Sudan University of Science and Technology

College of Graduate Studies

كلية الدراسات العليا

A Study of a Group of Materials Variety, and Methods Used in Fabricating High Critical Temperature Superconductors

دراسة لمجموعة متنوعة من المواد والطرق المستخدمة في تصنيع الموصلات الفائقة عالية الحرارة

A dissertation submitted as a partial fulfillment of the requirement for a master Degree (M.Sc.) in physics

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الأية

قَالَ تَعَالَىٰ:

﴿قَالَ كَذَٰلِكَ قَالَ رَبُّكَ هُوَ عَلَيَّ هَيِّنٌ وَقَدْ خَلَقْتُكَ مِن
قَبْلُ وَلَمْ تَكُ شَيْـًٔا ۝٩﴾

سورة مريم الاية (٩)

صدق الله العظيم

Dedication

I would like to dedicate this work with many thanks and gratitude to my parents , my family , my friends , all my teachers in all stages of my study and to the soul of my college (MoawiaAlrahma).

Acknowledgements

This research project would not have completed without the support of many people. I would like to express my deepest gratitude to my supervisor, **Dr. Mahmoud Hamid Mahmoud Hilo,** for his excellent guidance, care, advice, patience and provide me the necessary tools, in-additions for explaining to me how to do research, and thank him for considering me as his students and supporting me without hesitation throughout this work, without his effort and support this study would not be success. It is my great pleasure to be his students. I will forever remain indebted to him.

We thank Allah who made all these possible.

Abstract

This research is conducted so as to provide information about almost of the researches done so far regarding superconductors and to provide a reference study that can help researchers in the same field of applications. Through the study of some scientific papers in this area, and aiming to summarize findings, and to facilitate the search for the interested researchers according to their needs, moreover, to highlight weather more research is needed to be conducted in this field or what is the state of the art in this field.

This research used the audit method to collect and present information easily and relies on finding sufficient information in superconductors and presenting them in one combined search.

This research provided a model for investigative research to open the door to this type of studies as most of the researches carried out in this field has given results related to the nature of the superconductor and they all aim towards reaching a superconductor at normal room temperature, which is the hub of the importance of this topic.

مستخلص

تم إجراء هذا البحث لتوفير معلومات حول ما يقدم من الأبحاث التي أجريت حتى الآن بخصوص الموصلات الفائقة ولتوفير دراسة مرجعية يمكن أن تساعد الباحثين في نفس مجال التطبيقات، من خلال دراسة بعض الأوراق العلمية في هذا المجال. ، وتهدف إلى تلخيص النتائج ، وتسهيل البحث على الباحثين المهتمين وفقًا لاحتياجاتهم ، علاوة على ذلك ، لتسليط الضوء على مجال التوصيل الفائق ، مما يلزم إجراء مزيد من البحوث في هذا المجال أو ما هو متعلق بالبحث في هذا المجال.

استخدم هذا البحث طريقة التدقيق لجمع المعلومات وعرضها بسهولة ويعتمد على العثور على معلومات كافية في الموصلات الفائقة وتقديمها في عملية بحث واحدة مشتركة، كما قدم هذا البحث نموذجًا للبحوث الاستقصائية لفتح الباب أمام هذا النوع من الدراسات ، حيث أن معظم الأبحاث التي أجريت في هذا المجال قد أعطت نتائج تتعلق بطبيعة الموصل الفائق وتهدف جميعها إلى الوصول إلى موصل فائق في درجة حرارة الغرفة العادية ، وهو محور أهمية هذا الموضوع.

List of Symbols Abbreviations

Symbols/ abbreviation	Explanation
Tc	Critical Temperature
CUO	Copper Oxide
Nb3 Sn	Nibidium Arsenate
MgB2-MgO	Magnesium diboride- Magnesium oxide
MgB2	Magnesium Diboride
MgO	Magnesium oxide
YBCO	Yttrium Barium Copper Oxide
BCS	Bardeen-Cooper-Schrieffer
DSPI	Digital Speckle Pattern Interferometer
JPD	Josephson Penetration Depth

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Chapter One

Introduction

Chapter One

Introduction

1.1 Superconductivity

Superconductivity is a fascinating and challenging field of Physics. Today, superconductivity is being applied to many diverse areas such as theoretical and experimental science, military, transportation, power production, electronics and medicine as well as many other areas. Scientists and engineers throughout the world have been striving to understand this remarkable phenomenon for many years (Luiz, 2010).

