Three dimensional hologram-ROM duplication by UV-NIL

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Since the data size of pictures, videos and all other file has been increasing every year, a strong need exists for high speed and large capacity read only memory (ROM) to distribute it readily. Computer generated hologram-ROM (CGH-ROM) has received a lot of attention because it has possibility to meet the rising demand[1]. However, CGH-ROM needs a nano-scale precision structure as well as nano-steps[2], so it is difficult to produce in large volume at low cost. In order to fabricate the complex and high-precision pattern cost-effectively, nanoimprint lithography (NIL) is a promising method because of its process simplicity[3]. In this study, we demonstrate CGH-ROM duplication by ultra violet NIL (UV-NIL) via a three-dimensional (3D) master mold, which is fabricated by electron beam lithography (EBL).

Figure 1 shows the target structure of reflective type CGH. In order to fabricate CGH easily while it has high diffraction efficiency, the calculated depths of CGH were converted into 4 tones. The reconstruction wave length λ was 405 nm, and the step width Λ was 1.2 μm. The total size of CGH was 900 μm^2. In this case, EBL by using spin on glass and super-resolution technique via post exposure bake[4] was employed to fabricate a 3D master mold. First, spin on glass was spin-coated on a Si substrate. Then, ERA-8800FE (ELIONIX Co.) was used for EBL system. The EB acceleration voltage and current was 10 kV and 100 pA, respectively. At this time, the developed depth was controlled by EB exposure dose, namely, the higher EB dose tended to produce the deeper pattern. After EB exposure, the sample was post-baked at 300 °C at 5 min. Next, a buffered hydrofluoric acid (BHF) solution was used for developer and developing time was 90 s. Figure 2(a), (b) show the obtained master mold images. The developed spin on glass has enough hardness to be used for UV-NIL mold directly because this resist structure is almost equivalent to that of quartz and has high hardness. Finally, the duplication pattern was obtained by UV-NIL with PAK-01 (Toyo Gosei Co., Ltd.). Figure 3(a), (b) shows a design bitmap image and a reconstruction image obtained by CCD-camera using the replicated pattern via 405 nm continuous wave laser. The reconstruction image was corresponded to the design image.

We believe that our approach helps the realization of the CGH-ROM. We will investigate the finer and denser 3D pattern duplication and its reconstruction.

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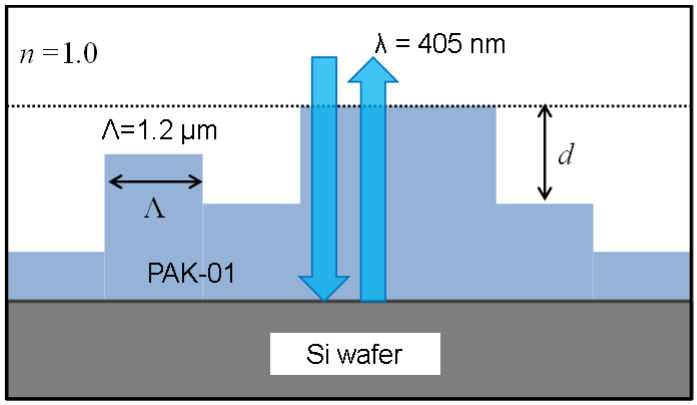
[3] J. Taniguchi et al., *Appl. Surf. Sci.*, 238 (2004) 324.
[4] N. Unno et al., *J. Vac. Sci. Technol. B* 26 (2008) 2390.



Phase	Calcurated depth d (nm)
π/2	379.7
π	253.1
3π/2	126.6

Figure 1: The target structure of reflective type CGH-ROM.

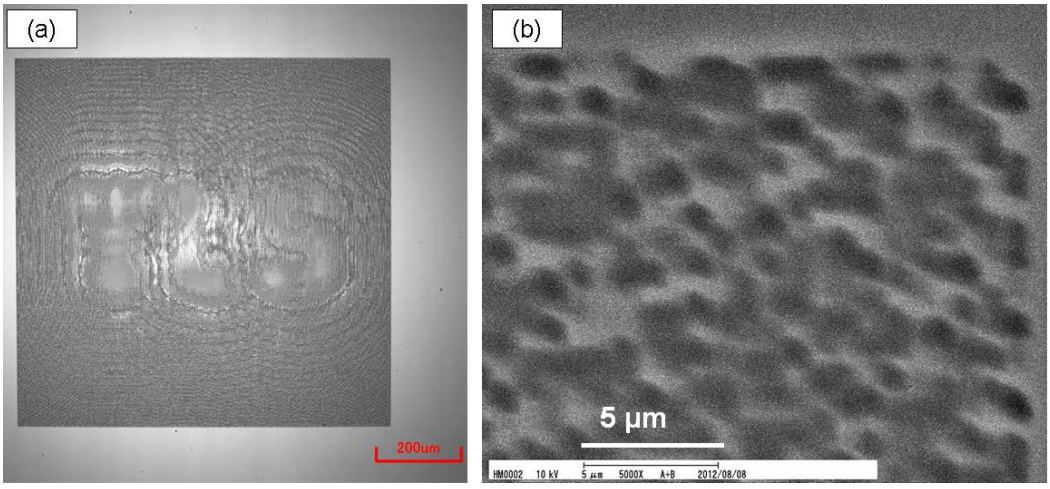


Figure 2: (a) Laser microscope and (b) SEM image of the master mold.

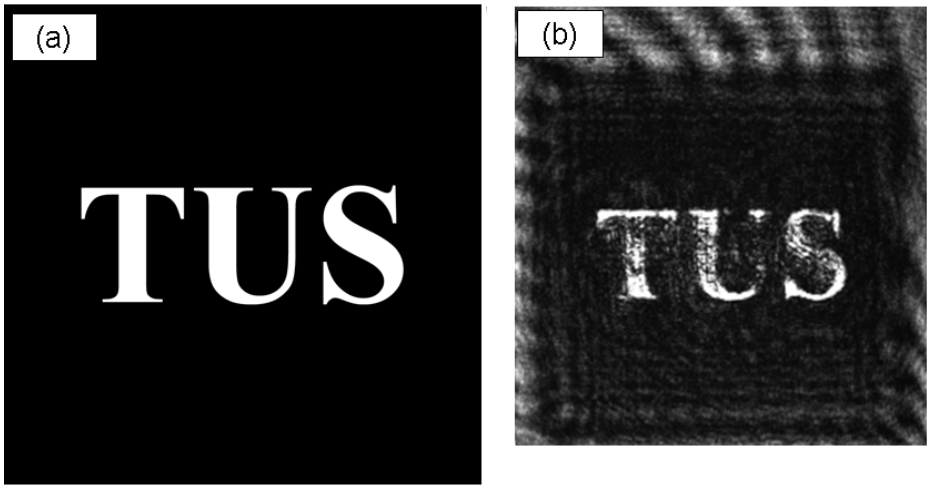


Figure 3: (a) Design BMP and (b) reconstruct image obtained by CCD-camera.