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Microstructure and Coercivity of Nanocomposite FePt Films with Different Capped Layer

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The $L1_0$ FePt film normally has (111) preferred orientation and its magnetic anisotropy can be changed from in-plane to perpendicular direction as introducing MgO (200) underlayer [1] into FePt film. In this study, the effects of MgO and Ag capped layer on the microstructure, coercivity, and magnetic anisotropy of the FePt film are investigated. The MgO underlayer with 5nm thickness is deposited onto naturally oxidized Si (100) substrates by rf magnetron sputtering at ambient temperature under an Ar pressure of 10 mTorr. The FePt magnetic layer with thickness in the range of 5~20 nm and a MgO capped layer or an Ag capped layer of 5 nm thickness are deposited sequentially by dc or rf magnetron sputtering onto the MgO underlayer. The as-deposited films are annealed at 600 °C for 30 min in vacuum which higher than 5×10^{-7} Torr.

Comparing the hysteresis loops of MgO 5 nm/FePt 20 nm with Ag 5 nm/FePt 20 nm nanocomposite films, although the in-plane coercivity is decreased slightly from 6965 Oe to 6780 Oe when MgO capped layer is replaced by Ag capped layer, the perpendicular coercivity of FePt films is enhanced greatly from 3169 Oe to 6726 Oe. The TEM bright field image of the Ag 5 nm/FePt 20 nm film shows a granular structure and its average grain size is only about 24 nm, as shown in Fig. 1. Comparing with the reports of Lee et al. [2] and Kuo et al. [3], a large grain size of above 30 nm will be obtained even annealing at a temperature of 500 °C for pure FePt films. The Ag atoms diffused from capped layer into the FePt magnetic layer are confirmed by AES analysis, and they mainly distribute at grain boundary of FePt that will hinder the grain growth and increase the grain boundary energy, therefore decrease the grain size and enhance perpendicular coercivity of the FePt film.

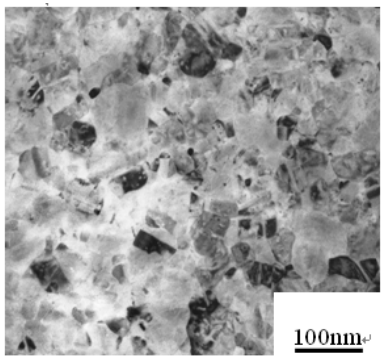

Fig. 1. TEM bright field image of Ag 5 nm/FePt 20 nm multilayer Films which annealed at 600 °C for 30 min.

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The Critical Properties of Magnetic Films

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Within the framework of the transverse spin-1/2 Ising model and by using the effective field theory with a probability distribution technique that accounts for the self spin correlations, we have studied the critical properties of an N-layer film of simple cubic symmetry in which the exchange strength and transverse field are assumed to be different from the bulk values in Ns surface layers. We derive and illustrate the expressions for the phase diagrams, order parameter profiles and susceptibility. In such films, the critical temperature can shift to either lower or higher temperature compared with the corresponding bulk value. We calculate also some magnetic properties of the film, such as the layer magnetizations, their averages and their profiles and the longitudinal susceptibility of the film. The film longitudinal susceptibility still diverges at the film critical temperature as does the bulk longitudinal susceptibility.

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