Supporting Information for:

Direct Observation of Polymer-Stabilized Blue Phase I Structure with Confocal Laser Scanning Microscope

Kenji Higashiguchi,[†] Kei Yasui, [‡] and Hirotsugu Kikuchi[†,*]

[†]*Institute for Material Chemistry and Engineering, Kyushu University, Kasuga Park 6-1, Kasuga, 816-8580, Japan;*[‡]*Nissan Chemical Industries, Ltd., Tsuboi-cho 722-1, Funabashi, Chiba,274-8507, Japan.*

1. Experimental.

Preparation of PSBP I. The liquid crystal materials used in this study consisted of a nematic mixture (JC-1041XX, Chisso Co.) and 4-cyano-4'-pentylbiphenyl (5CB). We used a chiral dopant, 2,5-bis-[4'-(hexyloxy)-phenyl-4-carbonyl]-1,4;3,6-dianhydride-D-sorbitol (ISO-(6OBA)$_2$), to induce blue phases. The acrylate monomers were dodecyl acrylate (12A, Aldrich) and liquid-crystalline diacrylate monomer (RM257, Merck). The photoinitiator was 2,2-dimethoxy-2-phenyl acetophenone (DMPAP, Aldrich). The constituent fractions of the samples are listed in Table S1. A glass cell with 10 μm spacers was filled with a homogeneous mixture at 45 ºC and cooled slowly for platelet growth to 39.0 ºC on a hot stage (LTS 350, Linkam). The mixture was irradiated with UV light (365 nm, L2859-01, Hamamatsu Photonics) of 1.5 mW cm^{-2} intensity for 20 min to give polymer-stabilized blue phase I (PSBP I) and it was allowed to cool down to room temperature.

Table S1. Composition of samples used in preparing the PSBP I

	weight / mg	weight ratio / wt%
5CB	105.3	43.4
JC-1041XX	105.3	43.4
12A	9.5	3.9
RM257	9.5	3.9
ISO-(6OBA)$_2$	12.5	5.1
DMPAP	0.7	0.3

Optical measurements. Reflection spectrum was recorded on a Jasco MSV-350. Imaging experiments were conducted with a transmission/reflection optical microscope (OPTIPHOT2-POL, Nicon) with objective lens 40× (NA = 0.55, Nicon) and confocal laser scanning microscope (LSM 510, Carl Zeiss) with oil-immersion objective lens 100× (NA = 1.4, Plan-Apochromat, Carl Zeiss). The incident beam (543 nm, He-Ne laser) is split by beam splitter (NT 80/20) and focused by an objective into a small volume. No fluorescence dye was used and the back-scattered light is detected by a photomultiplier tube in the spectral region 535-546 nm. A pinhole size was adjusted to good resolution, 51 μm. The optically isotropism of BP neglected the defocusing by extraordinary versus ordinary modes.[1]

2. Identification of Orientation.

The lattices of Figures 3(a, {110}) and (d, {211}) are rectangle, while the lattice of Figure 3(b, {100}) is square. The rectangle {110}, {211} and the square {100} are clearly distinguishable based on lattice symmetry. Although the images of {110} and {211} are actually similar, they are different in the ratio of the lengths of the basis vector, the color of domain and the Fourier transformed pattern. The observed ratio of the lengths of the basis vector, $\boldsymbol{t}_2/\boldsymbol{t}_1$, including deviation error were 1.46±0.03 and 1.60±0.08 for {110} and {211}, respectively. The expected ratios $\boldsymbol{t}_2/\boldsymbol{t}_1$ are calculated to be 1.41 and 1.63 for {110} and {211}, respectively. Moreover the color of the {110} domain is red, while the color of {211} is dark blue. Therefore they cannot be exchanged.

3. Confocal Laser Scanning Microscope *Z*-scanning

***Z*-scanning.** A depth scanning was carried out for {111} plane around a grain boundary as shown in Figure S1. Since the thickness of optical slice was ~4.2×10^2 nm and was larger than lattice spacing (188 nm), each slice involves a couple of layers of the lattice planes. That is, the dots in image are not always in an identical plane. The alignment of dots changed with focal depth. Although the face orientation did not change, the periodical patterns changed from dotted to partially striped as shown in Figure S2. The pattern was analyzed in detail, the positions of dots slightly moved and lines were formed between two dots. Additionally, the grain boundary moved to left. If the positions of dots do not change entirely with depth, the detecting image should come from the reflection at the interface between the cover glass and sample.[2] However, it is noted that the positions of dots slightly moved, it means that the image comes from bulk structure of the sample.

