THE ANISOTROPIC PROPERTIES OF QUASICRYSTAL $Bi_2Sr_2CaCu_2O_8$ BY FAST NEUTRON IRRADIATION

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Neutron irradiation is one of the most effective methods of increasing the defect concentration in controlled way over the whole sample volume superconductors [1-4]. The defects within the high-temperature superconductors (HTSC) created by neutrons present the pinning centers which enhanced the critical current [5] and influenced on HTSC parameters (critical temperature, critical magnetic fields, anisotropy parameter, etc).

In the present work studied the influence of the fast neutron ($E > 0.1$ Mev) irradiation with fluence $10^{16} - 10^{19}$ cm^{-2} on anisotropic properties of quasicrystals $Bi_2Sr_2CaCu_2O_8$.

It is known [6] that one of the common feature of HTSC is the quasi-two-dimensionality which originates from their layered perovskite structures, and which is considered to be key ingredient in the besic mechanism of high temperature superconductivity.

The quasi-two-dimensional anisotropic nature of superconductivity is manifest in the anisotropy of the basic critical parameters. Thus the upper critical fields of superconductor for two principal field direction are written in terms of the coherence lengths as:

$$H_{c2}^{\|c} = \Phi_0/2 \cdot \pi \cdot \xi_{ab} \qquad and \qquad H_{c2}^{\|ab} = \Phi_0/2 \cdot \pi \cdot \xi_{ab} \cdot \xi_c \ ,$$

where $\Phi_0 = h \cdot c/2 \cdot e$ — is the superconducting magnetic flux quantum, ξ_{ab}, ξ_c — are the ab-plane and c-axis coherence lengs, respectively.

The critical fields researched by hf-absorption method by crystals BSCCO with the change orientation in magnetic field allowed to determine the anisotropy parameter, which described within the framework of the anisotropic Ginzburg-Landau (GL) or London model. According to of the GL-model, anisotropy can be incorporated by introducing an anisotropic effective mass tenzor $(1/m^*)_{ij}$ in kinetic energy term. Considering an effective mass the coherence length is given by:

$$\xi_{ab} = h/(2 \cdot m_{ab}^* \cdot \alpha)^{-1/2} \sim m_{ab}^{*-1/2}, \ \ \xi_c = h/(2 \cdot m_c^* \cdot \alpha) - 1/2 \sim m_c^{*-1/2} \ .$$

For most of the layered superconductors the Ginzburg-Landau parameter $k = \lambda/\xi$ takes a constant value. Therefore, the penetration depth is proportional to the square root of the effective mass:

$$\lambda_{ab} \sim m_{ab}^{*1/2}, \qquad \lambda_c \sim m_c^{*1/2} \ .$$

The anisotropy parameter determind through the critical magnetic fields:

$$\gamma = H_{c2}^{\|ab}/H_{c2}^{\|c} = H_{c1}^{\|c}/H_{c1}^{\|ab},$$

or through the parameters HTSC:

$$\gamma = \xi_{ab}/\xi_c = \lambda_c/\lambda_{ab} = (m_c^*/m_{ab}^*)^{1/2} \ .$$

The measurements were performed with method of hf-absorption [7] at $f = 50 - 150$ Mhz ($T = 77$ K). The extarnal scaning magnetic field $H = \pm 700$ Oe.

The experimentally obtained values of the critical fields for two principal field direction allow to found the anisotropy parameter. The results of these experiments are shown in

