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Characterization of (Tb/Mo) Multilayers using the Scanning Auger Microprobe

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Since the discovery of the Giant Magnetoresistance effect in 1988 [1] the study of magnetic multilayers has continued growing due to the interest that this class of systems present from the point of view of both their applications and the fundamental Physics involved in its comprehension. These systems consist typically of alternating layers of magnetic and non-magnetic materials, each layer being a few nanometers thick.

In this work we present the characterization of (Tb/Mo) multilayers using a Scanning Auger Microprobe (SAM). This apparatus combines the use of the surface sensitive Auger Electron Spectroscopy with sputtering of the sample through focused Ar^+ bombardment and with scanning electron imaging detecting either secondary or backscattered electrons. Samples were fabricated in a computer controlled sputtering chamber using glass substrates, Ar as the working gas and two magnetrons with metallic Tb and Mo targets respectively. The nominal composition of the samples fabricated was Mo/10[Tb(1nm)/Mo(5 or 10 nm)]/glass, Tb being the magnetic material and Mo the non-magnetic one. One expects the small thickness of the Tb layers to make it difficult to characterize these samples with techniques other than TEM, as can be appreciated in Figure 1, where we present a TEM cross section image of a n[Tb(1nm)/Mo(10 nm)]/glass sample.

The characterization with SAM normally involves the recording of composition depth profiles combining AES with sample sputtering, what in our case would imply using sputtering rates very small as the Tb layers are very thin. However, we can easily visualize the different layers, obtaining a low magnification secondary electrons image of the Ar^+ bombarded zone after eroding the sample until reaching the substrate. Figure 2 shows such an image for a non-annealed Mo(5 nm)/10[Tb(1nm)/Mo(5 nm)]/glass sample, in which the concentric bright and dark bands correspond to the exposed Tb and Mo layers respectively, as was confirmed by AES. The high contrast observed in this image is Z-contrast, caused by the backscattered electrons contribution to the secondary electrons generation. Figure 3 shows an AES line profile obtained in the sense from the edge towards the centre on an image similar to that of Figure 2 but obtained from an annealed, non tilted sample. As one observes there is an oxygen signal associated with the Tb layers. Although Tb and Mo are not supposed to be miscible, the images obtained on annealed samples show less contrast, what would indicate some degree of mixing at the interfaces or the incorporation of low Z contaminants like C and O during the annealing process. We conclude that the use of low magnification (~x200) secondary or backscattered electron images obtained in the SAM on multilayers systems, after focused ion bombardment, can be used to characterize easily both the structural and compositional quality of this kind of samples.

References

[1] M.N. Baibich et al. Phys. Rev. Lett **61** (1988) 2472.
[2] C.E. Rojas acknowledges the support of the CDCH-UCV

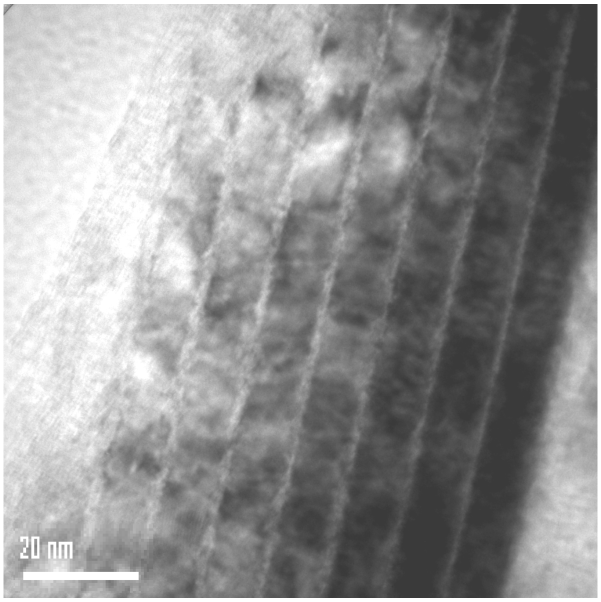

Fig. 1. TEM micrography of a Mo/10[Tb(1nm)/Mo(10 nm)]/glass cross section.

