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High Anisotropy Magnetic Recording Media

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Areal densities in magnetic recording have exhibited Moore's Law like increases in the last ten years. This is partially due to improvements in the media microstructure where reduced grain sizes, tighter grain size distribution, and chemical isolation between grains to break exchange provided increased signal-to-noise from decreased transition noise. With the recent shift from longitudinal to perpendicular recording, areal densities have again continued to increase with demonstrations of over 250 Gbits/in^2. However, areal density is limited by thermal stability considerations where the ratio of stored magnetic energy K_uV (anisotropy energy times the magnetic switching volume) to the thermal energy kT must be $\sim$ 50-70. The projected limit for traditional CoPtCr(X) granular media is on the order of 500 Gbits/in^2. Further increases in the areal density will require greater reduction in the grain size (switching volume), which necessitates finding media with higher anisotropy to maintain thermal stability. Possible candidate materials systems include FePt and $SmCo_5$, which have bulk K_u values 50 to 100 times greater than CoPtCr(X) media materials. High K_u allows for thermally stable grains sizes down to $\sim$ 2.5 nm, which would permit areal densities in the Tbit/in^2 regime. Accompanying this increase in K_u is an increase in the media switching field (H_0), which is proportional to the ratio K_u/M_s where M_s is the saturation magnetization. Therefore, while providing thermal stability, these high K_u materials would potentially require writing fields greater than 50 kOe which far exceed those of available recording head materials. One possible solution is heat-assisted magnetic recording (HAMR) where a laser locally heats the media in order to reduce the coercivity so that available head fields are sufficient. Numerous challenges exist for HAMR including high cooling rates so that the heating process does not render adjacent bits thermally unstable. This paper will review recent progress in this area and concentrate on the challenges for the production of high anisotropy media for Tbit/in^2 areal densities, such as maintaining grain sizes of 2 to 4 nm with the correct crystallographic texture and sufficient grain isolation to break exchange.