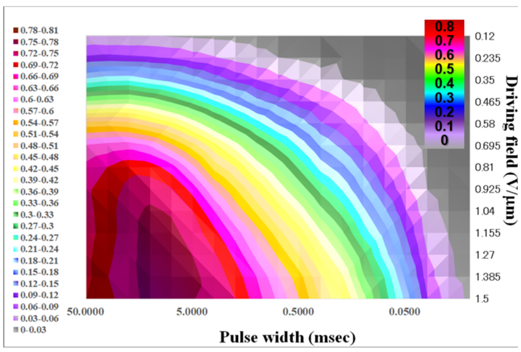

Fig.1 Reduction of driving voltage for SmC* on the slippery interface.

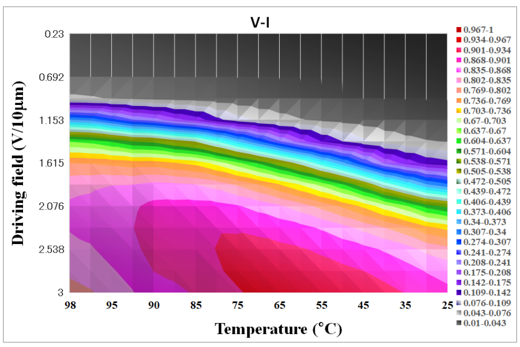

Fig.2 Temperature dependence of the mode efficiency of the slippery IPS nematic.

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Selected Papers:

1) Kanako Hata, Yoichi Takanishi, Isa Nishiyama and Jun Yamamoto, Softening of twist elasticity in the swollen smectic C liquid crystal, Euro. Phys. Lett. 120, 56001(5P) (2017). DOI: 10.1209/0295-5075/120/56001.

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5) S. Samitsu, Y. Takanishi and J. Yamamoto, Molecular Manipulator Driven by Spatial Variation of Liquid Crystalline Order, Nature Materials, 9, 816 - 820 (2010).

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12) H. Tanaka, M. Isobe and J. Yamamoto, Spontaneous Partitioning of Particles into Cellar Structure in Membrane System・Phys. Rev. Lett., 89, No.16, 168303(2002)

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15) J. Yamamoto and H. Tanaka, Shear Induced Sponge-to-Lamellar Transition in Hyper-Swollen Lyotropic System, Phys. Rev. Lett., 77, No.21. 4390-4393 (1996).
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18) J. Yamamoto and K. Okano, Anomalous Hydrodynamic Behaviors of Smectic Liquid Crystals at Low Frequencies, Jpn. J. Appl. Phys. Vol.31, No.4, 754-763(1991).

Award:

Achievement award of Japanese Liquid Crystal Society (2015).

Research interest:

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Job:

2005-Current: Full Professor, Department of Physics, Graduate School of Science, Kyoto University.

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Social Activity

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Japanese Journal of Applied Physics: Division Editor: 1997-2002

International Conference:

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Japanese-Italian LC Workshop 2016: Chair,
YITP 2012: Phase Transition Dynamics in Soft Matter: Bridging Microscale and Mesoscale: Chair,
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