Micro-nano mixture patterning by thermal-UV novel nanoimprint

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1. Introduction

Nano imprint lithography (NIL) is expected to realize low cost fine pattern fabrication technology in industrial usage. The advantages are not only high resolution but also wide range capability in various feature size especially for depth direction. In the conventional nano lithography, such as advanced excimer laser lithography, never realizes wide range focus depth over 1 μm or more. On the other hand, the NIL has capability to fabricate nano and micro patterns simultaneously even in depth directions.

In this paper, we propose hybrid patterning by thermal and UV NIL to fabricate micro and nano mixed structures for both lateral and depth directions.

2. Experiment and discussion

2.1 Hybrid process

Figure 1 shows hybrid NIL for micro and nano mixture fabrication. The negative resist is spun coated on Si substrate and the resist is thermally pressed[1-2] to form nano structures as shown in Fig.1-a,b). The mold is optical transmittable material and Cr mask is patterned for the micro pattern fabrication. After thermal imprinting, UV light is exposed to the resist through the mold as shown in Fig.1-c). Finally, the mold is removed and the resist is developed as shown in Fig.1-e,f).

As a result, the resist is developed under the Cr mask pattern and the deep micro structures are fabricated. At the same time, the nano structures are formed by removing the mold, simultaneously.

2.2 Result and discussion

We use SU-8 (Kayaku microchem) for the thermal-UV NIL process. Figure 2 shows visco-elastic property of the SU-8. Over around 60 $^{\circ}C$, the modulus of the SU-8 decreases. Based on this property, the thermal NIL condition is designed.

Figure 3 shows the experimental results of the thermal-UV hybrid NIL. The micro structures having 20 μm in depth and 30 μm in width is successfully fabricated. At the same time, 200 nm dots patterns are fabricated on the micro pattern. Using this method, micro-nano mixture pattern is successfully obtained by a simple NIL process and plain mold.

In advance, using this resist structure as a master, the replicated structure is obtained by Ni electro forming. Using the replicated Ni mold, reversed structure is replicated using polymer plate by NIL. The proposed method will useful to advanced mold fabrication for micro and nano hybrid structures using NIL process.

Acknowledgement
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References

1) W. Wissen, et al., Microelectronic Eng. **73–74** (2004) 184.
2) A. Sekiguchi, et al., *SPIE Microlithography* (San Jose, 2006),**6151**-90.

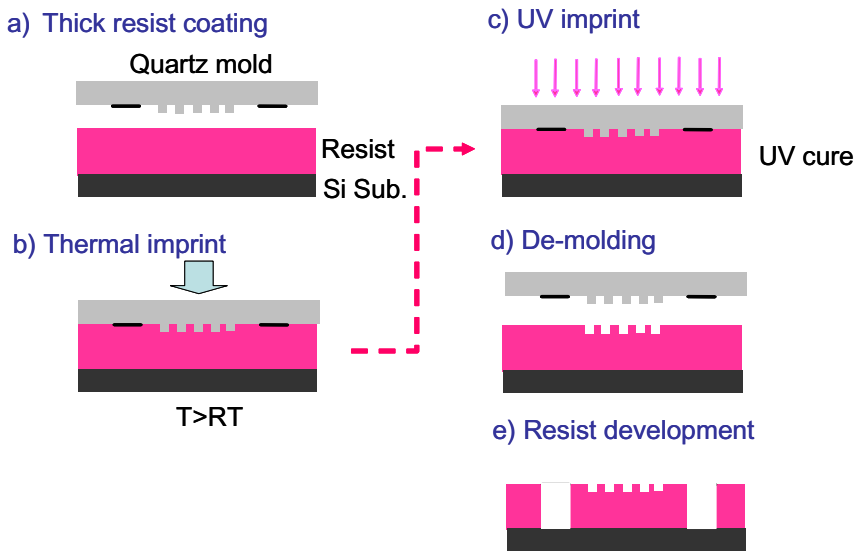


Figure 1. Fabrication process of micro and nano structures by thermal-UV NIL.

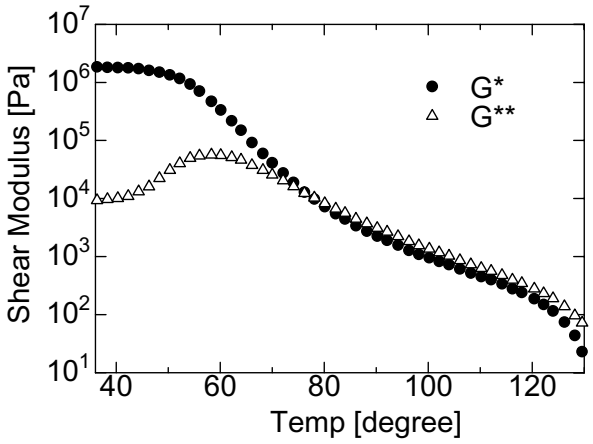
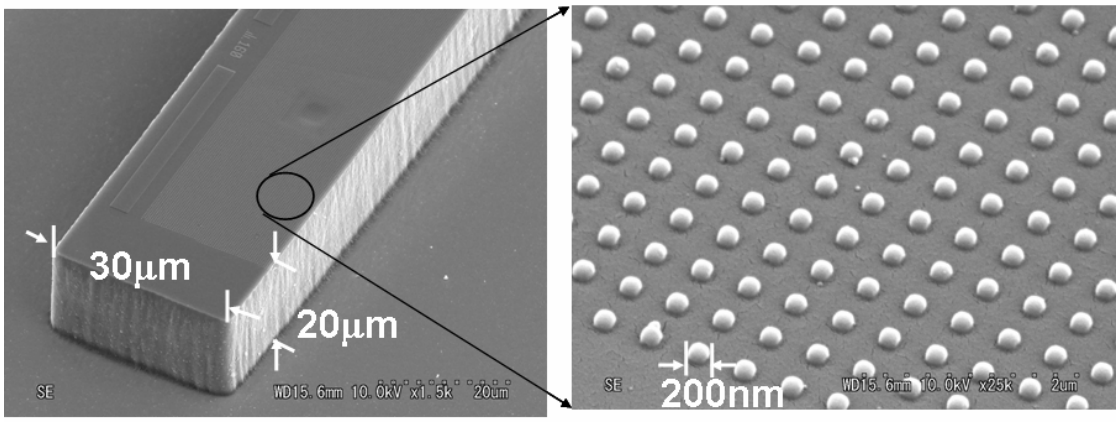


Figure 2. Visco-elastic property of the SU-8.



a) low magnification view b) zoomed view for nano structure.

Figure 3. Experimental result of the micro-nano patterning by the thermal-UV NIL.
(SU-8 20mm on Si ,1.0 MPa, 60 °*C*)