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STUDY OF THE EFFECT OF LASER IRRADIATION ON THE ELECTRICAL AND STRUCTURAL PROPERTIES OF Pb2-xHgxBa2-y Sry Ca2 Cu3 O10+Δ SUPERCONDUCTING AT COMPENSATION RATIOS Y= (0.1,0.2,0.3,0.4)

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Abstract

Superconducting compound Pb2-xHgxBa2-ySry Ca2 Cu3 O10+δ was pressurized (8 tons) using a hydraulic press for different compensation ratios x=(0-0.1-0.2-0.3-0.4./cm2). The prepared sample was put into an electric furnace, and the temperature was raised from room temperature to (600°C) at a rate of (120°C/h), and then the sample was kept at this temperature for (12) hours, and then the furnace temperature was increased at (120°C/h) h) from (600 °C) to (800 °C) and maintained at this level (24 h) in an oxygen-saturated atmosphere and then at a rate of (30 °C/h) from (800 °C) down to (600 °C) and hold at that temperature for (12) hours ،Thereafter, the temperature was lowered from (600° C.) to room temperature at a rate of (30° C./h), and when the synthesis of the compound was completed in X-ray diffraction XRD, laser light was irradiated. Experiments have shown that the results before laser exposure are best compensated. The ratio is x=0. If the compensation ratio of Y is increased to 0.2, its value and regularity increase with the size (c), a = b = 5.471 (A°), c = 34.683 (A°). The increased regularity we observed in the crystal structure of the compound, the compound played better in the crystal structure.Whereas after irradiating and increasing the scale and increasing the compensation ratio to 0.2, the value and regularity increase with increasing dimensionality (c) a = b = 5.479 (A°), c = 34.731 (A°) we note a If we increase the compensation percentage and make the compound play better in the crystal structure, we can improve the regularity of the crystal structure of the compound.Checking the electrical properties of the resistance test, the results show that when the compensation ratio also increases the critical temperature of the junction, the optimal compensation ratio before laser irradiation is x = 0.2, so the critical temperature is (K135). This result can explain that the compound plays an important role in the structure and crystal structure, but the critical temperature after laser irradiation is the same (140 K).

Keywords: Molecular Compensation, Annealing, Laser Irradiation.

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Introduction

Superconductivity An important phenomenon in solid state physics is the dissolution of magnetic flux at extremely low temperatures near zero Kelvin, a phenomenon in which the electrical resistance of metals and certain compounds decreases and is known as superconductivity. It was the first scientist to discover this phenomenon (Kamerlling Onnes). In his 1911 he measured the resistance of pure mercury at the temperature of liquid helium and found that the resistance of mercury dropped below 10-5 ohms)). And we start from low temperature (4.2K) (Onnes called this phenomenon superconductivity, because at this temperature the conductivity becomes infinite. This temperature is called critical temperature (critical temperature Tc)), the value of critical temperature is different For each material, some materials develop a superconducting voltage when cooled to a low temperature called the critical temperature The difference between the initial temperature Ton set and the final temperature T_{zero} is called the transition width. Of course, (Onnes) was the first scientist to discover this phenomenon, for which he was awarded the Nobel Prize in 1913. Materials with excellent electrical conductivity are of research interest due to their industrial importance The difference between the initial temperature Tonset and the final temperature T_{zero} is called the transition width. Of course, (Onnes) was the first scientist to discover this phenomenon, for which he was awarded the Nobel Prize in 1913. Materials with excellent electrical conductivity are of research interest due to their industrial importance[2,1].

In order to reach the superconducting state, three conditions must exist simultaneously, namely [3,2]:

1.The temperature should be lower than the critical temperature TC.

2.The magnetic field must be less than the critical magnetic field Hc.

3.The current density must be lower than the critical current density Jc.

These three factors depend on the quality of the material and are one of the most important for practical applications, so if you exceed any of these The three values are their critical value, the material loses its superconducting properties.

Superconducting materials are divided into two types:[4,1]

1- Type I Superconductor

This type of superconducting material is a magnetic material in which the induced magnetism increases with the increase of the external magnetic field.