In 1911, KamerlinghOnnes began to investigate the electrical properties of metals in extremely cold temperatures. It had been known for many years that the resistance of metals fell when cooled below room temperature, but it was not known what limiting value the resistance would approach, if the temperature were reduced very close to 0 K. Some scientists, such as William Kelvin, believed that electrons flowing through a conductor would come to a complete halt as the temperature approached absolute zero. Other scientists, including Onnes, felt that a cold wire's resistance would dissipate. This suggested that there would be a steady decrease in electrical resistance, allowing better conduction of electricity. At some very low temperature point, scientists felt that there would be a leveling off as the resistance reached minimum value allowing the current to flow with little or no resistance. Onnes passed the current through a very pure mercury (Hg) wire and measured its resistance as he steadily lowered the temperature. Much to his surprise there was no leveling off of resistance, let alone the stopping of electrons as suggested by Kelvin. At a temperature of 4.2 K, called the superconducting transition temperature T_c, the resistance suddenly vanished . Current was flowing through the mercury wire and nothing was stopping it, the resistance was zero. According to Onnes, "Mercury has passed into a new state, which on account of its extraordinary electrical properties may be called the superconductive state". The experiment left no doubt about the disappearance of the resistance of a mercury wire. KamerlinghOnnes called this newly discovered state, Superconductivity (Luiz, 2010).

1.2 Review Study

A review Study is both a summary and explanation of the complete and current state of knowledge on a limited topic as found in academic books and references.

There are two kinds of reviews methods: one that students are asked to write as a stand-alone assignment in a course, often as part of their training in the research processes in their field, and the other that is written as part of an introduction to, or preparation for, a longer work, usually a thesis or research report. The focus and perspective of review study and the kind of hypothesis or thesis argument you make will be determined by what kind of review are writing. One way to understand the differences between these two types is to read published reviews or the first chapters of theses and dissertations in subject area. Analyze the structure of their arguments and note the way they address the issues (Baglione, 2012).

1.2.1 Purpose of the Review Study

It gives readers easy access to research on a particular topic by selecting high quality articles or studies that are relevant, meaningful, important and valid and summarizing them into one complete report. It provides an excellent starting point for researchers beginning to do research in a new area. it can provide clues as to where future research is heading or recommend areas on which to focus (Baglione, 2012).

1.3 The Problem

There is a large number of application of superconductivity reaches the top of research or there will be more investigations to this research information gives the knowledge about the latest researches in superconductivity and its applications to ease getting it for future needs.

There is a great need of giving knowledge about superconductivity and adding more researches in this field.

1.4 Aims

This research aims to reach the followings

- To insure that the research has been constructed has astute of sufficiencies from applications that explains and apply to phenomena of superconductivity.
- To test whether these applications found in reality? And do people benefit from them or not?

1.5 Method

This research will adopt the review study of superconductivity phenomenon and all its related applications go as to give a review for the latest studies in details and the final results found , besides , to compare this to the future expectations.

In this research, a review study will be used to provide an integrated presentation of superconductivity applications and to study the results reach and what can be added to them in this field.

1.6 Scopes

Layout of the study:

This research will be organized in four chapters , chapter one for the introduction , then chapter two will be chosen for the background and the review study , chapter three for the summaries on the reviewed works , which is the main method of this research , after that , chapter four is for the discussion and conclusion of the work.

Chapter two

Background

Chapter two

Background

2.1 Fundamentals of Superconductor

Superconductors have the ability to conduct electricity without the loss of energy. When current flows in an ordinary conductor, for example copper wire, some energy is lost. In a light bulb or electric heater, the electrical resistance creates light and heat. In metals such as copper (Cu) and Aluminum (Al), electricity is conducted as outer energy level electrons migrate as individuals from one atom to another. These atoms form a vibrating lattice within the metal conductor; the warmer the metal the more it vibrates. As the electrons begin moving through the maze, they collide with tiny impurities or imperfections in the lattice. When the electrons bump into these obstacles they fly off in all directions and lose energy in the form of heat. Inside a superconductor the behavior of electrons are vastly different. The impurities and lattice are still there, but the movement of the superconducting electrons through the obstacle course is quite different. As the superconducting electrons travel through the conductor they pass freely through the complex lattice. Because they bump into nothing and create no friction, they can transmit electricity with no appreciable loss in the current and no loss of energy (Luiz, 2010).

