Coercivity Dependence on PrFeB thin films with Strong Perpendicular Magnetic Anisotropy

J. Soler-Morala[*,a], C. Navío[a] , G. Gkouzia[b], P. Pedraz[a], L. Zha[c,d], J.B. Yang[c,d,e], L. Alff[b], and A. Bollero[a].

[a]*IMDEA Nanoscience, 28049, Madrid, Spain. Tel: +34 91 299 87 00;*

[b]*Institute of Materials Science, Technische Universität Darmstadt, 64287, Darmstadt, Germany. Tel: +49 6151 16-22242;*

[c]*Beijing Key Laboratory for Magnetoelectric Materials and Devices, 100871, Beijing, China. Tel: +86 62753459;*

[d]*State Key Laboratory for Mesoscopic Physics, 100871, Beijing, China. Tel: +86 62753459*

[e]*Collaborative Innovation Center of Quantum Matter, 100871, Beijing, China. Tel: +86 62753459;*

**E-mail: Jimena.soler@imdea.org*

Rare-earth transition metal thin films hold great potential for implementation in devices at the micro and nanoscale [1-3]. While $Nd_2Fe_{14}B$ and $Pr_2Fe_{14}B$ share almost the same intrinsic magnetic properties (M_S, K_U, T_C…), $Nd_2Fe_{14}B$ has a limited use for low temperature applications (i.e. aerospace) due to the spin reorientation that occurs at 135 K [4]. This limitation can be overcome using $Pr_2Fe_{14}B$, whose magnetization direction remains along the c-axis until 4.2 K [4]. The understanding and optimization of these systems is of great importance when attempting their integration in novel miniaturized devices [5].

In this study, high coercivity PrFeB thin films of 100 nm have been fabricated by magnetron sputtering. The effect on the substrate temperature (T_S) in the structure and morphology and its resulting impact on the magnetic properties has been evaluated.

A highly textured growth of $Pr_2Fe_{14}B$ is achieved when $T_S \leq 600$ºC according to the X-Ray Diffraction (XRD) analysis (Fig. 1a). $Pr_2Fe_{14}B$ crystalline phase is accompanied by a Pr-rich phase that can be identified in all the XRD patterns. The correlation between the size and distribution of these Pr-rich areas with T_S and the role they play in the magnetism of the samples has also been thoroughly studied by Energy Dispersive X-Ray Spectroscopy (EDX) (Fig. 1c). Regardless of T_S, all films present strong perpendicular magnetic anisotropy which is in good accordance with the c-axis oriented preferential growth (Fig. 1d). Out of plane coercivities up to 15 kOe have been obtained at RT for T_S = 600ºC. Furthermore, Magnetic Force Microscopy measurements (MFM) prove the existence of interacting magnetic domains in all cases. The suitability of these $Pr_2Fe_{14}B$ thin films for low temperature

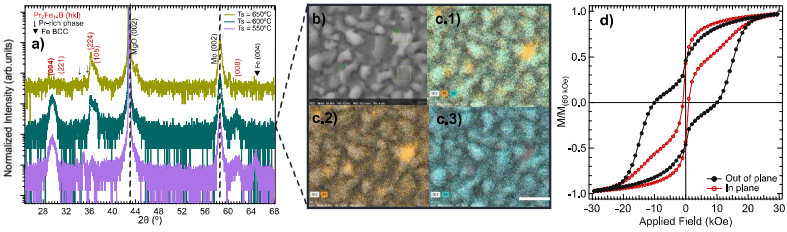

Figure 1. a) XRD pattern of PrFeB thin films grown at different T_S, b) Scanning electron microscopy (SEM) image of a PrFeB film grown at 600ºC, c) EDX mapping of a PrFeB film with a T_S = 600ºC showing the distribution of Pr and Fe (c.1) Pr distribution (c.2) Fe distribution (c.3). The scale bar is 800 nm in all cases. d) Room temperature hysteresis loop for T_S = 600ºC

applications has also been investigated.

Notes and References

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