2- Type II Superconductor

These superconducting materials and compounds are completely subject to the Mazner effect, since the magnetic flux begins to penetrate into an external magnetic field (Bc1) lower than the magnetic field of the material (Bc), but when the external magnetic field increases to (Bc2) or higher, that is, greater than Bc).

2- Practical part

2-1 Calculation of the weight

Elemental ratios Weight ratios (w5 - w4 - w3 - w2 - w1) of materials are balanced on electronic sensor balances (SCALTECINS TRUMENTS) with a precision (0.0001 g) as shown in Figure.(1))

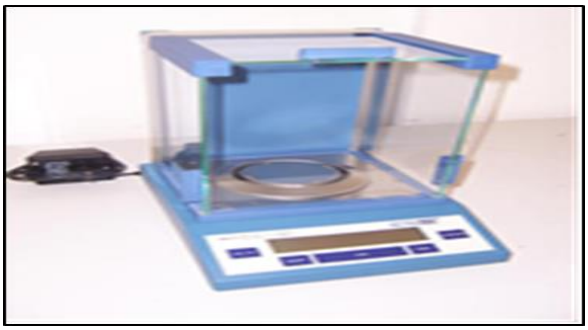


Figure (1) SENSITIVE BALANCE TYPE (SCALTEC INSTRUMENTS).

2.2 Heat treatment

- Mix the weights of carbonates, oxides and nitrates of (CuO, 3CaCO, (Pb2O3) to obtain the research compound Pb2Ca2Cu3O10+δ, then put these materials in a pooka and grind them with a garnet grinder for half an hour. In During this process, add isopropanol solution to grind to make the mixture uniform, avoid dropping or losing part of the powder during the grinding process, and then put it in an electric heating furnace with a temperature of ℃ (60-50℃) to remove isopropanol.
- Mix powder weights (W4 – W3 – W2 – W1) containing (CuO, BaCO3, Pb2O3, HgO Sr(NO3)2) to give (Pb2-x Hgx Ba2-y Sry O10+ δ). This process is done by grinding the powder and adding isopropanol.
- The powders were compressed at a pressure of (8 t/cm2) into tablets with a diameter of (12 mm) and a thickness of (0.8 mm) to (1.2 mm).
- Place the tablet in an air-saturated convection oven at 120°C/h until it reaches (800°C) and keep the mold at (800°C) for a period of time (12 hours) C). C), and then cool the model to room temperature at the measured cooling rate (30 °C/h). The temperature is controlled using a thermostat, and then the model is taken out of the furnace for a heating and cooling process in an air-saturated atmosphere, which is called sintering, as shown in Figure 2. After that, the powder was mixed and ground again for half an hour, and the isopropanol solution was added dropwise to prevent the volatilization loss of the powder, and then put into a powder oven to remove the added solution, and then weighed again.

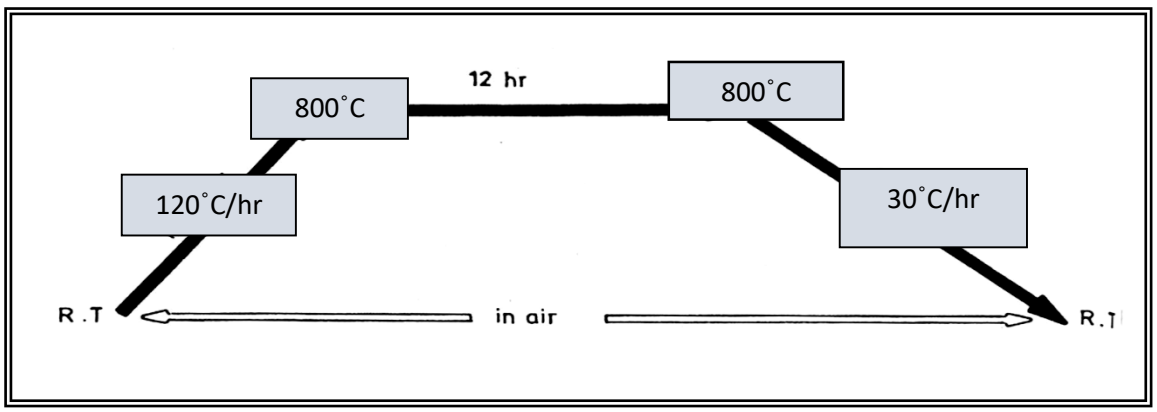


Figure 2 Sintering diagram in air[5]

