Thin PDMS antisticking layer formed by using PDMS-disilanol for nanoimprinting

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Nanoimprint mold are usually coated with an antisticking layer to be easily separated from resin pattern after nanoimprinting. The degradation of the antisticking layer causes pattern defects. Therefore, the antisticking layer is very important factor in nanoimprint process. We reported that a polydimethyl siloxane (PDMS) thin layer can be applied to the antisticking layer[1)]. PDMS has the strong chemical bond and sufficient release property because PDMS consists of siloxane chain and methyl groups. In our previous work, we used a PDMS-silanol for forming the thin PDMS layer. To enhance the stability of the thin PDMS layer, we focus on a PDMS-disilanol as a film-forming agent because the both terminal groups react the substrate. In this study, we formed the thin PDMS layer by using the PDMS-disilanol and evaluated the release property for nanoimprinting.

We used P11100B-DMS (Polymer Source Inc.) as the PDMS-disilanol. Figure 1 shows the chemical structure of P1110B-DMS. According to the information provided from Polymer Source, the number average molecular weight Mn is 2500. A Si substrate was cleaned by UV/O_3 cleaner (SKB401Y-01; Sun Energy Co.) and P11100B-DMS was spin-coated on the Si substrate. The substrate was annealed under vacuum of about 10^{-3} Pa at 200 ^{o}C for 1 h. After vacuum annealing, the substrate was rinsed by tetrahydrofuran for 3min. We firstly observed the surface by atomic force microscopy (AFM), as shown in Fig. 2(a). The root mean square (RMS) surface roughness was 0.3 nm. We next measured the water contact angle on the PDMS layer. The water contact angle was 100^{o}, as shown in Fig. 2(b). We considered the PDMS layer to be applied as the nanoimprint antisticking layer. Subsequently, we carried out UV nanoimprinting using the PDMS layer coated quartz mold. PAK-01-60 (Toyo Gosei Co.), which is the UV nanoimprint resin, was spin-coated on a UV/O_3 cleaned Si substrate. The substrate was prebaked at 80 ^{o}C for 1min to evaporate the solvent. Then, UV nanoimprinting was carried out with 1MPa and the imprinted pattern was observed by scanning electron microscopy (SEM), as shown in Fig. 3. The fine pattern was clearly imprinted on the resin. These results indicate that PDMS layer formed by using PDMS-disilanol can be applied as the nanoimprint antisticking layer.

We will discuss the comparative evaluation of the thin PDMS layer formed by PDMS-silanol and PDMS-disilanol.

References

1) M. Okada et al.: J. Vac. Sci. Technol. B **29** (2011) 06FC09.

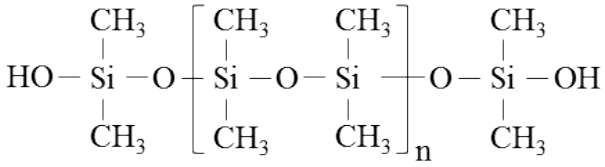
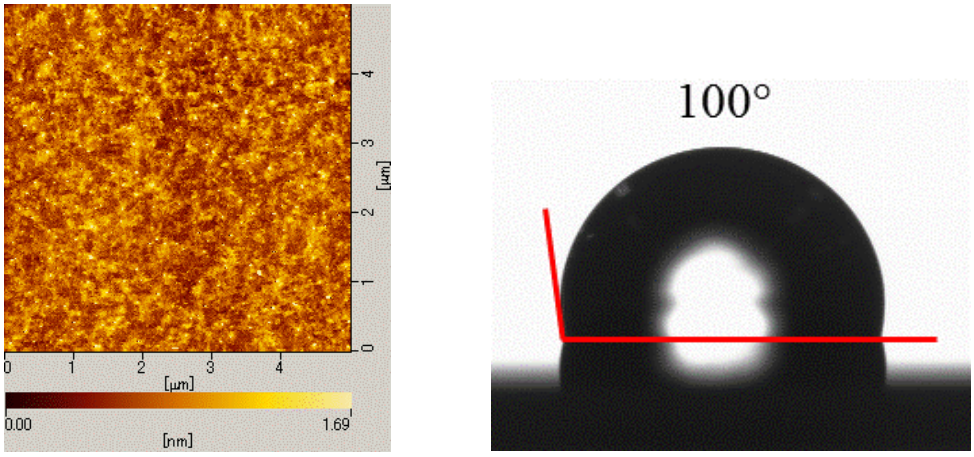


Fig. 1 Chemical structure of PDMS-disilanol.



(a) (b)

Fig. 2 (a) AFM image and (b) water contact angle of thin PDMS layer.

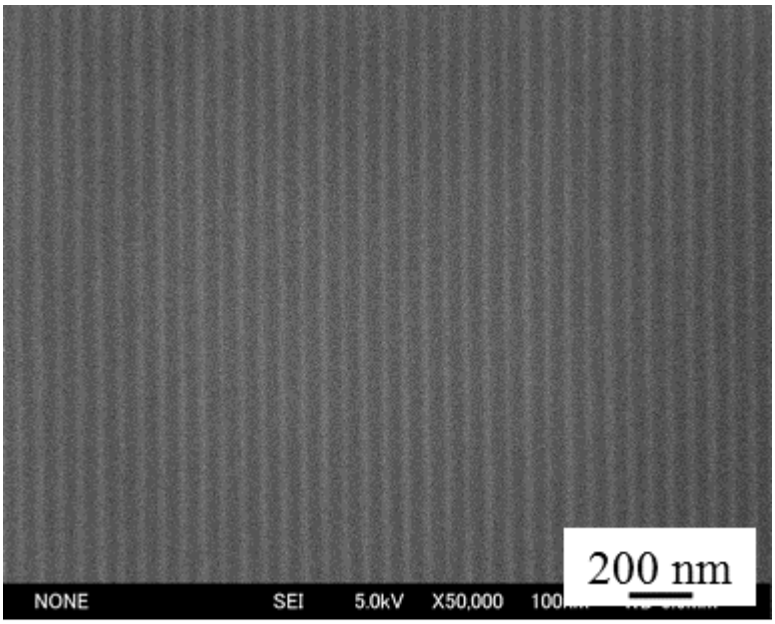


Fig. 3 SEM image of PAK-01-60 pattern fabricated by UV nanoimprinting using thin PDMS layer coated quartz mold.