Rose-petal surface fabricated by using moth-eye structure with micro-holes structure and UV nanoimprint

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Rose-petal surface has water adhesion property with high water contact angle[1]. This effect is expected to be used as water droplet control. To fabricate this surface, moth-eye structure surface and photolithography was applied. Figure 1 shows a process of fabricating microstructures on the moth-eye structure by photolithography. Moth-eye structured glassy carbon (GC) mold was fabricated by ion beam irradiation using electron cyclotron resonance ion beam equipment. Then SU-8 3025 (Nippon Kayaku Co., Ltd.) was dropped onto the master mold (Fig. 1(1)), and the resist was spread evenly by a spin coater (Fig. 1(2)). After pre-baking at 95 ºC for 10 min on a hotplate to remove excess solvent (Fig. 1(3)), UV irradiation was performed using photomask (Fig. 1(4)). Photomask patterns were circle array with diameter of 25 μm and pitch of 40 μm. Next, post exposure bake (PEB) was done (Fig. 1(5)), followed by immersion in PGMEA, a developer liquid, for 5 min to remove un-sensitized areas, and then rinsed with IPA and pure water (Fig. 1(6,7)). Finally, post-baking in an electric furnace was carried out (Fig. 1(8)). Figure 2 shows a process of transferring moth-eye structure and micro-holes structure using UV-NIL. Fabricated mold (Fig.1(8)) was release coated (Fig. 2(1)). UV curable resin containing fluorine was dropped onto the mold (Fig. 2(2)), then a polyester film was covered on the resin and a slide glass was used to pressurize them (Fig. 2(3)). The resin was then cured by UV irradiation (Fig. 2(4)) and released from the mold (Fig. 2(5)).
Figure 3 shows SEM images of the transferred film. The moth-eye structure and micro-holes structure was obtained. Top surface was transferred of moth-eye structure from GC mold (see Fig. 2(4)). The moth-eye structure made from fluorine-containing resin contributes to water repellency. On the other hand, micro-holes structure fabricated by photolithography contributes to water adhesion. Figure 4 shows the contact angle (CA) and the sliding angle (SA) of the transferred film when the drop volume is increased from 5 to 9 μL. To comparison, results of moth-eye structure film were listed. In the case of the moth-eye structure film, the surface was super hydrophobicity and non-adhesive, whereas the film with moth-eye structure and micro-holes structure was adhesive water-repellent. By adding micro-holes structure to the moth-eye structure, we were able to create a rose petal effect surface. This fabrication method can be used to fabricate various micro-shapes by changing the photomask, and in the future, we will also be able to form water droplet alignment patterns.

1. L. Feng, Y. Zhang, J. Xi, Y. Zhu, N. Wang, F. Xia, and L. Jiang, *Langmuir*, **24** (2008) 4114-4119.

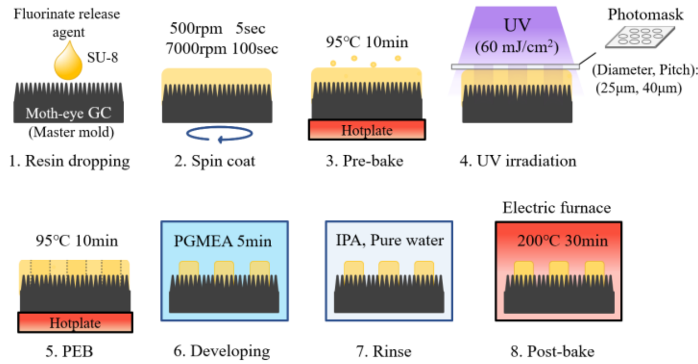


Figure 1: Fabrication process of microstructures on the moth-eye structure by photolithography.

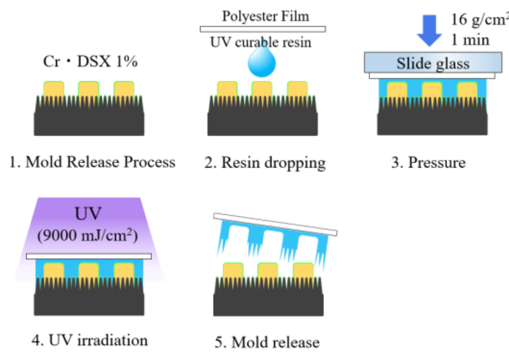


Figure 2: Transfer process of moth-eye structure and micro-holes using UV-NIL.

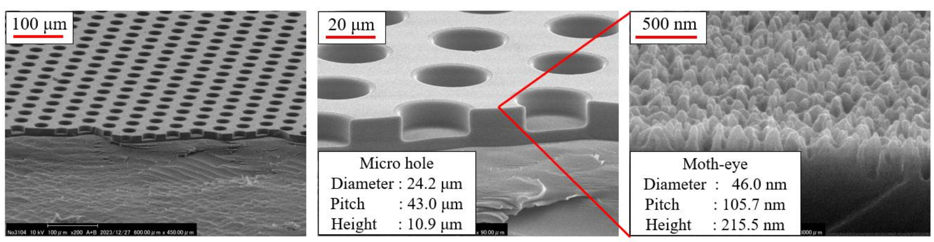


Figure 3: SEM images of the transferred film.

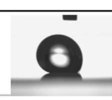
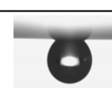
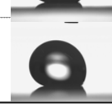
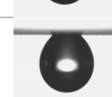
	Moth-eye film		Micro-nano Hybrid film	
Drop volume [μL]	CA [°]	SA [°]	CA [°]	SA [°]
5	152.1	57 	156.2	180 
7	152.7	42 	153.2	180 
9	151.8	34 	153.4	180 

Figure 4: The contact angle (CA) and sliding angle (SA) of the transferred film and moth-eye structure film.