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Micro magnetic exchange tensor and interpretation of magnetometry for hcp Co based high anisotropy thin film alloys

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Abstract

We present results of investigation on the role anisotropic micromagnetic exchange tensor for interpretation of out-off-plane (OP) and in-plane (IP) magnetization loop of hcp CoCrPt thin film alloys. We combine electronic structure calculation methods to quantify magnetic interactions [1] and OOMMF micro magnetic simulation software [2] to investigate role of anisotropic exchange tensor. The hcp CoCrPt alloys are widely used as magnetic media for perpendicular magnetic recording in the form of highly textured epitaxial (0001) thin films. Interpretation of OP and IP M(H) loops for hcp CoCrPt alloys requires detailed knowledge of material parameters and information about microstructure. It has been suggested that some features of OP and IP can be explained by spin-orbit interaction driven anisotropic exchange with unrealistically large exchange anisotropy [3]. In our study we consider crystal symmetry driven anisotropic micro magnetic exchange tensor. Material dependentaAnisotropy of this tensor calculated for hcp Co using ab-initio method [1]. In our micro magnetic simulations hcp CoCrPt alloys have been studied for two cases isotropic tensor (1:1) and tensor with 2:1 ratio of out off plane in plane micro magnetic exchange. We investigate role of realistic anisotropic exchange interaction tensor by considering two cases (1) single layer and (2) hard/soft two layer systems. For single layer case the alloy composition and parameters are Cr 10% Pt19.8% with M_s=1100 emu/cc, K1=9e6 erg/cc and A =0.45e-11 J/m. For the two layer case we add soft layer with composition Cr 0% Pt0% having A=1.64e-11 J/m, Ms = 1342 emu/cc and K1=2.06e6. For both the system studied the external field was applied in the plane, out of plane and at various angles w.r.t. the easy axis showing contribution of anisotropic exchange tensor to magnetization switching process.

References

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