

The Fermi Level Variation in $\text{YBa}_2\text{Cu}_3\text{O}_y$ Doped by Ca and Pr and Its Influence on the Critical Temperature

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We have studied the electron transport phenomena in three Ca, Pr→Y doped HTSC-systems, namely, $\text{Y}_{0.75-x}\text{Ca}_x\text{Pr}_{0.25}\text{Ba}_2\text{Cu}_3\text{O}_y$ (Ca_xPr), $\text{Y}_{0.85-x}\text{Ca}_{0.15}\text{Pr}_x\text{Ba}_2\text{Cu}_3\text{O}_y$ (CaPr_x), and $\text{Y}_{1-2x}\text{Ca}_x\text{Pr}_x\text{Ba}_2\text{Cu}_3\text{O}_y$ (CaPr). The peculiarities of the thermopower behavior are discussed in comparison with results for systems with single Ca and Pr doping. The variation for the critical temperature, T_c , with doping level is observed to have distinctive features in each of investigated systems. In CaPr system a T_c drop with x coincides with the case of single doping both by Pr and Ca, in CaPr_x system the $T_c(x)$ dependence has two different regions remaining to be almost constant up to $x=0.175$ and then falling sharply, in Ca_xPr system this dependence is non-monotonic. The thermopower results were analyzed within a narrow-band model that allowed us to determine the main parameters of the energy spectrum and charge-carrier system, including the Fermi level, E_F , position. The obtained $E_F(x)$ dependences are analyzed and explained taking into account a particular influence of Ca and Pr ions on the conduction band structure. The role of the Fermi level variation in modification of the superconducting properties is discussed. The work is supported by grant from the Ministry of Education and Science of Russia, Contract No. P1237.