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'Magneto-electric ceramic composites'

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At Stockholm University we are involved in development of new composite materials for which a magneto-electric coupling is present. The work is focused on the development of new composite materials consisting of ferromagnetic and ferroelectric phases, which could have a stronger magneto-electric coupling than "intrinsic multiferroics" materials. It was shown by Zheng *et al*. [1] that a decrease of magnetization at the ferroelectric Curie temperature exists in thin-films of $CoFe_2O_4$-$BaTiO_3$ nanostructures. The effect was considered as an evidence of magneto-electric coupling.
Our aim is to evaluate the magneto-resistance effect which we can get depending on the volume percentage of the phases which are mixed in the case of x $CoFe_2O_4$- (1-x) $BaTiO_3$ nanocomposites. The magneto-resistance effect is characterized by the change of electrical resistance when the material is subjected to an external magnetic field. Nowadays, the effect has a major impact on information and communication technologies and allows the development of new reader equipments necessary to all hard drives devices.

Purpose of the visit

A visit to Max-Planck-Institute for Solid State Sciences (Festkörperforschung) in Stuttgart by Marian Stingaciu was taking place between 14-19 of November. The goal of this visit was to discuss together with Dr. Reinhard K. Kremer our recent results concerning the magneto-resistance properties of our composite materials and also to perform additional measurements on x $CoFe_2O_4$- (1-x) $BaTiO_3$ nanocomposites using their Physical Properties Measuring System (PPMS).

Description of the work carried out during the visit

The magneto-resistance measurements were performed in PPMS using a standard four-probe dc method. The resistivity was measured for three different compositions x = 0.20, 0.25 and 0.30 at constant temperature while the magnetic field was swiped between -2.5 ÷ 2.5 Tesla, magnetic fields. The temperature dependence measurements were performed in the temperature range between 150-300K.

Description of the main results obtained

The resistivity was measured in the presence of an external magnetic field. The relative change of the resistivity is defined as $MR = [\rho(H)-\rho(H_0)]/\rho(H_0)$ where H and H_0 represent the applied magnetic field and zero magnetic field, respectively.
The measured samples revealed a negative MR effect which means that the resistance of the samples was decreased when the applied external field was increased. The effect was observed for all the samples but with an enhanced effect when the temperature was decreased from 300K to 150K for example in the case of x=0.30 composition for which an increase of the effect was increased from 0.95% at 300K to about 4.5% at 150K at the highest applied magnetic field of 25 kOe.

Further collaboration with the host institute

In the frame of this project, further collaboration with the Max-Planck-Institute for Solid State Sciences (Festkörperforschung) in Stuttgart is planned to take place. We plan to measure the magneto-capacitance at different frequencies for those composites which possess a high electric resistance.

Project publications

A publication is planned to be submitted were the additional measurements in Stuttgart will be included.

Reference

[1] H. Zheng , J. Wang , S. E. Lofland , Z. Ma , L. Mohaddes-Ardabili, T. Zhao, L. Salamanca, Riba, S. Shinde, S. B. Ogale, F. Bai, D. Viehland, Y. Jia, D. G. Schlom, M. Wuttig, A. Roytburd, R. Ramesh, Science 30, 661 (2004)