

ELECTRICAL PROPERTIES AND  $T_c$  OF  $\text{Bi}_2\text{CaSr}_2\text{Cu}_2\text{O}_8$  UP TO PRESSURES OF 15 GPa

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By means of four-point resistivity measurement the critical temperature of  $\text{Bi}_2\text{CaSr}_2\text{Cu}_2\text{O}_8$  was studied under high pressure. Evidence for three phases, one non-superconducting and two superconducting with  $T_c$ 's of 80 and 110 K is found. Both  $T_c$ 's are only weakly pressure dependent. The non-superconducting background increases with pressure and with measurement current indicating the presence of weak links and a "weakening" of these links with pressure.

1. INTRODUCTION

Since the beginning of high temperature superconductor research, pressure has played an important role in identifying possible new materials and mechanisms<sup>1</sup>. Our efforts<sup>2,3</sup> were concentrated on ultrahigh pressure as obtainable in a diamond anvil cell. In this contribution we look at the pressure dependence of  $T_c$  of  $\text{Bi}_2\text{CaSr}_2\text{Cu}_2\text{O}_8$  and we also investigate the non-superconducting background.

2. SAMPLE PREPARATION

We describe three experiments on samples from two different batches, prepared by a standard sintering technique<sup>3,4</sup>.

3. EXPERIMENTAL

Experiments were done in a diamond anvil cell<sup>3</sup>. Pressure was measured using ruby fluorescence, corrected for temperature. The samples were small grains taken from a crushed pellet. Each grain was checked separately for superconducting properties by levitation. No pressure medium was used, hence the pressure was quasi-hydrostatic. Four-point resistivity measurements and I-V curves were obtained using gold or copper wires as shown in fig. 1 of ref. 3.

4. RESULTS

A typical curve for resistivity versus temperature showed one jump for sample 1 and two jumps for sample 2a and 2b. For all samples a non-superconducting background was observed. From this we conclude that samples 2a and 2b consisted of two superconducting phases with  $T_c \approx 80$  K and  $T_c \approx 110$  K and a non superconducting phase.  $T_c$  was determined after background subtraction. For the midpoint a weak pressure dependence is found:  $-0.7$  K/GPa and  $-1.6$  K/GPa (80K-phase) and  $-0.1$  K/GPa (110K-phase), see fig. 1.

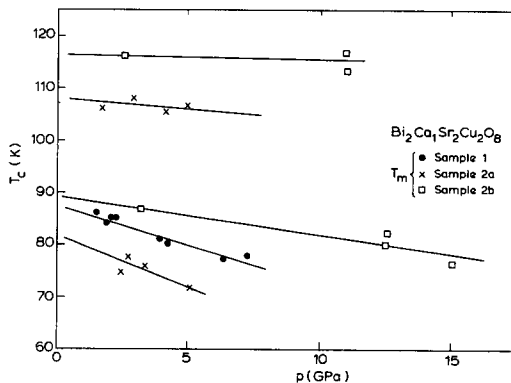


FIGURE 1  
The midpoint of the resistive transition for  $\text{Bi}_2\text{CaSr}_2\text{Cu}_2\text{O}_8$ .

This result follows the general trend<sup>1</sup> that high  $T_c$  superconductors with a high  $T_c$  have a very small pressure dependence  $\partial T_c/\partial p$ , whereas high  $T_c$  superconductors with a low  $T_c$  generally show a very strong increase of  $T_c$  with pressure (the n-type superconductors as  $(\text{Nd}_{1-y}\text{Ce}_y)_2\text{CuO}_4$  seem to be an exception).

We now address the non superconducting phase. At ambient pressure our resistivity measurements did not show such a phase. However this may have been masked by the fact that the metallic/superconducting phase was connected through a percolation path. Upon pressurization a non superconducting background developed with increasing pressure. We speculate that the grain edges lost part of their oxygen due to highly anisotropic stress and became semiconducting. The fact that the superconducting transition was still observable indicated that this is not a bulk effect and that a superconducting phase still coexists. Apparently the non-superconducting regions acted as weak links between superconducting particles. With increasing current the insulating behaviour became more dominant (see fig. 2). A qualitati-

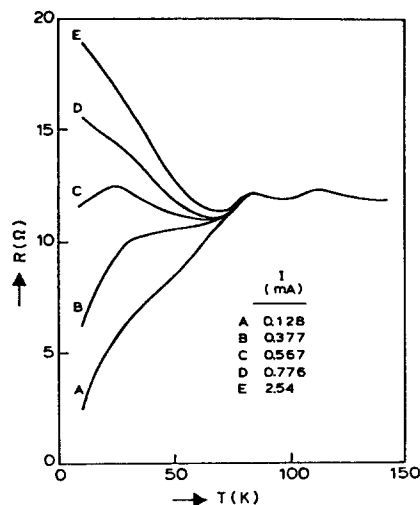


FIGURE 2

The resistivity of sample 2b at  $\sim 4$  GPa as a function of temperature for different values of the current.

vely similar behaviour was observed in granular aluminium<sup>5</sup> and thin films<sup>6</sup>. The correspondence between those results and  $\text{La}_{1.8}\text{Sr}_{0.2}\text{CuO}_4$  was discussed by Markiewicz<sup>7</sup>. He suggests that this behaviour is a strong indication that the sample behaves as a Josephson coupled array.

The observed values for  $T_c$  (after background subtraction) did not seem to depend on the measurement current, as expected.

In conclusion, using pressure we have created an interesting weak-linked superconducting array with the possibility to change continuously the coupling strength of the links by changing pressure. The pressure dependence of the  $T_c$ 's seems to confirm existing ideas.

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