Behaviour of Magnetic Susceptibility and Current Density in Y, Bi &Tl- Based High Temperature Superconductors

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The critical current density in Y,Bi,&Tl- based superconductors has been measured over the magnetic field. The variation of AC susceptibility for these samples with temperature has been depicted. The curves have been normalised to flat regions of the characteristics at temperature far above and below T_c.

Keywords: Electrical resistivity,magnetic susceptibility,phase transition.

1. INTRODUCTION

With the recent discovery of Y, Tl [1] and Bi-based high T_c superconductors have stimulated into research work aimed at its identification and characterization [2, 3]. It is necessary to know the character of higher T_c material at high field. In the present study the transport critical current in Y, Tl and Bi-based superconductors have been measured over the five orders of magnitude of magnetic field from 10^{-4}T to 10T in a single field sweep. The results show that the critical current density at liquid nitrogen temperature in all the three material system shows a similar two stage drop off with the magnetic field. The first drop in Jc occurs between about 0.3 and 30mT and second drop in Jc occurs between about 0.3 To 10T

2. SAMPLE PREPARATION AND EXPERIMENTAL STUDY

All samples tested for each of the three high T_C superconductor system were bulk sintered polycrystalline samples made by the powder process.

For $YBa_2Cu_3O_{7-x}$sample, powders of CuO, Y_2O_3 and $BaCO_3$ were weighed after drying, homogenized by repeated grinding and mixing and then calcined at the temperatures between the 940^0C and 950^0C in following oxygen. The calcined material was then homogenized again by repeated grinding and mixing, and then cold pressed into final form. The pressed pellet was then sintered at 940^0C to 950^0C in flowing oxygen. The samples were then colled and annealed in flowing oxygen at the temperatures about 400^0C to 500^0C.

For Tl-based sample, powders of Tl_2O_3 $CaCO_3$, Ba_2CO_3 and CuO which were mixed ,ground and heated at 925^0C for at least 24 hour with several intermediate grindings and pressed into a pellet. The pellet was then placed in a quartz boat in furnace preheated to 880^0Cto 910^0C and was heated for 3 to 5 minute in flowing oxygen, followed by cooling to room temperature in 1 to 1.5h.

The Bi-based sample was prepared using starting powders of BiO_3,Pb_3O_4 $SrCO_3$,$CaCO_3$andCuO.The mixed powder was calcined at 800^0C for 11 hours in air and reground into powder and then pressed into pellet. The pellet was placed in an Al_2O_3 boat and sintered at 845^0C for 220 h in air and furnace cooled to room temperature at the rate of 100^0C/h [4, 5].

The HTS samples were employed in 4-prob Hall geometry and air drying silver paste was used for making electrical contacts on the samples. The sample temperature was monitord with an accuracy of ± 0.1 K using a standard 100 Ohm platinum sensor in the conjunction with Keithley 224 programmable constant current source and Keithley181nanovoltmeter.

3. RESULTS AND DISCUSSION

Figure 1 shows the temperature variation of AC susceptibility of the samples has tendency to decrease with the increasing the temperature and has sharp break in the susceptibility around the 84K in Bi2212 phase

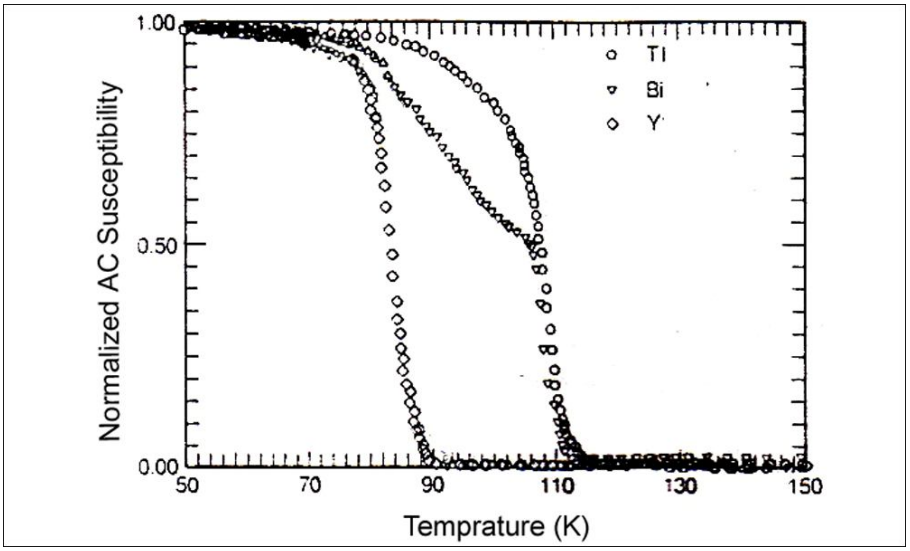

Fig. 1: Variation of AC susceptibility with temperature for Y, Bi and Tl-based high Tc superconductors.

Figure 2 shows the critical current density J_c measured in the bulk sintered polycrystalline samples for each of the three primary high T_c systems.

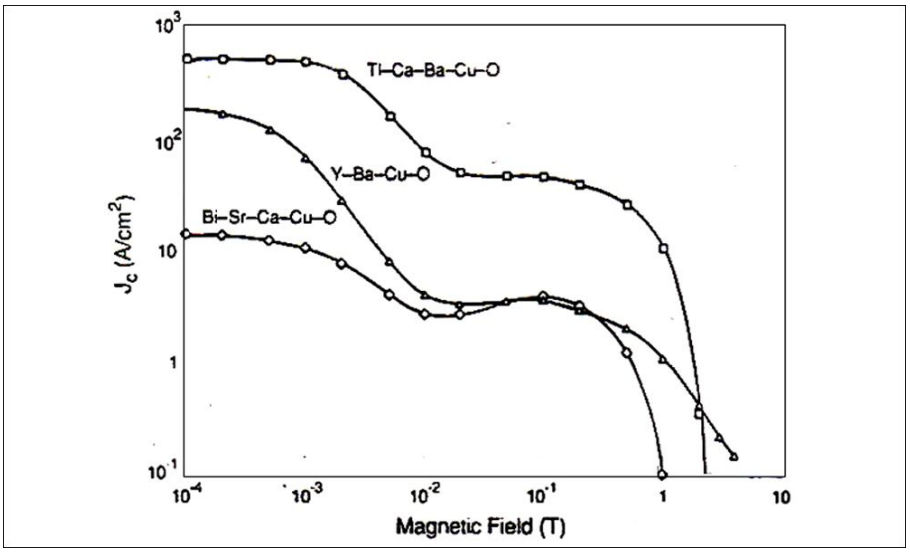

Fig. 2: Variation of critical current density with magnetic field at 76K for Y, Bi and Tl-based high Tc superconductors

All the three superconductor system shows a similar double step J_c characteristic. At very low field J_c is constant up to the first step, which occurs between about 0.3 to 30mT. Depending on the sample, the decrease in J_c at this first step varies from about one to two order of magnitude and the magnetic field where the stap starts varies form 0.3 to 2mT. At fields higher than about 30mT, there is a plateau region. At still higher magnetic fields there is a second drop in J_c for all the three bulk sintered superconductor systems. This second step start at about 0.3T with J_c reaching negligibly small values between about 1 and 10T depending on the superconductor.

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