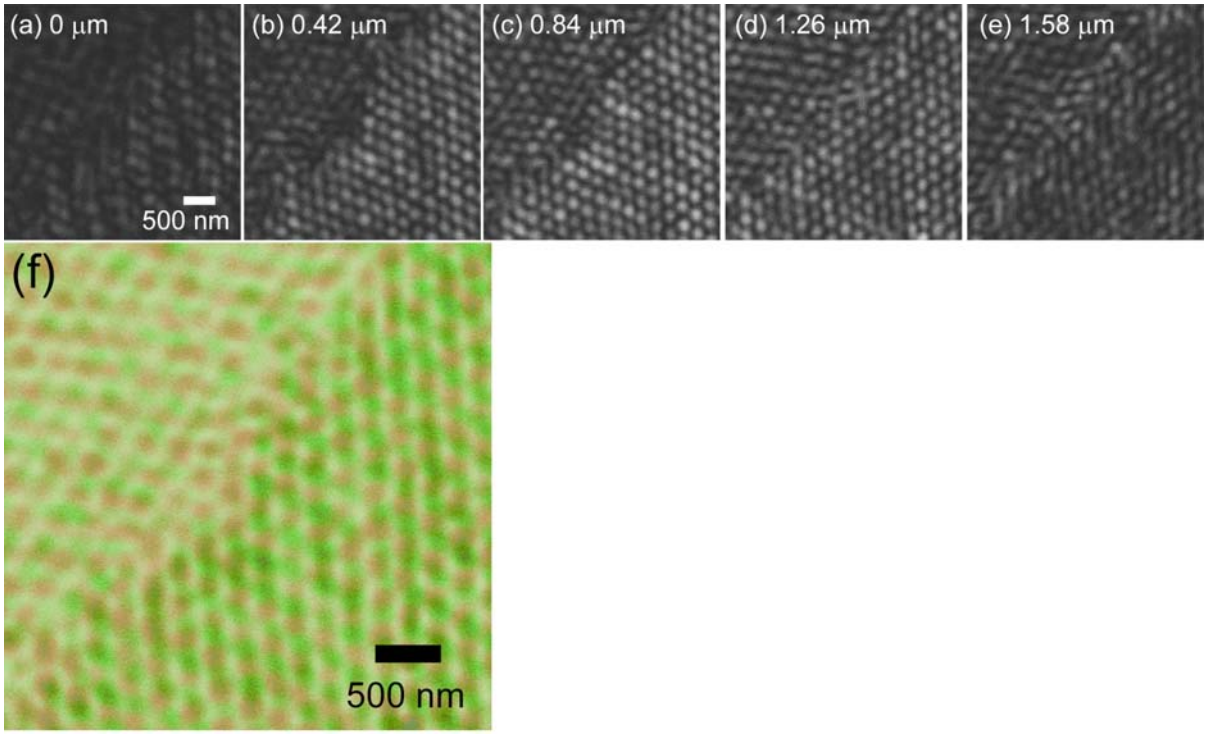

Figure S1. (a)-(e) Sequence of five CLSM images of two {111} domains separated by boundary: image interval = 0.42 μm. (f) CLSM texture of the same position as (a)-(e) with inverting light/dark contrast. The pattern images of the depth at 0.42 μm and 1.26 μm were indicated as green and red, respectively.

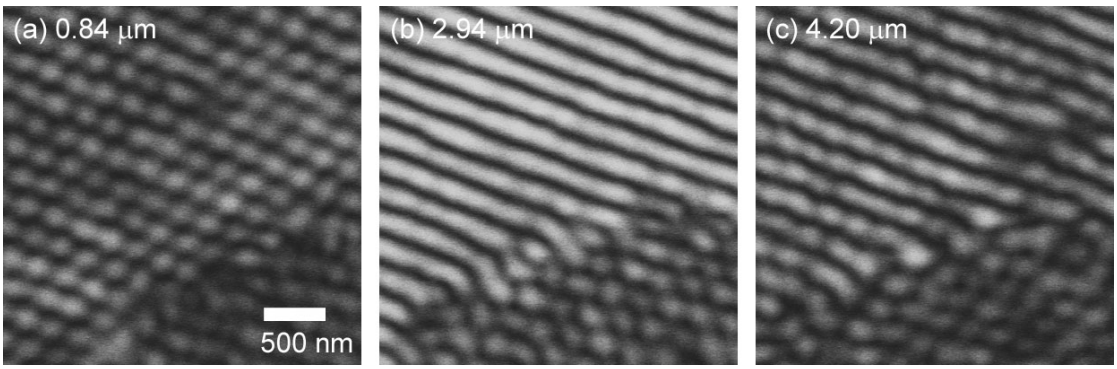

Figure S2. The changing of periodical patterns from dotted to partially stripe.

References

1 Saupe, A. *Mol. Cryst. Liq. Cryst.* **1969**, *7*, 59-74.

2 Kikuchi, H.; Hirata S.; Uchida, K. *Mol. Cryst. Liq. Cryst.* **2007**, 465, 283-288.