2-3 Measurement of the electrical resistance of samples as a function of temperature

The main purpose of this study is to measure the critical temperature of the sample as there is no direct way to measure this temperature since we use resistance measurement where the resistance is almost zero at a specific temperature and can be considered as the critical temperature.

Figure (3) Voltage and current difference measurement system for samples at low temperatures.

Prepare the samples for resistance measurements by cutting slices into rectangular prisms with dimensions approximately mm (12 x 3 x 1). Two points inside the silver (silver paste) are used to measure the potential difference (V), and two points near the edge are used to measure the current path (A). It is connected to a digital power pack and measurements are performed under negative pressure (10-4 mbar). resistance can be found from the following relation

$$R = \frac{V}{I} \qquad \text{.....(1)}$$

The resistance depends on the cross-sectional area of the sample and the length of the sample, expressed by the following relationship:

$$\rho = \frac{RA}{l} \qquad \text{.....(2)}$$

where (R) is the resistance of the sample, (A) is the cross-sectional area of the sample, and (l) is the length of the potential difference between two points on the sample [3].

2-4 X-ray diffraction XRD

The structure and crystal structure have been verified by Iran's X-ray machine, and the machine has the following performance and specifications:

Table (1) Characteristics of the X-ray Machine Used

. Source	Cu Target
Current	30mA
. Voltage .	40k.V
scan Range	10.- 80deg
scan mode	continuous scan
Wave length	1.154 ^{0}
7. preset time	0.15 second
Scan speed	8 deg / min

Figure (4) X-ray machine used to examine samples.

3

.Results and discussion

3.1 Study of the volumetric structural properties of Pb2-xHgxBa2-y Sry Ca2 Cu3 O10+δ

Investigate the bulk structural properties of the compound at the annealing temperature (800 °C). A study under pressure (8 t/cm2) shows his X-ray diffraction of these samples in the fabrication of models with different ratios of Y values.

When substituting by y = 0.1, a clear uniformity in the crystal structure and the appearance of clear peaks were , and through the use of Braque's law in diffraction, the values of (dhkl) were calculated, which is the distance between parallel planes, and through the angles of reflection (2 ɵ Miller's coefficients (hkl) were found, finding the values of the dimensions Substituting y = 0.1, the clear uniformity of the crystal structure and the appearance of clear peaks , and by applying Braque's law of diffraction, the value of (dhkl), which is the distance between the parallel planes , and through the reflection angle (2ɵ), find the Miller coefficient (hkl), and find the value of the unit cell size. a = b = 5.463(A°)), c = 34.523 (A°), which is square) of the cell unit, if they were .a = b = 5.463(A°), c = 34.523 (A°) i.e. it is of the tetragonal type).

When the compensation ratio of Y increases to 0.2, as the dimension (c) increases, its value increases and its regularity appears, a = b = 5.471 (A°), c = 34.683 (A°), as shown

in the figure (5), as the compensation ratio increases, we notice that the crystal structure of the compound appears regular, and the compound plays a better role in the crystal structure than the previous compensation.

