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Nowadays, ferromagnetic materials are widely used, e.g. in engines, turbines, bank cards, children's toys. One of the most important applications of these materials, produced in the form of thin layers or layer systems, are data storage and information processing. These include mass storage devices (hard disk drives) and magnetoresistive random-access memories (MRAM) giving direct access to any memory location, and retaining information when the power is turned off. For both types of memory materials investigations are conducted to develop layer systems, which would allow to increase the recording density of information and at the same time guarantee the stability of the encoded data. In addition,this investiagtion of layer systems would allow to considerable reduce energy consumption in the MRAM.

In the magnetic memories the information is coded by setting directions of magnetization. In these memories a binary system (i.e., zeroes and ones) is used to store the information, and these two states correspond to mutually antiparallel magnetization configurations. Stability of the stored information depends on the magnetic anisotropy (this parameter determines the energy required for switching of magnetization), size of the switching area and temperature. The larger the sizes (note, that we aim for miniaturization) and anisotropy are and the lower the temperature is (computing devices usually operate at room temperature), the greater the stability is. Another factor that influences the stability is the distribution of magnetizatic dipolar interactions between neighboring areas (bits corresponding to a logical 1 and 0) with mutually antiparallel magnetization directions. It turns out that these interactions are smallest when the direction of easy magnetization axis of the layer is perpendicular to its surface. Thus, to obtain high density and stability of the recorded information the materials exhibiting a strong perpendicular magnetic anisotropy are being investigated. It should be noted that the value of the anisotropy must still be matched to the magnetic field produced in the recording heads. For this reason, layered magnetic materials, for which the ability to control the anisotropy has been well studied, are very important. In our opinion, in the proposed scientific project, designed layer systems fulfill these conditions, as confirmed by our preliminary results.

The recording in M-RAM memories is carried out with a magnetic field produced by the conductor paths or, in newer designs, by passing an electric current directly through the system of thin magnetic layers. In the second case the magnetization switching is a result of the transfer of angular momentum of spin-polarized charge carriers. It should be noted, however, that a relatively large current densities which are required to generate the magnetic field necessary to switch magnetization direction or achieve this switching by the angular momentum transfer, lead to high energy losses and heat generation. This is highly undesirable . Therefore, there exists a lot of interest in ways to achieve the ability to control the direction of magnetization by applying an external electric field, potentially providing a 100 times reduction of current density required to write data [1]. Therefore, in many laboratories, researches are conducted into the development of materials technology providing such way of magnetization switching. The aim of our project, in addition to the control of perpendicular anisotropy in layered systems with the interlayer exchange bias coupling, is to verify the suitability of these materials for applications described above, especially in a form of the spin valve-type structures (with a non-conducting antiferromagnetic interlayer) showing the possibility of magnetization switching by applying an electric field.

[1] W-G. Wang et al., Nature Mat. 11, 64 (2012).