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Analyze the Structure and Electrical Properties of $PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$ Superconducting Gamma Irradiation

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Abstract. The purpose of the current work was to evaluate the effect of Radiation of Gamma on the superconducting characteristics of the compound $PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$ utilizing a ^{137}Cs source at doses of 10, 15, and 20MRad. Solid state reaction technology was used to prepare the samples. Before and after irradiation, X-ray diffraction (XRD) and superconductor properties were examined. Results indicated that the tetragonal structure of our chemical corresponds to the Pb-1223 phase with an increase in the ratio c/a as a result of gamma irradiation. ($T_{c\ (onset)}$) and on set temperature $T_{c\ (offset)}$) were also dropping from 113 to the 85.6 K and 129.5 to 97 K, respectively, for a transition temperatures.

Keywords: Radiation, Gamma, Zero critical temperature, properties of Superconducting and XRD

1. Introduction

bringing to a close our earlier research on the impact of additions, such as Sr, La, Pb, Cr, Cd, Y, Sb, Ag, and O2, based on the chemical composition and electrical characteristics of superconducting material , crystallization constants and melting points, modified[1–13]. We will research the impact of gamma radiation on the structural and optical properties of the superconducting moreover the effect of the preparation circumstances on these properties [14–16]. Furthermore, irradiation can be used to study some of the characteristics of Bi2Sr2Ca2Cu3O10 [17]. Because of the ability to compare the state of a sample before and after irradiation, irradiation techniques are helpful for determining how much of an impact faults have on superconductors [18]. This eliminates issues with sample variability. In this article, we provide the results of an investigation into the effect of gamma rays on the superconducting transition in a bulk polycrystalline sample of $PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$. A ^{137}Cs source was used to irradiate air at room temperature with doses of 10, 15, and 20 MRad.

2. Preparation Methods

$PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$ was prepared using the solid state reaction technique in four samples. The necessary quantities of PbO, BaO, CaO, Sb2O3, and CuO starting materials were used in the synthesis. The mixture was heated for two hours at 750 °C in a programmed furnace. Re-grinding the powder produced pellets with a diameter of (1.5 cm) and a hydro static pressure of approximately (8 tons/cm^2).

The pellets were then put into a sintering furnace at 855°C for 24 hours at a rate of 160°C per hour, subsequently, they were cooled to ambient temperature at an identical pace. Four specimens have been prepared: sample A, which has not been exposed to radiation; samples B, C, and D, which have all been exposed to radiation at room temperature using ^{137}Cs at doses of 10, 15, and 20 MRad. These samples' ρ-T (resistivity vs. temperature) properties were assessed using a conventional d.c. four-probe method to look into their superconducting condition. Other sources [14-20] have described how to measure the crucial temperatures. Structure was discovered through (XRD) measurements in the 20 to 50 range. The (a, b, and c) lattice parameters were calculated using Cohen's least squares [21, 24].

3. Results and Discussion

One may determine the values of the critical temperature $T_{c(offset)}$ and $T_{c(onset)}$ before and after irradiation of gamma by employing a ^{137}Cs source with doses of 10, 15, 20 MRad based on the graph of normalized resistivity with temperature curves (ρ –T) given in the Figure 1. $T_{c(offset)}$ was found to be 113, 103, 97 and 86 K, and Tc(onset) was found to be 129, 123,115 and 97 K, respectively.

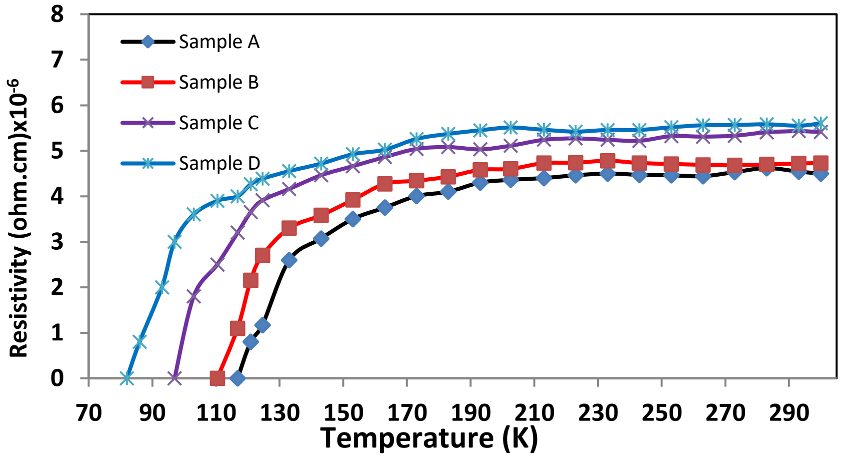

Figure 1. The resistivity vs. temperature for $PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$ Gamma Irradiation.