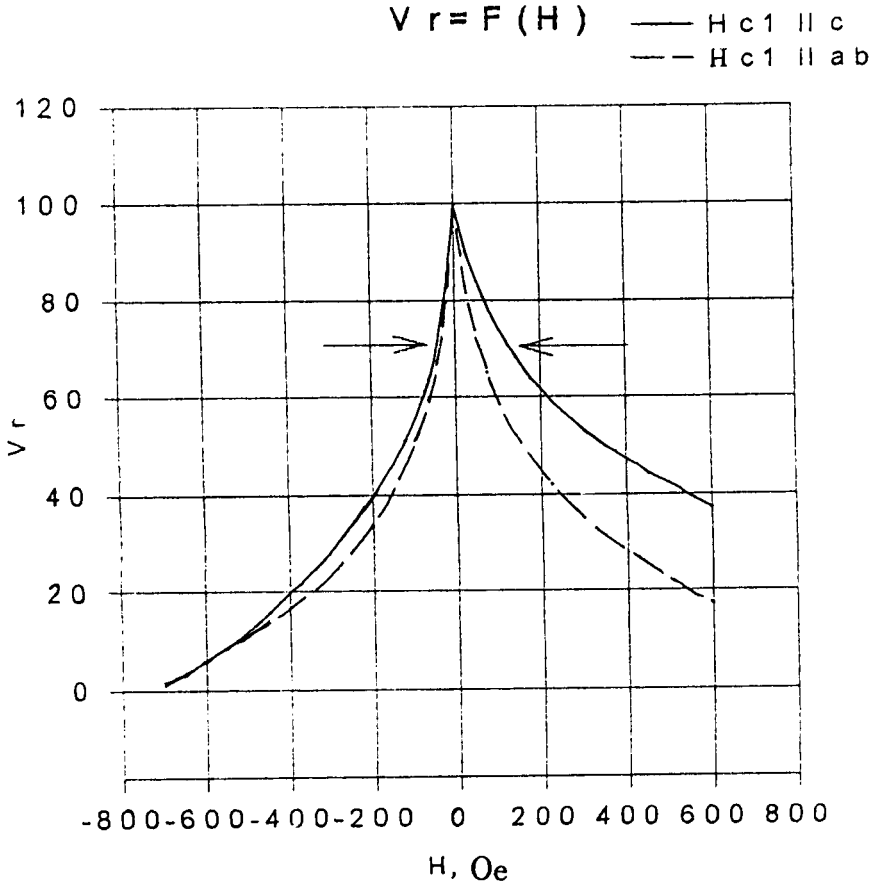

Fig. Dependence of the critical fields for two principal field directions for before (a) and after (b) irrediation at the neutron fluence 10^{16} cm^{-2} in $Bi_2Sr_2CaCu_2O_8$

figure. The values of critical fields $H_{c1}^{\|c}, H_{c1}^{\|ab}$, obtained on level 0.707 and determined the anisotropy parameter γ for different neutron fluences presents in the table.

Table

Φ, n/cm^2	$H_{c1}^{\|c}$, Oe	$H_{c1}^{\|ab}$, Oe	γ
0	100	40	2.5
10^{16}	35	17.5	2
10^{17}	30	17.5	1.7
10^{18}	42.5	25	1.7

At a fluense of $\Phi = 10^{16}$ cm^{-2} observed the reduce of critical fields $H_{c1}^{\|c}$, $H_{c1}^{\|ab}$ and anisotropy parameter γ. In this case, by neutron irradiation the pre-existing defect structure may be weakened significantly. This can explained with the "small doze" effect at the lowest neutron fluence [8]. At the fluence range from 10^{16} cm^{-2} to 10^{17} cm-2, an average values of $H_{c1}^{\|c}$, $H_{c1}^{\|ab}$ and γ practically independent of the neutron fluence.

The enhancement of the neutron fluence over then 10^{17} cm^{-2} leads to increase the critical fields in results introduction of the high concentration "strong" pinning centers. The non-monotonous effect of neutron irradiation on critical fields of BSCCO-crystals connected with an interaction between the pre-irradiation defect structure and the neutron induced defect cascades, that mark in [9]. In this case, the anisotropy parameter remains almost constant so long as the introduction defects apparently distribution of the isotropy, and, consequently, do not influence on degree of the anisotropy.

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PECULIARITIES OF Cu MAGNETIC SYSTEM BEHAVIOR IN MODERATELY OXYGENATED La_2CuO_{4+x} SINGLE CRYSTALS AT PHASE SEPARATION

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As now well established, moderately doped crystals of La_2CuO_{4+x} ($0.01 \leq x \leq 0.055$) phase separate into the oxygen-poor ($x \approx 0.01$) near to stoichiometric regions and the oxygen-rich ($x \approx 0.055$) domains of a conducting (superconducting below $T_c \leq 40$ K) subphase [1].

We shortly report here the results of study of Cu magnetic system behavior in three single crystals of La_2CuO_{4+x} at phase separation (PS), that starts at some temperature T_{ps}. In these crystals the excess-oxygen content x corresponded to three different physical situations for the PS: a) PS starts befor magnetic ordering ($T_{ps} > T_N \approx 222$ K); b) PS starts simultaneously with magnetic ordering ($T_{ps} \approx T_N \approx 243$ K); c) PS starts after magnetic ordering ($T_{ps} < T_N \approx 272$ K). To characterize x-value and T_{ps} in the samples the data on their correlation with Neel temperature T_N were used [2].

For investigation of dynamic magnetic properties of La_2CuO_{4+x} compounds, the technique has been used of nonlinear longitudinal response (NLR) in a sample under study to