Durability of DLC Release Coating in Ultraviolet Nanoimprint Lithography

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Nanoimprint lithography (NIL) is very useful for fabrication of nano-scale pattern[1]. In particular, Ultraviolet NIL (UV-NIL) has several merits such as short process time, room temperature operating and high resolution feature size. However, disadvantage of UV-NIL is necessary of release coating to prevent a transfer resin adhesion. To prevent the resin adhesion, diamond like carbon (DLC) coating is a candidate method[2]. However, there are few results of durability of DLC coating in UV-NIL. Therefore, we examined the durability of DLC coating for repetition UV-NIL transfer.

Silicon molds with line and space pattern were used for UV-NIL mold. After the cleaning of Si mold, DLC with fluorinate (F-DLC) was deposited on Si mold by RF plasma chemical vapor deposition (CVD). The deposition conditions of F-DLC were as follows: substrate power, 200 W; gas species, C_6F_6; and flow rate of gas, 6 sccm. After the DLC coating, UV-NIL was carried out. The transfer resin was PAK-01 (Toyo Gosei Co. Ltd.) and UV dose was 200 mJ/cm^2. Figure 1 shows SEM photos of Si mold with F-DLC and UV-NIL pattern. In this case, several wrinkles were generated, because F-DLC has hydrophobic property, thus, adhesion between F-DLC and Si mold was not enough. To improve this problem, intermediate layer was deposited. The deposition conditions of intermediate layer were as follows: substrate power, 80 W; gas species, tetramethylsilane (TMS); and flow rate of gas, 5 sccm. After the intermediate layer with 20 nm thickness on Si mold, F-DLC was deposited with the thickness of 30 nm or 100 nm. Figure 2 shows SEM photo of after 1000 repetition times UV-NIL transfer Si mold, which has 20 nm intermediate layer and 30 nm F-DLC. In this case, DLC coating was broken by repetition UV-NIL transfer. Figure 3 shows SEM photos of initial mold and transfer patterns. In this case, intermediate layer was 20 nm and F-DLC coating was 100 nm. As shown in figures, transferred patterns has 800 nm line and space pattern after 1000 repetition time UV-NIL transfer and any breakages did not occur. Thus, thin F-DLC coating wears during repetition imprint times. We have evaluated durability of F-DLC release coating and intermediate layer and sufficient thickness of F-DLC layer is necessary.

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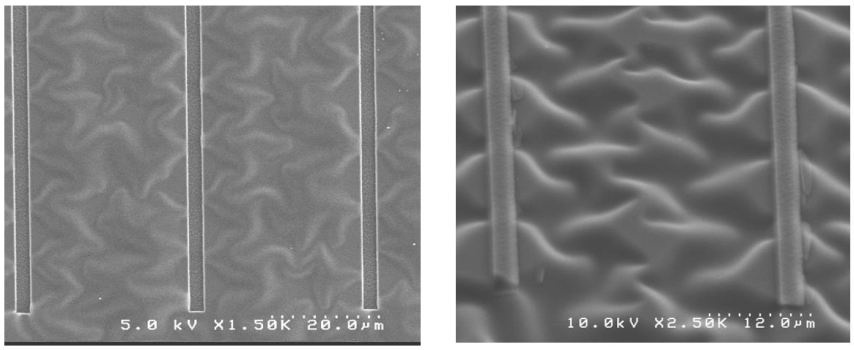
2. F.A. Houle *et al.*, Appl. Phys. Lett. 90 (2007) 213103.



(a) F-DLC coated Si mold (b) UV-NIL transferred pattern

Figure 1: F-DLC coated Si mold (a) and transfer result (b).

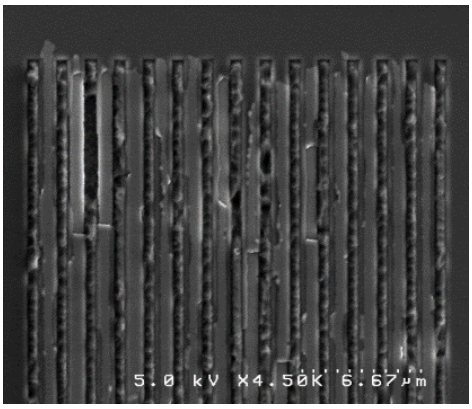
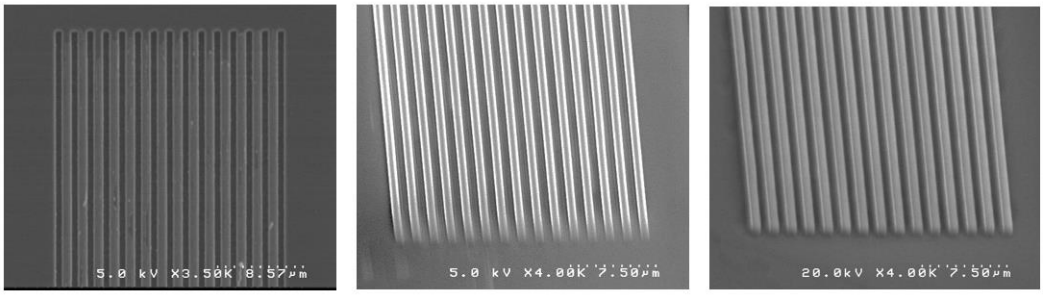


Figure 2: SEM photo of F-DLC coated Si mold after 1000 repetition times.



(a) Si mold with F-DLC (b) 1st time transfer pattern (c) Transfer pattern after 1000 repetition times.

Figure 3: SEM photos of F-DLC coated Si mold (a), 1st time transfer result (b), and Transfer result after 1000 repetition times.