

Research Article

Electric Field Behavior with Current for Bipbsrcacuznxo Thin Film System

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Abstract

In this search the investigation of electric field behavior with current for BiPbSrCaCuZnxO film at ($x=0, 0.2, 0.4, 0.6, 0.8, 1$). Where observed two regions, first (linear region) field be constant nearly, and another region increase quickly.

Keywords: Critical field, super conducting, thin film, capacity.

الخلاصة

نبين في هذا البحث سلوك المجال الكهربائي مع التيار المار لغشاء BiPbSrCaCuZnxO عند ($x=0, 0.2, 0.4, 0.6, 0.8, 1$) حيث نلاحظ منطقتان لسلوك المجال الكهربائي. المنطقة الاولى (الخطية) والتي يكون فيها المجال تقريباً ثابتاً مع زيادة التيار، والمنطقة الثانية والتي يزداد عندها المجال ازدياداً سريعاً.

Introduction

Super-conductivity is a phenomenon characterized by the disappearance of electrical resistance in various metals, alloys, and compounds when they are cooled below a certain temperature (critical temperature, T_c). In addition to the zero resistance state, superconductor has displayed many unique properties such as critical field (H_c), and critical current density J_c [1].

The discovery of superconductivity brings a tremendous change in the field of science and engineering from twentieth century onwards. Research is being carried out to develop superconductors for high temperatures [2], via: Energy and electricity field such as power transmission wire, SMES, transformer industry and transportations field such as maglev, motor, magnet used for growth of superconductor [3]. Diagnosis and medical field such as accelerator, magnetic resonance imaging (MRI) [3][4].

The most important small scale applications of superconductivity are those applications based on the properties of SQUID (superconductor quantum interference devices used it from thin film superconductor) and Josephson Junctions device (SQUID). This is incredibly sensitive to small magnetic fields so that it can detected the

magnetic fields from the heart (10^{-10} Tesla) and even the brain (10^{-13} Tesla) [5][6][7].

Promising future applications include high-performance transformers, power storage devices, electric power transmission and electric motors. However, unless material that superconductor at room temperature can be found, the use of superconducting in practical application will be costly [8][9].

The aim of this search is to investigate the ability of CuO layer in BSCCO system to store charges where the electric field formation between two layers drift the cooper pairs and improvement of high T_c phase and transition temperature of BSCCO system by substituting Zn on Cu in BiPbSrCaCuZnxO.

A capacitor is a device consisting of two conductors separated by vacuum or an insulating material. When charges of equal magnitude and opposite sign are placed on the conductors of a capacitor, an electric field is established in the region between them, with a corresponding potential difference between the conductors. Placing charges on the conductors requires an input of energy, this energy is stored in the capacitor and can be regarded as associated with the electric field in the space between conductors like CuO, when this space contains an insulating



material (a dielectric) rather than vacuum such as Zn, the capacitance is increased [7]. In this search when speak of a capacitor as having charge Q , this mean that the conductor Cu^+ at higher potential has a positive charge and the conductor at lower potential has negative charge. This interpretation how much charges (super pairs) for given voltage. Figure 1 schematic CuO capacitor show Zn layer separate between them [7]. In this paper it can be investigated the important of multi layers (phases) in perovskite lattice which play as capacity plates, so the substituted atoms present insulator matter between plates. When phases increase the lattice becomes multi plate's capacity to store the charges and it can be expressed by law [7]:

$$C = n \epsilon_0 k \frac{A}{d}$$

Where n phase number of super conductor, K dielectric of Zn atom, ϵ_0 vaccum permittivity equal to $8.85 \times 10^{-12} \frac{\text{Farad}}{\text{m}}$, A layer area, d distance between layers.

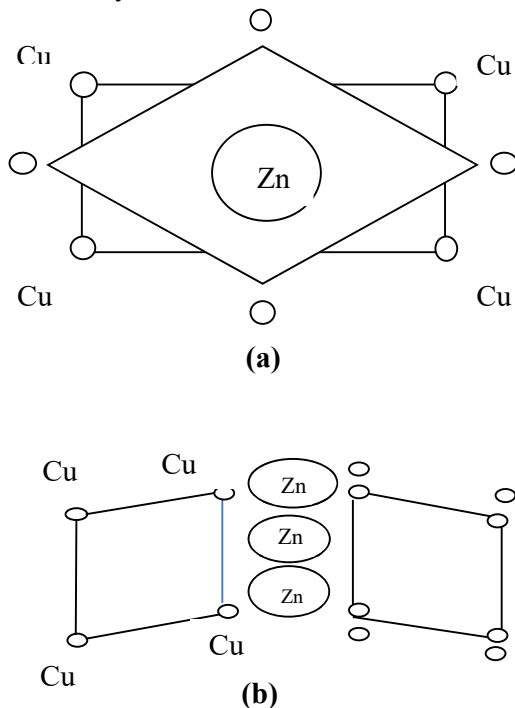


Figure 1: (a and b) schematic CuO capacitor show Zn layer separate between them [7].

