Molecular orientation evaluation of negative-tone and positive-tone photo-cross-linkable liquid crystalline polymer pattern fabricated by nanoimprint-graphoepitaxy

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Nanoimprint technology can fabricate nanostructures on functional materials. We reported that the molecular orientation of P6CAM[1)], which is one of photo-cross-likable liquid crystalline polymers (PLCPs), is induced by thermal nanoimprinting[2)]. The P6CAM molecules are reoriented parallel to the imprinted line. The molecular orientation phenomena of P3HT and PS-b-PDMS induced by nanoimprinting are also reported[3, 4)]. We call the nanoimprint process for inducing the molecular orientation "nanoimprint-graphoepitaxy". In nanoimprint process, the negative-tone and positive-tone patterns are easily formed by using positive-tone and negative-tone pattern molds. In the case of nanoimprint-graphoepitaxy, the molecular orientation states to be different between the negative-tone and positive-tone patterns, the observation of which is help understanding of nanoimprint-graphoepitaxy. Thus, we carried out nanoimprint-graphoepitaxy on P6CAM using positive-tone and negative-tone pattern molds and evaluated the molecular orientation.

We used about 300 nm-thick P6CAM. Figures 1(a) and 1(b) show the optical micrograph images of SiO_2/Si mold with the positive-tone and negative-tone patterns, respectively. The pattern depth and height were 200 nm. The molds were coated with a thin-PDMS layer[5)]. We carried out nanoimprinting on P6CAM. The nanoimprinting pressure, temperature, time were 10 MPa, 165^{o}C, and 5 min, respectively. After nanoimprinting, we observed the fabricated pattern by polarized optical micrography (POM) under crossed-nicols (the polarizer and an analyzer are crossed at 90^{o}, orange arrow in POM images). In this observation, bright field means P6CAM molecules are reoriented. Figure 2(a) and 2(b) shows POM images of the negative-tone and positive-tone P6CAM patterns, which are obtained by using the molds of Fig. 1(a) and (b), respectively. In the case of negative-tone P6CAM pattern, the horizontal narrow lines were bright field with strong intensity. However, the vertical wide lines were dark field. These results suggest that the P6CAM molecular orientation was strongly induced in narrow lines. On the other hand, the horizontal narrow and vertical wide lines of positive-tone P6CAM pattern were bright field, as shown in Fig. 2(b). However, the intensity of positive-tone P6CAM pattern was weaker than that of negative-tone P6CAM pattern. These results indicate that the molecular reorientation behavior is different between negative-tone and positive-tone P6CAM patterns fabricated by nanoimprint-graphoepitaxy.

Acknowledge
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References

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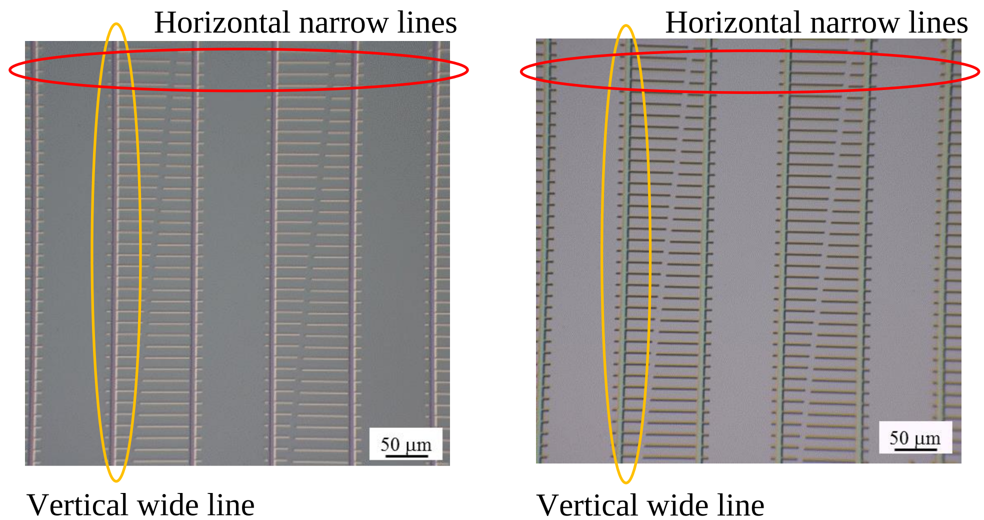
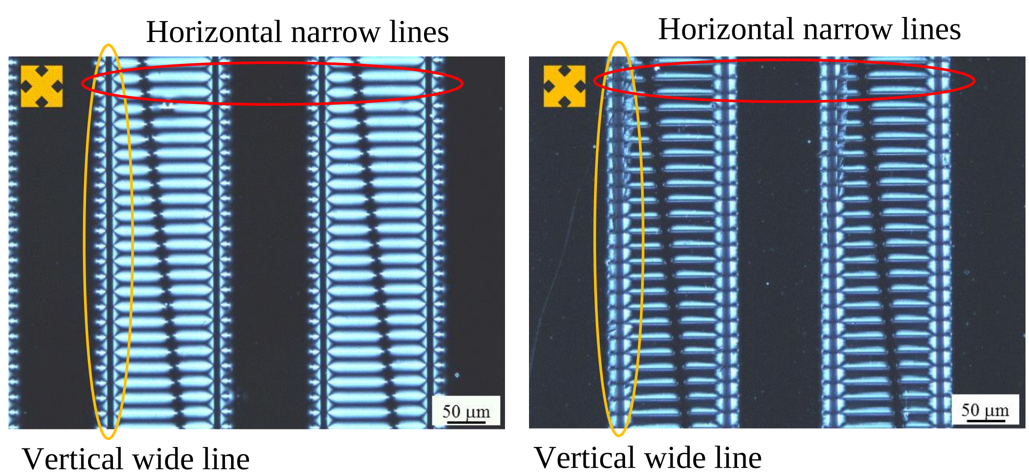


(a) (b)

Fig. 1 Optical micrograph images of (a) positive-tone pattern and (b) negative-tone pattern molds.



(a) (b)

Fig. 2 POM images of (a) negative-tone and (b) positive-tone P6CAM patterns.