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TUNNELING EFFECT IN THE MGB_2/LCMO JUNCTION: SUPPRESSION OF THE CONDUCTION BAND OF A MANGANITE AT $T \to T_C$

The effect of temperature on energy spectrum of the $La_{2/3}Ca_{1/3}MnO_3$ manganite (LCMO) was investigated using tunneling spectroscopy. Tunnel junctions of MgB_2/LCMO were prepared on partially deoxygenated ($d \le 50$ Å) thin surface layer of manganite crystals with Curie temperature $T_C^* \approx 150$ K, that was lower of the temperature $T_C = 250$ K of the bulk LCMO. This allowed monitoring the temperature change of the electronic spectrum of the manganite up to the temperature of the metal–insulator transition, while retaining metallic conductivity of the facings of the MgB_2/LCMO tunnel junction. As a result, sharp suppression (collapse) of states of $e_g^{\uparrow}$ band manganite at the metal–insulator transition temperature was observed. Comparison with the optical spectroscopy data shows that the cause of the phenomenon is that the conduction electrons of LCMO, falling out of the coherent dynamics of the band at $T \approx T_C$, are localized and form covalent bonds with the oxygen ions in the energy range from –2 to –8 eV, i.e. substantially below the Fermi level. Therefore, the effect of colossal magnetic resistance involved much wider energy range than that in the standard double-exchange model, which also takes into account the antiferromagnetic exchange and lattice Jan–Teller effects. It follows that the sharp increase in the resistance of the manganites at $T \approx T_C$ reflects not only double exchange, participation in the Jan–Teller distortion, charge ordering but mostly the effects of strong electron correlations.

Keywords: manganites, effect of colossal magnetic resistance, band structure, tunnel effect

Fig. 1. MgB_2 energy gap in the spectrum of MgB_2/LCMO junction: —– calculation, –♦– – experiment

Fig. 2. Temperature dependence of the conductance $G(V = 0)$ of MgB_2/LCMO junction

Fig. 3. Dependence of the conductance $G(V) = dI/dV$ of the MgB_2/LCMO junction at $T =$ = 4.5, 20, 40, 77, 102, 124, 140, 187, 197, 232, 251, 269 K

Fig. 4. Comparison of the tunneling spectra of MgB_2/LCMO junction (–○–) and Ag/LCMO [11] (—). The insets: *a* – tunneling spectrum of MgB_2/LCMO (–△–) and STM data [9] (—); *б* – pseudogap in the spectrum of MgB_2/LCMO junction at $T = 28$ K