High Density Pattern Transfer via Roll to Roll Ultraviolet Nanoimprint Lithograpy using Replica Mold

J. Taniguchi[1], N. Unno[1], H. Maruyama[1], M. Saito[1], H. Yoshikawa[1]
[1]*Department of Applied Electronics, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba 278-8510, Japan*
junt@te.noda.tus.ac.jp

G. Tazaki[2], T. Zento[2]
[2]*Tsukuba Reserch Center, KURARAY CO., LTD., 41 Miyukigaoka, Tsukuba, Ibaraki305-0841, Japan*

Since the appearance of the first reports on roll-to-roll (RTR) nanoimprint lithography (NIL) [1], research on this technology has expanded to include pattern-transfer techniques[2], fabrication processes for roll molds[3], and various methods for RTR NIL. However, transfer of high density pattern by RTR-NIL is difficult because fabrication of high density pattern is difficult. In order to solve this problem, we have developed replica mold techniques for high density line and space pattern transfer. As a result, high density pattern can be transferred via RTR UV-NIL.

Silicon mold with 100 nm line width and 200 nm depth was fabricated by semiconductor process. This mold pitch was 100 nm line width and 100 nm space width and patterned area was 10 mm square. A replica mold was fabricated by parallel plate UV-NIL process with UV curable resin (PAK-01, Toyo Gosei, Co., LTD.) and polyethylene terephthalate (PET) support film. Patterned surface was release coated by fluorinate silane coupling agent and this film is the replica mold. After the fabrication of the replica molds, these molds were wrapped on base roll mold which was made of cupper and diameter was 150 mm using double side adhesive tape. In this case, 24 pieces replica molds were tiled on base roll mold.

Figure 1 shows the schematic diagram of RTR UV-NIL process and transfer conditions. In this time, UV curable resin (PAK-01) was directly dropped onto wrapped replica mold. In the case of line pattern direction of replica mold and feed direction is vertical; we defined “vertical direction”. On the other hands, line pattern direction of replica mold and feed direction is same; we defined “parallel direction”.

Figure 2 shows cross sectional STEM photos of transferred patterns via RTR UV-NIL. Both directions patterns were transferred, however, line widths and depths were shrunk because of shrinkage of UV curable resin. The high density pattern transfer can be transferred using this technique. The high density patterns are very useful for wire-grid polarizer and other flat panel display films.

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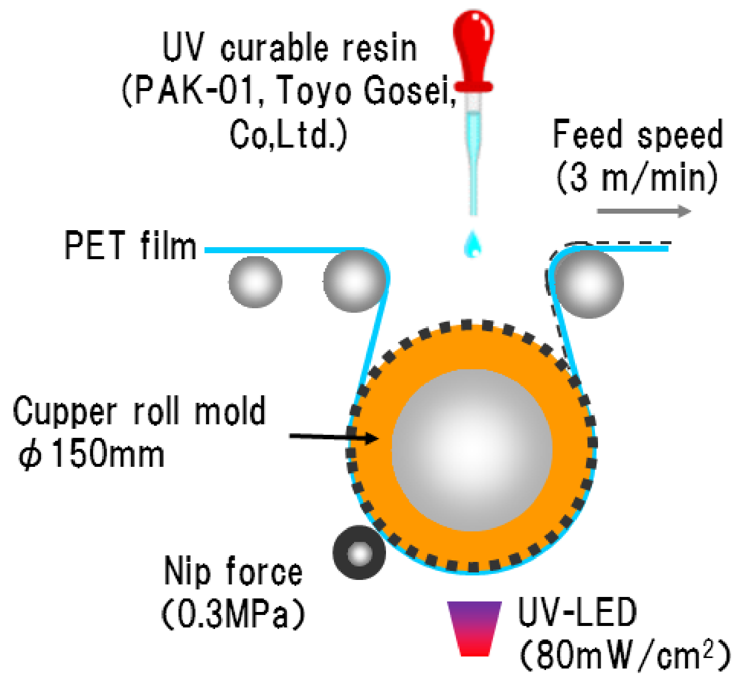

Figure 1: The RTR UV-NIL system and experimental conditions.

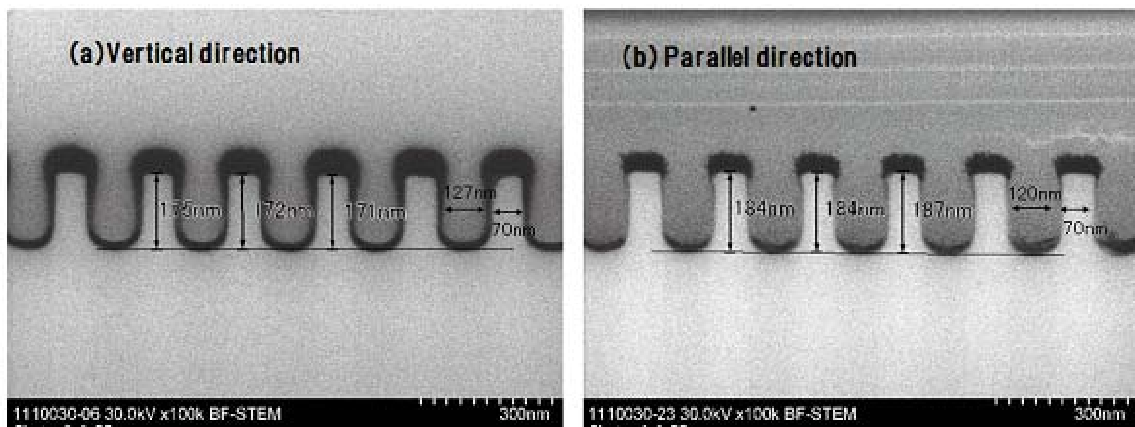

Figure 2: Cross sectional STEM photos of transferred pattern.
(a) Vertical direction (b) Parallel direction