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Thin Film Deposition: Layer by Layer until the Sensor

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One of the focuses of this project is the deposition and optimization of magnetic sensors, in particular, spin valves, that are based on the Giant Magnetoresistance (GMR). These are fundamental in detecting magnetic fields, with a range of applications from industrial detection to advanced biotechnology. They rely on the orientation of the magnetic moments between the free layer and the pinned layer. Controlling such things as the spacer (a layer between the two layers), the exchange bias, and the ferromagnetic coupling are relevant to achieving a sensitive magnetoresistive profile.

Another focus of this study is the influence of the thin layer-by-layer film deposition on the sensor's magnetic response and sensitivity, while taking into consideration aspects like the quality of the interfaces and the magnetic stability.

The deposition method chosen was the magnetron sputtering on the Nordiko 2000 at INESC MN. This machine allows the sequential deposition of different films, allowing the change in the deposition rate of each material. After this procedure, the samples went through a magnetic annealing process to help define the sensor's anisotropy and stabilize its performance.

First spin valves confirmed the alteration of the resistance under an external field, confirming that the sensors are sensitive to it. Through the systematic optimization of the thicknesses of various layers and the use of the magnetic annealing process, it was possible to double the magnetoresistance (MR) signal compared to the initial configuration. But this value still needs to be improved because it didn't reach what is considered to be a good signal (MR>10%). To achieve this, in future work, is planned to improve the vacuum conditions on the Nordiko 2000 and optimize the deposition conditions. Additionally, parameters such as the use of a nano-oxide layer (NOL) and the optimization of the target-substrate distance can be explored to increase the magnetoresistance and magnetic anisotropy of the sensor.

Field of Research/Work

Condensed Matter and Materials

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