ROLE OF INTERFACE AND MORPHOLOGY IN THE MAGNETIC BEHAVIOUR OF PERPENDICULAR THIN FILMS BASED ON $L1_0$ FePt

F. Albertini[1], F. Casoli[1], S. Fabbrici[1], L. Nasi[1], C. Bocchi[1], F. Bolzoni[1], R. Cabassi[1], P. Luches[2], S. Valeri[2, 3], G.C. Gazzadi[2]
[1]IMEM - CNR, Parco Area delle Scienze 37/A, 43010 Parma, Italy.
[2]S3 CNR-INFM, via G. Campi 213/a, 41100 Modena, Italy
[3]Dipartimento di Fisica dell'Università di Modena, via G. Campi 213/a, 41100 Modena, Italy

FePt $L1_0$ ordered alloy is a promising material for high-density magnetic recording, since it allows the ferromagnetic stability in particles of few nanometers. Here we present our recent studies on the correlation between magnetic and morphological/interfacial properties of FePt –based thin films, nanostructures, and nano-composite bilayers.
$L1_0$ FePt (001) epitaxial thin films with high structural quality were grown on (100) MgO by sputtering r.f., using the alternate-layer deposition method. By playing with growth temperature on the one hand and post-annealing temperature and time on the other, we have been able to finely control epitaxy, structural order, and morphology from 3D laterally confined structures to continuous film, with desired grain size. In particular we have been able to decrease grain size and to optimise magnetic properties (increase of anisotropy/coercivity ratio) at the same time, by post-annealing in situ [1].
Laterally confined magnetic structures were also obtained by focused ion beam (FIB). We have shown that for suitable Ga+ doses (1×10^{14} ion/cm^2), it is possible to transform the $L1_0$ ordered phase to the A1 disordered one, without affecting morphology, giving rise to substantial modifications of magnetic properties from hard to soft. Perpendicular 2D magnetic patterns (dots, stripes) in a soft easy-plane matrix were realized in films of continuous morphology [2].
FePt $L1_0$ has also been exploited as the hard layer of nanostructured hard-soft nanocomposite bilayers. The exploitation of the exchange-coupling between hard and soft layers in exchange-coupled media represents a possible approach to overcome the so-called "recording trilemma" [3]. The samples were prepared by growing a magnetically soft Fe layer (2 and 3.5 nm) over a hard FePt(001) layer (10 nm). Three bilayers series have been grown based on FePt epitaxial layers with high degree of chemical order ($S\geq0.76$) and different morphologies, corresponding to different interface characteristics. The resulting hard layer anisotropy is high ($K>1\times10^7$ erg/cm^3), and the coercivity is increased by the grains separation (from 1.7 to 3 T). In the Fe/FePt bilayers the coercivity H_C is strongly reduced compared to the hard layer value (H_C/H_C^{hard} down to 0.37), indicating that high anisotropy perpendicular systems with moderate coercivity can be obtained [4]. Moreover, the control of the interface morphology allows to modify the magnetic regime at fixed Fe thickness (Rigid Magnet to Exchange-Spring), due to the nanoscale structure effect on the hard/soft coupling, and to tailor the hysteresis loop characteristics.

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