# TEM CHARACTERISATION OF CoFeB-BASED STRUCTURES FOR MTJ SENSOR APPLICATIONS

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Magnetic tunnel junctions (MTJs) have been extensively studied in view of their technological applications as magnetic random access memories (MRAM) or high sensitivity field sensors. The achievement of high TMR values and a low level of noise are crucial in the construction of reliable magnetic devices. Although large TMR has been realised by using CoFeB as the pinned and/or free layer material with MgO as the barrier [1], the fulfilment of low noise level devices is still a challenge.

Wisniowski et al. [2] have explored the possibility of reducing the noise in MTJ sensors by varying the thickness of the free layer. They found that below a critical thickness (15.5 Å) the transfer curves are hysteresis-free, but this was achieved at the expense of a fall in TMR.

A deeper understanding of this result can be achieved by characterising the physical microstructure and the domain structure of analogous samples by trasmission electron microscopy. To this end, investigations on three multilayer structures composed of MgO/CoFeB/MgO with 30 Å, 15.5 Å and 14.5 Å CoFeB layer thicknesses are in progress.

The magnetisation reversal mechanisms observed during Lorentz TEM experiments are found to be dependent on the applied field orientation with domain processes and magnetisation rotation being observable in all three samples. However, where they exist, the domain structures supported are different. The maximum density of domains increases as the magnetic layer thickness decrease, with the average inter-domain distance ranging between tens of microns in the thickest sample to hundreds of nanometers in the thinnest one. Furthermore the persistence of domains, even with high applied magnetic fields, has been observed.

As regards the physical microstructure, only the sample with 30 Å CoFeB layer thickness has been characterised to date. The TEM images show that, in this case, the CoFeB layer has grown as a typical polycrystalline thin film and there is no evidence of discontinuities. The grain size distribution is quite wide and is peaked around 10 nm.

Progresses on all these experiments will be here presented

[1] Y.M. Lee et al., Appl. Phys. Lett., **89**, 042506 (2006)
[2] P. Wisniowski et al., J. Appl. Phys, **103**, 07A910 (2008)