$L1_0$ FePt/FeCo thin films towards rare earth free permanent magnets applications

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Permanent magnets are used in a wide variety of applications, from personal computers to cars and magnetic sensors. Rare-earth elements are extensively used in permanent magnets in order to achieve high anisotropies. Fe-Co is proposed as a possible alternative to rare-earth permanent magnet based alloys, due to its very high magnetic moment. The magnetocrystalline anisotropy can be induced via straining the FeCo unit cell as shown in theory [1] and confirmed by experimental studies on ultrathin films . For this reason several underlayers have been employed to cause tetragonal distortion to the cubic FeCo cell [2]. In this work we present our results on epitaxial growth of $Fe_{45}Co_{55}$ ultrathin films on L10 phase FePt thin underlayers, producing an exchange spring system [3-5] leading to high coercivities and very high energy products. We used magnetron sputtering to deposit FePt layers at 500^{o}C to favor the fct phase formation and to deposit Fe-Co at 300^{o}C. The thickness was varied between 5 and 7 monolayers for the FePt and up to 9 monolayers for the FeCo. In all samples full FePt fct phase transformation was observed according to structural analysis, along with epitaxial growth of Fe-Co on FePt. Coercive field was reduced from 1.3 T down to almost 0.2 T through exchange coupling of FePt and FeCo magnetic layers with increasing thickness. The anisotropy is out of plane while the energy product is estimated in the excess of 200kJ/m^3.

Acknowledgements: This work was supported by the EU-REFREEPERMAG project

References

[1] T. Burkert, L. Nordström, O. Eriksson, O. Heinonen PRL 93, 027203 (2004)
[2] S. Kauffmann-Weiss, S. Hamann, L. Reichel, A. Siegel,V. Alexandrakis, R. Heller, L. Schultz, A. Ludwig, and S. Faehler APL Materials 2, 046107 (2014)
[3] D. Kim, J. Hong Surface Science 606 (2012) 1960–1964
[4] D.Kim, Ar. Hashmi and J. Hong Journal of the Korean Physical Society, Vol. 62, No. 6, March 2013, pp. 918~923
[5] B. Wang, H. Oomiya, A. Arakawa, T. Hasegawa, and S. Ishio , J. Of Appl. Phys. 115, 133908 (2014)