Injection Compression Molding of High-Aspect-Ratio Nanostructures

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Injection compression molding is well known to be used to reproduction of optical disks with a short cycle time. The base disks for digital versatile disks (DVDs) are replicated for only 2.5 s as a cycle time. In injection molding, the melted polymer is injected into a cooled cavity and the nanostructures are replicated at the same time cooled down under glass transition temperature (T_g). Therefore, injection molding can realize much higher throughput than general thermal nanoimprint. In this study, high-aspect-ratio nanostructures were replicated by injection compression molding.

Figure 1 shows an overview photo of a replica. The outer diameter, inner diameter, and thickness were 120, 30, 0.6 mm, respectively. This size is similar to that of DVDs. The motion of the mold, injection speed, and injection pressure were also similar to that of DVDs. We used polycarbonate (PC, T_g: 145 °C) which is used for DVDs. We verified the mold temperatures; 80, 90, 100, 110, 120, 130 °C. The cycle time were 2.5 s for the process with mold temperatures of 80, 90, 100 °C, and 5 s for those of 110, 120, 130 °C. The Ni stamper used to the process has 200 nm size and 400 nm deep structures. Figure 2 shows the scanning electron microscopy (SEM) images of the replicated. The filling fraction is higher in the process with higher mold temperature. There was no unevenness of the filling fraction in each sample disk, i.e, the filling fraction near the injection gate was similar to that far from the gate.

Reference: S. Hattori, K. Nagato, T. Hamaguchi, M. Nakao, *Microelectron. Eng.* **87** (2006) 1546.

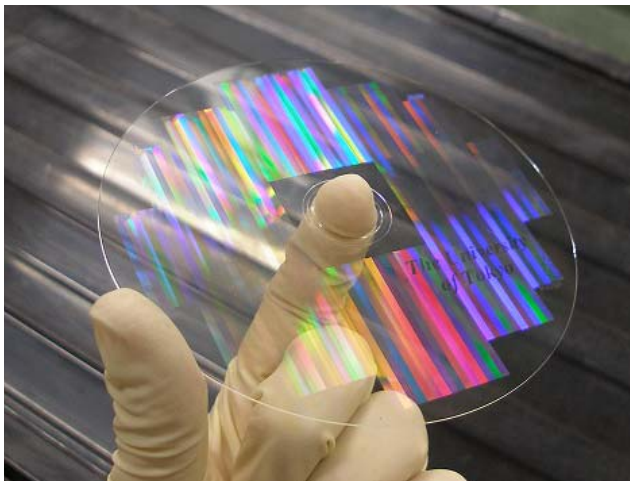

Figure 1. Overview photo of an injection-compression-molded replica. The size is ϕ130 mm, t0.6 mm.

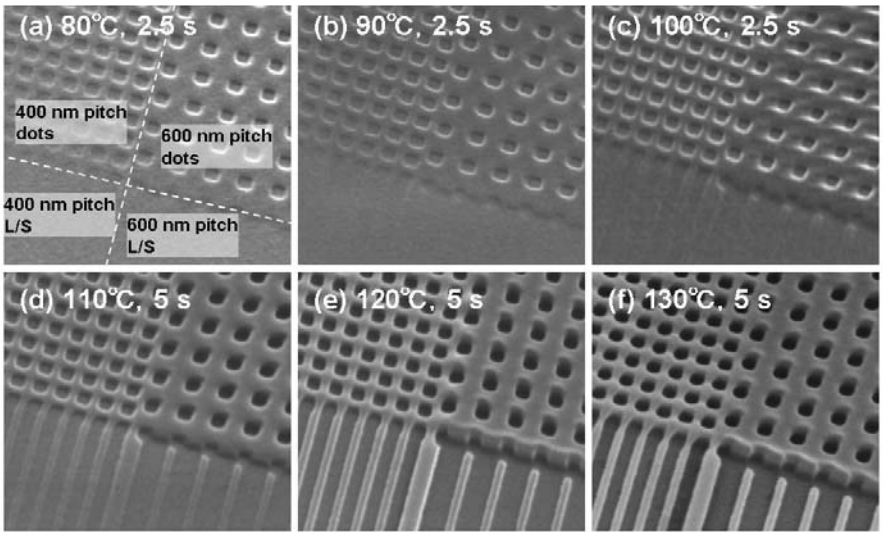

Figure 2. SEM images of replicated PC surface. The mold temperatures and cycle times were (a)80 °C, 2.5 s, (b) 90 °C, 2.5 s, (c) 100 °C, 2.5 s, (d) 110 °C, 5 s, (e) 120 °C, 5 s, and (f) 130 °C, 5 s (Tilt angle: 30 °).