Patterned Media: Pushing the Limits of Lithography in Manufacturing

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Present disks drives offer low cost data storage. Intense competitive pressures from within the storage industry and competitive technologies, have put the storage industry on a very steep roadmap to increase data storage density. The existing disk drive design of perpendicular magnetic recording in continuous granular media is facing serious technological problems due to the write head constraints and thermal stability of the media. There are two solutions to the density increase "road block" that are under development: energy assisted magnetic writing and patterned media. Bit Patterned Media (BPM) is expected to be inserted into manufacturing at densities of 1-2 Tb/in^2. The patterned media approach is thought to be extendable to at least 4Tb/in^2. A combination of Bit PM and a thermally assisted recording (TAR) head is a method to extend well beyond this figure. In fact, the combination of BPM and TAR head has already achieved reading and writing at 1 Tbit/in^2 in the lab.

A BPM density of 1 Tb/in^2 corresponds to island center-to-center spacing of 25 nm if the bits are placed on a square lattice, or 35 nm by 17.5 nm lattice if the bits are placed on a 2:1 lattice of track pitch to bit pitch. Pattern placement requirements are ~10% of the bit pitch and disk manufacturing is a high volume process with hundreds of disks per hour. The high volume patterning process will be UV imprint lithography. Since imprint lithography is a 1X process, a great investment is required to make the masks. Quartz nano-imprint master masks will be fabricated by e-beam lithographically directed self assembly. Self assembly is employed to both enhance patterned bit placement and to multiply the pattern density. In this manner, very dense patterns can be fabricated on the master with a larger beam current and faster throughput than possible by e-beam lithography without self assembly.

In the presentation, the magnetic recording design rules for patterned media fabrication are discussed in relation to lithography and media patterning requirements. Approaches to patterning the media, after lithography, are discussed. Examples illustrating the relation of patterned nanomagnetic physics, nanofabrication, and read/write of patterned bit media are given.