Perpendicular Media

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Research related to perpendicular media focused on two areas: a) soft underlayers employing synthetic anti-ferromagnets; and b) high speed switching. Both efforts found new experimental results [Doyle et al] supported by strong theoretical predictions [Visscher et al].

Synthetic antiferromagnetically coupled films have been studied for soft underlayers for perpendicular media. Initially, FeCo bilayers were prepared by DC magnetron sputtering with a structure of glass/ Ru(2.5 nm)/ FeCo($t_F$)/ Ru($t_{Ru}$)/ FeCo($t_F$)/ Ru (10 nm), where $t_F$ was varied from 5 nm to 200 nm and $t_{Ru}$ from 0.2 nm to 1.4 nm. The antiferromagnetic coupling showed a maximum at $t_{Ru}=0.6-1.0$ nm as expected, depending on $t_F$. However, the surface coupling energy $J_{AF}$ decreased very rapidly with $t_F$ from 2.8 erg/cm$^2$ at $t_F=5$ nm to 0.6 erg/cm$^2$ at $t_F=10$ nm. A structure of glass/ Ru(2.5 nm)/ FeCo(50 nm)/ Ru(1.0 nm)/ FeCo(55 nm)/ Ru (10 nm) showed nearly zero remanence and very well separated hysteresis segments at $\pm 30$ Oe along the FeCo easy axis and a single narrow hysteresis loop with coercivity of 3.5 Oe along the hard axis. These characteristics were thermally stable up to at least 200 °C, which is superior to IrMn exchange-biased systems. Further optimization supported by simulations was achieved with a trilayer structure of glass/ Ru(2.5 nm)/ FeCo(25 nm)/ Ru(1.0 nm)/ FeCo(45 nm)/ Ru(1.0 nm)/ FeCo(25 nm)/ Ru (10 nm). Inverted hysteresis loops in a sputtered FeCo/Ru/FeCo bilayer have been investigated. A Stoner-Wohlfarth energy minimization calculation reproduced the negative remanence assuming a small misalignment of the easy axes of the ferromagnets. During the initial stage of the growth of the top layer the external field fails to overcome the strong antiferromagnetic exchange coupling between the layers. The magnetizations, as a result, are no longer collinear and the easy axis of the top layer will vary with its thickness. The negative remanence disappeared following an annealing of the sample in a strong field confirming the theory. Future work will be directed at the optimization of the structure based on simulations including interlayer fanning.

The switching behavior on a nanosecond time scale of a CoCrPt-based perpendicular medium has been studied both experimentally and by simulation. The sample was composed of a granular storage layer with a saturation remanence close to unity and a soft underlayer. The time-dependent remanent coercivity was measured down to 2.3 ns. The results are in good agreement with the extrapolation of the long time data, in accordance with the thermal switching model proposed by Sharrock, with $n=2/3$. The dependence of the switching field in the nanosecond regime on the initial remanence was studied. The remanent coercivity of the saturated sample was found to be lower than that of a partially demagnetized sample. This counter-intuitive behavior was confirmed by simulation, which elucidated the role of the local demagnetizing field in the switching process. The simulation also showed that the effect is sensitive to the time scale of the initial demagnetization process. Future work will include experimental measurements of $H_{cr}[t]$ after pulse demagnetization to verify the theoretical prediction of the sensitivity to the time scale of the demagnetization.