Materials and Methods

Standard four probe technique was used for electrical characterization of superconducting samples. Electrical resistivity (ρ) measurements were carried out from 77K-300K to determine

the transition temperature. The probe contacted to the surface of the samples using conductive silver paste. The two outer probes were for current and the two inner were for voltage in order to measure the electrical resistivity (ρ), the sample was fixed inside the cavity cryostat instrument open-cycle refrigerator system which employed liquid nitrogen in the cooling process. The cryostat was joined to rotary pump to get a vacuum pressure (10^{-2})mbar inside it by using (Edward pressure 12) gauge, also a sensor of digital thermometer type (RTD) with a sensitivity of about \pm ic was used for measuring temperature, thermometer down to boiling point of liquid nitrogen, and thermo-couple type (T) was put near the sample position, the voltage drop (V) across the sample was measured by a digital Nano voltmeter type keithley model 180, which had sensitivity of about ± 1 nano volt, and D.C power supply type (hp 6236 A triple, 30v) was used to supply the current(I) through the sample which was measured by a multi meter, after have been dropped voltage(V) to zero attended super state, increase current(I) slowly, and by dividing each value of voltage(V) on (t) the thickness of the film (182.4nm) to obtain electric field (E). The voltage gradient could be found from the curve of electric field $E=V/t$ versus temperature as shown in the Figures 2, 3, 4, 5, 6, and 7.

Results and Discussion

It can be believed CuZnO in perovskite lattice BiPbSrCaCuZnO as capacity; copper and oxygen chains represent positive and negative plates respectively so insulator layer between them is zinc concentration substitution. In this case electric field springs from copper plate and vanish at oxygen plate. It can be showed the relationship between electric field (E) with current (I) as in the Figure 2 at ($x= 0, 0.2, 0.4, 0.6, 0.8,$ and 1).

It can be observed from figures, that there are two regions; one linear region where field be constant in this region capable of CuO layers to store charges enhancement with increasing current I, this evidence increasing of grains areas, field in the second region increase randomly with current, that means it's intensity changes from point to another inner CuO plate as to density of force lines increase.

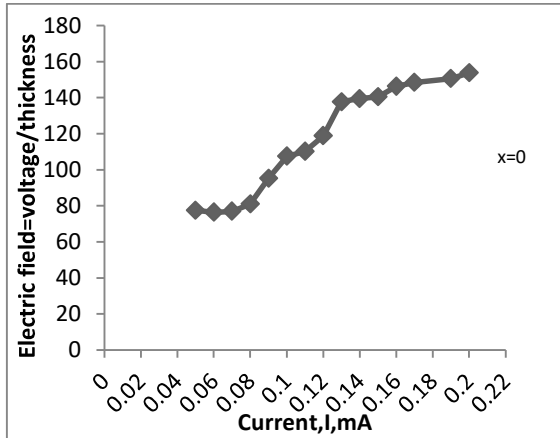


Figure 2: Relation between electric field E with current I for BiPbSrCaCuZnxO thin film system at x=0.

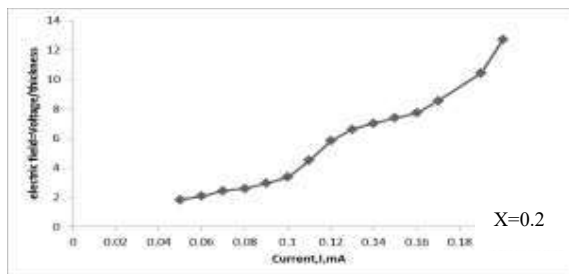


Figure 3: Relation between electric field E with current I for BiPbSrCaCuZnxO thin film system at x=0.2.

