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Fast Reversal in Multilayer Exchange Spring Media

D. SUESS, Vienna University of Technology

Hard disk media that support ultra high densities require small grains in order to obtain high signal to noise ratios. The use of high coercive materials such as alloys in the L_10 phase allow for thermally stable grains at grain diameters in the order of 4nm . However state of the art write heads produces too small fields to reverse these extremely hard magnetic grains. Recently composite media and exchange spring were proposed in order to decrease the write field requirements [1,2]. In exchange spring media an ultra hard magnetic storage layer is strongly exchange coupled to a softer magnetic nucleation host layer. The nucleation host decreases the switching field of the storage layer up to a factor of five without lowering the thermal stability of the entire structure. If the nucleation host is composed of multiple magnetic layers where the anisotropy increases from layer to layer it was shown that the resulting structure has a high thermal stability whereas at the same time the coercive field decreases with one over the total layer thickness [3]. Besides the previous results which were obtained in the quasi static limit, where the external field was applied slowly (several nanosecond) further surprising effects occur if the field rise time is in the order of several hundred picoseconds. These fast field rise times together with small damping constants in the media allow for precessional switching in composite media. It was demonstrated that precessional switching significantly lowers the coercive field [4] and also leads to ultra fast reversal modes [5]. We will present results on the reversal time of magnetic bilayers and magnetic trilayers in the precessional switching regime. Micromagnetic simulations show that a magnetic bilayer with a total thickness of 25 nm (hard layer anisotropy is $K_1 = 1$ MJ/m^3) can be reversed with a field pulse of 20 ps. Interestingly the reversal time increases to 0.5 ns as the field rise time is decreased from 0.1 ns to 0.01 ns.

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