Rozprawa doktorska

(z komentarzem)

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Modyfikacje anizotropii i oddziaływań w magnetycznych strukturach cienkowarstwowych

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Abstract

The main aim of the study, presented in a series of publications constituting my Ph.D. thesis, was to develop production technology a layered thin films, in which a modification of perpendicular anisotropy of the ferromagnetic sublayers or an interlayer coupling between them enable to create properties attractive for domain wall manipulation. In particular we tried to create structures, in which the magnetization reversals occur by propagation of a single straight domain wall, as well as those in which, due to the interaction between the ferromagnetic layers, it is possible to copy the domain structure from a magnetically harder to a magnetically softer layer.

Ultrathin structures with Co layers sandwiched between Au or Pt were prepared using ultra high vacuum magnetron sputtering. In these systems the Co layers are characterized by perpendicular magnetic anisotropy. The fabricated structures are distinguished by a lateral gradient of the perpendicular anisotropy and interlayer coupling important features for domain wall manipulation. The lateral anisotropy gradient was achieved by the use of wedge-shaped Co layers or by ion-beam bombardment with continuously increasing/decreasing the He^+ ion fluence along one lateral coordinate. It has been shown that the Au/Co/Au/Co-wedge/Au layered systems may be used as a magnetoresistive sensor which allows recording the maximum magnetic field acting on this sensor. For the Au/Co/Au/Co/Au multilayer with a coercive field/anisotropy gradient obtained by the ion bombardment it has been shown that the process of magnetization reversal may occur by propagation of a single, straight domain wall. This specific magnetization reversal process, which is attractive for many applications, is easier to obtain the stronger anisotropy and larger coercive field gradient is.

We have also investigated changes in the interlayer coupling between Co layers by using the wedge spacer layer in Au/Co/Au-wedge/Co/Au and Pt/Co/Pt-wedge/Co/Pt layered systems. For the structures with the Au spacer it has been shown that an increase in crystallite size and interface roughness (modified variation in thickness of buffer layer) results in of increase in the amplitude of the RKKY-like interaction and the occurrence of antiferromagnetic dipolar coupling caused by interface roughness (orange peel coupling). For the structures with Pt spacer, characterized by a strong gradient of ferromagnetic interaction, it has been shown that

magnetization reversal of magnetically softer Co layer (with a smaller switching field) occurs through the reversible propagation of a single straight domain wall over relatively large distance (of the order of millimeters). It is important that the gradient of coupling results in deceleration of the domain wall propagation both when it moves in the direction of the stronger and weaker interaction. This effect is responsible not only for generation of a straight domain wall, but also for its propagation controllable by homogeneous external magnetic field.

It was also shown that in the structure of pseudo-spin valves characterized by a non-zero coupling, the process of magnetization reversal of the magnetically softer layer, performed under the partial reversal of the magnetically harder layer, takes place through a distinct intermediate state. This state corresponds to the copying of domains in an antiferromagnetic or ferromagnetic configuration. Depending on the type of the interaction, antiferromagnetic or ferromagnetic, duplicated domain structure has an antiparallel or parallel magnetization configuration in both ferromagnetic layers, respectively.