Selective Edge Lithography for Fabricating Imprint Mold with Nano Size and Large Size Mixed Patterns

H. Noma[1,2], J. Sakamoto[1], H. Kawata[1,2], M. Yasuda[1,2] and Y. Hirai[1,2]
[1]*Osaka Prefecture University, Sakai city, Osaka 599-8531, Japan*
[2]*CREST-JST , Kawaguchi , Saitama, 332-0012, Japan*
kawata@pe.osakafu-u.ac.jp

1. Introduction

It is very important to fabricate an imprint mold with nano size patterns for NIL. We have developed the advanced edge lithography process for fabricating nano size patterns [1], and nano size patterns were successfully obtained. However, it is difficult to fabricate large size patterns by the edge lithography. In many applications, nano size and large size patterns are mixed. Therefore, the selective edge lithography process for fabricating nano size and large size mixed patterns is developed. The process and results are shown in this report.

2. Experimental

Si step patterns with SiO_2 film (Fig. 1(A)) are used as the starting patterns for the edge lithography processes. First, we briefly explain the advanced edge lithography which has been already presented [1] by using Figs. 1(A1)~(A4). Both the step top and bottom SiO_2 films are removed by CHF_3 RIE (Fig.1(A1)). A photo resist is spin-coated. Since the resist thickness at the step top is thinner than that at the step bottom (Fig.1(A2)), only the resist on the step top can be removed by O_2 RIE (Fig.1(A3)). Note that the step bottom is covered by the resist. This technique is named as the step bottom coating method. The step top is etched by SF_6 plasma. Then, SiO_2 nano-patterns can be obtained (Fig.1(A4)). In this process, all step tops are removed and no large size patterns are obtained. The selective edge lithography for fabricating nano size and large size mixed patterns is shown in Figs. 1(B1)~(B5). The step bottom with SiO_2 film is covered by the resist by using the step bottom coating method (Fig. 1(B1)). The SiO_2 film on the step top is removed by CHF_3 RIE (Fig. 1(B2)). Note that the SiO_2 film on the step bottom remains. The residual resist is removed and new photo resist is coated. The resist is patterned by photolithography ((Figs. 1(B3) and (B4)), and the Si etching is carried out (Fig. 1(B5)). The step top in the unexposure region is protected by the resist for the Si etching, and the starting large patterns are left. In the exposure region, the step top is etched by the SF_6 plasma, but the step bottom is not etched because it is protected by the SiO_2 film. Then, nano patterns are obtained only in the exposure region.

3. Results and discussions

Figures 2 show the fabricated Si molds. In Fig. 2(a), the line widths of the large and nano patterns are 1.2 μm and 80 nm, respectively. In Fig. 2(b), the line widths of the large and nano patterns are 0.29 μm and 40 nm, respectively. It is clearly shown that both the micron size and nano size mixed patterns and the submicron size and nano size mixed patterns are successfully fabricated.

[1] J. Sakamoto, et al.; Microelectron. Eng., 88, 1992 (2011).

