Sample Processing Pressure-Dependence of Weak Links in Polycrystalline $YBa_2Cu_3O_7$

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ABSTRACT

We have studied the sample processing pressure dependence of AC susceptibility of polycrystalline $YBa_2Cu_3O_7$ in different applied AC magnetic fields and at different temperatures.

1. INTRODUCTION

Interestingly, in field H<0.1 Oe for some high T_c superconductors, the dc field-cooled (FC) magnetization in a small temperature region below T_c becomes paramagnetic[1]. This behavior can be explained in terms of orbital paramagnetic moments due to the spontaneous currents which may be originated in so-called π contacts in the weak link network of crystallites in polycrystalline materials [1,2]. Two methods have been introduced for determination of these properties, dc zero field-cooled (ZFC) and FC magnetization measurements and AC susceptibility measurements[3]. Two absorptive peaks in the imaginary component x" have been observed [4]. In our previous paper we reported glass behavior at low fields in polycrystalline $YBa_2Cu_3O_7$ and the effects of pellet pressure on the magnetic properties of these HTSCs[2]. In this paper, we continue the studies of the effects of pellet pressure on the intergranular weak links and intragranular flux array in terms of AC susceptibility measurements.

2. EXPERIMENTAL

The stoichiometrical amount of highly pure Y_2O_3, $BaCO_3$, and CuO were thoroughly mixed and then pressed into pellets 3/4 in. in diameter and about 1/8 in. thick with four different pellet pressures, i.e. 2kbar, 4kbar, 10kbar, and 2kbar for sample S-1, S-2, S-3, and S-1A, respectively[3]. The pellets were fired in air at 950°C for 16 h, then ground into powder and the heat treatment process mentioned above was repeated again. Sample S-1A was annealed at 500°C in flowing oxygen for 16 h. The pellet pressure was kept the same for the individual sample in every sample processing step. The AC susceptibility measurements were carried out with a commercial LakeShore 7000 series susceptometer. The measurements were made with the applied AC field parallel to the length of the specimen.

3. RESULTS AND DISCUSSION

The typical AC susceptibility plots under zero-field cooled condition (ZFC) are shown in Fig.1 for sample S-3 at an applied AC magnetic field of 5Oe. The peak temperature of the imaginary component of AC susceptibility vs the applied AC magnetic field is shown in Fig.2.

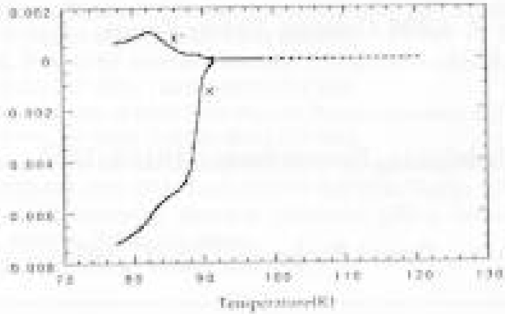

Fig.1, Temperature dependence of AC susceptibility in an AC magnetic field H_{ac}=5 Oe. The upper curve is the imaginary component and the lower curve is the real component. The lines are guides to the eye only.

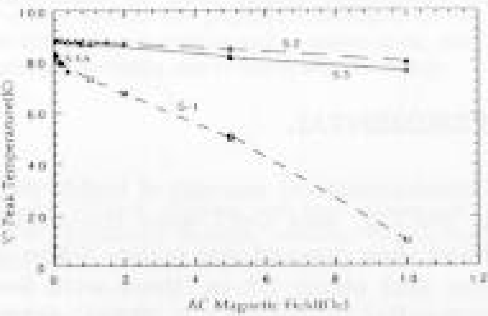

Fig.2, AC magnetic field dependence of the x" peak temperatures. The lines are guides to the eye only.

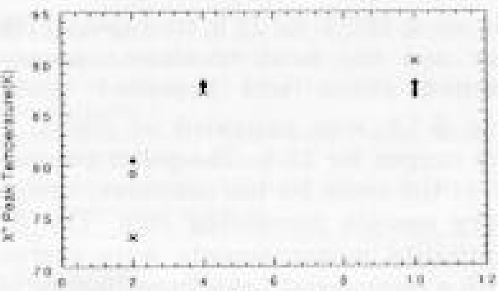

Fig.3, Pellet pressure dependence of the x" peak temperatures in different AC magnetic fields.

According to the thermally assisted flux-flow (TAFF) theory the relation:

$$1-\frac{T_p}{T_c}=\alpha[H]^{2/3}$$

where T_p is the peak temperature of imaginary component of the AC susceptibility, T_c is the superconducting transition temperature, a is a constant and H is the dc applied magnetic field, can be applied to the condition under AC field when the sample produced with a lower pellet pressure which means that the material is more porous. Fig.3 and Fig.4 show the relations of x" peak temperature T_p and weak links temperature T_w to the pellet processing pressures at different AC fields, respectively. We found that the best pellet pressure for processing the high T_c $YBa_2Cu_3O_7$ compound is approximately 4Kbar.

Fig.4, Pellet pressure dependence of the weak links transition temperatures in different AC magnetic fields.

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