Surface evaluation of HSQ with PDMS additive after room temperature nanoimprinting using hard and soft molds

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Hydrogen silsesquioxane (HSQ) is one of the spin-on-glasses (SOGs) and it is known as a high resolution negative-tone electron beam (EB) resist[1)]. We can use the HSQ pattern fabricated by EB lithography as a nanoimprint mold because it has high hardness and transmittance. However, the EB exposure time to make the HSQ pattern is very long. Previously, we reported that the HSQ pattern can be obtained by room temperature (RT) nanoimprinting with ease[2, 3)]. Furthermore, we tried to fabricate the HSQ replica mold with release property by RT-nanoimprinting using PDMS soft mold onto HSQ with PDMS additive[4)]. However, the life time of HSQ with PDMS additive pattern was about 50 times. To examine why a sufficient release property was not induced, we evaluated the surfaces of HSQ with PDMS additive after RT-nanoimprinting using hard and soft molds.

OCNL103 (Tokyo Ohka Kogyo Co., Ltd) and P7268-DMS (Polymer Source Inc.) were used as HSQ and PDMS additive, respectively. Figures 1 (a) and (b) show the chemical structures of ladder-type HSQ and PDMS additive. To examine of the effect of mold's material, we used SiO_2/Si hard mold and PDMS soft mold (SYLGARD184, Dow Corning Toray Co., Ltd). SiO_2/Si mold was coated with an antisticking layer by using OPTOOL HD1100-TH (Daikin industries, Ltd). We carried out RT-nanoimprinting using these molds on HSQ with and without PDMS additive. Following, the imprinted patterns were annealed. Annealing time was 1 h and annealing temperature were 100, 200, 300, 400 and 500 ºC. To evaluate the release property, we measured water contact angles of HSQ with and without PDMS additive flat surfaces before and after annealing. Figure 2 shows the annealing temperature dependence of water contact angle of the HSQ with and without PDMS additive imprinted by using hard mold. Before annealing, the water contact angle of imprinted HSQ was improved by adding PDMS additive. In addition, the water contact angle of imprinted HSQ with PDMS additive was about 25 º higher than that of imprinted HSQ without PDMS additive after annealing at 300 ºC. We confirmed from these results that the release property was induced by adding PDMS additive when we used a hard mold. Next, we measured the water contact angles of HSQ with and without PDMS additive imprinted by using a soft mold, as shown in Fig. 3. In the case of soft mold, the water contact angles of imprinted HSQ with and without PDMS additive were almost the

same values. Moreover, the water contact angle of HSQ without PDMS additive was over 100 ° by annealing at 300 ºC. This value was higher than that of HSQ without PDMS additive imprinted by using hard mold. These results indicate that the mold's material affect the release property of imprinted HSQ pattern.

In the presentation, we will report the mechanism of mold's material affect.

REFERENCES

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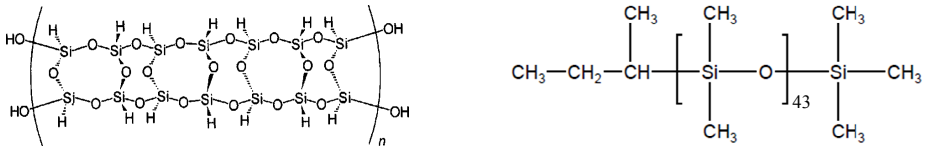

(a) (b)

Fig. 1 Chemical structures of (a) ladder-type HSQ and (b) PDMS additive.

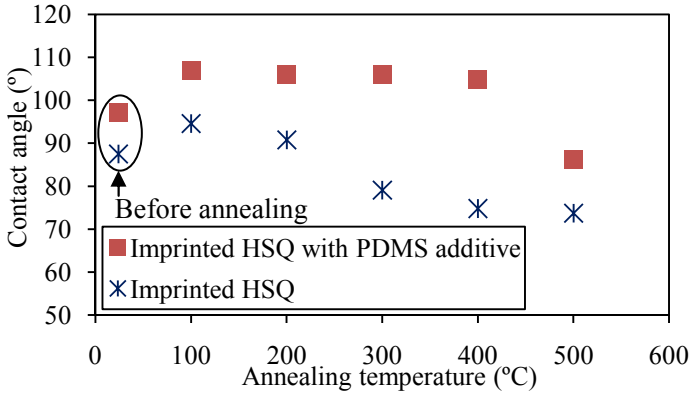

Fig. 2 Annealing temperature dependence of water contact angle of HSQ with and without PDMS additive patterned imprinted by using SiO_2/Si hard mold.

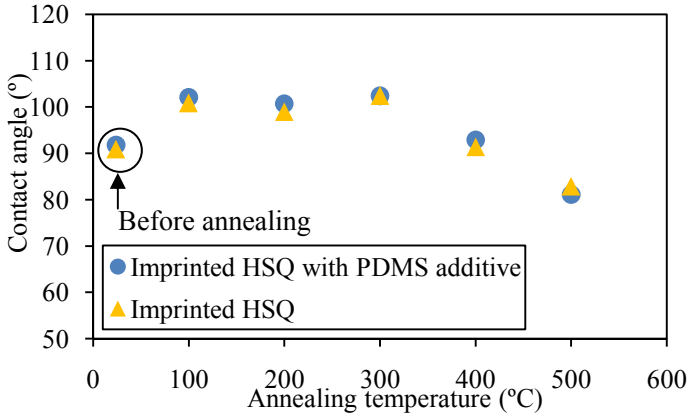

Fig. 3 Annealing temperature dependence of water contact angle of HSQ with and without PDMS additive patterned imprinted by using PDMS soft mold.