Evaluation of PDMS thin layer as antisticking layer for UV nanoimprinting

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An antisticking layer is usually coated on the UV nanoimprint molds to prevent the resin adhesion. Therefore, the improvement in durability of the antisticking layer is required to mass-produce the nanostructure devices by UV nanoimprinting. In the case of graphoepitaxy of self-assembled polystyrene-b-polydimethylsiloxane (PS-b-PDMS), the PDMS brush treatment of the template is carried out. [1, 2)] The PDMS brush treatment means that the PDMS thin layer with a few nm thickness is coated on the template. We focused on this PDMS thin layer because the PDMS has a hydrophobic property. In this study, we evaluated the characteristics of the PDMS thin layer as the antisticking layer and examined the durability of this layer by step and repeat (S&R) UV nanoimprinting.

We used PDMS-silanol (P2171-DMS: Polymer Source, Inc.) in this experiment. The coating process is as follows. (1) The PDMS-silanol was spin-coated on a substrate. (2) The substrate was annealed at 170 °C in vacuum at about 1.0×10^{-3} Pa for 15 h. (3) After annealing, the substrate was washed with toluene to remove unreacted material. First, we measured a water contact angle of the PDMS layer. The contact angle was 100° as shown in Fig.1 (a). We then measured the surface roughness by dynamic force mode-atomic force microscopy (DFM-AFM). Figure 1(b) shows the AFM images of the PDMS layer. The RMS value was 0.18 nm. These results indicate that the PDMS layer has a sufficient hydrophobic property and a smooth surface.

To examine the durability of the PDMS layer, we carried out S&R UV nanoimprinting using the quartz mold (200 nm-line and space pattern) coated with the PDMS layer. PAK-01-200 (Toyo Gosei Co.) was used as a UV-curable resin. The imprinting pressure and time were 5 MPa and 30 sec. UV wavelength and intensity were 365 nm and 40 mW/cm^2, respectively. Figures 2(a) and 2(b) show the scanning electron microscopy (SEM) images of the 1st and 150th imprinted pattern on the PAK-01-200, respectively. After 150 times of repeated UV nanoimprinting, the pattern was clearly imprinted on the resin. This result indicates that the PDMS thin layer has a sufficient durability for repeated UV nanoimprinting.

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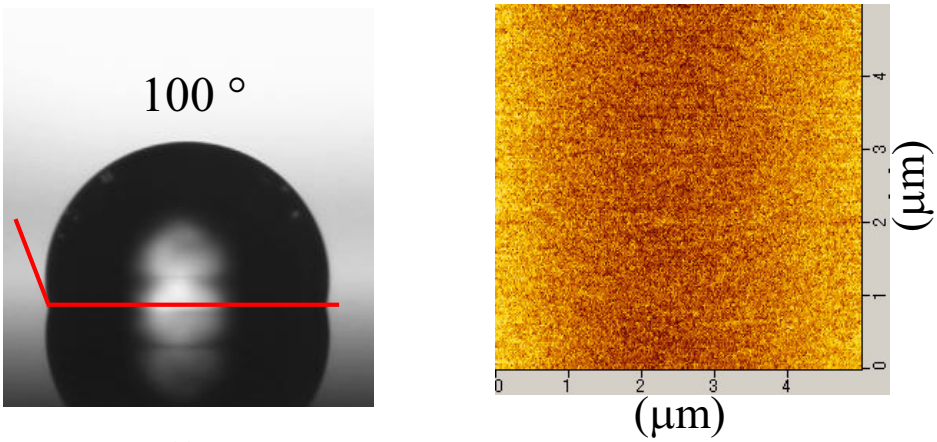
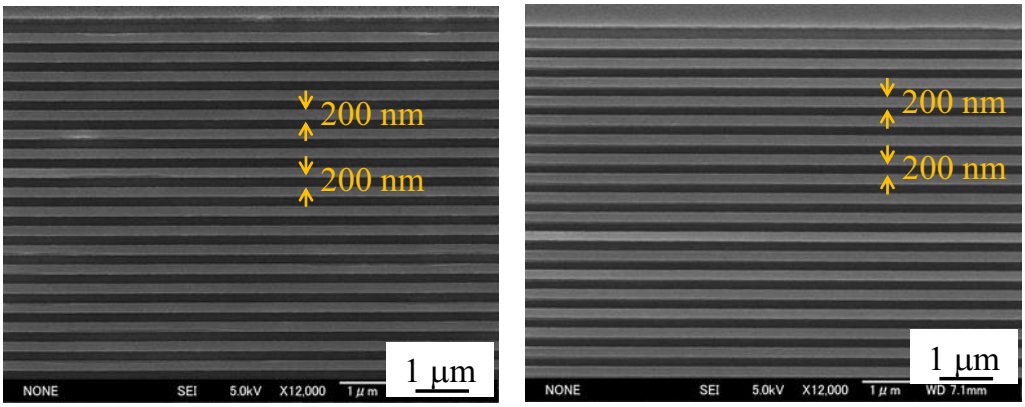


(a) (b)

Fig. 1 (a) Water contact angle and (b) AFM image of PDMS thin layer.



(a) (b)

Fig. 2 SEM images of (a) 1st and (b) 150th imprinted pattern on PAK-01-200.