Influence of pressure and stoichiometry on the Ginzburg-Landau parameter in superconducting YB_6

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After superconducting MgB_2 with a critical temperature of T_C = 39 K, yttrium hexaboride YB_6 exhibits the second highest transition temperature $T_C \leq 7.4$ K among borides. From recent studies on the superconducting properties of this compound [1-3] follows that there is still a dispute about, what affects the value of the superconducting transition temperature of various YB_6 samples. To explain such the significant T_C - variation it was suggested in [1] that the transition temperature is controlled by the B/Y ratio (the highest T_C is obtained for a B/Y < 6). Thus, both a growth of the number of boron vacancies, which is associated with the deviation from the stoichiometric composition of the boron sublattice, and a decrease of yttrium vacancies in contrast, which requires an almost stoichiometric metal sublattice composition, result according to [1] in a T_C enhancement in this compound. On the other hand, it is argued in [3] that the T_C enhancement in YB_6 single crystals is determined by the increase of the number of vacancies, both at yttrium and boron sites, leading to a nonstoichiometric composition, which is accompanied by the enhancement of electron-phonon interaction. In mentioned studies [1, 3] also the relevant superconducting state parameters as e.g. the coherence length ξ (0), penetration depth $\lambda(0)$, the Ginzburg-Landau parameters $\kappa(0)$ and the superconducting gap 2Δ were determined. They show that YB_6 compounds exhibit type II superconductivity in "dirty limit" with a medium to strong electron-phonon interaction and *s*-type pairing of charge carriers with $2\Delta(0) / k_B T_C \approx 3$ - 4.

The Ginzburg-Landau parameter $\kappa(0) = \lambda(0) / \xi(0)$ is one of the most important phenomenological parameters of superconductors. As its estimation under the influence of pressure is rather complicated, any new result related with the pressure dependence of this parameter are appreciated. Until now, $\kappa(0)$ was measured under pressure only up to 0.92 GPa [4]. In the present work we estimated the pressure effect on $\kappa(0)$ of YB_6 up to 3 GPa.

Using an array of miniature Hall-probes we have investigated for the first time the penetration of magnetic field and the pinning strength in four YB_6 samples having different stoichiometry and superconducting transition temperatures T_C between 4.2 K and 7.4 K. The obtained results show that except the sample with lowest T_C = 4.2 K, which exhibits weak pinning, all others show strong pinning features. On the other hand, the comparison of penetration field H_p temperature dependencies with BCS theory points in all samples to strong *s*-type pairing of charge carriers with $2\Delta / k_B T_C \approx 4$. In addition, based on the temperature and field dependencies of ac-calorimetry, the Ginzburg-Landau as well as another the superconducting state parameters were determined independently and compared with results of previously published works.

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