Correlation between structure and exchange coupling parameters of IrMn based MTJ

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In this work particular attention will be paid to the correlation between structure and magnetic parameters of interfacial and interlayer exchange coupling in as deposited and annealed junctions with the structure of Ta(5)/Cu(10)/Ta(5)/NiFe(2)/Cu(5)/IrMn(10)/ CoFe(2.5)/Al-O/CoFe(2.5)/**NiFe(t)**/Ta(5), where t = 10, 30, 60 and 100 nm. MTJ's were prepared on thermally oxidized Si wafers using DC magnetron sputtering with ultra clean Ar(9N) as the process gas, in a chamber with base pressure of 4×10^{-9} hPa. The samples were annealed in vacuum (10^{-6} hPa) at 300°C for 1 hour under a magnetic field of 80 kA/m, followed by field cooling. The magnetic measurements were performed by R-VSM, MOKE magnetometers and Kerr microscope. In order to find the correlation between structure and magnetic properties the samples have been characterized by XRD measurements: GID (scan-2θ), θ-2θ-scan, rocking curve (scan-ω) and pole figures scan. The annealing treatment induces an increase in (111) peak intensity, crystallites size and decrease of lattice constants and FWHM of the (111)$IrMn_3$ and (111)Cu-rocking curve, indicating an improvement in texture of the multilayer structure. Accompanied by the increase of grain size of $IrMn_3$, an increase in exchange biased field (H_{ex}) and coercivity (H_{cp}) of pinned layer $Co_{70}Fe_{30}$ was observed (Fig.1). After annealing the interlayer coupling energy increases from J = $0.75 \cdot 10^{-5}$ J/m^2 to $1.04 \cdot 10^{-5}$ J/m^2. The variations of free layer coercivity (H_{cf}) and interlayer shift field (H_s) correlate with the size of NiFe grains (Fig.2) determined from GID measurements. The enhancement of interlayer coupling between pinned and free layers indicates the correlated in-phase roughness of magnetostatic interacting interfaces, due to increase of crystallites size.

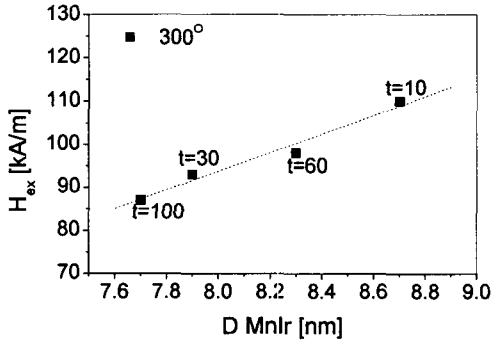

Fig.1. H_{ex} vs. sizes of (111) IrMn crystallites.

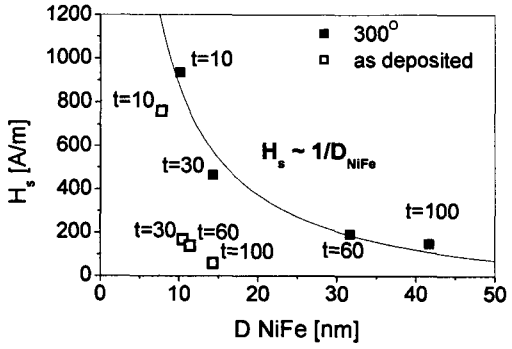

Fig.2. H_s vs. sizes of (111) NiFe crystallites.