Fabrication and Recording Performance of Bit Patterned Media

Elizabeth A. Dobisz, Michael Grobis, Dan Kercher, Olav Hellwig, M. Schabes, Thomas R. Albrecht

Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135

Bit patterned media (BPM) is a solution to data thermal instability in future generation hard disk drives (HDDs). BPM presents a paradigm shift in the manufacture of disk drives and in magnetic recording. We evaluate the recording performance of BPM with integrated servo patterns using conventional read/write heads. The patterns enable error rate measurements that give valuable feedback on the media fabrication strategy, lithographic size and defect specifications, magnetic media development, head design, and recording strategy.

The first step is to fabricate BPM samples with millions of bits and a low fraction of “hard” defects. Direct write e-beam lithography offers fast turnaround flexibility for a variety of dot array patterns and servo schemes. The e-beam lithographic process will be extendable to making master templates for the nanoimprint lithography process in BPM disk manufacturing. At present, we have found ZEP 520A resist developed in isopropanol to give the lowest defect concentration over the large area required, as compared to other resists and processes. Disks coated with media and hard mask layers were e-beam patterned in arrays of varying pitch aspect ratio at bit densities of 500 Gb/in^2 to 1 Tb/in^2 with servo patterns. Shown in Figure 1 is a lifted off servo pattern on a disk with write synchronization and burst marks for a 720 Gb/in^2 pattern. The lifted-off e-beam patterns are etched into hard masks and then into the media. A 950 Gb/in^2 etched data region is shown in Figure 2.

The recording performance is measured by running a commercial head in contact with a stationary disk.[1] Static recording has been previously reported on BPM at densities 100 - 500 Gb/in^2 with write error rates at 1 X 10^{-3} or smaller.[1,2] The results also showed the viability of the exchange coupled composite magnetic media[3] for recording.[2] Figure 3 shows the readback signal from a 720 Gb/in^2 pattern ac erased (top) and a DC erase trimmed 1T pattern (bottom), showing good recording performance. Figure 4 shows the on track error rate as a function of write phase for pseudo-random data at 720 Gb/in^2 with a 5X10^{-3} floor. We discuss the recording performance and its relation to media patterning process at higher bit densities.

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[1] M. Grobis, E. Dobisz, O. Hellwig, M.E. Schabes, G. Zeltzer, T. R. Albrecht, Appl. Phys. Lett., **96**, 052509-1 (2010).
[2] M. Grobis, O. Hellwig, T. Hauet, E. Dobisz, T.R. Albrecht, IEEE Trans. Mag., **47**, Jan. 2011.
[3] T. Hauet et al., Appl. Phys. Lett., 75, 262504 (2009).

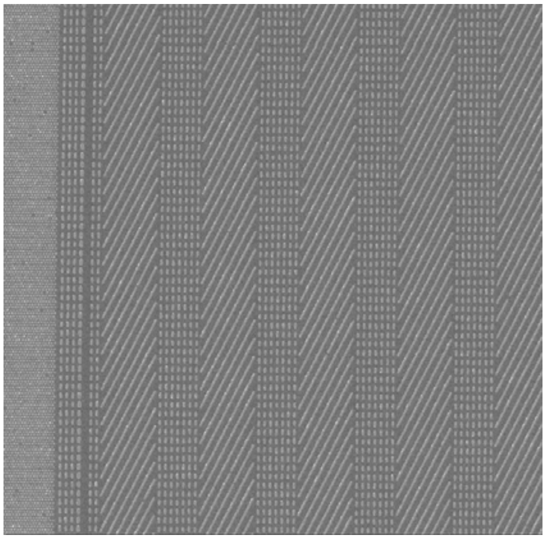

Figure 1. The Lifted-off servo pattern on the disk media for 720 Gb/in

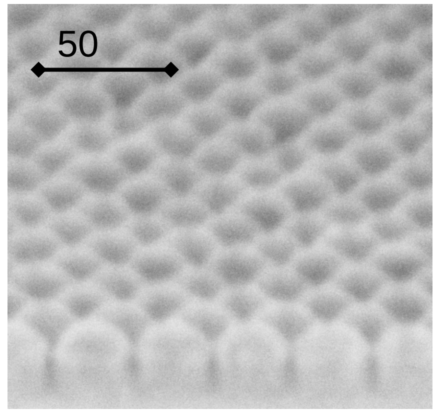

Figure 2. Etched media 950 Gb/in^2 with mask present

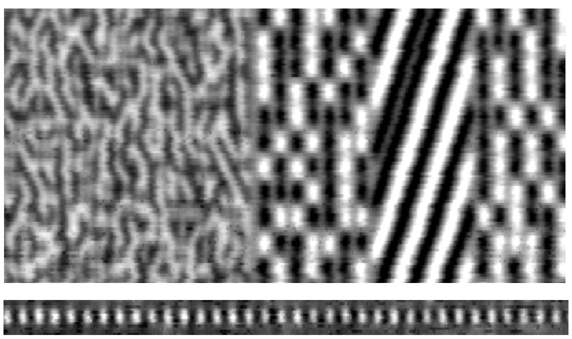

Figure 3. Readback signal on a 720 Gb/in^2 pattern. (top) ac erased and (bottom) DC erase trimmed 1T tone data.

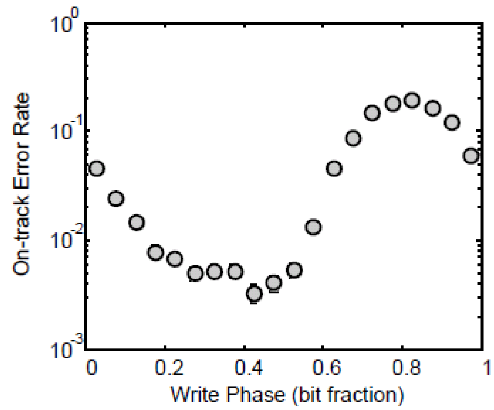

Figure 4. On track error rate vs. Write phase offset for pseudo-random written data at 720 Gb/in^2.