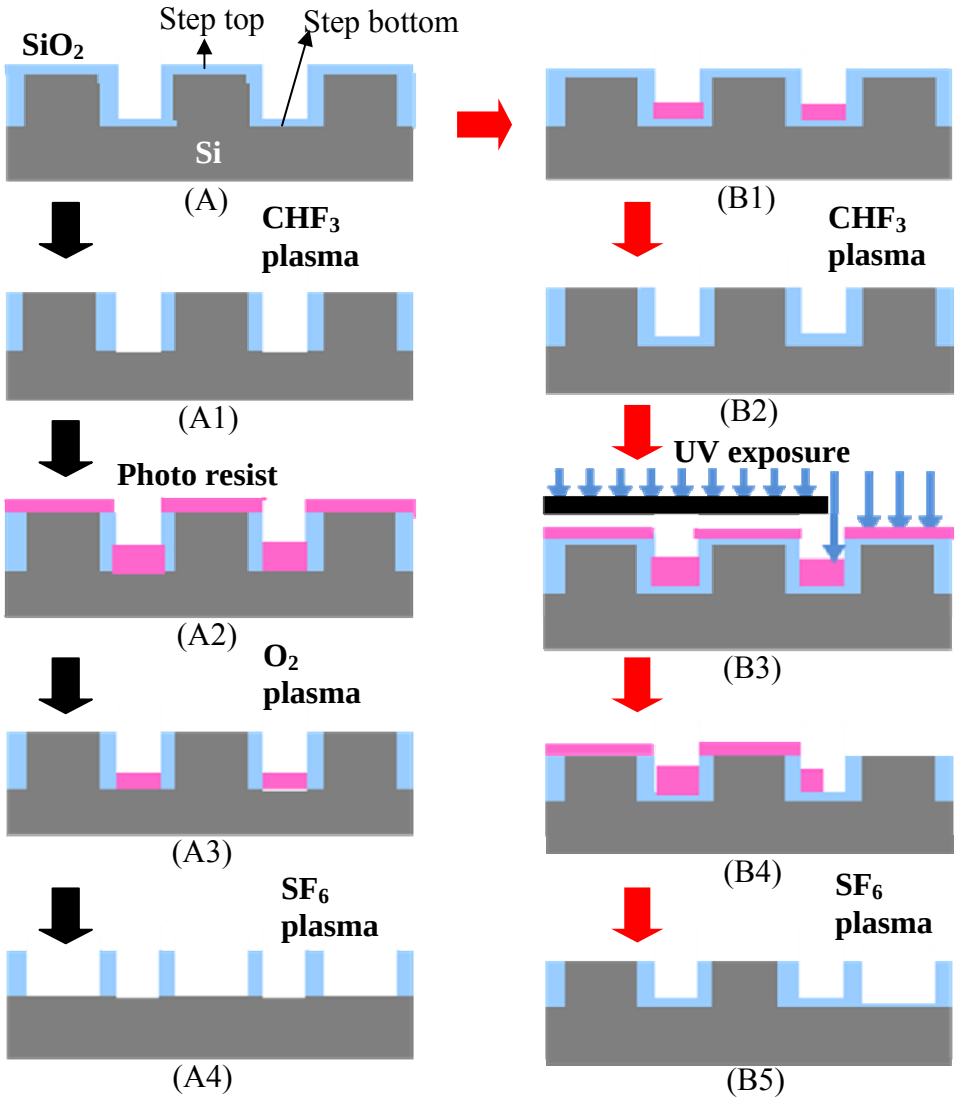
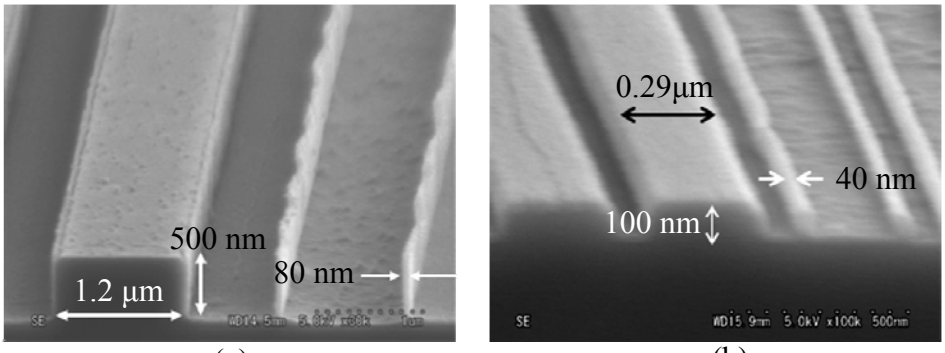


Fig.1 Process flow for the advanced edge lithography ((A1)~(A4)) and the selective edge lithography ((B1)~(B5)).



(a) (b)

Fig.2 Fabricated Si molds, (a) micron size and nano size mixed patterns and (b) submicron size and nano size mixed patterns.