PREPARATION AND RESISTANCE MEASUREMENTS OF BIPBSRCACUO SUPERCONDUCTOR

P.R.FERNANDO AND N.PATHMANATHAN
DEPARTMENT OF PHYSISCS, EASTERN UNIVERSITY, SRI LANKA.

1. INTRODUCTION

Superconductivity is a phenomenon occurring in certain materials at low temperatures. characterized by the complete absence of electrical resistance and the damping of the interior magnetic field.

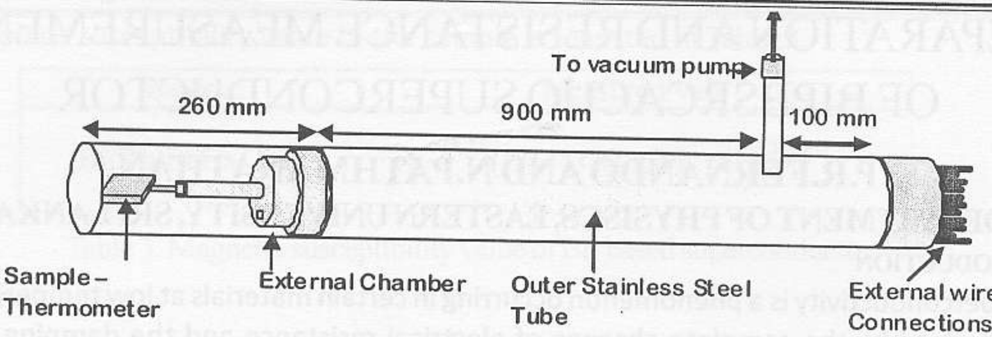
Superconductivity was first discovered in 1911 by the Dutch physicist, Heike Kammerlingh Onnes[4] that mercury loses all its electrical resistivity when cooled below 4.2 K, Zero resistivity was not observed above 23 K, in all other superconducting materials discovered upto 1986[2]. In 1986, Georg Bednorz and Alex Müller, working at IBM in Zurich Switzerland, were experimenting with a particular class of metal oxide ceramics called **perovskites** and the found indications of superconductivity at 35 K, in LaBaCuO system. Soon researchers from around the world were working with the new types of superconductors. In February of 1987, a **perovskite** ceramic material YBaCuO was found to superconduct at 90 K[1]. This discovery was very significant because now it became possible to use liquid nitrogen as a coolant to study the ceramic superconductor, Because these materials superconduct at significantly higher temperatures they are referred to as **High Temperature Superconductors**. Soon after a superconductor with composition BiSrCaCuO was discovered with the transition temperature 108 K to 112 K[3]. Then TlBaCaCuO superconductor was discovered with T_c around 120 K[6]. Since then scientists have experimented with many different forms of perovskites producing compounds that superconduct at temperatures around 120 K.

In this work a Pb doped BSCCO superconductor was prepared using solid state reaction technique and the resistance measurements were performed on the sample in the temperature range from 77 K to 175 K.

2. Experimental Techniques

Oxides powders with compositions Bi_2O_3, PbO, $SrCO_3$, $CaCO_3$ and CuO of 99.99 % purity were used as starting raw materials. The weights of these chemicals were selected according to nominal cation ratio Bi:Pb:Sr:Ca:Cu is 0.8:0.2:1:1:1.5.

The starting raw materials of 1/70 mole mostly pre dried oxides and carbonates of purity grater than 99.99 % were weighted to an accuracy of 0.1 mg. After thoroughly mixing, the mixture was grinded to a fine powder using the motor and pestle. Then the sample was first subjected to a preliminary sintering at constant temperature 820^{0}C, in the furnace and was allowed to furnace cooling to room temperature in air for 24 hours. Then the fired powder was again reground, and pallets of diameter 14 mm and thickness 1-2 mm were prepared under the pressure of 250 kg/cm^2. These pallets were again subjected to secondary sintering at constant temperature of 820 ^{0}C in the furnace for 24 hours and were allowed to furnace cooling to room temperature in air. The above steps were repeated again and the pallets were subjected to final sintering at 860^0 C in the furnace for 100 hours and were allowed to furnace cooling to room temperature in air.



The diagram of the Resistivity Probe[5] used in this experiment is shown in the figure 1. Initially both side of the sample bed was well cleaned smoothly with sand paper. Then the resistance Rh-Fe thermometer was mounted on one side of the bed and the sample was mounted to the other side of the bed. After that, four electrical wires were connected to the thermometer two of them for voltage and the rest for current. Similarly four wires were connected to the sample.

1. EXPERIMENTAL PROCEDURE

The circuit diagram of the experiment is presented in figure 2. The temperature of the sample was measured by Rh-Fe thermometer and controlled by electrical heating.

