Nanocomposites and nanomaterials

Characteristics of interacting ferromagnetic nanolayers

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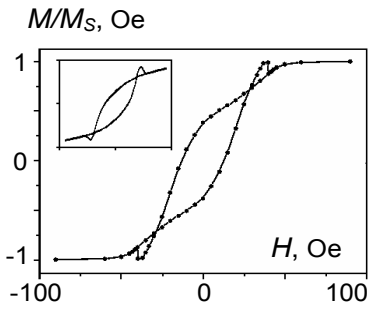
Thin films composite structures consisting from ferromagnetic nanolayers separated by nonmagnetic one - the so-called spin-valves - are used now mainly as the magnetic field sensors. Their parameters have to be further improved due to necessity of the extension of their applications in spintronics.

The studying samples Fe/Cu/Fe were the sandwiched nanolayers of Fe separated by Cu sublayer deposited on the transparent substrate. The magnetic hysteresis curves of the top Fe layer were obtained experimentally with magneto-optical Kerr effect. At the same time hysteresis loops were also calculated by means of minimizing the total energy of magnetization in ferromagnetic layers. The obtained theoretical curves quite accurately coincided with the experimental ones as qualitatively as quantitatively, although the approximate values of magnetostatic interaction and uniaxial anisotropy parameters were used. The example of the loops is shown on the graph, where the points correspond to minimal energy of the magnetization vector position at various magnetic fields and a small insert presents the experimental curve taken magneto-optically.



The results of these calculations allowed to explain all series of the loops, that had a tendency to change their shape depending on the direction of the applied magnetic field. In particular, the “interlaced” hysteresis loop, shown on the diagram was formed due to non-synchronous rotation of coupled magnetization vectors in both Fe layers under applied magnetic field. The differences in rotation were caused mainly by the different directions of the uniaxial anisotropy axes in the nanolayers, that were formed technologically. Thus a necessary working curve of the spin-valve and its basic parameters can be adjusted by orientation of the applied magnetic field and required parameters of the spin valve based devices could be optimized depending on the specified conditions for their applications.