Evaluation of fluorine additive segregation in UV nanoimprint resin by X-ray photoelectron spectroscopy

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UV nanoimprint lithography (UV-NIL) has been studying as mass production technique in the nanotechnology field. Since UV-NIL is a contact process, it is very important to decrease the number of defects on the patterned resin. Recently, it has been shown that the additive of fluorine compounds to UV nanoimprint resin maintains the low surface energy, which induced by fluorine compounds segregation[1, 2)]. To improve this technique, we have to investigate the behavior of fluorine compounds in UV nanoimprint resin. In this work, we evaluated the fluorine additive segregation in UV nanoimprint resin by X-ray photoelectron spectroscopy (XPS).

NICT103K (Daicel Co.) was used as UV nanoimprint resin. This resin is cured through the cationic polymerization reaction. We added the non-reactive liquid fluorine additive of 2 wt% to NICT103K and called this resin NICT103Kw20. NICT103K and NICT103Kw20 were spin-coated on Si substrates and prebaked at 80 °C for 1 min. After spin-corting, these resins were exposed to UV for 60 sec in air. UV wavelength and intensity were 365 nm and 64 mW/cm^2, respectively. We then evaluated surfaces of the NICT103K and NICT103Kw20 with 100-, 250-, 500-, and 1000-nm thick by XPS and water contact angle measurement. Figure 1 shows XPS wide scan spectra of NICT103K and NICT103Kw20, and Figs. 2 (a) and (b) show the film thickness dependence of water contact angle and F1s peak area ratio, respectively. The F1s peak area ratio means the F1s peak area percentage to the sum of F1s, O1s, and C1s peak areas in XPS wide scan spectrum. The contact angle of NICT103Kw20 was about 30° higher than that of NICT103K. In addition, although the contact angle of NICT103K did not depend on the film thickness, that of NICT103Kw20 decreased with decrease in the film thickness. The F1s peak area ratio of NICT103Kw20 also showed the same tendency. Especially, the F1s peak area ratio of 500 nm thick-NICT103Kw20 was drastically increased compared to that of 250 nm thick-NICT103Kw20. We therefore examined the depth profile of these resins as shown in Fig. 3. The F1s peak was detected until the depth of 3 nm in 500 nm thick-NICT103Kw20. On the other hand, in 250 nm thick-NICT103Kw20, the F1s peak was disappeared at about 2 nm-depth. These results indicate that the amount of the segregated fluorine additive depends on the resin film thickness.

References.

1) S. Ito, *et al*., J. Vac. Sci. Technol. B **30** (2012) 06FB05.
2) M. Okada, *et al*., J. Vac. Sci. Technol. B **29** (2011) 06FC04.

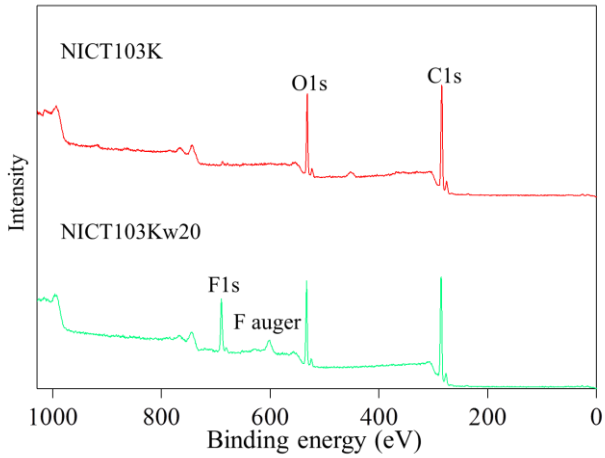
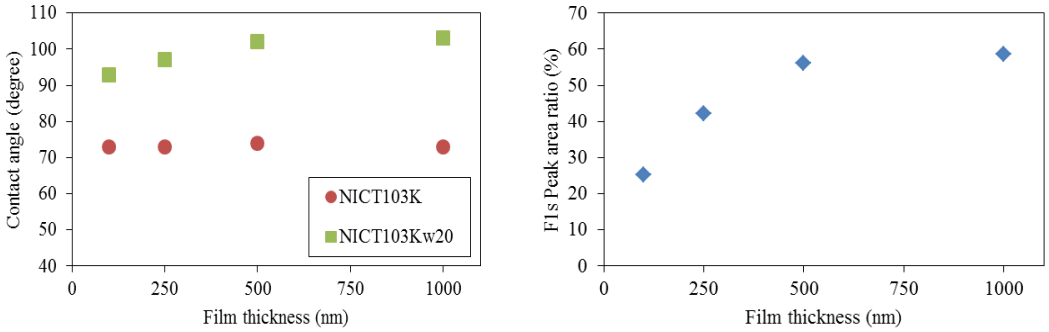
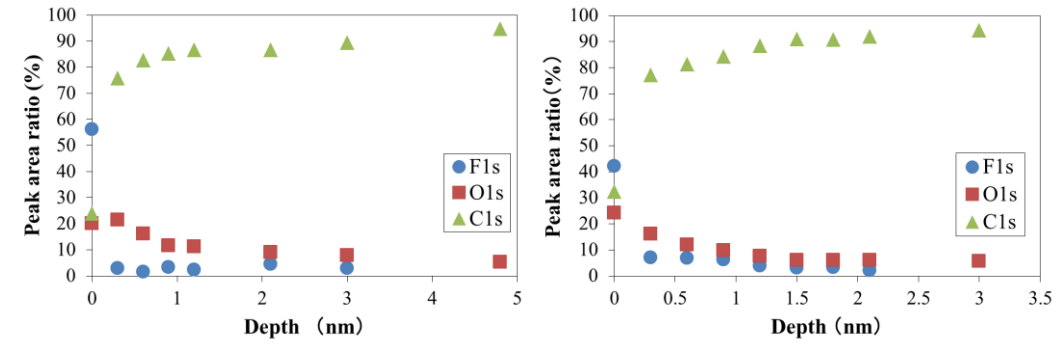


Figure 1: XPS wide scan spectra of NICT103K and NICT103Kw20.



(a) (b)

Figure 2: Film thickness dependence of (a) water contact angle and (b) F1s peak area ratio.



(a) (b)

Figure 3: Depth profile of NICT103Kw20 of (a) 500 nm- and (b) 250 nm-thick.