Development of a large areal metallic nano stamp fabrication process using UV nanoimprinting and pulse reverse current electroforming for discrete track media with pattern width of 35nm

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A reliable and efficient fabrication technology for nano-patterned substrate is required for mass production of components in the fields such as data storage, functional surfaces, bio-sensors and so on. Nanoimprinting and nano-injection molding which utilize nano stamp have been commonly used to replicate nano patterns at low cost. Among the various candidates for nano stamps, the metallic stamp is more suitable for mass production since it offers a high durability, pattern fidelity, and dimensional accuracy.[1] In this research, we proposed a method to fabricate large areal metallic nano stamp using UV nanoimprinting process and pulse reverse current (PRC) electroforming. To test a feasibility of the method, a 4-inch nano stamp for discrete track media (DTM) which has combination of complicated servo tracks and data tracks with the minimum pattern width of 35nm and pitch of 70nm was designed and fabricated.
Firstly, the DTM-patterned silicon nano master was fabricated by electron-beam recording and inductively coupled plasma etching. Figure 1(a) shows the fabricated silicon nano master, Figure 1(b) and (c) show atomic force microscopy (AFM) images of the data track with a line pattern pitch of 70 nm, and the servo track. The polymeric nano master was replicated on a glass substrate from the silicon nano master by UV nanoimprinting. Finally, a metallic nano stamp was fabricated using a nickel seed layer deposition process and electroforming. During electroforming, accomplishing high pattern fidelity for all feature size is very important. The PRC electroforming offers ultra high pattern fidelity for nano structures with variable pattern size. (Figure 2) The metallic nano stamp was successfully replicated, as confirmed using AFM measurement techniques as show in figure 3.

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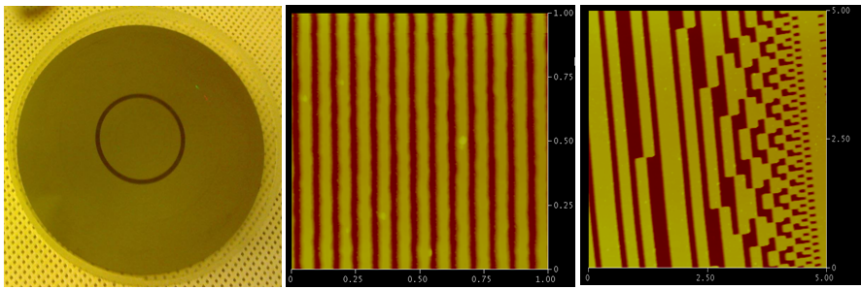
[1] S. Kang, Jpn. J. Appl. Phys., 43, 8B (2004)



(a) (b) (c)

Figure 1: (a) Photograph of silicon master with DTM full tracks, (b) AFM image of data area (pitch of 70nm, width of 35nm), (c) AFM image of servo area (line pitch of 360nm, ellipses pitch of 140nm, and rectangular shape of various pattern sizes)

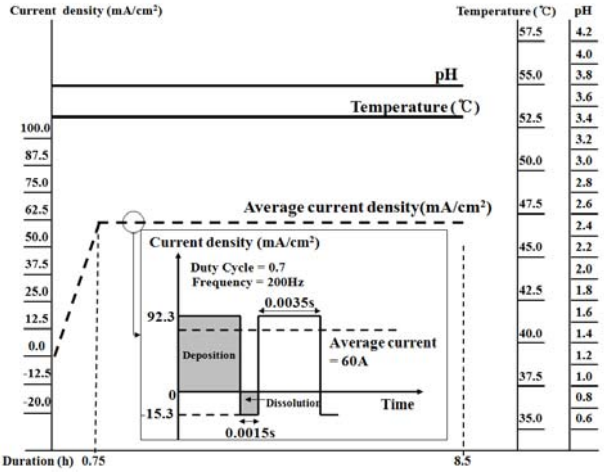
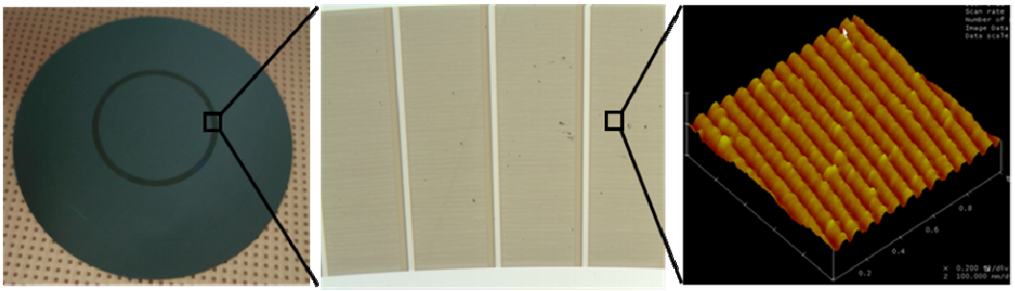


Figure 2: Process graph of electroforming process. (pH: 3.84, Temperature: 53°C, Current density 56.25mA/cm^2, ramping time 30min, total process time 8hours and 30min)



(a) (b)

Figure 3: (a) Photography and microscopic image of metallic nano stamp with DTM full track, (b) AFM image of data track with line pitch of 70nm on metallic nano stamp.

Acknowledgements

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