

Fabrication of nano dots array mold using inorganic electron beam resist and post exposure bake

Jun Taniguchi¹⁾, Tetsuro Manabe¹⁾, and Kiyoshi Ishikawa²⁾

1) Tokyo University of Science, 2641 Yamazaki, Noda, Chiba 278-8510, Japan

2) TOKYO OHKA KOGYO CO., LTD 1590 Tabata, Samukawa, Koza, Kanagawa, 253-0014 Japan

Nanoimprint lithography (NIL) is a promising method for fabricating nanoscale patterns and this technology applies to fabrication of patterned media. However, fabrication of patterned media mold is very severe because patterns are very high resolution and very high density even if we use the electron beam direct writing. Thus, novel fabrication process is required. Our previous studies have reported that a low-acceleration-voltage electron beam lithography (EBL) system with inorganic resist can be used to delineate the fine L&S pattern [1, 2]. In addition, post exposure bake (PEB) is effective to reduce proximity effect, so fine pitch L&S pattern have been obtained [3]. Using inorganic electron beam resist and PEB, novel mold fabrication process for patterned media has been established. Advantages of this process are as follows: developed resist pattern can use as mold and resolution are improved by post exposure bake.

NIMO-P0701 (TOKYO OHKA KOGYO CO., LTD), which is composed mainly of siloxane, was employed as positive type inorganic resist. First, NIMO-P0701 was spin-coated at 3000 rpm on a Si substrate, followed by a 90 seconds prebake at 300 °C, resulting in a 300 nm film. Then, ERA-8800FE (ELIONIX Co.) was used for EBL system with 4 kV acceleration voltage, 17 pA of beam current and about 30 nm beam diameter. A buffered hydrofluoric acid (BHF) solution was used for developer and developing time was a minute. The developed inorganic resist has enough hardness to be used for mold because this resist structure is almost equivalent to that of quartz. The replicated pattern was obtained by ultraviolet-NIL with photo curable resin (PAK-01, Toyo Gosei Co., Ltd.).

Figure 1 shows the designed nano dots array pattern. Spot electron beam irradiated at black parts on resist. Figure 2 shows the SEM images of nano dots array pattern with 200 °C PEB temperature and 60 μ C/cm² EB dose. Nano dots array with 20 nm diameter and 40 nm space was fabricated. Without PEB, nano dots array did not obtain. This dose is reasonable in EB direct writing method. Thus, low acceleration voltage EBL enhances the sensitivity and PEB suppresses the proximity effect. Figure 3 shows replicated pattern using Fig.2 mold and 20 nm dots were replicated. This method is very useful for patterned media and nano dots patterned plasmon devices.

[1] Y. Ishii and Jun Taniguchi, *Microelectron. Eng.* **84**, 912(2007).

[2] N. Unno, J. Taniguchi and Y. Ishii, *J. Vac. Sci. Technol. B* **25** (2007) 2361.

[3] N. Unno, J. Taniguchi *et al.*, *J. Vac. Sci. Technol. B* **26** (2007) 2390.

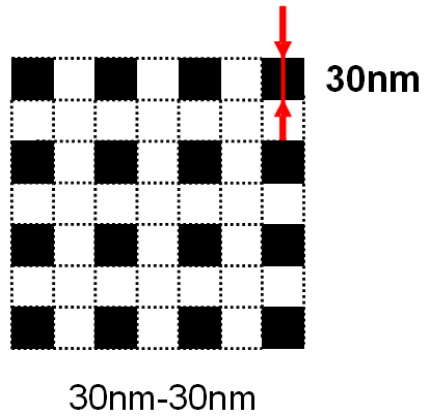


Fig 1: The designed nano dots array pattern.

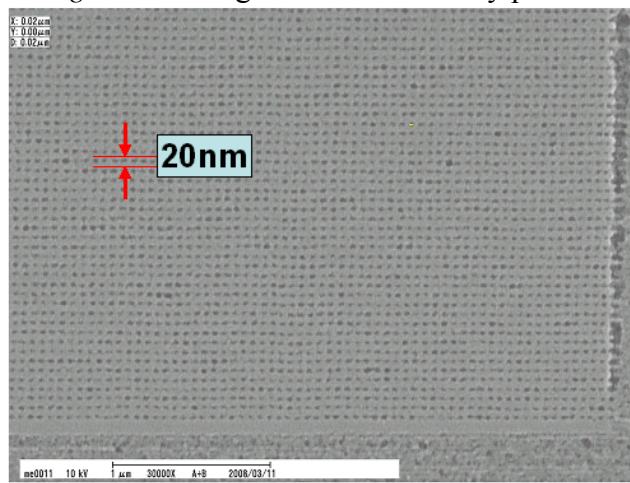


Fig 2: SEM images of nano dots array pattern with 200 °C PEB temperature and 60 $\mu\text{C}/\text{cm}^2$ EB dose.

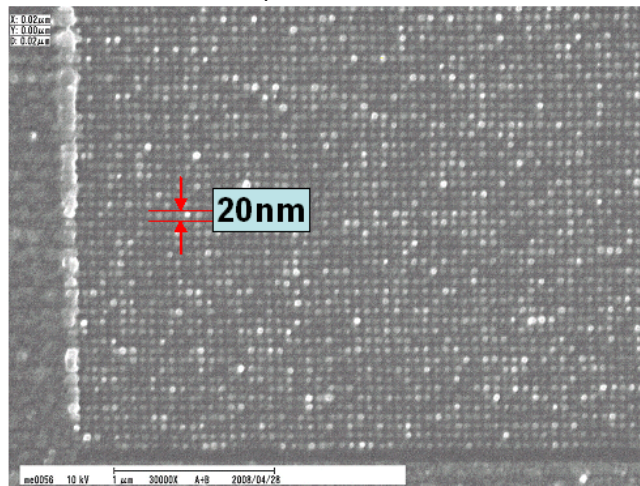


Fig 3: SEM image of replicated pattern using Fig.2 mold.