Analysis of the microstructure of Co-Cu/Cu multilayers with GMR effect produced by electrochemical deposition

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An increased demand for higher sensitivity of magnetic sensor and at the same time a reduction in the production costs is one of the current issues in fabrication of this group of functional materials. Metallic multilayers, of which one component is ferromagnetic (i.e. Co, Fe, Ni) and the other diamagnetic (i.e. Cu, Au, Cr, Ru, Pt) show spin-dependent electron scattering due to the (antiferromagnetic) coupling of the magnetic moments via the non-magnetic spacer layers. This results in a large change of the electrical resistance of the multilayer structure upon the change of an externally applied magnetic field, which is known as the giant magnetoresistance (GMR) effect. These structures are used for the read-heads in virtually all hard-disk drives available nowadays.
In order to match the criterion of the cheapness of the deposition of the multilayers in comparison to the widely used physical, vacuum assisted methods, an electrochemical process elaborated and perfected by I. Bakonyi and his research group was used. The disadvantage of this process is their comparably large distortion of the multilayer structure by microstructural defects, layer undulations and incorporation of foreign species in the nominally pure layers. These microstructure defects are responsible for the decay of the magnetoresistance ratio, the reduced field sensitivity of the deposits, etc.
A systematic study of the features of Co-Cu/Cu multilayers with different thicknesses of the spacer layer produced by electrochemical deposition (ECD) was performed. Results on microstructural parameters such as (individual) layer thicknesses, interface roughness and its correlation, kind of microstructure defects, degree of crystallinity and interplanar spacings were obtained by small-angle (SAXS) and wide-angle X-ray scattering (WAXS) methods in combination with transmission electron microscopy (TEM) with high resolution.
These microstructural features were correlated on one hand with the magnetic properties (i.e. magnetoresistance ratio) and on the other hand with the parameters of the ECD process in order to analyse how the deposition process can be tuned to design a deposit with tailored properties.