When the compensation ratio was increased to Y = 0.3, we noticed that the peak appeared more clearly than the previous compensation, and the length of the c-axis increased, which is evidence of the increased regularity of the crystal structure, and Connection played a more important role than the previous compensation. Good effect, , the value of lattice dimension is a = b = 5.345 Å, c =35.753Å .

when the compensation ratio increased to 0.4, the peak intensity decreased significantly, which indicated that the irregular state occurred due to the increase of the sample compensation ratio and the sample lattice size was a = b = 5.438 (A°), c = 33.462 (A°)[5]

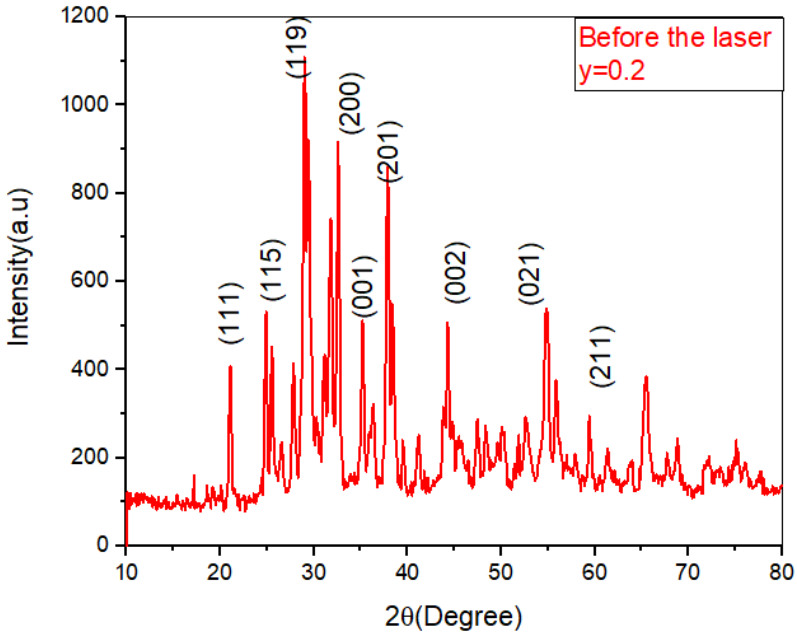


Figure (5) X-ray diffraction of Pb2-xHgxBa2-y Sry Ca2 Cu3 O10+δ when y=0.

The study irradiated the models with laser light to see how it affected them, and showed X-ray diffraction from these samples when the models were made with different ratios of Y values. It was found that when the compensation ratio of y was increased to 0.1, we found that the baseline of the diffraction values was not so broad and more obvious, indicating that the crystal structure or crystal structure was further enhanced, , the size (c) increases, indicating increased regularity of the crystal structure, a = b = 5.491 (A°), c = 34.547 (A°).

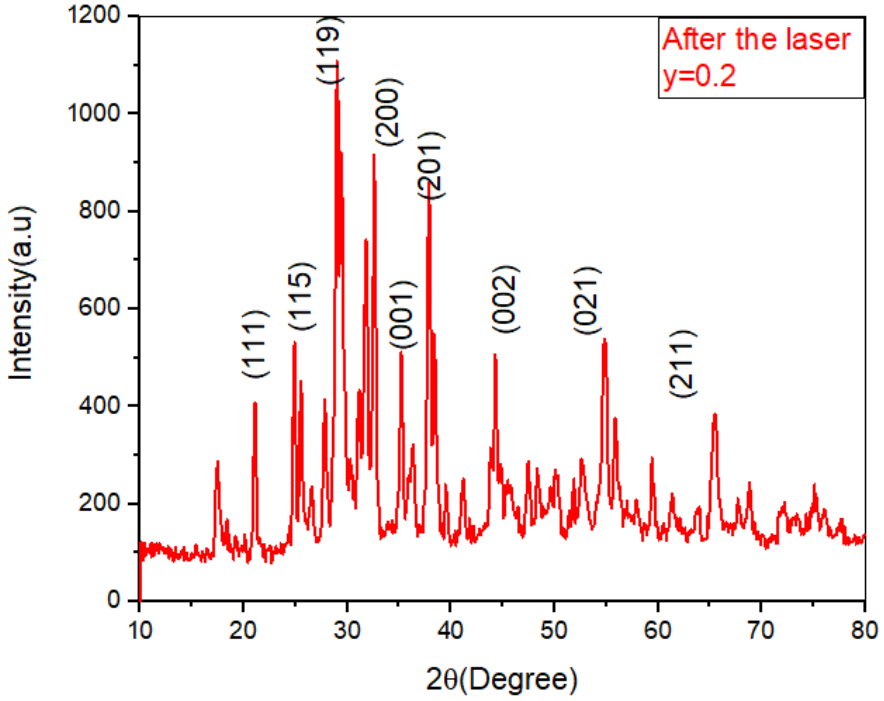
Increasing the compensation ratio to 0.2 increases the value and its regularity with increasing dimensions (c) a = b = 5.479 (A°), c = 34.731 (A°) and as shown in (6) we notice a regularity Properties As the compensation ratio increases, the compound works better in the crystal structure and the compound works better in the crystal structure؛

