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GLASS BEHAVIOUR OF Y-Ba-Cu-O HIGH T_c SUPERCONDUCTORS

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High superconducting materials were investigated by means of the inductive method. The "quasi" de Almeida-Thouless line was verified on YBaCuO samples, starting from a magnetic field equal to 8×10^3 A/m approximately. A glass behaviour of samples with insufficient macroscopic screening currents for an ac magnetic field could not be observed by this method.

I. INTRODUCTION

The spin glass model led to the suggestion of the superconductivity glass mechanism [1—3]. For its verification the "quasi" de Almeida-Thouless line is often used. The "quasi" AT line can be usually obtained from temperature dependence measurements of either magnetization or dc susceptibility for various magnetic fields. In this contribution the glass behaviour of high T_c Y-Ba-Cu-O superconductors prepared under different technological conditions was examined by the ac susceptibility method.

II. RESULTS AND DISCUSSION

Samples were prepared from powders of Y_2O_3, BaO_2 and CuO. These constituents were mixed, ground and pressed into the toroidal form. One part of the material was pressed at 0.6×10^8 Pa (samples A), the other part at 1.2×10^8 Pa (samples B). Samples were annealed at 870°C for 12 hours in air followed by a slow cooling to room temperature. The dimensions of the toroids were: $r_1 = 6$ mm, $r_2 = 10$ mm, $h = 2.5$ mm. The 1 : 2 : 3 structure of the samples was confirmed by X-ray diffraction. Measurements of the inductance L of a copper coil wound on a ring of Y-Ba-Cu-O were performed by the bridge method in the temperature range from 77 K to 300 K and at magnetic fields up to 3×10^4 A/m. An example of the $L(T)$ dependence at various magnetic fields for sample A is shown in Fig. 1. Transition temperatures T_c' s were determined from these $L(T)$ dependences in the same way as in [3] and the "quasi" AT line:

$$H^{2/3} \sim [1 - T_c(H)/T_c(0)] \qquad (1)$$

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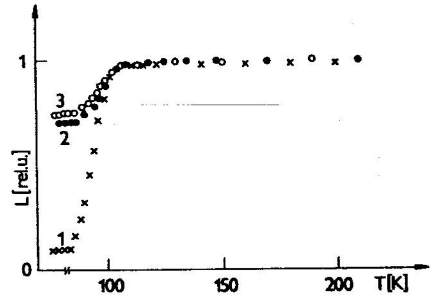

Fig. 1 Temperature dependence of inductance L for sample A (see text) at various magnetic fields.
1. — $H = 0$, 2. — $H = 16 \times 10^3$ A/m, 3. — $H = 24 \times 10^3$ A/m

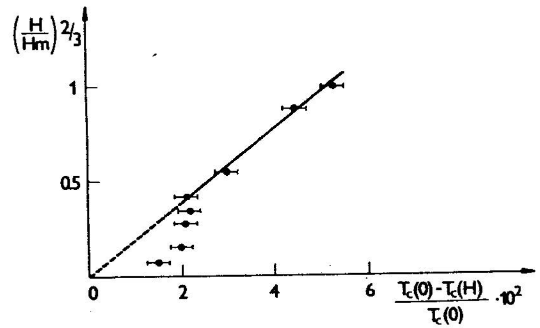

Fig. 2 Magnetic field $(H/H_m)^{2/3}$ against $[T_c(0) - T_c(H)]/T_c(0)$ for sample B (see text). $H_m = 24 \times 10^3$ A/m

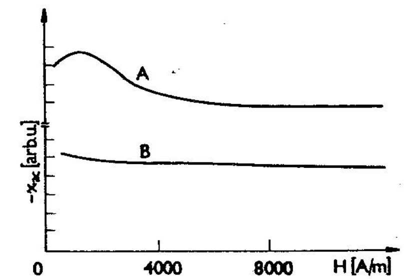

Fig. 3 Magnetic susceptibility as a function of magnetic field H.

was verified, where $T_c(H)$ is the transition temperature for the magnetic field H; $T_c(0)$ is for $H = 0$. The relation (1) is fulfilled for the sample B starting from the magnetic field equal to 8000 A/m approximately (Fig. 2.), whereas for sample A such dependence was not found. The experimental results indicate the existence of two regions in the $T - H$ phase diagram for sample B corresponding to a weak random phase and a superconducting glass phase, respectively [3]. We have expected the glass behaviour for sample A to occur at a lower magnetic field because of its greater porosity and many defects. Similarly a lower intergrain critical current density I_c may be expected in this case and it can provide an explanation of the measurements. In this sample there is not a sufficient macroscopic screening current for an ac magnetic field and the T_c values cannot be correctly determined. Nevertheless, the critical field H_{c1} of sample A is very small. It is confirmed by measuring the inductance L as a function of the magnetic field perpendicular to the toroid axis in the field cooling regime. In Fig. 3. we can see the ac magnetic susceptibility nearly independent of the magnetic field for sample B, while a curve maximum occurs at a low field in the case of sample A. This maximum seems to be due to flux trapping. Weak ac susceptibility dependence on the magnetic field is in agreement with the superconducting grains model [1]. In conclusion, the ac susceptibility measurement supports to superconducting glass models. However, it cannot be used for materials with very low intergrain critical current densities.

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РЕЗЮМЕ

Изучение высокотемпературных сверхпроводников проводилось индуктивным методом. «Квази» де Алмейда-Таулесса линия проявляется у образцов YBaCuO, начиная с величины около 8 000 Am^{-1} магнитного поля.

У образцов с недостаточным макроскопическим током экранирования переменного магнитного поля сверхпроводящее стеклообразное поведение незамечалось.