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MAGNETORESISTANCE OF SINGLE NiFe AND MULTILAYERED NiFe/Cu NANOWIRES

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Introduction

After the observation of the GMR effect and its use in high-density magnetic recording media and novel magnetic sensors, the interest for nanostructured magnetic materials increased significantly.

The nanowires, because of their dimensions and unique characteristics, exhibit unusual physical properties, which make them exciting from both fundamental and technological point of view. Magnetic nanowires, in particular, are very interesting from the point of view of the spin-dependent electric transport phenomena. There are many different ways to produce nanowires, but one of the cheapest ways is the electrochemical deposition, which avoids the difficulties inherent to the nanolithography processes and allows producing important amounts of nanowires in relatively short periods of time.

Aim

This study is focused on the magnetoresistance of single NiFe and multilayered NiFe/Cu nanowires in the current perpendicular to plane (CPP) geometry. The measurements done on a number of nanowires (tens to hundreds) are compared with those obtained for individual nanowires. For this last purpose, special equipment has been designed and fabricated. The main goal of this work was the design, fabrication and the improvement of a special equipment in order to achieve such kind of measurements. That will give the opportunity for achieving reliable MR measurements for a number of single NiFe and multilayered NiFe/Cu nanowires in the future, that will lead to important conclusions .

Samples

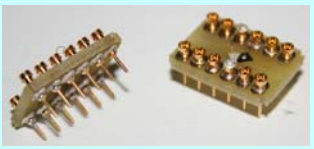
The samples that was used for the measurements were prepared by electrochemical deposition in the pores of alumina templates. It is NiFe(30nm)/Cu(5nm) in 1600 sequences, NiFe(200nm)/Cu(50nm) with 200 sequences and NiFe(30nm)/Cu(10nm) with 1300 sequences

Magnetoresistance Measurements

The CPP-MR measurements were made using a two point-contact method. The bottom of the sample, that was sputtered with gold, was mounted on a sample base using silver conductive paint. At the top of the template after polishing it, the second contact was made using again silver conductive paint. It is very important for the measurements, the area that the silver paint appropriate at the top of the sample must be as much less as it can be.

The equipment includes a source, which was a 6 Volt battery, an electromagnet of 1,5 Tesla, a polymeter for measuring the tension at the sample, a Gauss-meter for measuring the field, the base of the sample and the computer for the data analysis. It was also added an electric circuit for changing the current that was passing through the sample. Also specific program was made using Testpoint, in order to operate the hole system from the computer. It is very crucial for the measurements, the equipment must be shielded as much possible in order to avoid the existence of noise at the signal.

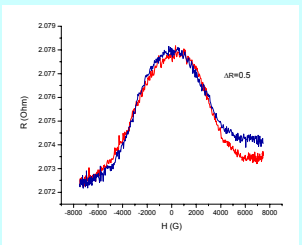
For specific current from the source, the tension of the sample is changing as the field is changing and according to Ohm's low the resistance of the nanowires that are included under the silver paint at the top of the template can be measured



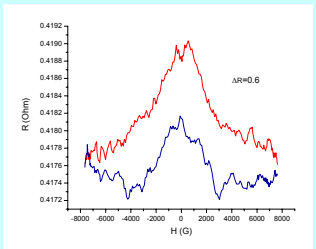
Results

The CPP-MR was measured for the three different samples

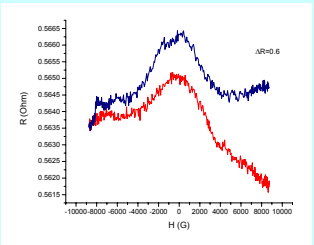
NiFe(30nm)/Cu(5nm)



NiFe(200nm)/Cu(50nm)



NiFe(30nm)/Cu(10nm)



where $\Delta R=R_{(H=0)}-R/R \times 100$, the red line is from positive to negative field and the blue line the vise versa

Even though the nanowires have about the same dimensions (~100nm diameter and ~52nm length), their behavior has great differences, depending on the thickness of the NiFe layer and the Cu layer. It is obvious that in the case of the first sample which has the thicker NiFe and Cu layer of the three the behavior is mach more uniform.

Conclusions

The fabrication of an equipment for MR measurements was succeeded. That can be easily concluded from the form of the graphs which have the chartacteristic Gaussian form.

That will help for the measurements of a number of single NiFe and multilayered NiFe/Cu nanowires and will help in the understanding of the phenomena that take place at that dimensions in these kind of materials and of cousre for future applications.

References

X.-T. Tang, G-C Wang, M. Shima Phys. Review B 75, 134404 (2007)

A.O.Adeyeye, J.A.C. Bland, C. Dadoo, J. Appl. Phys. 79 (8) 1996

S. Dudois, C. Marchal, J.M. Beuken, L. Piraux, Appl. Phys. Lett 70 (3), 1997