Superconductivity was discovered in 1911 by Kamerlingh Onnes. The history of superconductivity is full of theoretical challenges and practical developments. In 1986 the discovery of Bednorz and Müller of an oxide superconductor with critical temperature (Tc) approximately equal to 35 K has given a novel impetus to this fascinating subject. Since this discovery, there has been a great number of laboratories all over the world involved in researches of superconductors with high Tc values, the so-called “high-Tc superconductors”. The discovery of a room temperature superconductor has been a long-standing dream of many scientists. The technological and practical applications of such a discovery should be tremendous. However, the actual use of superconducting devices is limited by the fact that they must be cooled to low temperatures to become superconducting. Currently, the highest Tc value is approximately equal to 135 K at 1 atm Pressure (Luiz, 2010). The knowledge of the microscopic mechanisms of high-Tc superconductors should be a theoretical guide in the researches to synthesize a room temperature superconductor. However, up to the present time, the microscopic mechanisms of high-Tc superconductivity are unclear. Superconductivity is a very curious phenomenon characterized by a phase transition at a critical temperature (Tc) in which the conducting phase is in equilibrium with the superconducting phase. The most important properties of the superconducting phase are: zero resistance, ideal diamagnetism (Meissner effect), magnetic flux quantization and persistent current in superconducting rings, cylinders or coils. On the other hand, many effects are found in superconducting constrictions as well as in junctions between two superconductors or in junctions between a superconductor and a conductor.

Superconducting wires can be used for power transmission and in other applications when zero resistance is required. A possible application of magnetic levitation is the production of frictionless bearings that could be used to project electric generators and motors. Persistent currents can be used in superconducting magnets and in SMES (superconducting magnetic energy storage).

Superconducting magnets are been used in particle accelerators and may also be used to levitate trains. Many of these devices are successfully been used and new devices are been developed. However, the actual use of these superconducting devices is limited by the fact that they must be cooled to low temperatures to become superconducting.The discovery of a room temperature superconductor should trigger a great technological revolution. The knowledge of the microscopic mechanisms of oxide superconductors should be a theoretical guide in the researches to synthesize a room temperature superconductor. However, up to the present time, the microscopic mechanisms of high-Tc superconductivity are unclear.

According to the type of charge carriers, superconductors can be classified in two types: n-type superconductors, when the charge carriers are Cooper pairs of electrons and p-type superconductors, when the charge carriers are Cooper pairs of holes (Luiz, 2010).

2.1.1 Meissner effect

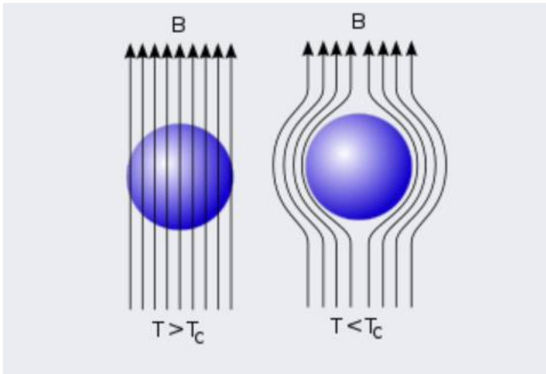

Figure 1 : Messnier Effect

Magnetic field lines ,represented as arrows, are excluded from superconductor when it is below it's critical temperature. The meissner effect demonstrated by levitating amagnet above a cuprate supe . The Meissner effect is the expulsion of a magnetic field from a superconductor during it's transition to the superconducting state .

The German physicists Walther Meissner and Robert Ochsenfeld discovered this phenomenon in 1933 by measuring the magnetic field distribution outside superconducting and lead samples. The samples , in the presence of an applied magnetic field , were cooled below their superconducting transition temperature, where the sample cancelled nearly all interior magnetic fields. They detected this effect only indirectly because the magnetic flux is conserved by a superconductor:When the interior field decreases, the exterior field increases. The ability for the expulsion effect is determined by the nature of equilibrium formed by the neutralization within the unit cell of superconductor, which is cooled by liquid nitrogen. A superconductor with little or no magnetic field within it is said to be in the Meissner state. The Meissner state breaks down when the applied magnetics field is too large (Bibcode, 2018)

2.1.2 Type I and type II Superconductors

High magnetic fields destroy superconductivity and restore the normal conducting state.The graph shown in Figure 2 illustrates the internal magnetic field strength, Bi, with increasing applied magnetic field. It is found that the internal field is zero (as expected from the Meissner effect) until a critical magnetic field, Bc, is reached where a sudden transition to the normal state occurs. This results in the penetration of the applied field into the interior. Superconductors that undergo this abrupt transition to the normal state above a critical magnetic field are known as type I superconductors. Type II superconductors; on the other hand, respond differently to an applied magnetic field, as shown in Figure 3 . An increasing field from zero results in two critical fields, Bc1 and Bc2. At Bc1 the applied field begins to partially penetrate the interior of the superconductor. However, the superconductivity is maintained at this point. The superconductivity vanishes above the second, much higher, critical field, Bc2. For applied fields between Bc1 and Bc2, the applied field is able to partially penetrate the superconductor, so the Meissner effect is incomplete, allowing the superconductor to tolerate very high magnetic fields (Bibcode, 2018).

