Patterned Media using Step and Flash Imprint Lithography

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The Step and Flash Imprint Lithography (S-FIL®)[1] process uses drop dispensing of UV curable liquids for high resolution patterning. Several applications, including patterned media, are better served by a full substrate patterning process since the alignment requirements are minimal. Patterned media is particularly challenging because of the aggressive feature sizes necessary to achieve storage densities required for manufacturing beyond the current technology of perpendicular recording. In this paper, the ability to fabricate Master Templates, replicate Masters and create Working Templates, and print disks are demonstrated.

The process starts with the fabrication of a Master Template. An example of this process, for 25nm bit patterns, is shown in Figure 1. A high resolution electron beam resist, such as PMMA or ZEP520A is used to define the bit array. Since the pattern is radially symmetric, a rotary stage e-beam tool is required. A chromium lift-off process, followed by a glass etch is used to form the patterns in the template (See Fig 1a and 1b). The Master Template is then replicated by imprinting onto a blank fused silica wafer using an Imprio 1100[2], a fully automated full disk/wafer imprint system (Figure 1c). After transferring the pattern into the substrate, the Replicate Template can then be used to print on disks to create the patterned media. A final template layout is shown in Figure 2. Depicted along with the patterned media are marks designed to align both the template and the disk.

It is anticipated that bit patterned media will be required for very high density hard drives (~ 1Tb/in^2). It is possible, however, that an interim solution such as discrete track media will be adopted for earlier insertion. Discrete track media consists of an array of concentric lines (or tracks), with half pitches on the order of 50nm and below. The formation of the tracks is challenging because of the line densities required over substantial distances.

Pictured in Figure 3 are top-down and cross sectional images of the imprinted tracks at a half pitch of 50nm (See Figures 3a and 3b). Also shown (Figure 3c) are servo-like patterns that are interspersed between the tracks. This paper will cover the details of both the Master Template fabrication process and the Replicate Template process. Details of the imprint process will also be described. Finally, the prospects for printing smaller bit arrays and finer track pitches will also be discussed.

1. M. Colburn, S. Johnson, M. Stewart, S. Damle, T. Bailey, B. Choi, M. Wedlake, T. Michaelson, S. V. Sreenivasan, J. Ekerdt, and C. G. Willson, Proc. SPIE, Emerging Lithographic Technologies III, 379 (1999).

2. R. Hershey, M. Miller, C. Jones, M. Ganapathi Subramanian, X. Lu, G. Doyle, D. Lentz, D. LaBrake, Proc. SPIE 6337, 2006.

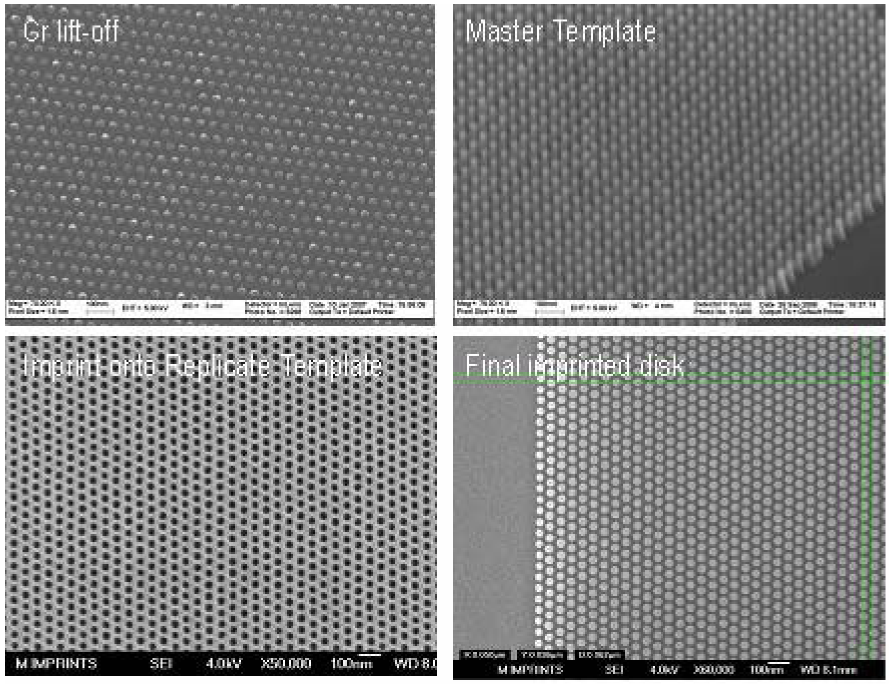

Figure 1. a) 25nm Bit patterns on a Master Template after Cr lift-off. b) The Master Template, after etching into the glass and stripping the remaining Cr. c) The imprinted pattern, using an Imprio 1100 full disk imprinter. This resist mask is then used to pattern the Replicate (or working) Template. d) An imprint created from the Replicate Template, forming the bit pattern on the magnetic media.

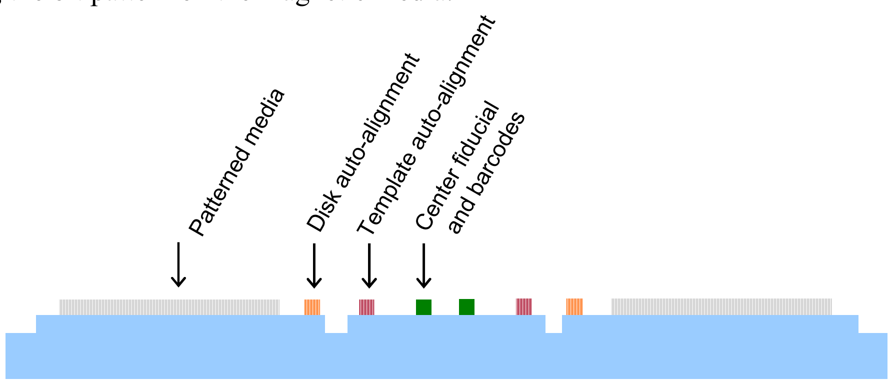

Figure 2. Schematic layout of a Replicate Template. Shown are the patterned media, and auto alignment marks.

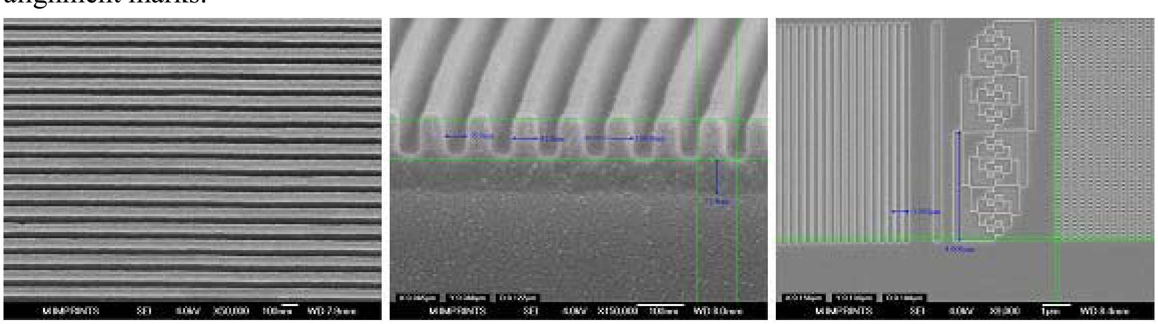

Figure 3. 50nm half pitch discrete tracks (3a and 3b) along with servo patterns that are interspersed between tracks (3c).