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A pump-probe technique to measure the Curie temperature distribution of exchange-decoupled nanoscale ferromagnet ensembles

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Heat assisted magnetic recording (HAMR) has been recognized as a leading technology to increase the data storage density of hard disk drives[1]. Dispersions in the properties of the grains comprising the magnetic medium can lead to grain-to-grain Curie temperature variations, which drastically affect noise in the recorded magnetic transitions, limiting the data storage density capabilities in HAMR[2]. In spite of the need to investigate the origin of the Curie temperature distribution (σ_{Tc}) and establish means to control it, no approach to measure σ_{Tc} has been available.
We have recently presented a method to measure the switching temperature distribution of an ensemble of exchange-decoupled grains with perpendicular anisotropy subject to nanosecond heating pulses of varying intensity[3]. The rapid cooling rate ensures that the grain magnetization is not affected by thermal activation, so that the grains switch at Tc. A switching temperature distribution can then be directly interpreted as a measure for σ_{Tc}.

Here we summarize the results of this measurement routine to a series of FePt HAMR media samples in which the degree of $L1_0$ chemical ordering and alloy composition is systematically varied. We also present modeling results based on the Landau-Lifshitz-Bloch formalism that validates the experimental approach and provides experimental bounds for its validity[4]. Measurements of σ_{Tc} reveal a sizable dependence, which we interpret in the context of thermodynamic drive for disordered to ordered crystalline structure phase transformation. Besides the ability to measure σ_{Tc}, which is of importance to engineer suitable HAMR media capable of high density magnetic recording, the presented technique can be applied to studies on the competition between Zeeman energy and thermal fluctuations that affect the switching probability upon cooling from Tc.

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