9th International Workshop on Electrodeposited Nanostructures

Electrochemical Deposition of Co(Cu)/Cu Multilayered Nanowires

Fedor S. Fedorov, Jens Igolf Mönch, Chistine Mickel, Kristina Tschulik, Margitta Uhlemann, Annett Gebert, Jürgen Eckert

Leibniz Institute of Solid State and Materials Research, P.O. Box 270016, D-01171 Dresden, Germany, f.fedorov@ifw-dresden.de.

Among known multilayer systems with alternating magnetic and non-magnetic layers for giant magnetoresistance (GMR) sensor applications, superior GMR values are assigned to Co(Cu)/Cu multilayers [1]. Fabrication of multilayered Co(Cu)/Cu nanowires would allow a current-perpendicular-to-plane geometry what might result in enhanced magnetoresistance properties in comparison with current-in-plane geometry of conventional multilayer electrodeposits. Liu et al. measured a GMR value of about 11% at room temperatur for [Co (5 nm)/Cu (0.8 nm)]$_{1000}$ nanowires electrochemically deposited into track etched polycarbonate membranes [2].
We fabricated multilayered Co(Cu)/Cu nanowires by electrochemical potentiostatic double pulse deposition in alumina templates from a single bath electrolyte. The electrochemical deposition is discussed concerning the diffusion (Cu) or kinetically controlled (Co) behavior of the multilayer-constituting elements. Results show high impact of spherical diffusion on enhancement of limited current density of the diffusion controlled Cu with respect to the flat surface [3]. Therefore, the deposition of magnetic Co layer is greatly affected by co-deposited ions of the non-magnetic Cu. To overcome this behavior and increase the Co-deposition rate the deposition potential for Co layer was shifted to more negative potentials. TEM, EDX and XRD studies are performed to correlate deposition parameters with the structure of multilayers. Deposited multilayers possess no considerable alternations in single layer thicknesses and composition over the analyzed length of multilayered nanowires. The GMR-effect was measured by a 4-probe technique lithographically designed on the template surface. An unexpectedly high giant magnetoresistance of about 12% was detected for [Co(Cu) (9 nm)/Cu (11 nm)]$_{380}$ multilayered nanowires with current-perpendicular-to-plane geometry and in-plane applied magnetic field at room temperature.

References:

[1] I. Bakonyi, L. Péter, "Electrodeposited multilayer films with giant magnetoresistance *(GMR)*: Progress and problems," Progress in Materials Science, **55**, 107-245 (2010);
[2] K. Liu, K.Nagodawithana; P.C. Searson; C.L. Chien, "Perpendicular giant magnetoresistance of multilayered Co/Cu nanowires," Physical Review B **51**, 7381-7385 (1995);
[3] F.S. Fedorov, J.I. Mönch, Ch. Mickel, K. Tschulik, M. Uhlemann, B. Zhao, A. Gebert, J. Eckert, "Electrochemical Deposition of Co(Cu)/Cu Multilayered Nanowires," Journal of The Electrochemical Society, submitted.