Effect of UV Irradiation on Sol-Gel ITO Nanopatterns Replicated by Room-Temperature Nanoimprint

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Nanoimprint lithography (NIL) is a very useful technique to make nanostructure devices with low cost and high throughput. So far, we reported room-temperature NIL (RT-NIL) using hydrogen silsequioxane (HSQ) as a resin, which has a high dry etching durability.

Indium Tin Oxide (ITO) is taken of characteristic by high conductivity and high light transmittance. Therefore, ITO film has been widely used transparent electrode for Liquid Crystal, Solar Panel, and Touch Panel etc. In this paper, we report RT-NIL process using sol-gel ITO (purchased by Kojundo Chemical Lab. Co. Ltd, ITO-05C) as a replicated material. The annealing temperature dependence of resistivity for the spin-coated ITO films was measured, which indicates that the spin-coated ITO film has to be annealed at over 600 ℃ to obtain a low resistivity. The spin-coated ITO film can be delineated by RT-NIL, but the patterns disappeared after annealing process. To overcome the above problem, we examined UV irradiation effect onto a spin-coated ITO film. As a result, we found that the ITO patterns imprinted by RT-NIL were kept at annealing of 600 ℃ for 1 hour by UV irradiation before annealing.

Figure 1 shows a schematic of RT-NIL process using sol-gel ITO. (1) First, ITO was spin-coated onto a glass substrate. The film thickness was 300 nm. (2) And then ITO-coated substrate was prebaked at 180 ℃ for 2 min before nanoimprint. (3) Following, RT-NIL was performed by using the SiO_2/Si mold. The imprinting temperature, pressure and time were RT, 20 MPa, and 60 sec, respectively. Next, (4b) UV (365 nm, 62 mW/cm^2) was irradiated onto the patterned ITO film for 60 sec. (5) Finally, the ITO film was annealed at 600℃.

Figure 2 shows SEM micrographs of imprinted ITO patterns before and after the annealing. Figures 2 (a) shows the line patterns with 300 nm L&S and 200 nm heights before the annealing. Figure 2 (b) shows the patterns disappeared after annealing. However, the line patterns exposed by UV were remained after the annealing as showing in Fig.2 (c). The line patterns were 600 nm pitch, 100 nm linewidths and 70 nm heights. These results indicate that the patterns linewidth and height were reduced

to one to third due to the evaporation of organic solvent in sol-gel ITO. These results have demonstrated that the sol-gel ITO film can be delineated by RT-NIL using UV irradiation before the annealing.

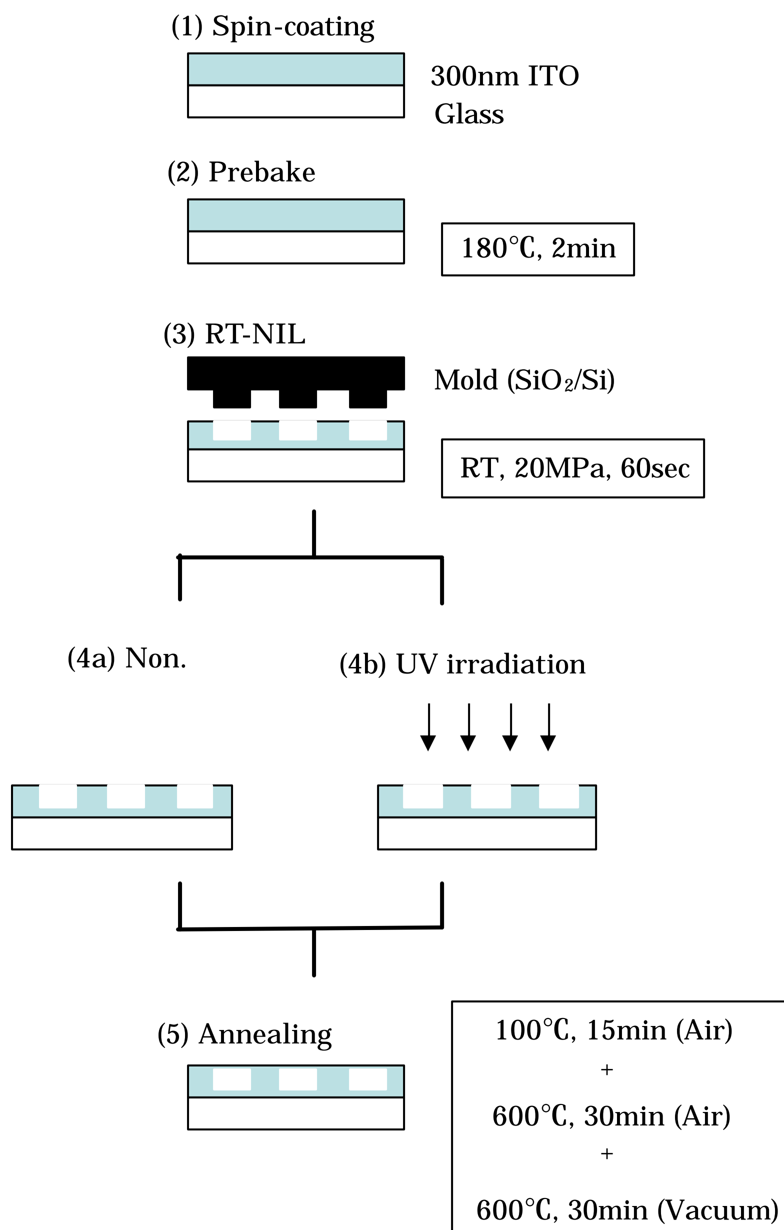
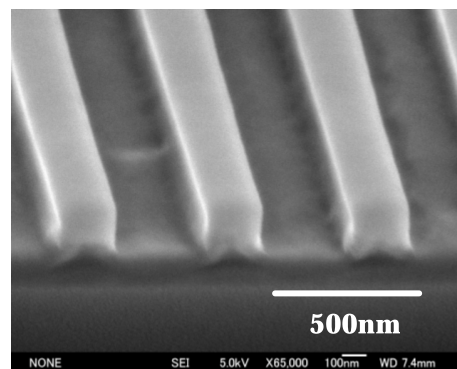
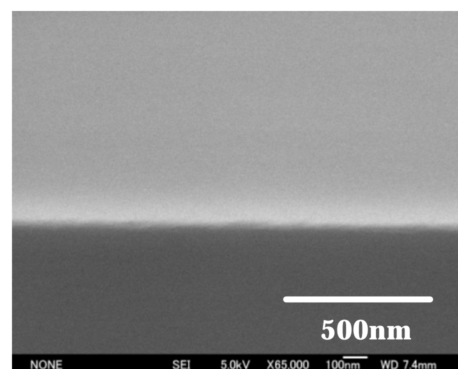


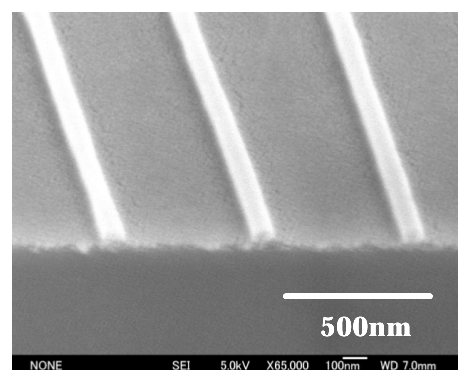
Fig.1 Schematic of RT-NIL process using sol-gel ITO.



(a) Before the annealing(Process (3))



(b) After the annealing without UV irradiation (Process (4a))



(c) After the annealing with UV irradiation (Process (4b))

Fig.2 SEM micrographs of imprinted ITO patterns.