Magneto-resistance of the $YBa_2Cu_3O_{7-\delta}$ single crystals with a small deviation from the oxygen stoichometry

R. V. Vovk[1] , V. M. Gvozdikov[1], M. A. Obolenskii[1], Z. F. Nazyrov[1], V.V. Kruglyak[2].
[1] Kharkov National University, 4 Svoboda Sq., 61077 Kharkov, Ukraine,
Ruslan.V.Vovk@univer.kharkov.ua, [2] University of Exeter, Stocker road, Exeter, EX4 4QL, United Kingdom, V.V.Kruglyak@exeter.ac.uk

We study the excessive conductivity $\Delta\sigma$ as a function of temperature and angle between the magnetic field 15 kOe and the ab-plane α in untwinned $YBa_2Cu_3O_{7-\delta}$ single crystals with a small oxygen hypostoichiometry. Assuming that $\Delta\sigma \propto (T-T_c)^{-\beta}$ near the critical temperature T_c we found that the function $\chi(T) = -d(ln\Delta\sigma)/dT$ is characterized by the superconducting transition T_{c0}, vortex-lattice (VL) melting T_M, and the mean-field critical T_c temperatures. We found that: (i) the $\chi(T)^{-1}$ has a linear asymptotes $\beta_{c0}^{-1}(T-T_{c0})$ and $\beta_c^{-1}(T-T_c)$ nearby the T_{c0} and T_c with $\beta_{c0} > \beta_c = 1/2$ which means a crossover from the tree-dimensional-like (3D) behavior to the lower effective dimensionality. (ii) The transitional region $T_c - T_{c0}$ increases from 0.3K at $\alpha = 0$ to approximately 6K at $\alpha = 60^0$. (iii) The peaks at the T_M grow up and shift toward the T_{c0} with increasing α. (iv) The $\chi(T)$ displays a universal scaling in 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 model for the fluctuation conductivity at $T > T_c$ and with the 3D-2D crossover on the VL melting line caused by the crossover of the upper critical magnetic field $H_{c2}(\alpha, T)$ through the elastic moduli of the VL which are polynomials of the ratio $H/H_{c2}(\alpha, T)$ at $T < T_c$.