

The effect of heat treatment BPSCCO-2212 and LSCO superconductor

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Abstract. Research on superconductors (Bi, Pb) -2212 have been mixed with LSCO superconductors. The mixture was carried out after the phase (Bi, Pb) - 2212 and LSCO phase were formed. The sample was made by solids reaction method with sintering temperature 850°C and 1050°C. The precursors were mixed with a composition of 50%: 50%, obtained 5 samples, namely B1, B2, B3, B4, and B5 and heated for 10 hours each at a temperature of 400°C, 600°C, 800°C, 900°C and for B1 only mixed without being heated. Based on our results, the effect of optimal temperature was 900°C with the formation of T_c, onset of 70.83 K and T_c, zero 30 K.

1. Introduction

The discovery of high T_c superconductors by Bednorz and Muller stimulated a large number of works and research worldwide [1]. Most of the research aimed at increasing superconductivity at a temperature of <110K was a superconductor based on the BSCCO Bi system. The BSCCO superconductor system which has two BiO layers can be formulated as Bi₂Sr₂C_{an-1}Cu_nO_z with n = 1,2,3 can be synthesized well [2,3]. In the case of the Bi-2212 phase, an increase in J_c and its resistance in the external magnetic field can be done by reinforcing the pinning strength of the superconductor. For example, the substitution of Pb to replace a portion of the Bi cation in the Bi-2212 Crystal can provide an increase in current density J_c [4]. High temperature superconductors at La_{1.85}Sr_{0.15}CuO₄ (T_c = 37K) have been studied and published mainly in 1987 [5]. La-Sr-Cu-O superconductors have a tetragonal crystal structure, as well as bismuth Bi-Pb-Sr-Ca-Cu-O-based superconductors. Even though it has the same crystal structure, but both of these superconductors have different T_c values, with similarities and differences researchers were interested in synthesizing the two superconductors to see whether after mixed critical temperatures (T_c) will form and reduce the fragility of superconductors.

2. Methodology

High purity powder: Bi₂O₃, PbO, SrCO₃, CaCO₃, and CuO were weighed according to stoichiometry to prepare BPSCCO-2212, then mixing and grinding for 3 hours. The powder was then heated at 300°C for 8 hours. The next step was annealing and grinding again for 6 hours before calcining at 800°C for 20 hours. The powder was then compacted for 10 minutes to get a pellet sample. The pellets were sintered at 850°C for 30 hours as the final step for precursor preparation. The first test was the Meissner Effect applied to the sample before it was characterized by the resistivity and XRD tests. LSCO precursors were made by mixing:

La_2O_3 , SrCO_3 and CuO powder that has been weighed according to stoichiometry. then mixing and grinding for 3 hours. The powder was then heated at 300°C for 8 hours. The next step was annealing and grinding again for 6 hours before being compacted for 10 minutes to get a pellet sample. The pellets were sintered at 1050°C for 16 hours. BPSCCO-2212 and LSCO have crushed again for 3 hours to obtain a fine powder. The powder was then mixed with a ratio of 50/50 for 5 samples, before being compacted for 10 minutes to get pellets. The pellets were sintered for 10 hours at temperatures of 400°C , 600°C , 800°C , 900°C and the last sample without sintering was only mixed. The characterization was carried out with XRD with $\lambda = 1.5418 \text{ \AA}$ and resistivity test with Cryogenic Magnet type Cryotron FR Oxford.