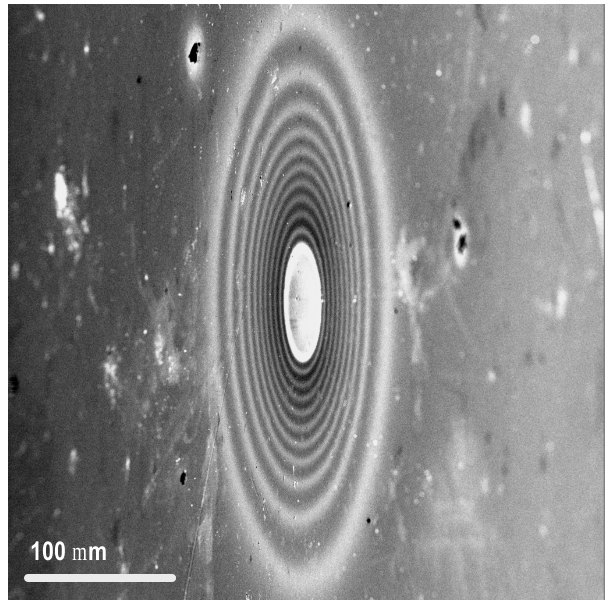

Fig. 2. Secondary electrons image of a Mo/10[Tb(1nm)/Mo(5 nm)]/glass sample after Ar^+ bombardment. Sample tilt: 75º.

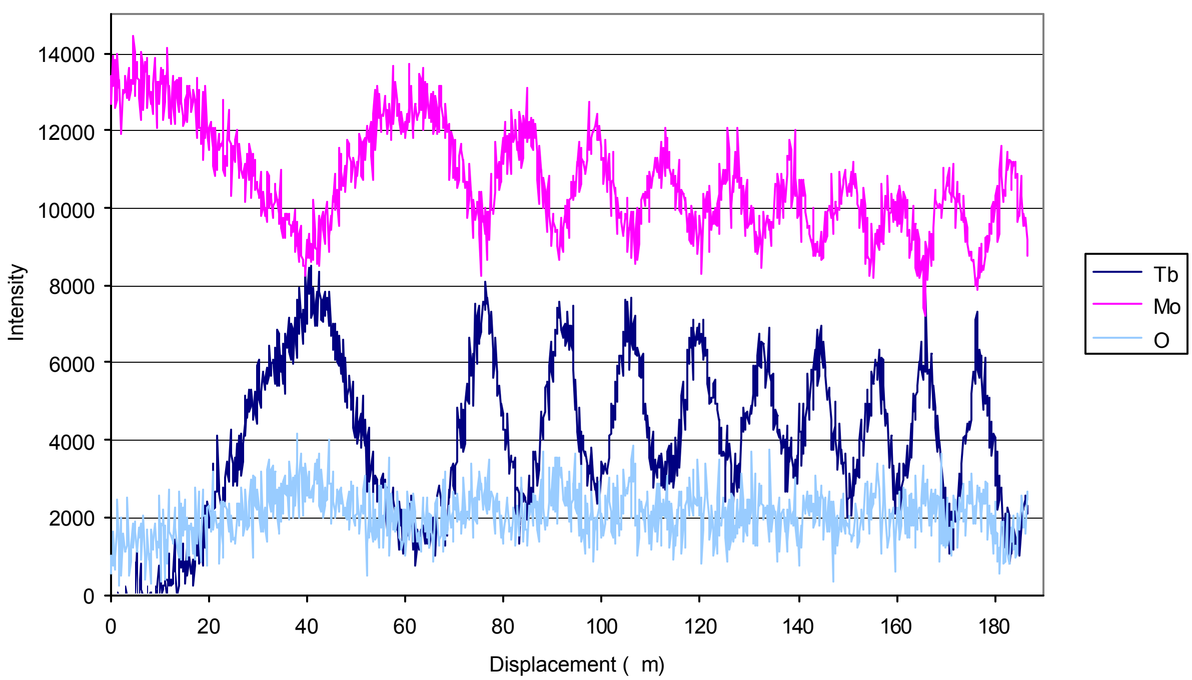

Fig. 3. AES line profile across a secondary electron image of a sputtered annealed Mo/10[Tb(1nm)/Mo(5 nm)]/glass sample.

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