Multilevel Nonlinear Transition Shift in High Density Perpendicular Magnetic Recording

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In magnetic recording, electric currents pass through the head to apply an external field that changes the polarity of magnetic grains, thus binary data is written and stored on the media. Nonlinear transition shift (NLTS) produced by the interaction between transitions is a significant source of distortions in the writing process of magnetic recording. It is defined as the shift between the ideal and the actual position when writing a transition, due to the fact that the total field not only depends on the write field of the head, but also is affected by the demagnetizing field from the previously written transitions. NLTS must be reduced to realize higher density and maintain signal quality, meeting the ever-increasing demand for data storage.
In this work, the production and the behavior of NLTS in high density perpendicular magnetic recording (PMR) were studied, and the confusion about NLTS in previous reports [1,2] was revised. Combined with the micromagnetic simulation of CoCrPt-oxide-based thin film with Voronoi grains and nonmagnetic grain boundaries, we have developed a complete theoretical model to predict NLTS in PMR.
The results show that the observed NLTS (τ_{ob}) in PMR is inversely proportional to the bit length (BL) squared, i.e. $\tau_{ob} \propto \mathrm{BL}^{-2}$. τ_{ob} can be over 30% of BL at high linear density under the given conditions. Optimizing the write field gradient can effectively reduce τ_{ob}, but only at a low write field gradient. Particularly, for multilevel NLTS, which is caused by consecutive multiple transitions previously, τ_{ob} will firstly increase and quickly approach a constant value as the number of consecutive transitions increases.

References:

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