when the compensation ratio increased to 0.3, the intensity of the peak increased significantly, indicating a regular state of the crystal structure and an increase in size (c),

which indicated that the compound was more than the previous compensation (A°) 5.685 a = b = and 36.423 (A°) c = have a more regular crystal structure[6].

Increasing the compensation ratio to 0.4 increases the value and its regularity with increasing dimensions (c) a = b = 5.482 (A°), c = 33.472 (A°) ,we increase the compensation ratio to observe According to the regularity of the crystal structure of the compound, we draw the conclusion that the optimal compensation ratio is 0.2 [7].

Figure (6) X-ray diffraction of Pb2-xHgxBa2-y Sry Ca2 Cu3 O10+δ after CO2 laser



irradiation when y=0.

2-3- Study of the electrical properties of Pb2-xHgxBa2-y Sry Ca2 C u3 O10+δ

The electrical properties of the compound (Pb2-xHgxBa2-ySryCa2Cu3O10+δ) were studied by partially substituting different ratios of Y values at (Y=0.1,0.2,0.3,0.4).

As the compensation ratio increases (0.1), the critical temperature is (134 K). We found that as the compensation ratio increased to (0.2), the critical temperature increased to (139 K), while the critical temperature increased to (135 K), and the critical temperature decreased significantly (133 K) at the compensation ratio (0.3), The compensation ratio (0.4) is shown in Figure (7). The decrease in the critical temperature is due to the reduced length of the axis (c), which in turn leads to a decrease in the critical temperature. Critical temperature value, i. H. Slope compensation rate (y)[8].

Greater than 0.3 due to changes in the crystal structure of the compound.

When the laser is irradiated with the prepared model and different compensation ratios are applied to the value of (y), we notice that the critical temperature increases, noting that the critical temperature increases (134 K) as the compensation ratio increases to y = 0.1, and when When the compensation ratio increases from x = 0.2, the critical temperature of the compound increases, so that the critical temperature is equal to (140 K), when the compensation increases to (0.3), the critical temperature becomes (135 K), the

compensation ratio is 0.4, and the critical temperature (133 K (as shown in Figure (8), This result can be explained by the fact that the compound remains homogeneous in the crystal structure, while the increase in the oxygen content of the compound can be explained by the compound remaining homogeneous in the crystal structure due to the increased oxygen content in the junction[9].

