

Room-temperature nanoimprint using spin-coated HSQ with high boiling-point solvent

Y. Kang^{1,2,3}, S. Omoto^{1,2}, M. Okada^{1,2,3}, Y. Haruyama^{1,2}, and S. Matsui^{1,2}

¹*University of Hyogo, Kamigori, Ako, Hyogo 678-1205, Japan*

²*JST-CREST, Sanbancho, Chiyoda-ku, Tokyo, 102-0075, Japan*

³*JSPS, Sumitomo-Ichiban Bldg., 6 Ichibancho, Chiyoda-ku, Tokyo 102-8472, Japan*

Tel: +81-0791-58-1432, E-mail:kang@lasti.u-hyogo.ac.jp

Nanoimprint lithography (NIL) is a very useful technique to make nanostructure devices with low cost and high throughput. So far, we reported nanoimprint technique using casted hydrogen silsesquioxane (HSQ; Tokyo Ohka Chemical, OCD T-12) with propyleneglycol dimethylether (PGDM) as a solvent by hard-poly(dimethylsiloxane) (h-PDMS; Shin-Etsu Chemical, X-32-3095) mold.¹⁾ The imprinting technique were replicated at room-temperature (RT) and a low pressure with high throughput, because the mold was pressed onto the liquid-phase HSQ film at low viscosity. Then the solvent in HSQ gradually evaporated through the pores of the h-PDMS mold, and the HSQ was hardened gradually by reaction with water in the air at RT. However, in the case of fabricating a bilayer structure using the HSQ pattern as a etching mask and AZ photoresist as the bottom layer, the imprinting was partly failed due to uneven residue, as shown in Figs. 1(a) and 1(b). The HSQ film with uniform thickness is achieved by spin-coating. However, it is required a high imprinting pressure compared to casting method. To achieve low imprinting pressure in spin-coating method, in this study, we used high boiling-point solvent of tripropyleneglycol dimethylether (MTPOM) which boiling-point is 215 °C in place of previously used solvent of PGDM which boiling point is 96 °C.

We observed whether the solvent evaporated from HSQ films fabricated by casting and spin-coating method by using FT-IR. As shown in Figs. 2(a) and 2(c), the organic peaks for the HSQ films fabricated by casted method using PGDM and MTPOM included C-H stretching at 2800-3000 cm⁻¹ and C-H bending at 1300-1500 cm⁻¹. After spin-coating using PGDM as a solvent, as shown in Fig. 2(b), the organic peaks disappeared. On the other hand, the organic peaks remained after spin-coating using MTPOM as a solvent, as shown in Fig. 2(d). The results indicate that the organic solvent with high boiling point was evaporated slowly. Figures 1(c) and 1(d) show the bilayer structure fabricated by using MTPOM as a solvent. The imprinted patterns were even residues.

Finally, HSQ patterns were successfully replicated on a 6 inch Si wafer in full area and 30 nm line patterns, as shown in Figs. 3 and 4.

In the presentation, we will discuss more details about the time dependences of the solvent evaporation of the spin-coated HSQ film with MTPOM.

References

- 1) Y. Kang *et al.*, Jpn. J. Appl. Phys. **49** (2010) 06GL13.

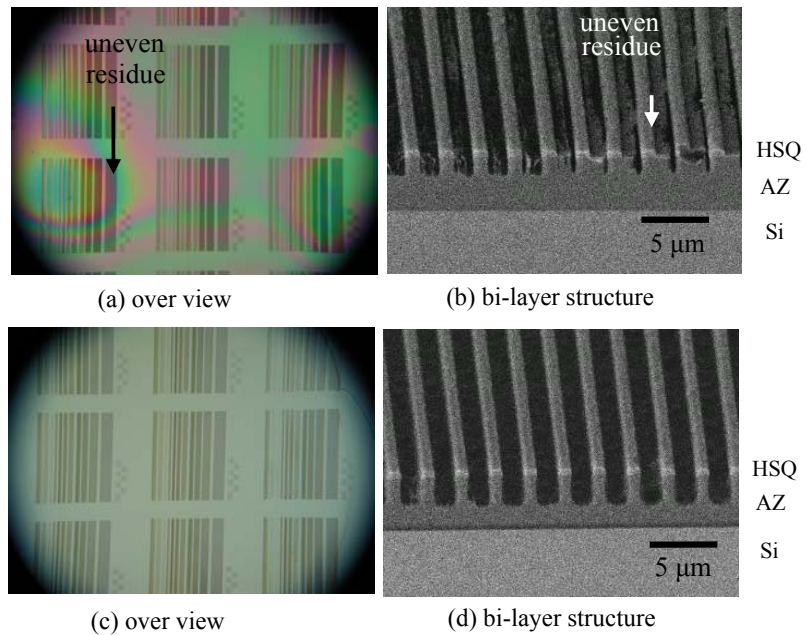


Fig. 1. Micrographs of the imprinted HSQ pattern: (a) and (b) are casted HSQ with (c) and (d) are spin-coated HSQ with MTPOM.

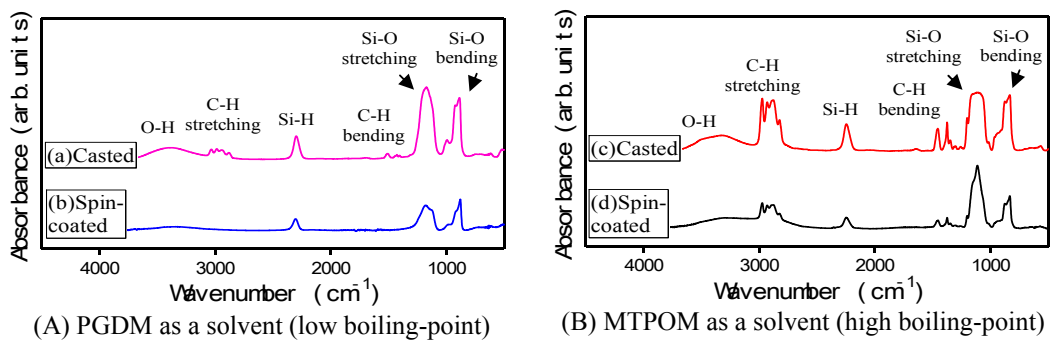


Fig. 2. FT-IR spectra: (a) and (b) used casted HSQ and spin-coated HSQ with PGDM. (c) and (d) used casted HSQ and spin-coated HSQ with MTPOM.

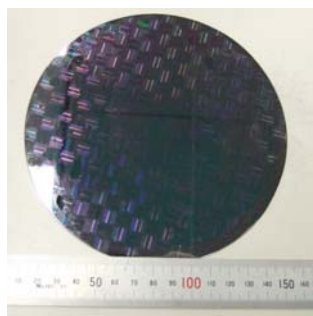


Fig. 3. Photograph of HSQ pattern imprinted on a 6-in. Si wafer.

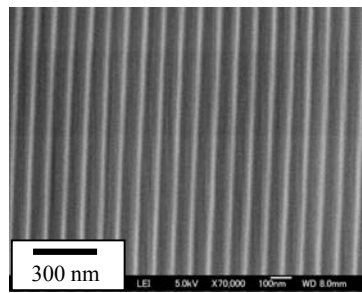


Fig. 4. SEM image of imprinted HSQ pattern. (30 nm lines, 60 nm spaces)