MAGNETIC HEAD DESIGN FOR TRANSITION CURVATURE CORRECTION IN HAMR

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INTRODUTION

In heat assisted magnetic recording (HAMR), curved recording thermal profile creates transitions with pronounced curvature and significantly limits linear density capability [1]. With write head field being spatially uniform, transition fronts of recorded bits essentially follow the temperature contour of the thermal profile at recording, or “freeze”, temperature. Consequently, the recording thermal gradient degrades at cross track positions away from track center, allowing increased medium noise in the presence of grain-to-grain Curie temperature variation [2]. Furthermore, at small transition spacing, the curved transition fronts yields severer erasure-after-write away from track center, causing significant track narrowing at high linear densities [2].

The key to correcting transition curvature is to have recording occurs at different “freeze” temperatures across track width such that transition front can be straight with curved temperature contours of recording thermal profile. This can be achieved by designing write heads to produce head field with varying amplitude adequately across the recording track [2, 3]. The cross-track varying field should have the lowest amplitude at the center of the track where the peak temperature occurs and the highest amplitude at track edges to lower the “freeze” temperature for straightening transition front. Thus, for a straight transition front, the “freeze” temperature decreases from the center to the edges and this temperature varying range is essentially determined by the maximum field amplitude available from the write head and the lowest field amplitude which needs still sufficiently high to yield magnetization saturation [3]. If the head field maintains its amplitude beyond track edges, wing-like recording patterns will be created beyond the edges of straightened transitions and the evolve into erase bands at high linear densities [4]. Field reduction beyond track edges will reduces the erase band width.

In this paper, we present a modeling study which combines write head design, near field transducer design, and micromagnetic simulation of the HAMR recording process to understand the potential as well as the limit of practical implementation for correcting transition curvature.

SIMULATION RESULTS AND DISCUSSIONS

Figure 1 shows a head design, referred to as dual-rail design, which is formed by two magnetic poles, semi-infinite along the recording track direction both are magnetized in the same direction perpendicular to the ABS. The produced head field at middle of a 10nm thick magnetic medium is used for recording simulations with the center of the head (middle of the gap) aligned with the center of the circular thermal profile. Recording 1T transition patterns at four different linear densities are shown in Fig. 3(b) with the results of spatially uniform head field shown in comparison (Fig. 3(a)). The degree of the transition curvature for recording with the dual-rail write head is significantly reduced comparing to that for recording with the spatially uniform head filed with optimized head field amplitude 10.5kOe.

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At 2500 KFCI, the transitions for recording with uniform write field are all percolated whereas the transitions for recording with the dual-rail head field still remains intact. Figure 2 shows the calculated SNR for both recording cases. In the talk, more detailed head design and analysis will be presented.

REFERENCES

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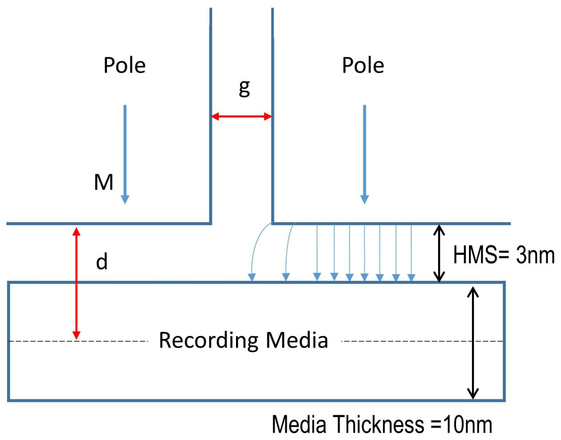

Fig. 1 Illustration of the write head design and recording geometry in the cross-track direction. The head gap of 15 nm is assumed for the simulation results presented here.

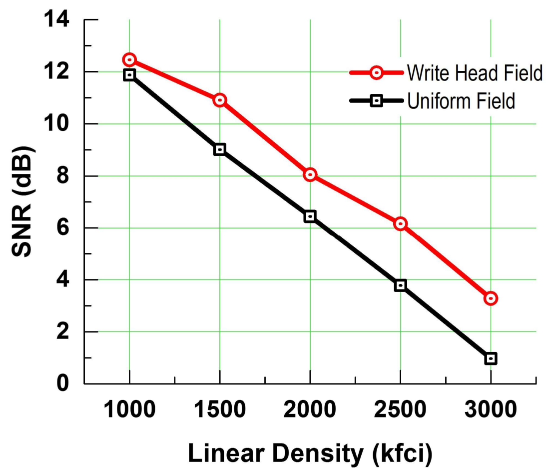

Fig. 2 Calculated medium 1T signal-to-noise ratio (SNR) as a function of linear density for recording with the write head shown in Fig. 1 (*Red*) and with the spatially uniform field (*Black*).

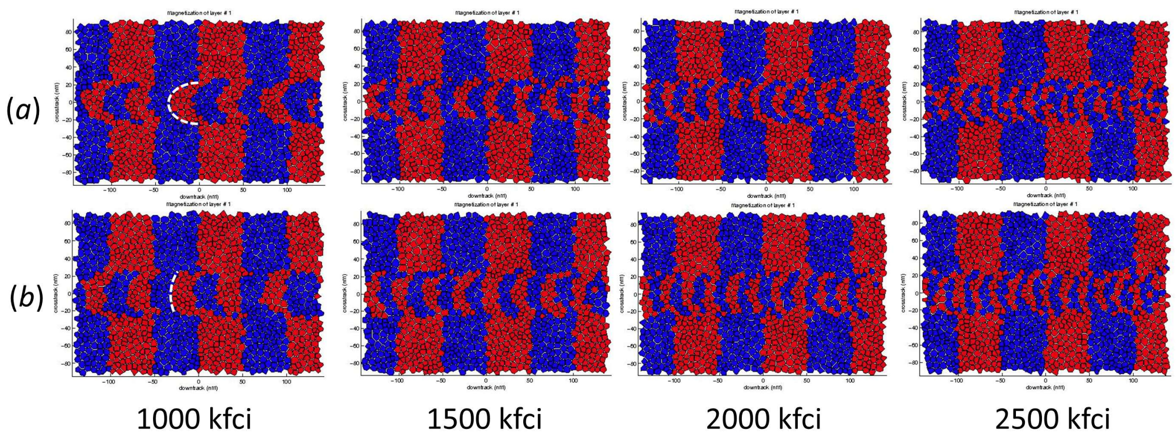

Fig. 3. Simulated 1T recording patterns at four different linear densities for (*a*) recording with the write head shown in Fig. 1 and (*b*) recording with spatially uniform head field.