# MAGNETIZATION REVERSAL MECHANISM IN $L1_0$ FePt GRANULAR THIN FILMS FOR HAMR APPLICATIONS

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## I. INTRODUCTION

THE mechanism of magnetization reversal in $L1_0$ FePt granular media is investigated. Two series of samples are use in this study: series (A) consist of single layer FePt (MAG) films of variable thickness in the range of 4 – 11 nm and series (B) are bilayers containing an FePt film of thickness variable in the same range as series (A) and an additional 1 nm thick Co-based (CAP) film deposited on top of the FePt film. For both series of samples, the coercive field $H_C$ measured at ambient temperature ($T_{RT}$ = 300 K) features a non-monotonic behavior as a function of MAG thickness, displaying a pronounced maximum at a critical thickness of $t_{CR}$ = 7.5 nm. In order to understand the relationship between $H_C$ and the anisotropy field $H_K$, the latter is evaluated at $T_{RT}$ using the 45° torque method and also using the field dependence of the transverse susceptibility $\chi_{ACT}(H_{DC})$ where $H_{DC}$ is a DC field in the range of 0 – 8 T applied parallel to the sample plane. The latter is interpreted in the frame of Stoner-Wohlfarth (SW) model of coherent rotations to extract the average anisotropy field $<H_K>$ and the standard deviation of the anisotropy field distribution $\sigma_{HK}/<H_K>$. Figure 1 presents the dependence of $H_C$ on film thickness for both sample series A and B. The magnetization reversal mechanism is investigated using two types of measurements: (a) the time dependence of coercivity $H_C(\tau)$ measured at $T_{RT}$, and (b) the temperature dependence of the AC susceptibility $\chi_{AC}(T)$ in the range $T_{RT}$ – 800 K. Both these measurements are interpreted in the frame of SW model to extract the thermal stability factor $KV/(k_BT)$ and the short-time coercivity $H_0$ using $H_C(t)$ and the transition attempt frequency $f_0$ using $\chi_{AC}(T)$. The decrease of both, $H_C$ and $KV/(k_BT)$ with increasing MAG film thickness above $t_{CR}$ are associated with a transition from coherent (below $t_{CR}$) to an incoherent (above $t_{CR}$) magnetization reversal mechanism in isolated grains. As shown in Fig.2, for a MAG thickness larger than $t_{CR}$, the deviation from the coherent rotation reversal is enhanced by the presence of CAP (series (B)), which is thought to be an exchange spring effect.

The effect of CAP layer on the Curie temperature distribution (average $<T_C>$ and standard deviation normalized to $<T_C>$, $\sigma_{TC}$) of the underlaying MAG layer is also investigated. Two types of measurements are used for this purpose: (a) the temperature dependence of AC susceptibility $\chi_{\mathrm{AC}}(T)$ and fast thermal erasure or remanent magnetization $m_{ThEr}(T)$ involving the application of short-duration ($\tau$ = 6 ns) heating pulses of variable intensity. For the same thickness of MAG layer, $<T_C>$ is higher by ~ 15 – 20 K in the presence of CAP (series (B)) than in the absence of CAP (series (A)). This behavior is probably a finite size effect due to a larger physical grain size in the presence of CAP. The same effect leads to a lower value of $\sigma_{TC}$ for series B with respect to series A for same thickness of the MAG layer.

The effect of CAP on media writeability is investigated using the dependence of thermoremanent magnetization (TRM) on the applied field. It is shown that TRM saturates in lower applied fields in the presence of CAP, suggesting that CAP enhances the writeability of MAG layer. This is thought to be the consequence of the higher Curie temperature of CAP as compared to that of MAG layer. At the writing

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temperature of MAG, CAP has a non-zero saturation magnetization. As a result, an applied field of low intensity is able to orient the CAP magnetization. The orientation of the CAP magnetization is conveyed to that of the MAG layer during the refreezing process *via* the exchange coupling between CAP and MAG.

