Nanocomposite and nanomaterials

Composite structures with ferromagnetic and piezoelectric properties

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The structures that combine magnetic and electromechanical properties, have become the basis for a new direction of spintronics - the so-called straintronics. These structures are rigidly connected two main layers, one of which has (anti)ferromagnetic properties and the other is a strong piezoelectric as e.g. PZT or PMN-PT [1]. Producing of such composites is possible by method of layer-by-layer application, as well as by mechanical connection of the layers, each of which is deposited on its own substrate. Thus obtained functional straintronic cells are promising as spin transistors, non-volatile magnetic memory, field sensors, etc. Their magnetization can be switched by electrical voltage, due to piezoeffect occured in piezoelectric layer and which is transferred mechanically to magnetic layer, whose magnetic state accordingly changed under mechanical stresses. The small external magnetic field in such a case can play an auxiliary role, for example, it can create a distinguished direction of magnetic anisotropy.

In this studying were used the structures with magnetic layers from magneto-optical yttrium iron garnets $Y_3Fe_5O_{12}$, or antiferromagnetic Y, Dy, or Eu-based orthoferrites $Y(Dy,Eu)FeO_3$, as well as hexaferrites $SrFe_{12}O_{19}$, and with $Pb[Zr_{0.52}Ti_{0.48}]O_3$ as a piezoelectric plate, that was rigidly connected with the corresponding magnetic layer. In order to observe the quasistatic and dynamic remagnetization of the structures the magnetooptical methods were used in Faraday and Kerr effects mode. For observation of high-speed remagnetization on a picosecond time scale, the traditional *pump-&-probe* technique with a 200 fs pulsed laser was used.

The experimental results and performed calculations based on the energy balance equations, confirmed the possibility of reducing the threshold fields, necessary for remagnetization of such structures in different operating modes. Estimations of the energy consumption for magnetization switching in submicron cells also allowed one to conclude the possibilities of reducing the energy consumption on remagnetization with the additional use of the piezoelectric effect.

1. *I.V. Zavislyak, V. P. Sohatsky, M.A. Popov, G. Srinivasan.* Electric-field-induced reorientation and flip in domain magnetization and light diffraction in an YIG/LZT bilayer // Phys.Rev.-2013.-**B 87**- P.134417.