3. Results and Discussion

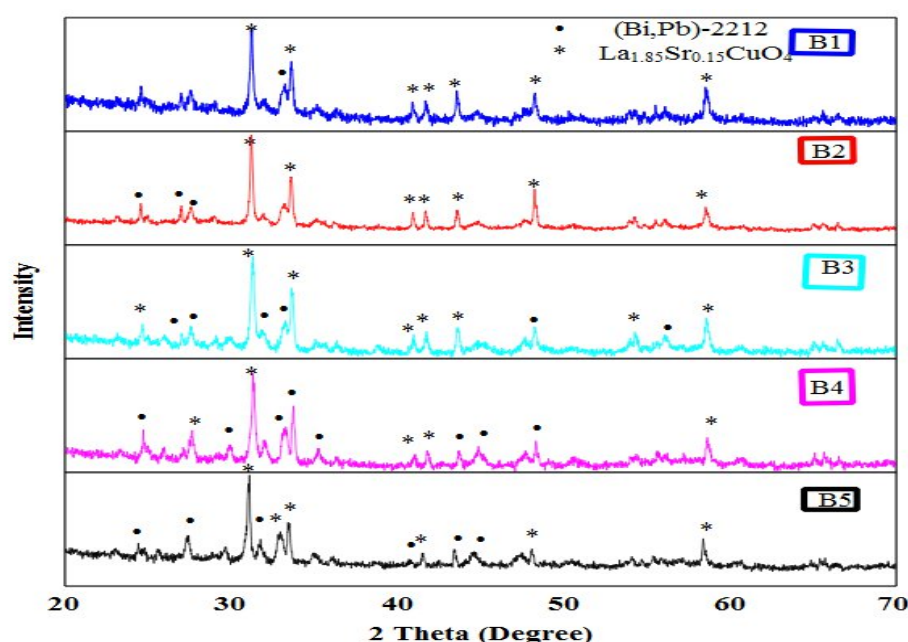


Figure 1.. Diffraction pattern of mixed LSCO superconductors (Bi, Pb) -2212

The diffraction pattern in figure 1 (B1) was a diffraction pattern of LSCO and BPSCCO Superconductor samples with a composition of 50%: 50% and without heat treatment. In sample, B1 shows the phases (Bi, Pb) -2212 and $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$. The optimum phase (Bi, Pb) -2212 at an angle of $2\theta = 35.19^\circ$, with an intensity of 41.37 cts. The phase $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$ was optimum at an angle of $2\theta = 31.22^\circ$, with an intensity of 486.57 cts. The diffraction pattern in figure 1 (B2) was a diffraction pattern of LSCO and BPSCCO superconductor mixed samples with a composition of 50%: 50% and given heat treatment at a temperature of 400°C for 10 hours. In sample, B2 shows the phases (Bi, Pb) -2212 and $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$. The optimum phase (Bi, Pb) -2212 at an angle of $2\theta = 24.57^\circ$, with an intensity of 254.99 cts. The optimum phase of $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$ at an angle of angle $2\theta = 31.20^\circ$, with an intensity of 1344.58 cts. The diffraction pattern in figure 1 (B3) was a diffraction pattern of LSCO and BPSCCO superconductor samples with a composition of 50%: 50% and given a heat treatment at a temperature of 600°C for 10 hours. In sample, B3 shows phases (Bi, Pb) -2212 and $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$. The optimum phase (Bi, Pb) -2212 at an angle of $2\theta = 33.66^\circ$, with an intensity of 429.94 cts. The phase $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$ was optimum

at an angle of $2\theta = 31.33^\circ$, with an intensity of 582.95 cts. The diffraction pattern in figure 1 (B4) was a diffraction pattern of LSCO and BPSCCO superconductor mixed samples with a composition of 50%: 50% and given a heat treatment with a temperature of 800°C for 10 hours. In sample, B4 shows the phases (Bi, Pb) -2212 and $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$. The optimum phase (Bi, Pb) -2212 at an angle of $2\theta = 33.05^\circ$, with an intensity of 186.83 cts. The phase $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$ was optimum at an angle of $2\theta = 31.29^\circ$, with an intensity of 644.06 cts. The diffraction pattern in figure 1 (B5) was a diffraction pattern of superconductor LSCO and BPSCCO mixed samples with a composition of 50%: 50% and given heat treatment at a temperature of 900°C for 10 hours. In sample, B5 shows the phases (Bi, Pb) -2212 and $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$. The phase (Bi, Pb) -2212 was optimum at an angle of $2\theta = 27.43^\circ$, with an intensity of 182.82 cts. The phase $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_4$ was optimum at an angle of $2\theta = 31.1^\circ$, with an intensity of 725.68 cts.