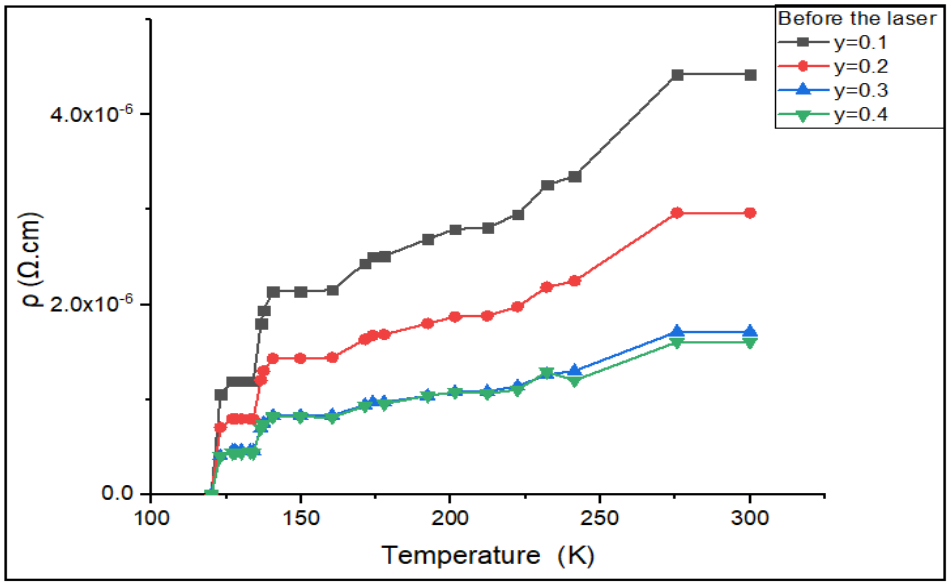


Figure (7) Relationship between resistivity and critical temperature of Pb2-xHgxBa2-y Sry Ca2 Cu3 O10+δ when y = 0.1 , 0.2 , 0.3 , 0.4,

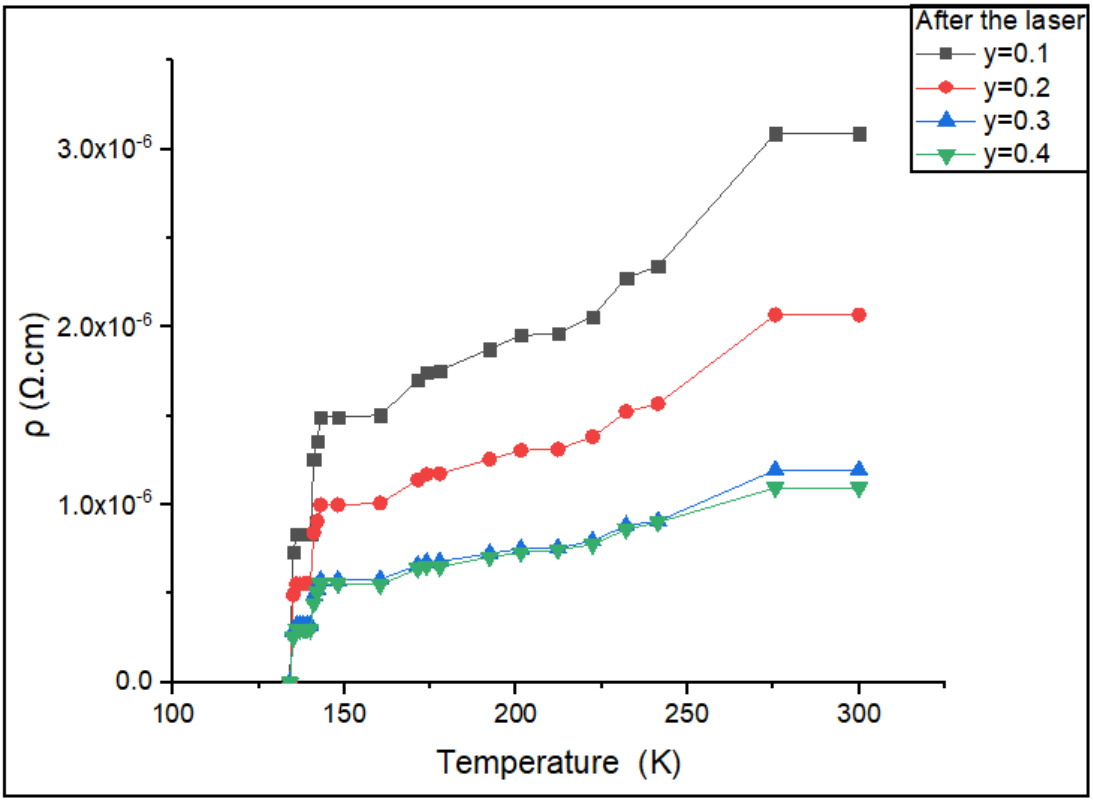


Figure (8) The relationship between resistivity and critical temperature of Pb2-xHgxBa2-y Sry Ca2 Cu3 O10+δ y=0.1, 0.2, 0.3, 0.4 after laser irradiation.

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