Type II superconductors are the most technologically useful because the second critical field can be quite high, enabling high field electromagnets to be made out of superconducting wire. Wires made from say niobium-tin (Nb3Sn) have a Bc2 as high as 24.5 Tesla – in practice it is lower. This makes them useful for applications requiring high magnetic fields, such as Magnetic Resonance Imaging (MRI) machines. The advantage of using superconducting electromagnets is that the current only has to be applied once to the wires, which are then formed into a closed loop and allow the current (and field) to persist indefinitely – as long as the superconductor stays below the critical temperature. That is, the external power supply can be switched off. As a comparison, the strongest permanent magnets today may be able to produce a field close to 1 Tesla (Bibcode, 2018).

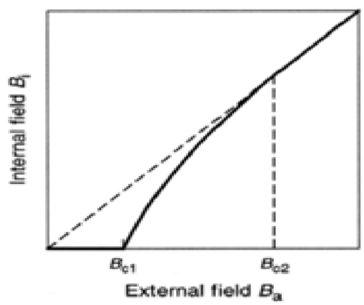

Figure 3: Type II Superconductor Behaviour

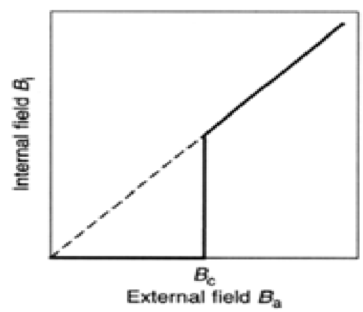

Figure 2 :Type-I Superconductor Behaviour

Chapter Three

Methodology

Chapter Three

Methodology

3.0 Introduction

This chapter is intended to introduce the review method of research via discussing of some papers in the field in which the thesis is going to prove, this in one hand, on the other hand these papers are in the same field but within different methods and techniques to show how this method fabricated and what benefits give to the researchers.

3.1 Adir MoysésLuiz,(Instituto de Física, Universidade Federal do Rio de Janeiro Brazil),A Model to Study Microscopic Mechanisms in High-Tc Superconductors, Concluded That

Our conjectures can be used to explain some remarkable properties of high-$T_c$superconductors.

(a) the anisotropy is explained considering that the electrons involved in the hopping mechanisms are 3d-electrons; (b) the order of magnitude of the coherence length (the mean distance between two electron pairs) is in accordance with the order of magnitude of the distance between the electron clouds of two neighboring ions; (c) the nonmonotonic dependence of Tc on the carrier concentration is explained by the hypothesis of double charge fluctuations and optimal doping.

The theory of bipolaronic superconductivity is similar to our phenomenological model. In the theory of bipolaronic superconductivity, bipolarons are formed supposing a mechanism to bind two polarons. However, by our hypothesis, it is not necessary to suppose the formation of bipolarons by the binding of two polarons. We have assumed that the preformed pairs are just pairs of electrons existing in the electronic configurations of the ions or atoms involved in double charge fluctuations ((Luiz, 2010), and the references there in) .

3.2 A.G. Shepelev , (National Science Center «Kharkov Institute of Physics and Technology» Ukraine) , The Discovery of Type II Superconductors (Shubnikov Phase) ,

Concluded That

knowledge About “practical applications” intense research by many scientists in order to discover superconductors with high critical fields and temperatures. The superconductivity in Nb_3Sn remained under large fields (~10 T). And those were exactly Nb_3Sn and Nb-Ti alloys used not so long ago in 1963-1964 to have the first superconducting solenoids with magnetic fields greater than 10 T built with. Note that in the extreme Type II superconductors æ > 20 for Nb_3Sn and æ > 100 for cuprates.

Whereas the values of H_{c2} and T_c, generally speaking, are determined by the basic characteristics of material (being hard to predict to date), the value of j_c is strongly dependent on the pinning centers (crystal defects, impurities, second-phase precipitates and their dimensions and distribution) , It took several decades for metallurgists to create the relevant microstructure of the superconductors by way of a complex metallurgical treatment.