The observed behavior might be caused by a change in the stoichiometry of oxygen, which controls hole concentration in conducting the CuO layer. Consequently, as anticipated, alteration in oxygen levels caused by irradiation may result in changes in carrier concentration, which would account for the reported values of Tc. According to Sauerzopf and Wiesinger [25-29], irradiation may cause damage to the weak linkages between grains, rendering them mainly disconnected after irradiation. The oxygen content values are displayed in Table (1). Due of the high probability of radiation-induced band damage in the CuO planes, defects are likely to be formed, it is evident from Table (1) that the oxygen content of the specimens has increased after irradiation. Defects reduce the lattice's number of holes, which lowers the temperature of the critical transition Tc [30, 34]. According to Table 1's results for oxygen content for the $PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$, compound an increase in gamma irradiation dose resulted in an increase in oxygen content from 8.169 to 8.289.
Samples were located to contain almost phase-pure polycrystalline Pb-1223 phase, according to the X-ray diffraction data [26]. However, very little Pb-1212 is present. All samples included Pb-1212 and extremely trace levels of secondary phases. The without-irradiated sample A is shown in Fig. 3 along with samples B, C, and D were exposed to gamma radiation at fluency of 10, 15, and 20 MRad, respectively. According to Fig. 2, sample (A) exhibits higher intensity high-Tc phase reflections than samples B, C, and D as the irradiation influences increase, while sample (1223) exhibits a drop.

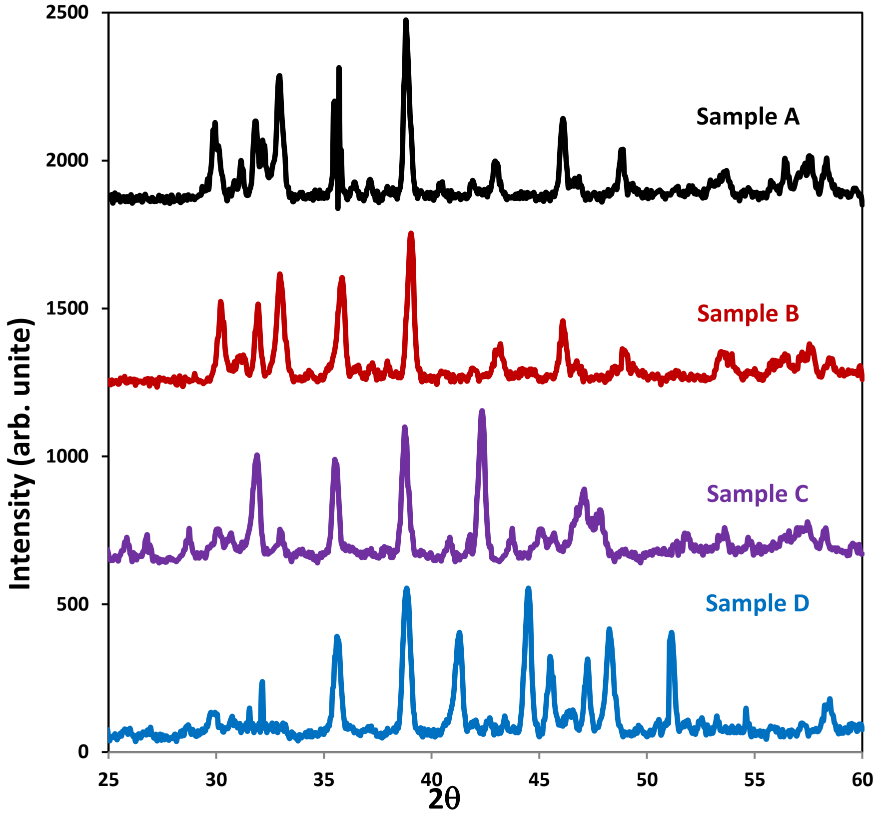

Figure 2. XRD patterns for the $PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$ samples A, B, C and D.

Using the values of d and (hkl) reflective of the observed XRD pattern from Figure 2 a computer program based on Cohen's least squares approach was used to drive the lattice parameters. The transition temperature parameters values Tc (displacement) [35-40], Tc (onset), excess oxygen $\delta_{(O2)}$, lattice parameters a, b, c, and volume fraction $V_{ph(1223)}$ are recorded in Table (1), it is important to mention that the experimental errors in the current results were calculated to be about (±5%). It is noted from the table that the lattice parameters changed when the samples were exposed to radiation [41-44], and this, if anything, indicates that the different energies of gamma rays have caused a change in the pore composition of the samples, and this The change increases as the radiation energy increases [44-50].

Table 1: values of $T_{c(Offset)}$,$T_{c(onset)}$, oxygen $\delta(o_2)$,a(A^0), b(A^0), c(A^0) for $PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$ samples depended to gamma dose.

Sample	**$T_{c(offset)}$(K)**	**$T_{c(onset)}$ (K)**	***δ (o_2)***	***a*(A^0)**	***b*(A^0)**	***c*(A^0)**	***$V_{ph(1223)}$***
A	113	129	0.169	5.33	5.47	36.92	76. 27
B	103	123	0.245	5.427	5.46	36.74	74.83
C	97	115	o.272	5.181	5.42	36.95	71.26
D	86	97	0.289	5.108	5.39	37.09	68.72

4. Conclusions

In this paper, we looked into the effects of gamma irradiating samples of $PbBr_2Ca_{1.9}Sb_{0.1}Cu_3O_{8+\delta}$ superconductors that were made under ideal circumstances. X-ray diffraction analysis revealed orthorhombic structure. The lattice parameters for the samples were changed after irradiation. It has been discovered that a transition temperature is sensitive to gamma radiation, with Tc(off) and Tc(on) falling from 113 to 85 K and 129 to 97 K, respectively.

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