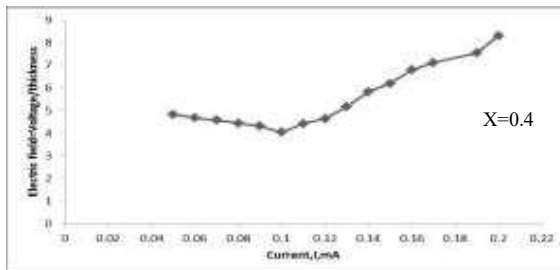


Figure 4: Relation between electric field E with current I for BiPbSrCaCuZnxO thin film system at x=0.4.

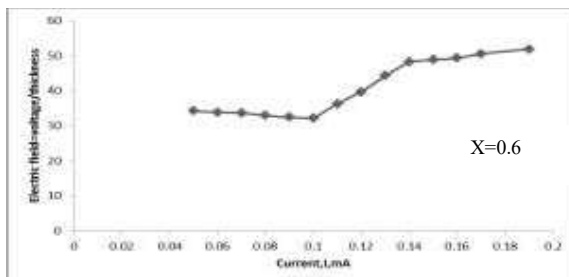


Figure 5: Relation between electric field E with current I for BiPbSrCaCuZnxO thin film system at x=0.6.

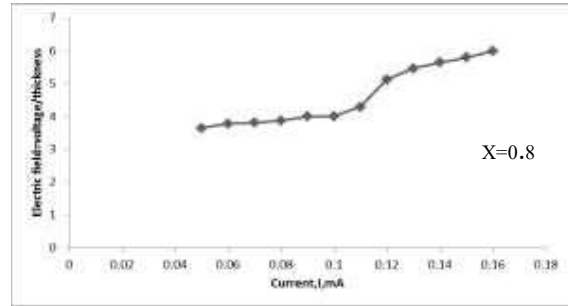


Figure 6: Relation between electric field E with current I for BiPbSrCaCuZnxO thin film system at x=0.8.

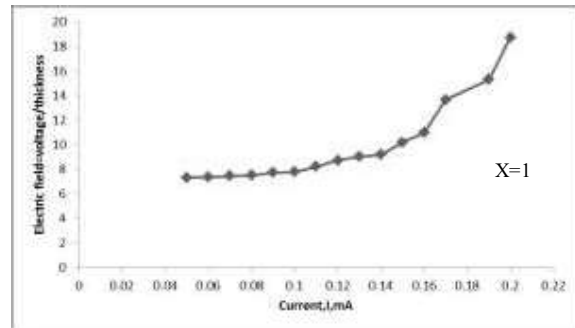


Figure 7: Relation between electric field E with current I for BiPbSrCaCuZnxO thin film system at x=1.

Zinc plays very important role in the linear region, where contain electrons binding to atoms however CuO layers contains free electron all of them are neutral when be insulated from external field as Zn exposure to external field, path of electron will changes around nucleus or behave elliptic path, therefore don't sit down negative charge center on positive charge center (nucleus), that means atom polarizes and establish field for atom consequently Zn but inversely less than polarized charges which generates external field between two plates. So that in Zn layer less than between CuO plates, consequently resultant of field will be constant with increasing of current.

Conclusion

From this research it is concluded the important role of Zn, its atoms contain of electronic pairs. If exposure to external magnetic field will generate inverse magnetic field and weak field in the matter, then inner flux density less than external flux density, this indicates the presence of a superconducting transition between grains coupled by weak links with a distribution of current.

References

- [1] J.W.Halley, "Theories of High Temperatures superconductivity", Addison Wesley 1988.
- [2] P.Komarch; Supercond. Sci Technol. Vol.13, P.456, 2000.
- [3] R.K. NKUM and W. R.D atars, supercond. Sci. Technol, Vol.8. No.11, 2015.
- [4] A. M. EI Sayad a, b, s, Taha a, G.Said a, F.Yakuphanoglu "controlling the structural and optical properties of nanostructured ZnO thin films by the cadmium content" 65(35), 2014.
- [5] F Yang, Z.Y.Liu, M.Y.Hanand F.G.Chang, Phys.D:APPI.Phys. 48. 215308, 2015.
- [6] N.Darsono, A. Imaduddin, K. Raju and D-Hyok Yoon J.Supercond Nov Magn., V28(8) pp2259-2266, 2015.
- [7] E.Sakiroglu, K.Kocabas, J Supercond Nov Magn. V24(4) pp.1321-1325, 2010.
- [8] Ling D., Lius., Lux.,Zhangc., Duy. Vol. 81(8):1033-1037, 2012.
- [9] Journal of nuclear materials.August 2004, Vol.329:1590-1593, doi: 10.1 proceedings of the 11th international.