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The T_c elevation effects and thermal and magnetic treatment of $YBa_2Cu_3O_{7-\delta}$ polycrystals

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Effect of thermal and pulse magnetic treatment on the $YBa_2Cu_3O_{7-\delta}$ polycrystals critical parameters has been studied. The state of increased T_c obtained by heat treatment has been found to relax in a pulse magnetic field. For the $H_{c1}<H<H_{c2}$ (mixed state), the pulse magnetic field effect has been considered under account for the vortex lattice pinning on the crystal structure defects.

Проведено экспериментальное исследование влияния термической и импульсной магнитной обработки на критические параметры поликристаллов $YBa_2Cu_3O_{7-\delta}$. Обнаружено, что состояние с повышенным T_c, полученное в результате термообработки, релаксирует при приложении импульсного магнитного поля. Для $H_{c1}<H<H_{c2}$ (смешанное состояние) анализ влияния импульса магнитного поля был сделан на основе учета пиннинга вихревой решетки на дефектах кристаллической структуры.

At least two temperature intervals (130–250 K and 350–700 K) where the kinetic and thermodynamic properties are anomalous are observed within the temperature region of $YBa_2Cu_3O_{7-\delta}$ ortho phase. From experiments on fixation of $YBa_2Cu_3O_{7-\delta}$ anomalous states using quenching and study of critical parameters (T_c, I_c) behaviour and the normal state properties (electric resistance, thermal expansion), the diffusion redistribution of oxygen vacancies has been concluded to predominate in those intervals, including their ordering and disordering processes [1–3]. The state with ordered vacancy distribution, referred to as the vacancy superstructure (VSS) is characterized by substantially enhanced critical parameters (T_c, I_c). The temperature regions where that kind of VSS exists in equilibrium (or quasi-equilibrium) are rather narrow. In the non-equilibrium state, the VSS are unstable and become relaxed rather easily already under heating up to 120–130 K. This work is devoted to the further experimental investigation of the defect redistribution in $YBa_2Cu_3O_{7-\delta}$ in the temperature region 100–190 K under isothermal exposures, study of the quenched defects influence on T_c as well as to study of the quenched defect state resistance against heat and magnetic treatments.

Polycrystalline $YBa_2Cu_3O_{7-\delta}$ samples with initial T_c values from 91.5 to 92.4 K were studied. The oxygen index values were determined from the lattice parameters at 293 K and were $\delta \leq 0.1$. The samples were shaped as 0.8 mm thick flat discs of 16 mm in diameter. The T_c values were measured from temperature dependences of magnetic susceptibility. The heat and magnetic treatments were carried out as follows. First, the samples were cooled down to 78 K and the initial state T_c was measured. Then the heating up to $T_a \approx 160$ K (the VSS existence temperature) was carried out followed by a 30 min exposure to realize the state with an enhanced critical temperature ($T_c = 103$ K). The samples were then quenched down to