Stable transfer technique of anti-reflection structure using high hardness and anti-fouling UV curable resin

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1. Introduction

A moth-eye structure, which is one of the anti-reflection structures (ARS), is manufactured by processing an oxygen ion shower on a glassy carbon (here after "GC"). Fabricated moth-eye structure on GC surface can use as an Ultraviolet nanoimprint lithography (UV-NIL) mold. However, this moth-eye structured mold is very fragile for high hardness UV-curable resin, so repetition UV-NIL is difficult. Typically, this mold was damaged around from five to ten times repetitions. To avoid this problem, we tried to use a replica mold, which made from moth-eye structured GC mold, for repetition UV-NIL process. A replica mold material was PAK-01-CL (TOYOGOSEI Co., Ltd., here after "PAK-mold") and transfer material was newly developed resin [1], which has high hardness and anti-fouling effect.

2. Fabrication process

Fig. 1 shows a fabrication process of moth-eye structure of newly developed resin from PAK-mold. A newly developed resin was dropped onto a PAK-mold (Fig. 1(a)), and UV curing was carried out with 80 ^{o}C heating and 1.08 kPa pressure. The UV dose was 50 J/cm^2 (Fig. 1(b)). After curing, replica mold was released (Fig. 1(c)). After releasing, transferred pattern was baked to obtain release property (Fig. 1(d)). We examined how many times the PAK-mold can transfer to newly developed resin. The transfer process was from Fig. 1(a) to Fig .1(c). In this experiment, every reflections of transferred moth-eye structures were measured and when the reflection was over 1.0% at 550nm wavelength, repetition UV-NIL was quit.

3. Result

Fig. 2 shows the reflectivity of moth-eye structures with newly developed resin. It shows the reflectance was increased by increasing of repetition times. In this experiment, UV-NIL was quit at 63 repetition times. Fig. 3 shows the SEM images of moth-eye structures at 1st (Fig. 3(a)) and 60th (Fig. 3(b)) by using newly developed resin. The heights of the moth-eye structure of the 1st and 60th were 228 nm, and 187 nm. These results show the reflectivity was increased by decreasing of moth-eye structure height.

4. Conclusion

Using replica mold (PAK-mold), repetition transfers is possible for newly developed resin with moth-eye structure. The replicated high hardness and anti-fouling moth-eye structure has low reflectivity, high hardness and hydrophobic properties and these properties are very useful for practical ARS film [1]. Thus, stable transfer technique using replica mold is very important.

Reference:

[1] Hikari Eto, Shin Hiwasa, Jun Taniguchi, "Tough and antifouling antireflection structures

made by partial-filling ultraviolet nanoimprint lithography" Microelectronic Engineering 197 (2018) 33–38

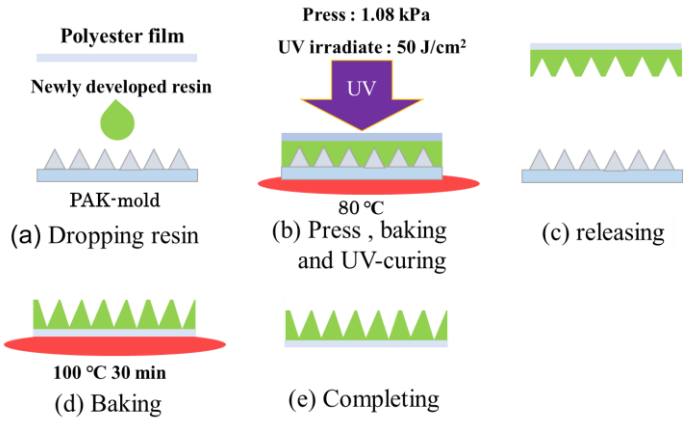


Figure 1. The fabrication process of moth-eye structure of newly developed resin from PAK-mold.

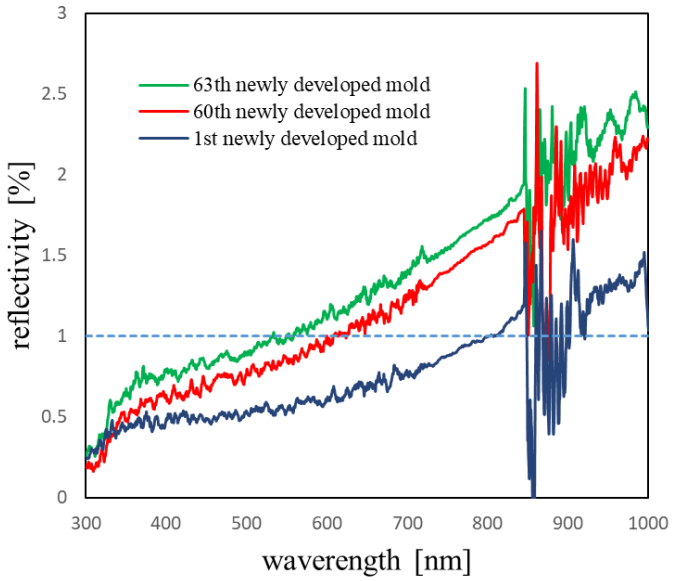
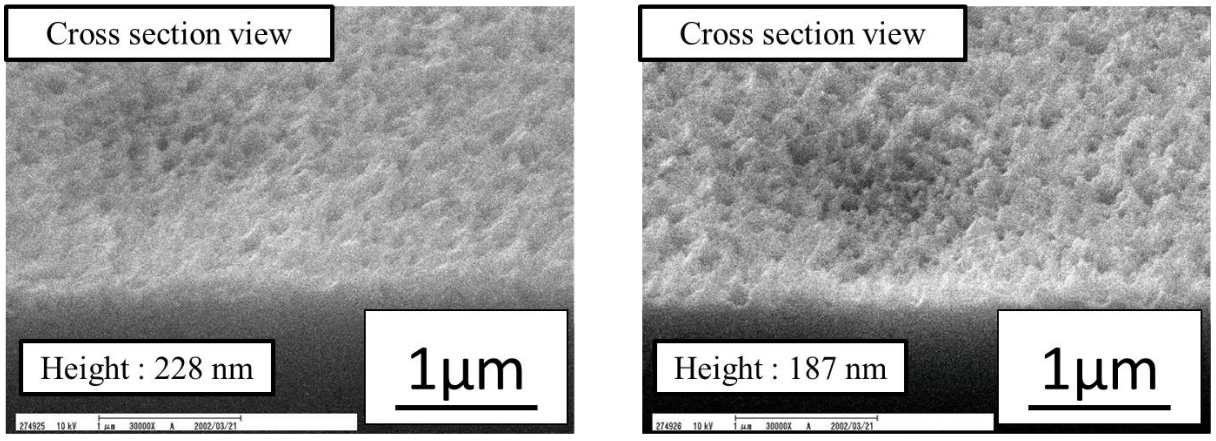


Figure 2. The reflectivity of moth-eye structure made of newly developed resin.



(a) (b)

Figure 3. The SEM images of height of moth-eye structure made of newly developed resin. (a) 1st transfer sample, (b) 60th transfer sample.