Features of tunnel magneto resistive effect in various types of nanocomposites

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An overview of the experimental data concerning the study of tunnel magneto resistive effect (TMR) in different type of nanocomposite (ferromagnetic-dielectric and ferromagnetic–semiconductor) prepared on the same equipment and under similar conditions has been made. The influence of material of ferromagnetic phase (CoFeB, CoNbTa and CoFeZr) on the magnetoresistance has been investigated in composites with amorphous metal granules. At the similar morphology of the composites and absent of a crystalline anisotropy in ferromagnetic granules the TMR values depends on the properties of metal phase. The maximum values of TMR and saturation magnetostriction of the metallic phase as well as maximum values of the Kerr effect are in composites, containing metal granules which have higher density of electron states at the Fermi level ($g(E_F)$). In studied systems it gives following sequence: CoNbTa→ CoFeB →CoFeZr (fig.1). In a case of crystalline granules, the positive magneto resistive effect is being added to usual negative TMR (see fig.2). The positive effect is observed in Co-Al_2O_3, Co-SiO_2, and Co-MgF_2 composites and is due to complicated morphology of the composites: simultaneous co-existence of clusters and separated nanogranules having different anisotropy. The positive magnetoresistance is not observed in every crystalline composite, for example it is not observed in Co-CaF_2 system. According to HRTEM this system has another morphology. One can suppose that the ratio between surface energy of metal and dielectric phases is responsible for the composites morphology and for presence or absence of the positive effect. In a case of semiconductor matrix the composites also exhibit tunnel magnetoresistivity but the value of the effect is much smaller. Comparison of the TMR values of Fe-Nb_2O_n and Ni-Nb_2O_n composites with Fe-Al_2O_n and Ni-Al_2O_n gives the conclusion: magnetoresistance in composites with semiconductor matrix is one order smaller than in composites with dielectric matrix. But the current mechanisms in composites with different type matrix are the same: tunneling of electrons between granules and tunneling of electrons via localized states.

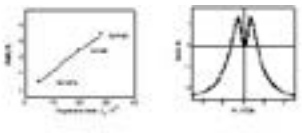

Figure 1: Maximum values of TMR in nanocomposites vs maximum values of magnetostriction of the composite metal phase.

Figure 2: Example of positive tunnel magnetoresistance observed in Co_{60} $(Al_2O_3)_{40}$ nanocomposites.

Biography

Oleg V Stognei has completed his PhD in 1990 in Voronezh Polytechnic Institute (Russia). He worked as an assistant professor and then as a professor at the Department of Solid State Physics in Voronezh State Technical University (Russia). The science interests are electrical and magnetic properties of nanostructured materials (nanocomposites and multilayers). As an invited researcher carried out investigations in Royal Institute of Technology (Sweden) and PTB (Germany). He has published more than 100 papers in reputed journals.

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