MAGNETO-CONDUCTIVITY OF THE UNTWINNED YBA2CU3O7-δ SINGLE CRYSTALS

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In this work we study the influence of the angle between the constant external magnetic field 15 kOe and the ab-plane α on the shape of the temperature dependence of the resistivity nearby a transition to the superconducting (SC) state in untwinned YBa2Cu3O7-δ single crystals with a small oxygen hypostoichiometry. Assuming that the excessive conductivity $\Delta\sigma = \sigma - \sigma_0$ [the deviation from the inversely-linear behavior σ0=(A+BT)−1] diverges as Δσ~(T-Tc)-β at the critical temperature Tc we found that the derivative $\chi(T) = -d\ln\Delta\sigma / dT$ is characterized by the following three temperatures: Tc0, TM and Tc, corresponding to the end of the resistive transition in SC state, the melting point of the vortex-lattice and the critical temperature in the mean-field approximation respectively. We found that: (i) the function $\chi(T)$ has a linear asymptotes $\chi(T)^{-1} = \beta^{-1}{}_{c0}(T - T_{c0})$ and $\chi(T)^{-1} = \beta^{-1}{}_{c}(T - T_{c})$ nearby the Tc0 and Tc with $\beta_{c0} > \beta_c \approx 1/2$ which means a crossover from the tree-dimensional-like (3D) behavior, $\beta_c \approx 1/2$, to the lower effective dimensionality. (ii) The width of transitional region Tc - Tc0 increases from 0.3K at zero field and $\alpha = 0$ to approximately 6K at $\alpha = 60^0$. (iii) The peaks at the vortex-melting point TM grow up and shift toward the T_{c0}.with increasing the angle α. (iv) The function $\chi(T)$ displays a universal scaling which means that all points measured at different angles α lay at a single curve in some reduced coordinates. (v) The function $\Delta\sigma(T)$ displays a pseudogap behavior and the 3D-2D dimensional crossover. We relate these features with the Hikami -Larkin theoretical model for the fluctuation conductivity at T>Tc and with the 3D-2D crossover on the vortex-lattice melting line caused by the crossover of the upper critical magnetic field $H_{c2}(\alpha, T)$ trough the elastic moduli of the vortex-lattice which are polynomials of the ratio $H / H_{c2}(\alpha, T)$ at T<Tc.