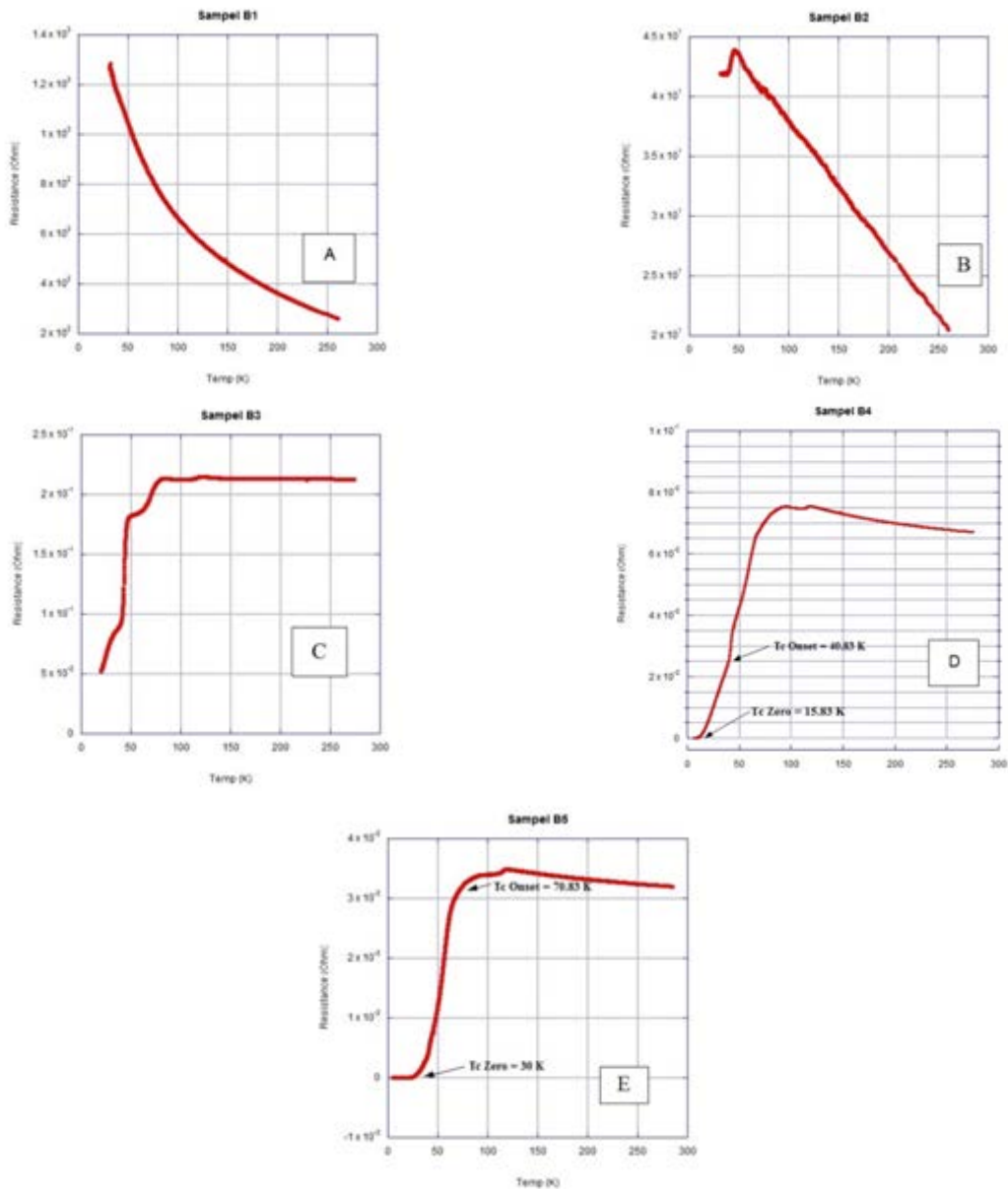


Figure 2. Graph of the relationship between temperature and resistivity of mixed LSCO superconductors (Bi, Pb) -2212

In figure 2 (a) shows that the superconductor tested was not obtained Tc, onset and Tc, zero. This was because when the superconductor was mixed it was not given a heat treatment that affects the nature of the sample superconductivity. In pictures (b) and (c) shows cryogenic results were not obtained also Tc, onset and Tc, zero. In pictures (d) and (e) each sample was obtained Tc, onset and Tc, zero.

Table 1 shows the variation in sintering temperature in the prepared sample. From table 1 it can be seen clearly that samples B4 and B5 show superconductivity. Samples B1 B2, and B3 turn into semiconductors. The increase of LSCO content, has changed the sample became insulator. This indicate that the formation of superconductor stage was in lower sintering temperature and in a good agreement with previous finding [6].

Table1. Variation in sintering temperature 5 pellets

Code	Sintering	Tc onset	Tc zero	Remarks
B1	-	-	-	semiconductor
B2	400°C	-	-	semiconductor
B3	600°C	-	-	semiconductor
B4	800°C	40,83 K	15,83 K	superconductor
B5	900°C	70,83 K	30 K	superconductor

4. Conclusion

After the samples were analyzed for resistivity it can be concluded that there was an effect of temperature changes during heating (Bi, Pb) -2212 mixed with LSCO in the manufacture of superconductors. Where samples B1, B2, B3 become semiconductors and not obtained Tc, onset and Tc, zero. Whereas in B4 and B5 samples remained superconductors with Tc, onset and Tc, zero each was 40.83 K and 15.83 K for B4 samples, 70.83 K and 30 K B5 samples.

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5. References

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