INCREASING THE SENSITIVITY OF MAGNETORESISTIVE-BASED BIOCHIPS

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In the last few years, biochips based in magnetoresistive sensors have been used for biomolecular recognition assays [1-3]. In these assays biological probes are immobilized on the chip surface and complementary target biomolecules can be detected using a magnetic label. The detection of the magnetic label fringe fields is accomplished by a magnetoresistive sensor. Because of its sensitivity, its reliability and its easiness of fabrication, spin valve sensors are the most commonly used sensor. Several groups reported the detection of tens and hundreds nanometer sized particles [4],[5]. In order to increase the sensitivity of this technique, an emerging interest in using magnetic tunnel junctions (MTJ) as magnetoresistive sensors is arising due to its higher magnetoresistance (up to 70% with AlOx barrier and 350% with MgO barrier) and its potential increase in sensitivity. However, due to its current-perpendicular-to-plane (CPP) configuration which increases the distance between the sensing layer and the particles, in similar sensor architectures, MTJs show lower particle sensitivity when compared to spin valves sensors (with current-in-plane configuration) [4].

MgO-barrier MTJs with linear response were successfully fabricated. The linear response observed in figure 1 was obtained by shape anisotropy (30x2 μm^2). The MTJ shows a tunneling magnetoresistance (TMR) of 78%, a sensitivity of 1.89%/Oe and a resistance of 2000 kΩ. In order to reduce the distance between the sensing layer and the particles, an Au contact was used for the MTJ top contact. In this way, if a thiol-based chemistry is used the biological probes can be directly immobilized on top of the contact and no passivation layer is needed. [6]

Figure 2 shows the MTJ voltage variation due to the presence of magnetic particles. The detection was made applying an external in-plane transverse 30 Oe + 15 Oerms magnetic field and acquiring the signal using a lockin technique. A volume of 10µl of 250nm superparamagnetic particles (~10^{11} particles/ml) was put over the chip and let to settle down during 10 minutes. A saturation signal of 860 µV was obtain. After washing, the signal came back to the baseline value meaning that all the particles were removed from the sensor (see fig. 2). It is important to note that these experiments with particles demonstrated that neither the Au contacts nor the MTJs are damaged by the corrosion due to liquid used in the experiments. Further experiments with different particles concentrations and with biological probes immobilized over the Au contact will be performed.

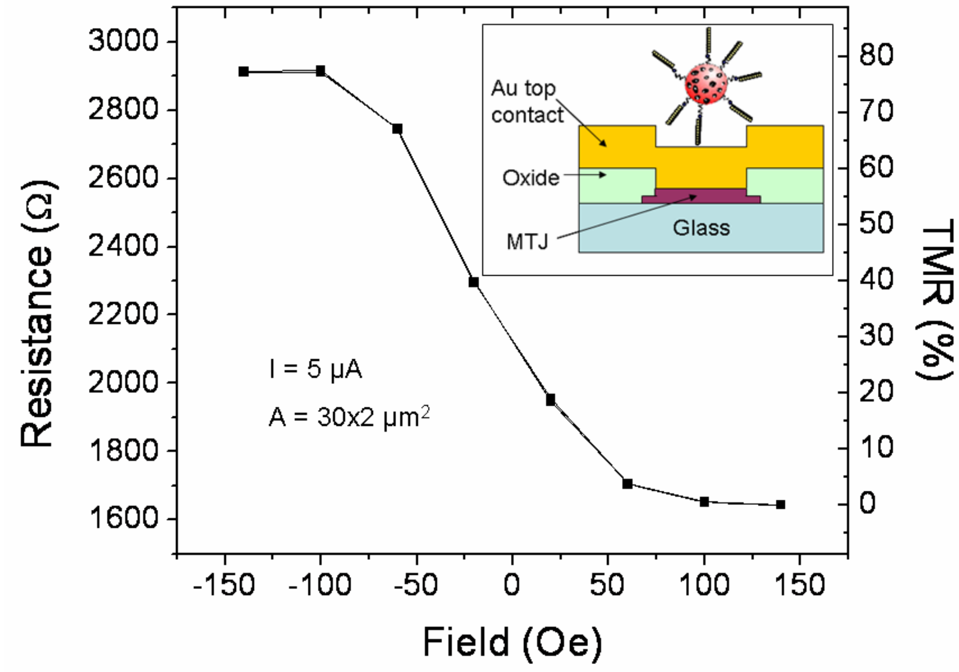

Figure 1: MTJ transfer curve measured for a current bias of 5 μA. The area of the MTJ is 30x2 μm^2. **Inset:** Cross section of the magnetic tunnel junction chip. The probes biomolecules are immobilized on top of the Au contact.

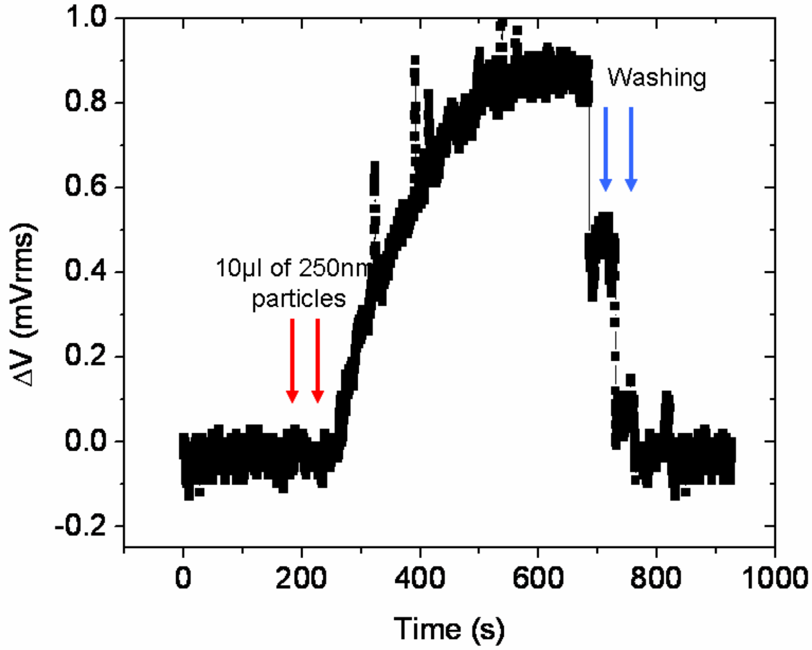

Figure 2: 10 μl of 250nm particles (~10^{11} particles/ml) detection using an MTJ. An in-plane external 30 Oe + 15 Oerms magnetic field was applied to magnetize the particles.

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