Structural and magnetic properties of strongly carbon doped Fe-Co thin films.

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Fe-Co is proposed as a possible candidate alloy for permanent magnet applications due to its high magnetic moment. Apart from high magnetic moment, a considerably high magnetocrystalline anisotropy is required for permanent magnets. In this work we present sputtered thin Fe-Co films doped with Carbon, in order to stabilize metastable tetragonal phases, by straining the unit cell and thus inducing magnetocrystalline anisotropy in the system [1]. Tetragonal distortion can be induced by epitaxial growth of the magnetic Fe-Co layer on appropriate substrate or buffer materials layer with different lattice parameters [2], thus changing the c/a . Adding a third element, Carbon, could stabilize the strain and increase the magnetocrystalline anisotropy of the system.

In our study, we alloyed high amounts of carbon to Fe-Co based on promising theoretical and experimental studies which investigated films with less C. ATC 2200-V high vacuum magnetron sputtering system supplied from AJA Inc was used to prepare the samples, with a base pressure of $4x10^{-9}$ Torr. The depositions were performed on single crystalline MgO (001) substrates. The layer structure consists of a 3nm Cr underlayer, a 30nm Au-Cu buffer and the Fe-Co magnetic layer with variable C content. In ultrathin layers, up to 2nm thickness, C addition can induce a strain in the Fe-Co films. Then, the observed magnetic anisotropy is more determined by the interface to the buffer where the film supposedly grows coherently. In thicker films above 3nm thickness, the high C content leads to the formation of separated Fe-Co grains. Although this avoids a coherent strain from the Au-Cu buffer layer, the overall strain is still above 1%. We argue that C may stabilize this low tetragonal strain up to higher thicknesses when the strain initializing buffer layer is applied.

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References

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