Replication of NIL Stamps by Metal-Assisted Chemical Etching of Silicon

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The current work describes the replication of nanoimprint lithography (NIL) stamps using metal-assisted chemical etching (MaCE) of silicon. The advantage of metal-assisted chemical etching of silicon includes process simplicity, high etching rate and good surface morphology.[1-3] The MaCE process uses noble metal (Au, Pt or Ag) as a catalyst to etch Si. In the present work we used the IPS/STU NIL process[4] to form catalytic Au patterns by using a lift-off.

In the first step of the process, an Intermediate Polymer Stamp (IPS) has been made from a primary master stamp. The IPS was then used to pattern a secondary master stamp from a 2" n-type Si (100) wafer with a resistivity of 10 Ohm cm. A double layer resist (LOR 3A/TU2-220) was used in the NIL process to form 25 nm thick, 260 nm in diameter Au dots by thermal evaporation. The Si wafer with the Au pattern was etched in aqueous solutions containing HF (48%), H_2O_2 (30%) and H_2O in a volume ratio of (2:1:8) at ambient conditions. The etch depth was intentionally limited to about 200-220 nm. The final fabrication steps include removal of the Au catalyst by wet etching and treatment of the Si surface by the antisticking layer (tridecafluoro-(1, 1, 2, 2)-tetrahydrooctyl-trichlorosilane (F-TCS)). Fig. 1 shows the scanning electron microscope (SEM) images of the secondary Si master stamp with holes 260 nm in diameter holes with the distance between them 210 nm. The fabricated Si stamp is thus a copy of the primary master stamp.

Secondary IPS was made, using a soft polymer film placed on top of the secondary master stamp and using a standard STU process[4]. A scanning electron microscope (SEM) image of the secondary IPS is shown in Fig. 2. The polymer stamp has been characterized also by an atomic force microscope (AFM). Fabrication process details are described and discussed.

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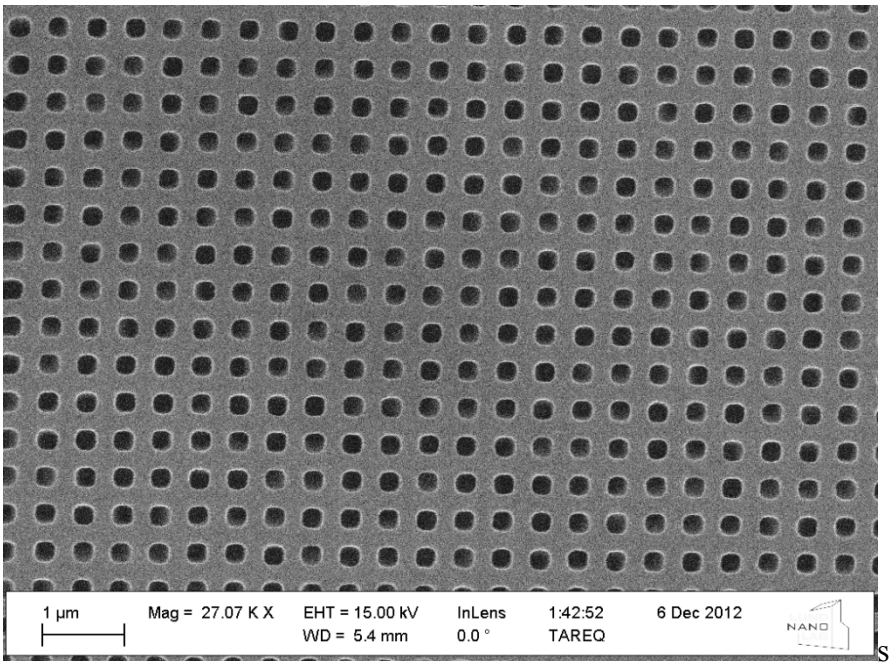

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Figure 1: SEM image of the secondary Si stamp made by MaCE process using etching in (HF: H_2O_2: H_2O, 2:1:8) aqueous solution for 15 seconds.

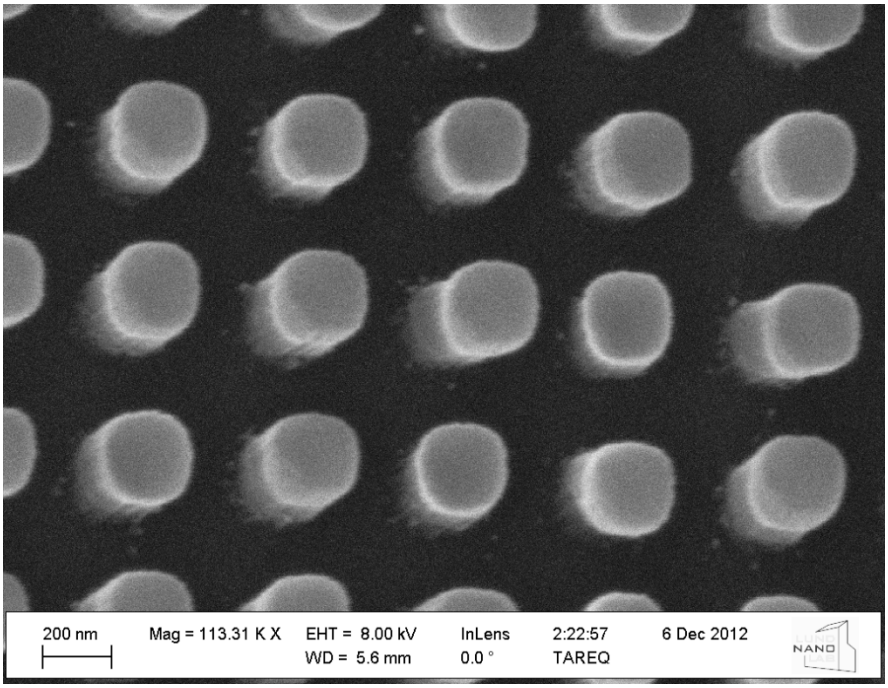

Figure 2: SEM image of the secondary Intermediate Polymer Stamp replicated from the secondary Si stamp (Fig. 1). Diameter of the squares are 260 nm and distance between them 210 nm.