Contribution ID: **46** Type: **Zamestnanci fyzika**

Thermal Stability of Magnetoresistive Properties in Permalloy-Copper Alloy Thin Films

Wednesday, November 26, 2025 3:32 PM (1 minute)

Thin-film systems exhibiting magnetoresistive effects have found broad practical application in various industries, including nanoelectronics, automotive engineering, and biotechnology. During the operation of devices that utilize magnetoresistive elements (e.g., non-volatile magnetic memory such as MRAM, or magnetic field sensors), the materials are subjected to elevated temperatures. The stability of the MR response under thermal exposure is a key parameter determining device reliability.
We present a systematic study of the nanostructure, phase state, and magnetoresistive properties in alloy thin films based on permalloy ($Ni_{80}Fe_{20}$) and copper, both as-deposited and after vacuum annealing up to 800 K. The films $(Ni_{80}Fe_{20})_xCu_{100-x}$ with compositions 21 vol. % $\leq x \leq$ 73 vol. % and a thickness of 40 nm were prepared by vacuum co-evaporation from two independent sources, enabling precise composition control.
Transmission electron microscopy (TEM) studies revealed that the structural and phase state of the as-deposited samples over a wide composition range was characterized by the presence of FCC-permalloy granules (with sizes ranging from 7 to 15 nm) embedded in an FCC-Cu matrix. The phase composition of the samples remained unchanged after isothermal annealing at 600 K, 700 K, and 800 K. The nanostructure of the films also exhibited high thermal stability. The size of the permalloy granules increased only slightly following heat treatment: 8–16 nm at 600 K, 8–21 nm at 700 K, and 10–22 nm at 800 K. No phase transformations or oxide formation were detected in the crystalline phase. The magnetoresistive effect was isotropic and composition-dependent. The magnetoresistive properties of the thin film samples also remained stable after annealing at 700 K. The highest GMR value of 0.68 % at room temperature in a magnetic field of 15 kOe was observed in the film sample with a permalloy concentration of $x = 50$ vol.%. Low-temperature measurements confirmed superparamagnetic behavior and enhanced spin-dependent scattering. Despite the relatively low GMR value, the system exhibits low coercivity and high sensitivity in weak magnetic fields, making granular alloy thin films based on permalloy and copper promising for use in high-sensitivity magnetic sensors and suitable for applications requiring magnetoresistive stability at elevated temperatures.

Acknowledgments
This work was funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V01-00044.

Pracovisko fakulty (katedra)/ Department of Faculty

Centre for Nanotechnology and Advanced Materials

Tlač postru/ Print poster

Nebudem požadovať tlač posteru / I don't require to print the poster

Author: SHPETNYY, Ihor (Centre for Nanotechnology and Advanced Materials, Faculty of Mathematics, Physics and Informatics, Comenius University Bratislava; Sumy State University)

Co-authors: Dr RUBAN, Anatolyi (Sumy State University); Dr SATRAPINSKYY, Leonid (Centre for Nanotechnology and Advanced Materials, Faculty of Mathematics, Physics and Informatics, Comenius University Bratislava); Mr LYFAR, Serhij (Sumy State University); Ms KULYK, Tetiana (Sumy State University); Dr PLECENIK, Tomáš (Centre for Nanotechnology and Advanced Materials, Faculty of Mathematics, Physics and Informatics, Comenius University Bratislava); Dr SHVETS, Uliana (Sumy State University); Dr PAK, Vasyl (Sumy State University); Mr HREBYNAKHA, Viktor (V.G. Baryakhtar Institute of Magnetism, National Academy of Sciences of Ukraine); Prof. SHKURDODA, Yurii (Sumy State University)

Session Classification: Poster session + káva: prezentácie vedeckých výsledkov FMFI UK Zamestnanci Fyzika

Track Classification: Poster session + káva: prezentácie vedeckých výsledkov FMFI UK Zamestnanci: Poster session + káva: prezentácie vedeckých výsledkov FMFI UK Zamestnanci Fyzika