Opportunities and challenges in electron beam lithography for bit patterned media

X-M. Yang, S. Xiao, W. Wu, J. Gong, K. R. Mountfield, and R. E. Rottmayer
Seagate Research Center, 1251 Waterfront Place, Pittsburgh PA 15222

K. Y. Lee, D. S. Kuo, and D. Weller.
RMO, Seagate Technology, 47010 Kato Road, Fremont, CA 94538

It is currently projected that "conventional" perpendicular magnetic recording technology, in which data bits are stacked perpendicular to the plane of the media on a disc, will not carry magnetic recording for hard disk drives to more than 1 Terabit/in^2 in areal density due to superparamagnetic effects on thermal stability. A leading technological candidate for extending perpendicular magnetic recording beyond 1 Terabit/in^2 is bit-patterned media (BPM), in which magnetic nano-arrays are fabricated and where each "island" in the array forms a separate recording magnetic bit.

Conventional wisdom envisages a manufacturing process involving fabricating a master template from which tens of thousands of disks are replicated by nanoimprinting. The imprinted patterns are then transferred into disks by either a subtractive or an additive process thus forming periodic arrays of isolated magnetic islands. Besides the requirements for high throughput, high volume, and low cost, very precise printing and pattern transfer are critical. Final disk planarization for head flyability is another key issue.

This talk will focus on the opportunities and challenges in advanced electron beam lithography for master mold fabrication. Key requirements include the high resolution, placement accuracy, size and shape uniformity, throughput and patterning extendibility. For example, 500 Gb/in^2 (likely the entry point) requires the bit size of 18 nm, and the center-to-center spacing of 36 nm. Moreover, for reasonable SNR, the bit size and positioning variation must not exceed 6% (1σ)[1]. Presently, the electron beam is now the only technology with both the potential resolution and precision needed, but it suffers from a substantially low throughput. In addition, such a tool will require a rotating stage and these are woefully lacking in both selection and sophistication in the market. In this talk, we will present our experimental results of successful sub-25 nm pitch (>1 Tb/in^2) patterning in resist and the formation of magnetic dots. The size and position sigma analysis will be given. We will discuss more about the challenging problems in electron beam patterning for BPM fabrication.

[1]Richter et al, APL **88**, 222512 (2006).