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PERCOLATION EFFECTS IN THE COMPOSITE OF SUPERCONDUCTOR AND HALF-METAL

Transport characteristics of the composite of the MgB_2 superconductor and nanopowder of manganite $La_{0.7}$ $Sr_{0.3}MnO_3$ (LSMO) with varied content of magnetic impurity are investigated. A differential peculiarityof the composite is substantially varied granule size of MgB_2 (d = 5–8 μm) and LSMO (d = 8–10 μm). It is demonstrated that mixing and high pressure at the sample formation result in effect of coating of larger grains of magnesium diboride by manganite nanoparticles. This fact is accompanied by breakdown of percolation routes of magnesium diboride even at the concentrations below 20% of magnetic doping. As a result, superconducting transition of MgB_2 becomes substantially wider and a grid of weakly-bound contacts through ferromagnetic inclusions is formed. The form of current-voltage characteristics indicates weakly bound character of the tested structure, too. The obtained result makes possible realization of spin-active surface at the interface of superconductor and manganite. In this case, Cooper's pairs with s-wave symmetry of the order parameter can be transformed into pairs with p-symmetry where the spins of both electrons are directed along the quantization axis. These pairs will have a clear passage through the half-metal.

Keywords: composite, superconductor, manganite composite, percolation cluster, the spin-activated area

Fig. 1. Dependence of the resistivity of the composite with varied volume content of LSMO. The inset shows the temperature dependence of the resistivity: *1* – MgB_2; *2* – MgB_2–LSMO (10% LSMO); *3* – MgB_2–LSMO (26% LSMO)

Fig. 2. Photos of the MgB_2 (*a*) and MgB_2–LSMO (26% LSMO) (*б*) plates obtained with a scanning electron microscope

Fig. 3. The resistivity of the MgB_2–Fe_3O_4 composite vs concentration of Fe_3O_4. The inset $R(T)$ illustrates the superconducting transition for MgB_2 (◆) and MgB_2–Fe_3O_4 with 17% (□), 29% (○) and 32% (◇) of the content of Fe_3O_4

Fig. 4. Current-voltage characteristics of MgB_2 (*1*) and MgB_2–Fe_3O_4 (25% Fe_3O_4) (*2*)

Fig. 5. Current-voltage characteristics of the MgB_2–LSMO composites with 10% (*a*) and 26% (*б*)