Characteristics of Antisticking Layer Formed by Plasma Irradiation using Mixture Gas with CHF_3 and O_2 for Nanoimprint

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Nanoimprint lithography (NIL) molds are usually coated with an antisticking layer to prevent them from adhering to replication materials. We carried out nanoimprint using the plasma chemical vapor deposition (CVD) film coated mold. The mixture gas with CHF_3 and O_2 gases were used as a source gas. CHF_3 and O_2 gases flow rates were 100 and 8 sccm, respectively. Pressure and RF power were 50 Pa, and 200 W, respectively. We exposed the plasma using the commercially available reactive ion etching system (RIE-10NR; SAMCO Co.).

First, we examined the characteristics of the CHF_3+O_2 plasma CVD film by contact angle and X-ray photoelectron spectroscopy (XPS). Figure 1 shows the plasma irradiation time dependence of the water contact angle. After plasma irradiation for 5 sec, the contact angle increased 100°. The XPS wide scan spectrum of the CHF_3+O_2 plasma CVD film is shown in Fig. 2. In this case, plasma irradiation time was 1 min. The intense F1s peak was observed. These results indicate that the CHF_3+O_2 plasma CVD film has the high contact angle because fluorine exists on this film surface.

Next, we carried out thermal nanoimprinting using the CHF_3+O_2 plasma CVD film coated SiO_2/Si mold. We used ZEP-520A as the thermoplastic resin. The ZEP-520A was prebaked at 130 °C on a hot plate for 2 min before nanoimprinting. The imprinting pressure and time were 20 MPa and 60 sec, respectively. In thermal nanoimprinting, the mold temperature increased by 170 °C. Figures 3(a) and 3(b) show the scanning electron microscopy (SEM) images of the pattern on the SiO_2/Si mold and ZEP-520A, respectively. The line- and space-widths of the SiO_2/Si mold were 210 nm and 400 nm. As shown in Fig. 2, the pattern was successfully imprinted on the resin without any signs of adhesion. In addition, we carried out repeated thermal nanoimprinting using the CHF_3+O_2 plasma CVD film coated SiO_2/Si mold. Figures 4(a) and 4(b) show the SEM images of the first imprinted and 100th imprinted pattern. After 100 times repeated nanoimprinting, the pattern was clearly imprinted on the resin. This result indicates that the CHF_3+O_2 plasma CVD film has the sufficient durability for repeated thermal nanoimprint.

We will also present that UV nanoimprinting using the CHF_3+O_2 plasma CVD film coated quartz mold.

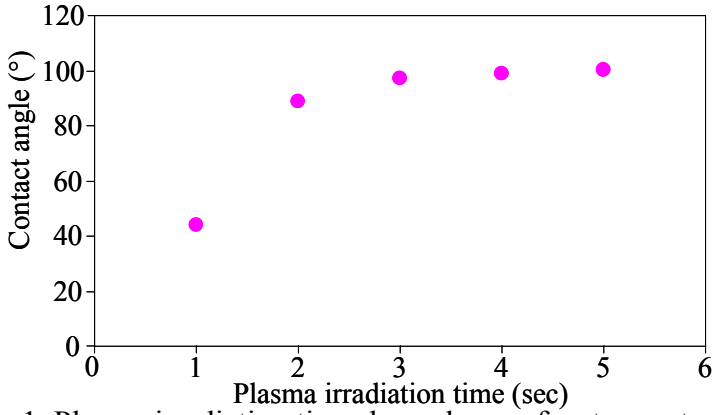


Figure 1. Plasma irradiation time dependence of water contact angle.

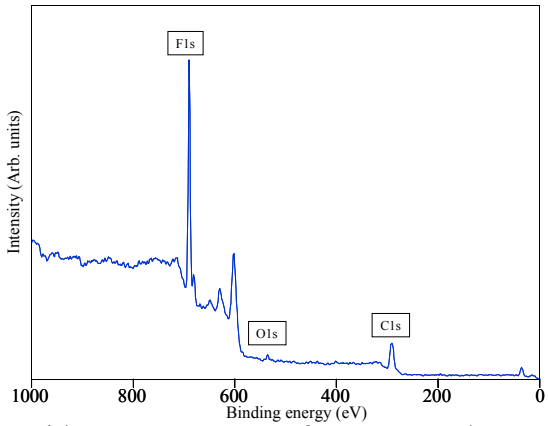
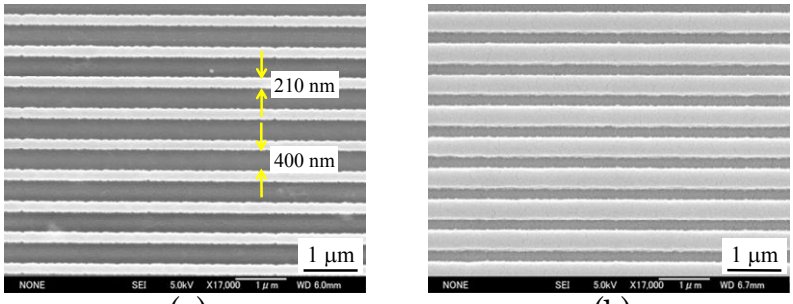
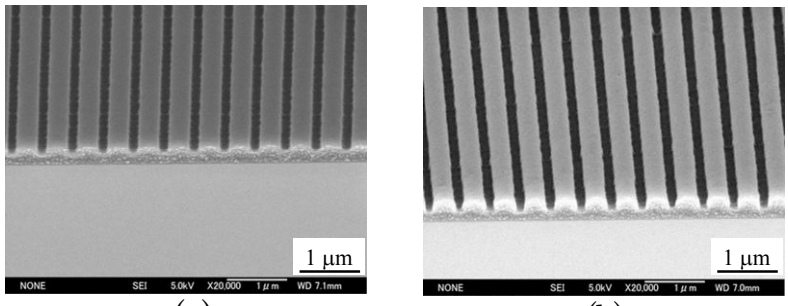


Figure 2. XPS wide scan spectrum of CHF_3+O_2 plasma CVD film.



(a) (b)

Figure 3. SEM images of (a) pattern on SiO_2/Si mold and (b) imprinted pattern on ZEP-520A.



(a) (b)

Figure 4. SEM images of (a) first imprinted pattern and (b) 100th imprinted pattern on ZEP-520A.