Assessment of release properties on UV-NIL using nano-scale high aspect ratio mold

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Ultraviolet nanoimprint lithography (UV-NIL) is a powerful tool for nano-scale fabrication. This process has many advantages; for example, UV-NIL is a room-temperature process, permitting rapid and high-throughput pattern transfer. Furthermore, UV-NIL is a low-pressure process, so damage to the mold is slight, and brittle molds can be used for pattern replication. In fact, we have been established the high-density and high-aspect-ratio (>15) nano-scale pattern transfer method [1]. In this method, however, the strong release force is required during the release step, thus, the degradation of release coating layer occurs. Therefore, this method can assess the release properties on UV-NIL.

Glassy carbon (GC) surface with an antireflective structure fabricated by irradiation with an oxygen-ion beam was used as mold. This mold surface contains high-aspect-ratio conical structures with pitch of less than 100 nm (Fig.1 (a), (b)). The surface area of this mold was estimated from SEM photos. The mold surface area can change by the changing the ion beam irradiation time. After fabrication of this mold, the mold surface was coated with 30 nm chromium and a fluorinated silane coupling agent. After the release coating the mold, UV-NIL and peel motion release were carried out. Faithful photo-curable resin (PAK-01, PAK-02; Toyo Gosei Ltd.) pattern of the mold structure was obtained (Fig.1 (c), (d)). The dependences of the release force and number of replication time on the surface area are shown in Fig. 2, 3. The release force increased with increasing mold surface area. On the other hand, the number of replication times decreased with increasing mold surface area. These results show larger surface area mold tends to shorter life time of release coating material because of surface area effect. The release force increased with increasing number of replication times (Fig.4). This result shows release force gives an indication of life time of release coating layer. In summary, widely change of mold surface area in UV-NIL can assess the release properties.

[1] J. Taniguchi *et al*., Microelectronic Engineering, in press.

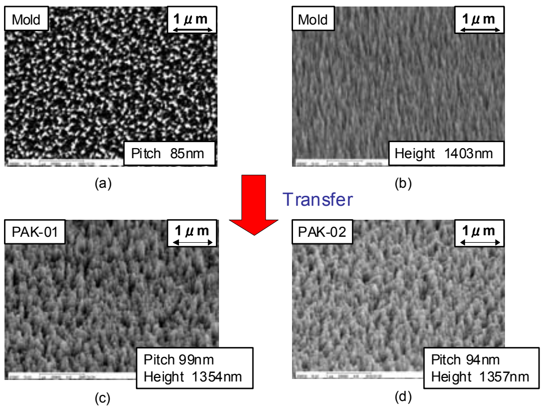

Fig.1 SEM photos of the fabricated GC mold and replicated pattern. GC mold acceleration voltage was 500V and irradiation time was 60min.

(a)Top view of GC mold, (b)Tilted-angle view.

(c)Tilted-angle view of replicated pattern.
Transfer resin was PAK-01.

(d)Transfer resin was PAK-02.

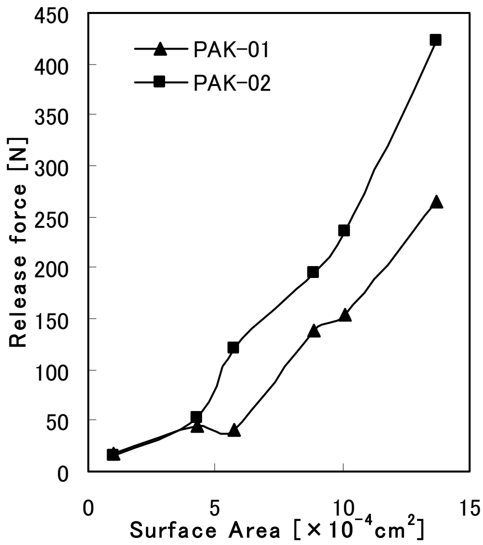

Fig.2 The dependence of the release force on the surface area for various UV photo-curable resins. Surface area was calculated with mold structure.

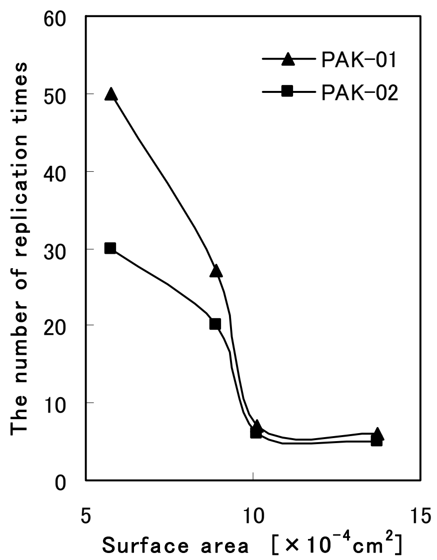

Fig.3 The dependence of the number of replication times on the surface area for various UV photo-curable resins.

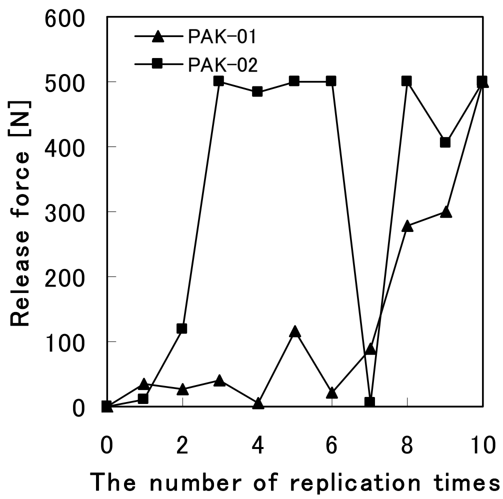

Fig.4 The relationship between the number of replication times and the release force from the 1st to the 10th replication times forced on 500V 30min mold.