MgO MTJ biosensors for immunomagnetic lagteral lateral-flow detection

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In recent years, particularly in the last two decades we have seen an enormous expansion of so-called biosciences, which are currently showing themselves as an area of scientific knowledge with advances and achievements of major scientific and social impact, even more in the present context of the constant threat to public health by various diseases and pathogens of human transmission all over the world (on one side the big cities characterized by the proliferation of places with high human concentration that favor the spread, on the other side there are underdeveloped countries in which their general population doesn't have the means to prevent and contain epidemics becoming a fertile land to the spread of diseases).

In this context it is clear the potential of nanotechnology, capable of providing the necessary means for the detection and screening of pathogens in the form of sensors capable of detecting them, it is precisely this field that integrates the current project.

The aim is the fabrication of magnetoresistive (MR) sensors, with linear response capable of performing tests of recognition by the detection of biological nanoparticles functionalized magnetically polarized and previously linked to biomolecules. It is a requirement to provide a practical use: to build a portable platform with integrated MR sensors. In addition this work uses MTJ elements connected in series.

A deposition sputtering system Nordiko 2000 is responsible for the growth of the magnetic film with the following structure: Ta 50Å / Ru 180Å / Ta 30Å /MnPt 200Å / CoFe 20Å / Ru 9Å / CoFeB 30Å / MgO XÅ / CoFeB YÅ / Ru 50Å / Ta 50Å . The devices are patterned according to the mask that is presented under [Figure1]. The sensors are made of series of **N=**360 MgO tunnel junctions elements corresponding to a much layer magnetic volume of the free layer. This architecture allows devices robust enough to withstand the voltage drops on the order of few hundreds of volts without suffering disruption, and obtaining output values of the order of 200kOhm, beyond the obvious gain in the noise level (S_V) of the sensor and positive implications for the detectivity (D) that is the minimum field detectable [1].

$$S_V{}^2(f) = \boldsymbol{N}\left(2eIR\,coth\left(\frac{eV}{2K_B\boldsymbol{N}\,T}\right) + \frac{\alpha V^2}{\boldsymbol{N}^2\boldsymbol{A}}\frac{1}{f}\right)$$

$$D = \frac{S_V}{\Delta V/_{\Delta H}}$$

where I is the bias current, R is sensor resistance, V is the bias voltage, α is a Hooge like parameter, A is the sensor area, T is the temperature, H is the applied magnetic field.

Values of TMRs of 70% [Fig.2], with a sensibility of the order of 440 are obtained , and the work focus in optimizing the stacks and MTJs dimensions in order to for improved the Signal Noise Ratio [SNR].

References

[1] R. Guerreroa, M. Pannetier-Lecoeura, C. Fermona, S.Cardoso,b R.Ferreirab and P.P.Freitas,"**Low frequency noise in arrays of magnetic tunnel junctions connected in series and parallel**."

[2] P.Wisniowski, S.Cardoso, P.P.Freitas, J.Appl.Phys., vol.103, pp.07A910-07A912. "**Effect of CoFeB thickness and shape anisotropy on the transfer curves of MgO Magnetic Tunnel Junctions**", April 2008.

Figures

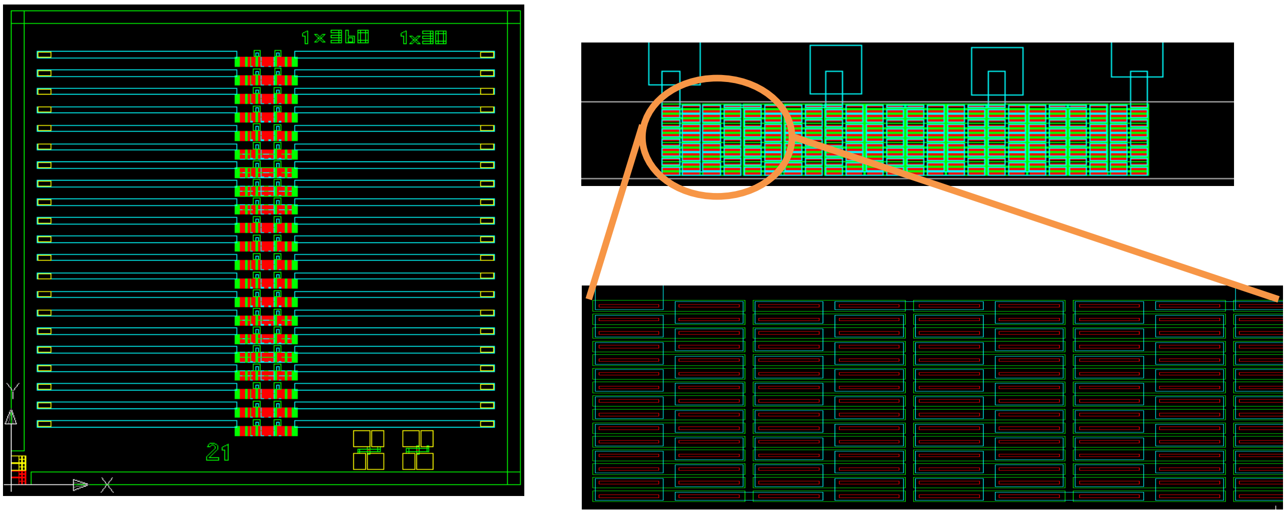

Fig.1 – Actual mask design and sensor detail.

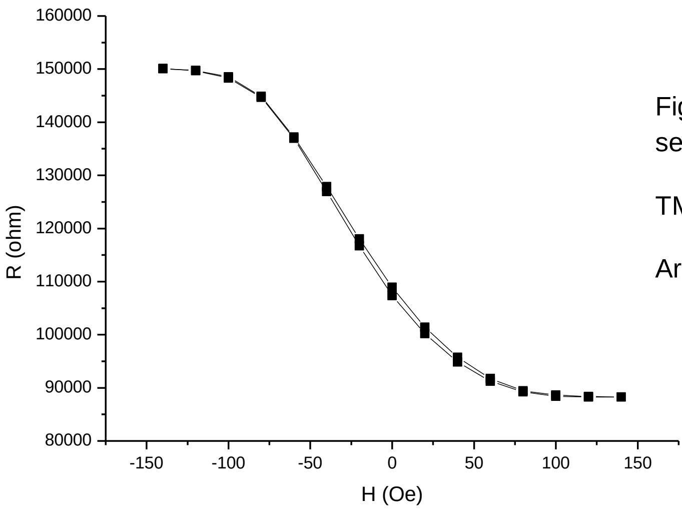

Fig.2 – Typical output result of 360MTJ in series (MgO 17Å, CoFeB 100Å);

TMR=70.5%;

Area 1 MTJ = 60μm^2