Effects of Surface Roughness on Magnetic Properties of Electrodeposited Co Thin Films

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Introduction

The roughness evolution of surfaces has been the subject of intensive research on fundamental and technological aspects of thin films. The surface and interface roughness affects magnetic properties of thin layers such as coercivity, magnetotransport, magnetic domain structure and magnetization reversal [1].

In this work we investigate the influence of the surface roughness on the magnetic properties of Co thin films electrodeposited on silicon substrates with and without a buffer layer.

Experimental

The Co thin films were electrodeposited on (100) n-type Si substrates with or without an electrodeposited $Cu_{60}Ni_{40}$ buffer layer. The Co layer was deposited at –1.1 x V SCE [2], with thicknesses in the range of 5 to 2,500 nm. The non magnetic buffer layer was electrodeposited at –1.0 V x SCE [3], with thicknesses ranging from 50 to 500 nm, yielding an interface roughness in the range of 10 to 100 nm, respectively.

The Co layers were examined by atomic force microscopy. Scaling parameters such as saturation roughness and correlation length were used to describe its surface morphology. The samples were characterized also by X-ray reflectivity. The magnetic properties were determined by magnetoresistive (MR) measurements, alternating gradient force (AGFM) and transversal Kerr effect (MOKE) magnetometry.

Results

Figure 1 shows the dependence of the coercivity on the thickness of Co layers, for buffer layers of two different thicknesses. As a general result, high coercive fields for very thin Co layers were observed, displaying a sharp decrease with increase of Co thickness and reaching an almost constant value for films thicker than 200 nm. It is observed, however, that the thickness of the buffer layer also influences coercivity. Films with a thicker buffer layer display higher values of coercive field. Since the $Cu_{60}Ni_{40}$ buffer layer is non-magnetic, the effect is solely due to the different degrees of rugosity resulting from varying buffer thickness.

Looking for an analytical description of the experimental results, variables such as film thickness, saturation roughness and correlation length were taken into account in a model that considers the effect of demagnetizing effects over the magnetization reversal process of thin films.

References

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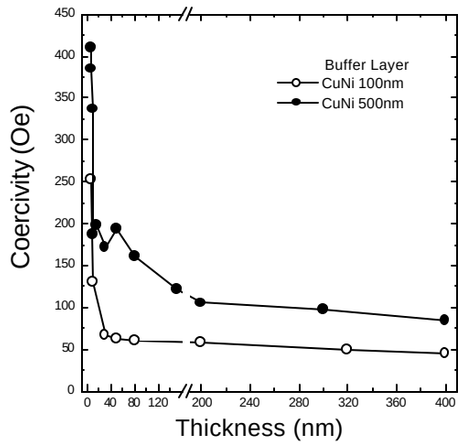

Figure 1 Coercivity of Co thin layers as a function of the thickness for to different thicknesses of the CuNi buffer layer.