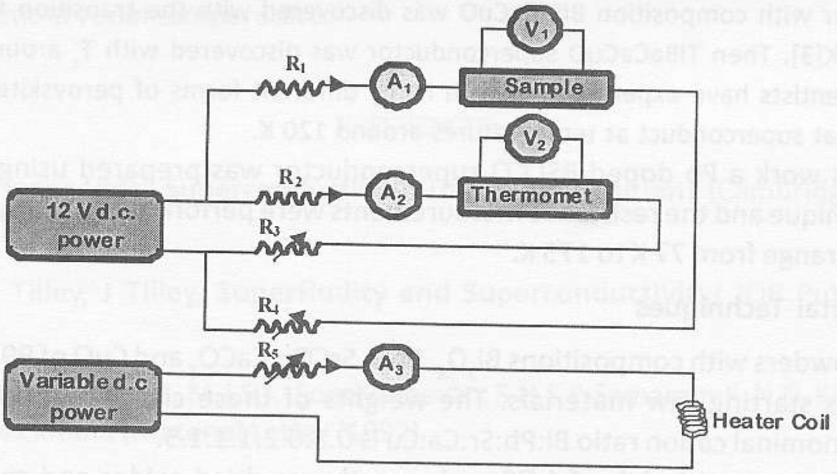


Figure 2: Electrical Circuit of the experiment

The Resistivity Probe was pumped out to a good vacuum and was immersed in liquid Nitrogen. A constant current of 1 mA and 50 mA were applied to the thermometer and the sample respectively. The voltages across the thermometer and the sample were measured by the digital voltmeters. While the sample was gradually warmed by electrical heating and the resistances of the sample and the corresponding temperatures of the sample were recorded. These measurements of the resistance were repeated while the sample was cooling.

2. Presentation of results

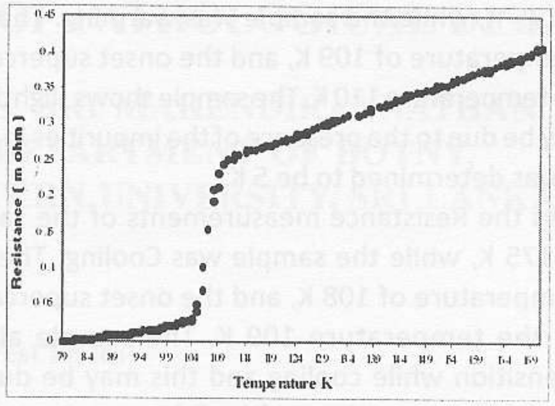


Figure 3: The temperature dependence of the electrical resistance of $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_3O_y$ Superconductor while warming

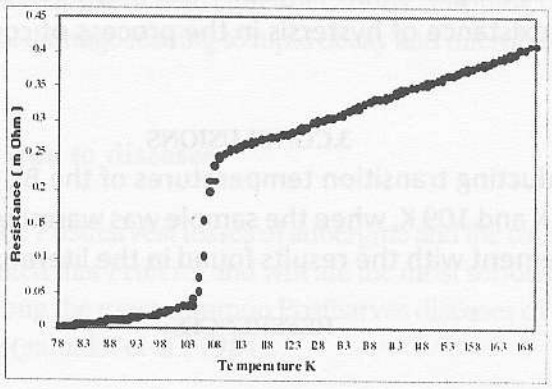


Figure 4: The temperature dependence of the electrical resistance of $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_3O_y$ Superconductor while cooling

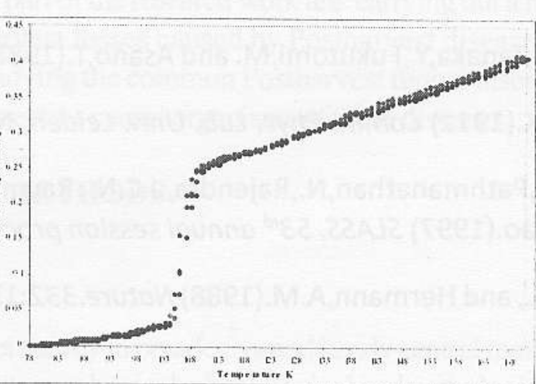


Figure 5: The temperature dependence of the electrical resistance of $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_3O_y$ Superconductor while warming and Cooling.

Figure 3 shows the Resistance measurements of the sample in the temperature range from 77 K to175 K, while the sample was warming. The sample showed metallic behavior up to the temperature of 109 K, and the onset superconductivity of the sample was found to be at the temperature 110 K. The sample shows slightly broad superconductiong transition and this may be due to the presence of the impurities in the sample. The transition width of the sample was determined to be 5 K.

Figure 4 shows the Resistance measurements of the sample in the temperature range from 77 K to175 K, while the sample was Cooling. The sample showed metallic behavior upto the temperature of 108 K, and the onset superconductivity of the sample was found to be at the temperature 109 K. The sample also shows slightly broad superconductiong transition while cooling and this may be due to the presence of the impurities in the sample. The transition width of the sample was determined to be 7 K.

Figure 5 shows the cooling and warming data of the sample together which indicates that there is a small change in the superconducting transition temperature of the sample 110 K and 109 K in the cooling and warming data. This may be due to the electronic problem in the experiment or existance of hystersis in the process of cooling and the warming of the sample.

3.CONCLUSIONS

The superconducting transition temperatures of the $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_3O_y$ samples were found to be 110 K and 109 K, when the sample was warming and cooling respectively, which is in good agreement with the results found in the literature.

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