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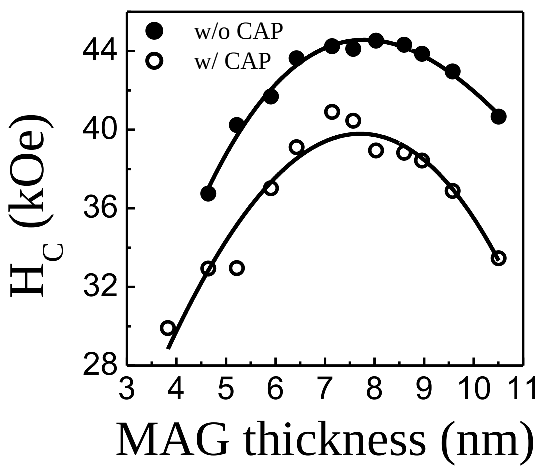


Fig. 1 Coercive field dependence on MAG thickness in the absence (●) and in the presence of CAP layer (○)

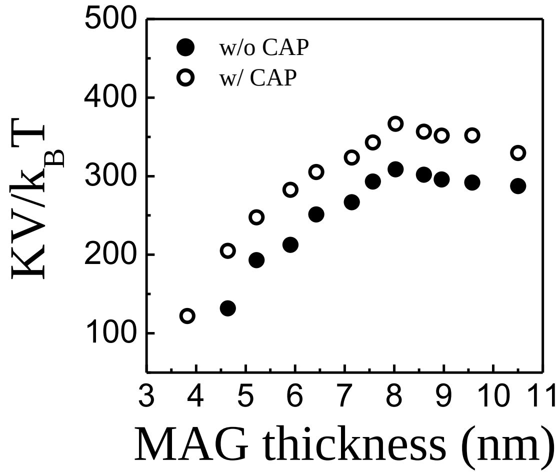


Fig. 2 Thermal stability dependence on MAG thickness in the absence (●) and in the presence of CAP layer (○)

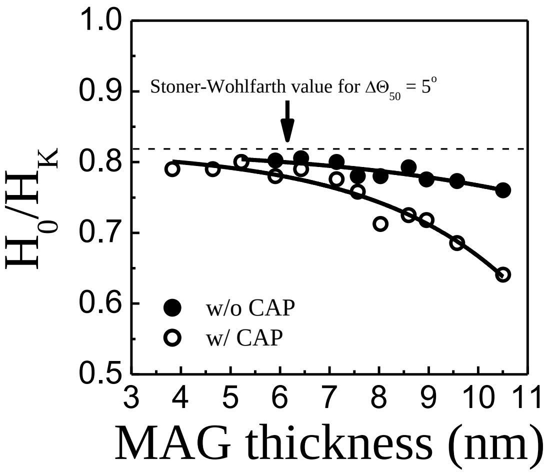


Fig. 3 Dependence of $H_0/H_K$ on MAG thickness in the absence (●) and in the presence of CAP layer (○)

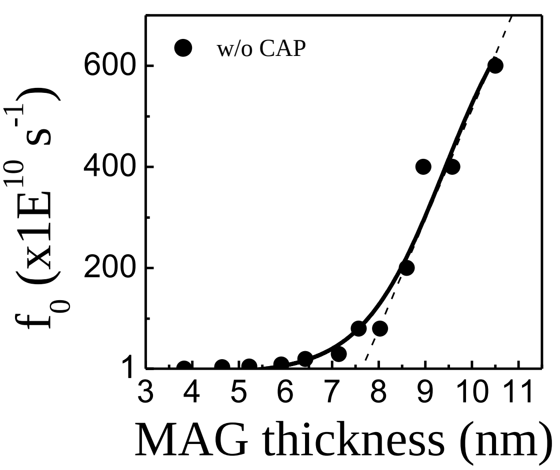


Fig. 4 Dependence of transition attempt frequency $f_0$, evaluated using $\chi_{AC}(T)$, on MAG thickness in the absence of CAP layer (●)

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