Structure and electronic properties of Fe-Ti thin films

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Fe/Ti multilayers (MLs) and Fe-Ti alloy thin films were prepared onto glass and SiO_2(101)/Si(111) substrates using UHV RF/DC magnetron sputtering. The surface chemical composition and the cleanness of all layers was checked *in-situ*, immediately after deposition, transferring the samples to an UHV (4×10^{-11} mbar) analysis chamber equipped with X-ray photoelectron spectroscopy (XPS). From the exponential variation of the XPS Fe-2p and Ti-2p integral intensities with increasing layer thickness we conclude that the Fe and Ti layers grow homogeneously. The structure of the samples with step-like wedge form (areas with constant-thickness Fe and Zr sublayers) was examined *ex-situ* by standard θ-2θ X-ray diffraction with Cu-K_α radiation. The thicknesses of individual Fe and Zr sublayers and average Fe-Ti alloy compositions after an *in-situ* annealing were determined using X-ray fluorescence analysis (XRF).

Results showed a significant drop of the coercivity measured for the Fe/Ti MLs with decrease in Fe layer thickness - typically from $H_c \sim 2.5$ kA/m to $H_c \sim 0.2$ kA/m – observed at a critical Fe thickness $d_{crit} \sim 2.3$. The coercivity behaviour could be associated with the structural properties of the Fe layer grown onto Zr, similarly to the transition observed earlier for the Co/Zr [1] and Co/Ti [2] MLs. According to above interpretation, iron sublayers grow in the soft magnetic nanocrystalline phase ($D << L_{ex}$) for a thickness lower than the critical one. In that case, the average Fe grain size is significantly smaller than the magnetic exchange length for the iron layer (L_{ex}) [3]. For a thickness greater than the d_{crit}, the Fe sublayers undergo a structural transition to the polycrystalline phase with average grains size $D > L_{ex}$ [3].

Structural studies showed that the deposition of the 0.18 nm - Fe / 0.22 nm -Ti ML at 520K leads to the formation of an uniform nanocrystalline Fe-Ti alloy thin film. On the other hand, *in-situ* annealing of the 1.8 nm - Fe / 2.2 nm -Ti ML at 750 K for 2 h resulted in the creation of an amorphous phase. Furthermore, *in-situ* XPS studies showed that the valence band of the amorphous Fe-Ti alloy film is broader compared to that measured for the nanocrystalline phase with the same average composition.

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