Evaluation of Residual Layer by Nanoimprint Using Liquid Phase Hydrogen Silsesquioxane

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Nanoimprint lithography (NIL) has been attracted a lot of attention from many researchers as a nanoscale patterning technology with many advantages such as simple process, high throughput and low cost. Recently, we reported a new nanoimprint technique using liquid-phase hydrogen silsesquioxane (HSQ) as a replicated material alternative to HSQ resin formed by conventional spin coating.[1)] The imprinting using liquid-phase HSQ provided various HSQ patterns with linewidths ranging from 25 nm to 300 µm, and allowed a simultaneous imprinting of arbitrary patterns including both submicron and greater than one hundred micron patterns by a one-step process. Moreover, after imprinting, the HSQ residual layer that remained in the compressed area was extremely thin. It seemed to be non-residual layer. In this paper, to confirm whether there remained a residual layer or not, we tried to demonstrate a bi-layer process without removing a residual layer.

Figure 1 shows a schematic of the fabrication process of the bi-layer resist structure. (a) First, 1.3µm-thick AZ photoresist was spin-coated on a Si substrate. It was baked at 250 ºC on a hot plate for 2 minutes to increase adhesion between the bottom layer and the substrate. (b) Second, HSQ was dropped on a Si substrate coated AZ photoresist. (c) Third, the mold was pressed at 4 MPa and keeping 90 ºC for 10 minutes to evaporate the solvent. (d) After water-cooling, the mold was removed from the substrate. (e) Finally, O_2 RIE was carried out to etch away AZ bottom layer using HSQ pattern as an etching mask. As the etching rate ratio for AZ photoresist to HSQ is higher than 100 as shown in Fig. 2, if the HSQ residual layer remains after NIL, it is expected that the AZ bottom layer is not etched away by O_2 RIE.

Figure 3 (a) shows a SEM image of 1µm-linewidth HSQ imprinted pattern on a Si substrate coated AZ photoresist. After O_2 RIE without a removing process of HSQ residual layer, HSQ/AZ bi-layer resist structure has been successfully demonstrated as shown in Fig. 3(b). This result revealed that there seems to be achieved non-residual layer in NIL using liquid phase HSQ.

1) K. Nakamatsu et al., Jpn. J. Appl. Phys. **45** , L546 (2006).

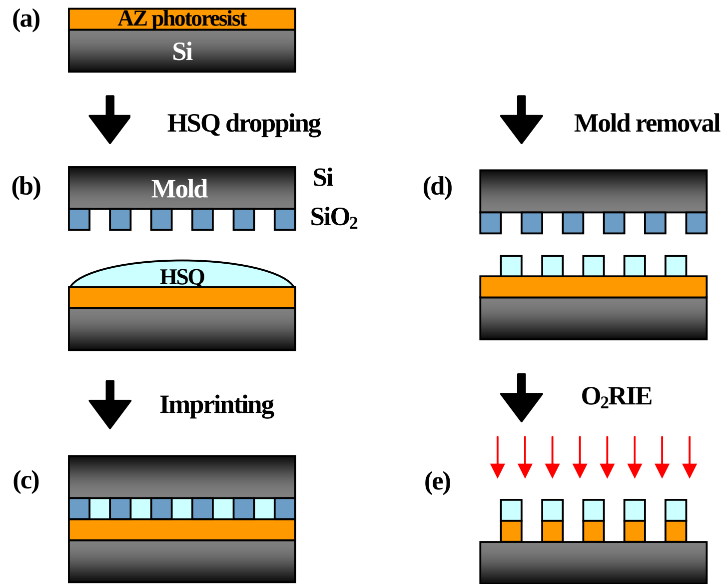

Fig.1 Fabrication process of the HSQ/AZ bi-layer resist structure.

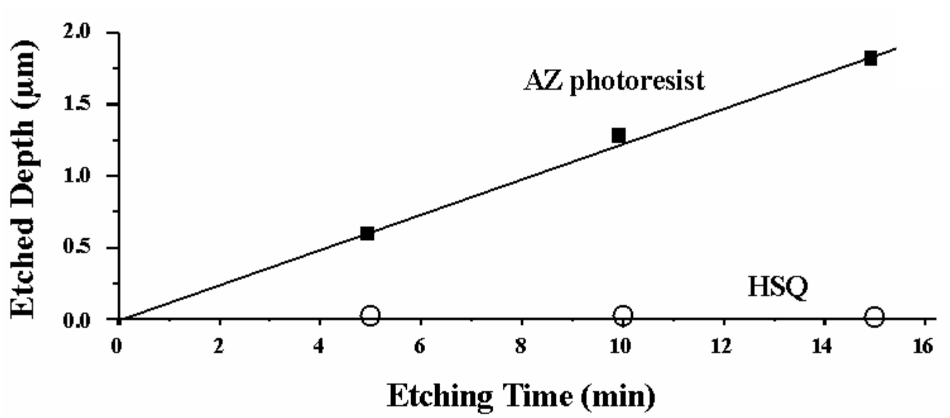

Fig.2 Etching time independence of the etching depth.

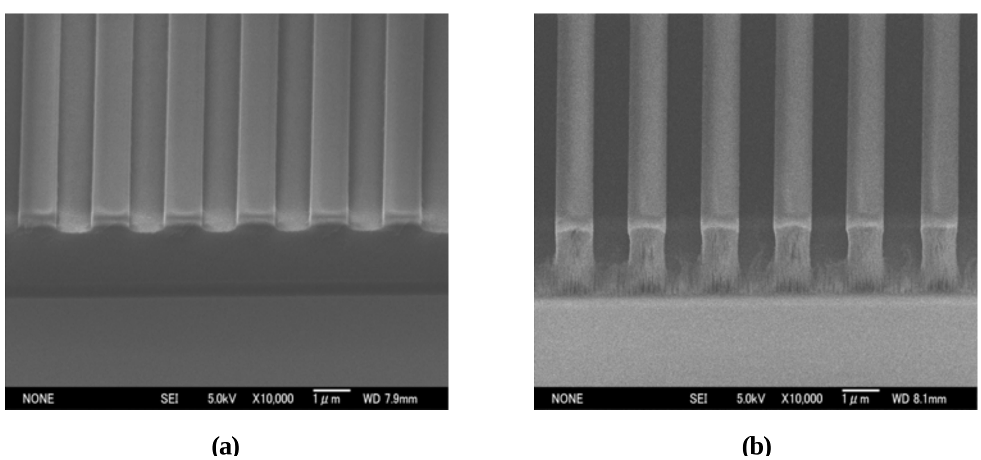

Fig.3 HSQ/AZ bi-structure resist structure (a) before and (b) after O_2 RIE.