# STUDY OF MAGNETORESISTIVE NANOGRANULAR FILMS WITH X-RAY SPECTROSCOPIES

**Cz. Kapusta**[1*], **M. Sikora**[1], **J. Przewoźnik**[1], **J. Żukrowski**[1], **J. Fedotova**[2], **and J. Kasiuk**[2]

[1] *AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland*
[2] *NC PHEP BSU, 220040 Minsk, Belarus*

*Keywords: X-ray absorption spectroscopies, nanogranular composite films, tunnel magnetoresistance*
[*] *e-mail*: kapusta@agh.edu.pl

Granular films composed of nanometer size particles of magnetic metals such as Fe, Co and their alloys in an insulating matrix such as $Al_2O_3$, $ZrO_2$ or $SiO_2$ have recently attracted a great deal of interest. This is due to their magnetoresistive properties and prospective application in magnetic sensors, information storage media and high frequency electronic devices. Relatively easy and flexible synthesis routes using sputtering techniques make possible tailoring of their magnetic and electrical properties in a wide range by varying composition and metal/insulator fraction ratio.

In the lecture the application of the X-ray absorption spectroscopy to the study of the (FeCoZr)-($Al_2O_3$) and (FeCoZr)-($CaF_2$) sputtered nanogranular composite thin films will be addressed. The spectra in the XANES and EXAFS ranges of the materials with different metal-to-insulator ratios prepared in the inert gas atmosphere and under oxidizing conditions will be presented and discussed. A relation to the results of X-ray diffraction, magnetometry, Mössbauer spectroscopy and electrical transport as well as magnetoresistivity measurements will be given.

In the Fig. 1 an example of the Fe and Co $K$-edge X-ray absorption spectra in the XANES range for fully oxidized $(FeCoZr)_{64}(Al_2O_3)_{36}$ film, pure FeCoZr film and a partly oxidized film of intermediate composition, are presented. Both, Fe and Co absorption edges of the FeCoZr film are similar to each other and resemble those of elemental Fe and Co. Much different shapes of absorption edges are revealed in the spectra of the nanocomposite films.

Surprisingly, the Fe spectrum for $(FeCoZr)_{56.5}(Al_2O_3)_{43.5}$ indicates a larger oxide contribution, in contrast to that of Co, which is closer to pure alloy spectrum. It shows that oxidation process is not spatially uniform, but favors oxidation of iron prior to cobalt.

The results of combined studies will be discussed in terms of their relation to the enhancement of the TMR effect in the "core-shell" granular structures through spin accumulation and filtering processes.

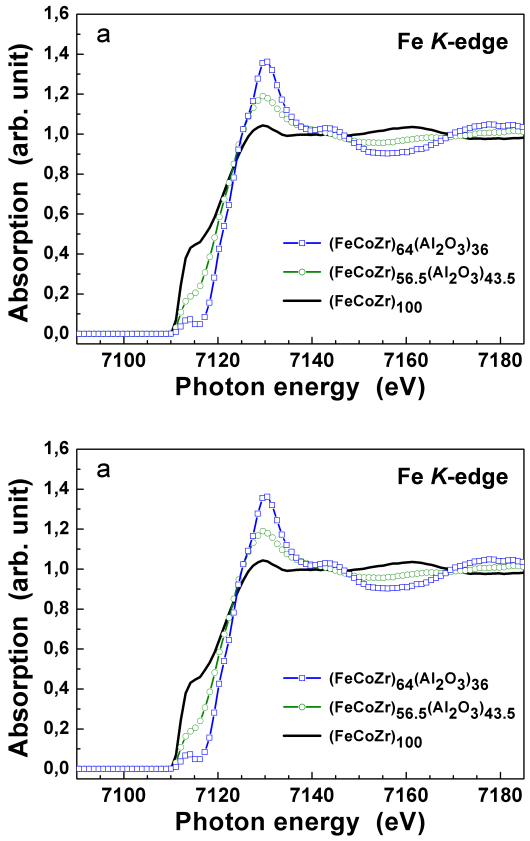


*Figure 1*: The Fe (a) and Co (b) $K$-edge XANES spectra of (FeCoZr)-($Al_2O_3$) thin films.