Residual layer less nano-transfer by roll press and liquid transfer imprint lithography

T. Hayashi, J. Taniguchi, M. Moro
Department of Applied Electronics, Tokyo University of Science,
6-3-1 Niijuku, Katsushika-ku, Tokyo 125-8585, Japan
junt@te.noda.tus.ac.jp

Nanoimprint lithography[1] (NIL) is a unique and cost-effective method for the fabrication of nanoscale patterns. However, controlling the thickness of the residual layer is difficult because the NIL transfer mechanism is based on pressing a thin-film polymer between a hard mold and a substrate. Liquid transfer imprint lithography[2] (LTIL) is one candidate for solving this problem, as excess resin is removed by splitting the mold from the resin in the liquid phase. This method also allows for transfer onto warped, undulated, and spherical surfaces because soft replica molds can be used. Polydimethylsiloxane molds are typically used, but other polymer molds can be employed. We examined the replica mold properties and the roll press motion in LTIL. The roll press motion was used for thinning the transfer resin and for the transfer to the substrate. The thinning process does not require other coating equipment such as an applicator or spin-coater.

In this study, holes patterns (diameter: 260 nm; pitch: 500 nm; height: 500 nm) were used for the master mold, and the replica mold was prepared using a UV-curable resins, OEX-028-X433-3 (Autex Co., Ltd.), on a polyethylene terephthalate (PET) film substrate (Cosmoshine A4300; Toyobo Co., Ltd.) and using parallel-plate UV-NIL equipment. Fig. 1 outlines the experimental procedure. The replica mold was brought into contact with the liquid resist layer (PAK-01CL (Toyo Gosei Co., Ltd.)) dropped onto the PET film substrate and pressed by a roller to thin the resist (Fig. 1(a)). The replica mold was then carefully peeled off from the liquid resist layer (Fig. 1(b)), splitting the liquid resist layer into two layers. The liquid resist layer remaining on the replica mold was then brought into contact with a Si substrate under contact pressure by a roller and UV curing (Fig. 1(c)), the replica mold was released from the Si substrate (Fig. 1(d)).

Fig. 2 shows a photograph of the transcription sample after UV curing. Almost the same color was obtained across the sample. We measured the thickness of sample at 9 points and obtained a thickness of 496 nm ± 6 nm with a surface profile meter. Fig 3 shows top and cross-sectional (75° tilted view) SEM images of the transfer result. This patterns were transferred to a silicon substrate without residual layer.

----

1. S. Y. Chou, P. R. Krauss, W. Zhang, L. Guo, and L. Zhuang, J. Vac. Sci. Technol. B 15 (1997) 2897.
2. N. Koo, J.W. Kim, M.Otto, C.Moormann, J. Vac. Sci. Technol. B 29 (2011) 06FC12

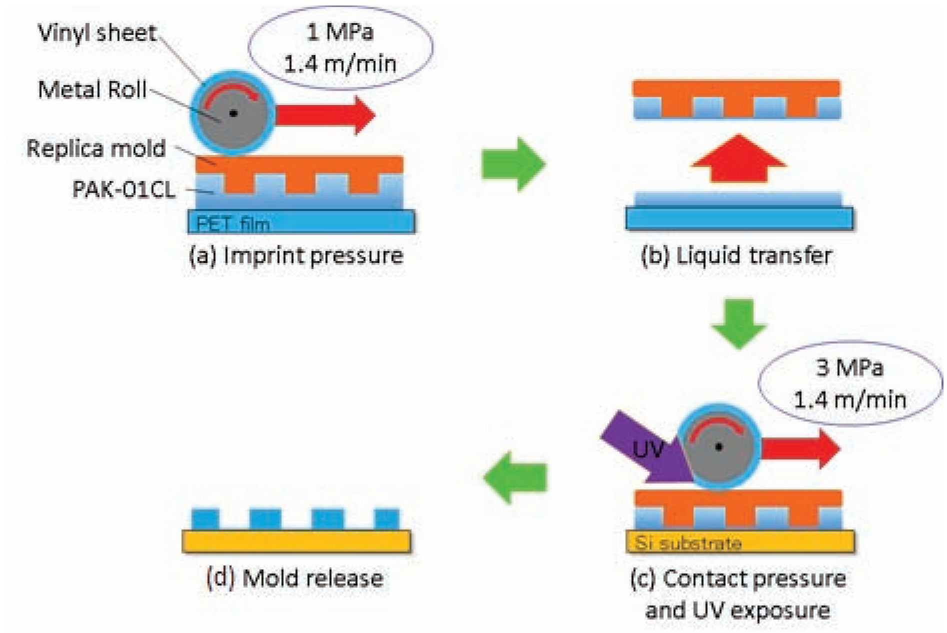

Figure 1: Experimental procedure.

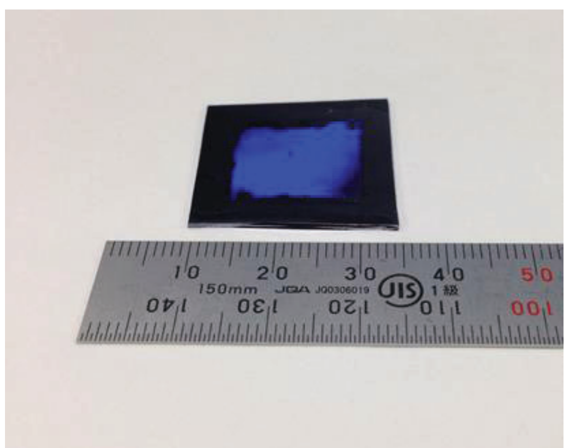

Figure 2: Photograph after transferred on Si substrate.

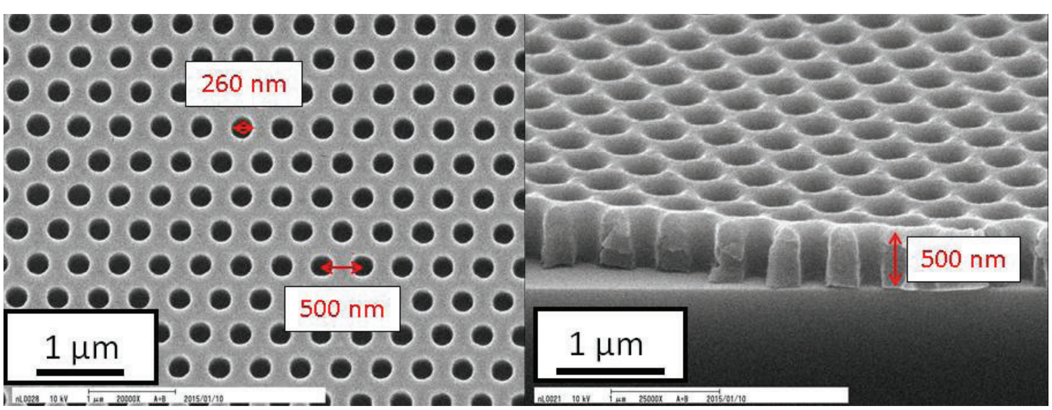

Figure 3: Top and cross-sectional (75° tilted view) SEM images of the transfer result.