ROBL-CRG	**Experiment title:** **Influence of O_2 integration in a NiFe/Cu multilayer sequence on the structural properties of the layers and interfaces**	**Experiment number**: 20_02_026
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Report:

Structural properties of metallic multilayers showing giant magnetoresistance (GMR) have been investigated by methods of X-ray reflectometry. A series of Co/Cu and NiFe/Cu multilayers with individual layer thickness of about 2nm corresponding to the second coupling maximum of the GMR have been annealed at different temperatures up to 400°C in vacuum. After annealing GMR measurements and X-ray scattering experiments were performed. The results of the experiments have been compared with those of samples annealed in air where structural changes are overlapped by the influence of oxide at the surface. Thus, the goal was to extract the changes of the interface structure due to thermal treatment from those due to surface oxidation. Although multilayers of these types have been investigated extensively in the past, the structural reasons for changes of the GMR, e.g. after heat treatment, are not completely clarified (e.g. [1-3]).

The electrical measurements of the samples show an continuos increase of the GMR from 24% in the as deposited state up to 30% after annealing at 400°C for the Co/Cu system, whereas for NiFe/Cu initial values of about 10% and a breakdown of the GMR between the annealing at 220°C and 300°C were found.

To improve the contrast for the scattering experiments between the used material combinations, the X-ray wavelength was adjusted to the Cu absorption edge. The specular scans indicate a stable layer sequence showing Kiessig fringes and Bragg peaks in the whole temperature range investigated. The interface r.m.s. roughness of initially 0.5nm was found to be nearly constant up to 400°C for Co/Cu and to increase slightly up to 0.6nm at 300°C, followed by a rising up to a formal value of 1.1nm at 400°C for NiFe/Cu. It should be considered that the latter value cannot be interpreted as the roughness of sharp interfaces but corresponds to the onset of interdiffusion in the NiFe/Cu system as proved by AES.

From the measurements of the diffuse scattering a nearly constant correlation of the roughness between the layer interfaces can be deduced for both multilayer systems, decreasing for NiFe/Cu beyond 300°C. Thus, the scattering measurements indicate that the GMR breakdown is accompanied a relatively small roughness increase. Additional diffraction experiments in the wide-angle region yield growing grains, increasing tensile stresses and modifications of the initially sharp {111}-texture. The experiments suggest that the key mechanism responsible for the GMR changes could be the onset of grain-boundary diffusion at elevated temperatures.

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[3] K. Rätzke, M.J. Hall, D.B. Jardine, W.C.Shih, R.E.Somekh, A.L.Greer, *J. Magn. Magn. Mat.* **1999**, 198-199, 653.