Electron beam lithography for fabricating heat assisted magnetic recording heads

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

The tremendous ever-growing demand for data storage has forced the magnetic storage industry to develop new technology to continue pushing the areal density beyond 1 Tbit/in^2. Scaling the areal density, while maintaining a proper balance between media signal-to-noise, thermal stability and writability will require a breakthrough in recording technology. One promising option for achieving 1 Tbit/in^2 and beyond is Heat Assisted Magnetic Recording (HAMR) [1-3]. By temporarily heating the media during the recording process, the media coercivity can be lowered below the available applied magnetic write field, allowing higher media anisotropy and therefore smaller thermally stable grains. The heated region is then rapidly cooled in the presence of the applied head field where the transition is recorded. A schematic illustration of the HAMR writing process is shown in Fig. 1.

This paper will introduce the basic concept of HAMR and then follow with a potential fully integrated HAMR head design, as shown in Fig. 2 (ABS view SEM and optical images). Hybrid lithography exposure strategies (e-beam/DUV) have been implemented for fabricating the HAMR head [4-5]. Direct write e-beam lithography was only employed for the printing of 30-50 nm critical dimensions in a variety of near field transducer (NFT) test structures (Fig. 3) and the top pole structures (Fig. 4), while DUV was used for the relatively large structures such as gratings, solid immersion mirror (SIM), coils, pedestals, and so on. Tight overlay requirements are very challenging for the HAMR head. Scanning Near-Field Optical Microscope (SNOM) characterization of the optics only HAMR head will be shown. Spin-stand recording experiments will be shown that were carried out using a spin stand that can fly and illuminate an optical head, provide an external magnetic field, and read back with a spin read head. Several key issues associated with head fabrication in e-beam lithography will be discussed.

Reference:

1. R. E. Rottmayer et al., *IEEE Trans Magn.* 42 (10), 2006
2. W. Challener et al., *Opt. Exp.,* 13 (18) 2005
3. M. Seigler et al., *IEEE Trans Magn.* in press, 2007
4. X-M. Yang et al., *J. Vac. Sci. Technol.* B21 (6), 3017, 2003
5. X-M. Yang et al., *J. Vac. Sci. Technol*. B23 (6), 2624, 2005

*Email: xiaomin.yang@seagate.com

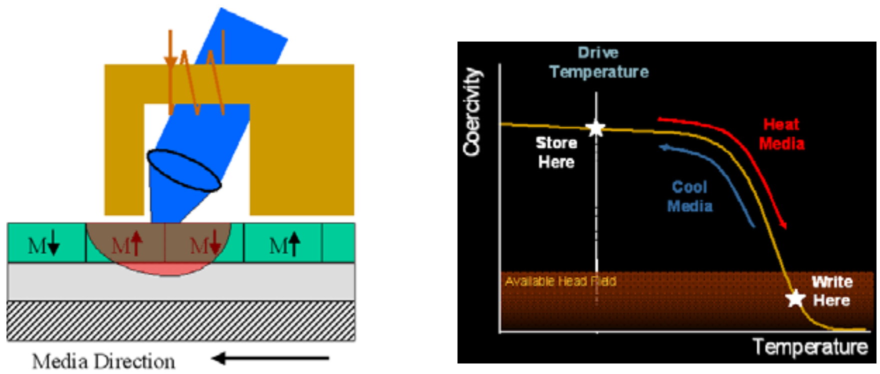

Fig. 1 Diagram shows the HAMR writing process.

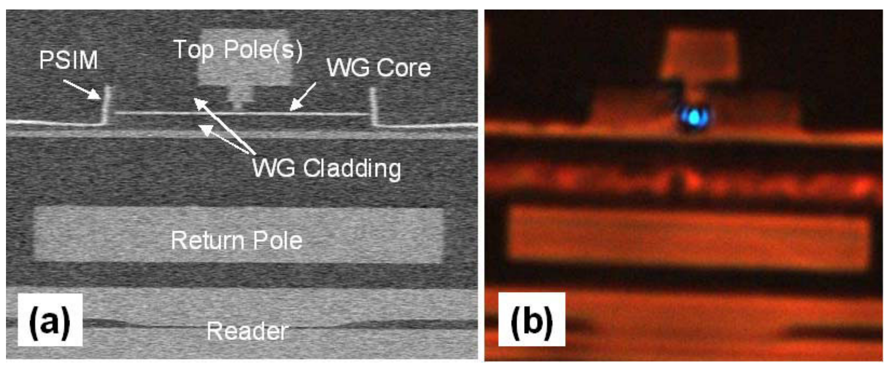

Fig. 2(a) ABS view SEM image of a HAMR head without an aperture, (b) ABS view optical image of a HAMR head with an aperture and with the light coupled into the WG

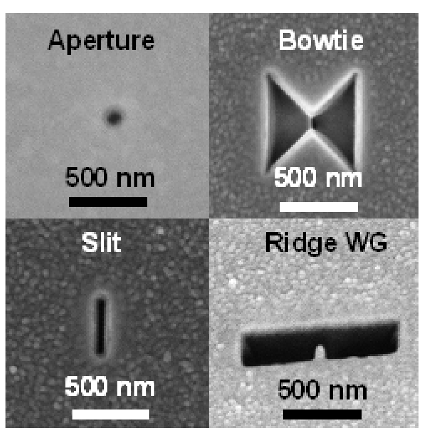

Fig. 3 SEM mages of various NFT structures

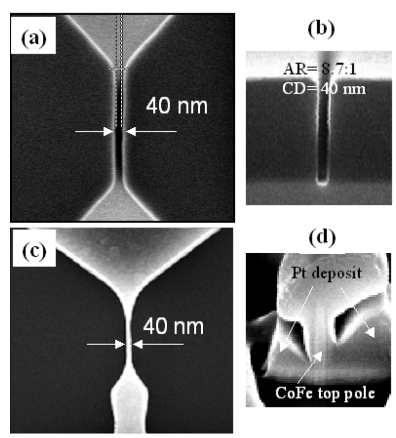

Fig. 4 SEM mages of top pole structures