Type II superconductors are used widely in many areas of science and technology around the globe. The most notable among them are:

- Only 20 years ago, there were more than one thousand superconducting solenoids made of Nb-Ti with the aperture 1 m for NMRI scans of human body.
- About six years ago the US and Denmark introduced into operation three Bi-HTSC-based electric transmission lines.
- A remarkable progress has been achieved in engineering the MAGLEV trains, in December, 2003, Japan recorded the MAGLEV train speed of 581 km/h:
- Not a single large magnetic system can be created without Type II superconductors.

superconductor will produce the axial magnetic field of 6 T (the maximum field about 12 T), while the Nb-Ti poloidal magnetic field coils will produce the field of 6 T . It is of interest to note here that the magnetic energy stored only in the toroidal magnetic field coils of this gigantic facility (around 30 m in diameter and in height) is 41 GJ!

Considering the importance of L.V. Shubnikov's scientific heritage for science and technology on the whole, the Presiding Council of National Academy of Sciences of Ukraine passed in 2001 an Ordinance about establishment of L.V.Shubnikov Prize for outstanding research in experimental physics.

As a remark, we shall also note here that the USA established an honorary degree of 'Shubnikov Professor' which has been bestowed on D.C.Larbalestier, Director of Applied Superconductivity Center.

The author acknowledges his sincere gratitude to the late Academician V.L.Ginzburg and to many colleagues for their interesting and stimulating discussions (Bagraev, et al., 2010).

3.3 Aloke Paul1, Tomi Laurila2 and Vesa Vuorinen2, (1Department of Materials Engineering, Indian Institute of Science, Bangalore -560012 2Electronics Integration and Reliability, Department of Electronics, Helsinki University of Technology), Microstructure, Diffusion and Growth Mechanism of Nb3Sn Superconductor by Bronze Technique

Concluded That

It is very difficult to draw any definite conclusion about the growth and diffusion mechanism in Nb3Sn based on the results available in the literature. It was found that the growth exponent is typically close to 0.5, when Sn content in the bronze alloy is relatively high. With the decrease in Sn content growth exponent deviates from this and this indicates that some other factors become important. Kirkendall marker experiments conducted clearly indicated that Sn is almost the only mobile species. Further, very minor amount of Cu was found in the Nb3Sn product phase and no Sn was found in Nb. Although thermodynamic analysis explains that there is no driving force for Cu to diffuse through the product layer, the trace amount of Cu was in mainly in grain boundaries. There is always a chance that some amount could be added as impurity. It is quite possible that when Sn content is high in the Cu(Sn) bronze alloy, the process is controlled by the diffusion of Sn through the Nb3Sn. At the later stage of the annealing or when the Sn content is initially low, the diffusion process may become much complicated because of lack of availability of Sn. Then the growth exponent could increase. The growth of the Nb3Sn phase mainly occurs because of grain boundary diffusion and developed a model to explain the diffusion process. They developed this model based on the growth exponent they calculated, which was found to 0.35 and the activation energy for growth, which was found to be 51.9 kJ/mol. However other researchers found much higher activation energy values (above 200 kJ/mol). It is in fact very difficult to find the exact diffusion mechanism from this kind of experiments. What we actually measure, is the apparent diffusion coefficient, which is a kind of average from the contribution from lattice and grain boundary diffusion. Nevertheless, the relatively high activation energy clearly indicates that there must be significant contribution from lattice diffusion. In 1981 found that after addition of Ti, Zr beyond a certain limit did not change the grain morphology, however, there was significant increase in the growth rate. There might be significant increase in the driving force for diffusion with the increase in alloy content and there could also be increase in defect concentration (vacancies and antisites). However, further understanding is lacking because of unavailability of these information at the present. Further dedicated study is required to develop better understanding especially the effect of alloy additions on the growth of the product phase (Adda, 2010).

3.4 Nikolay T. Bagraev1, Leonid E. Klyachkin1, Andrey A. Koudryavtsev1, Anna M. Malyarenko1 and Vladimir V. Romanov2

1Ioffe, (Physical-Technical Institute RAS),

Superconductor Properties for Silicon Nanostructures

Concluded That

Superconductivity of the sandwich' S-Si-QW-S structures that represent the p-type high mobility silicon quantum wells confined by the nanostructured δ - barriers heavily doped with boron on the n-type Si (100) surface has been demonstrated in the measurements of the temperature and magnetic field dependencies of the resistance, specific heat and magnetic susceptibility.

The studies of the cyclotron resonance angular dependences, the scanning tunneling microscopy images and the electron spin resonance have shown that the nanostructured δ - barriers consist of a series of alternating undoped and doped quantum dots, with the doped dots containing the single trigonal dipole centers, B+ - B-, which are caused by the negative-U reconstruction of the shallow boron acceptors, 2B0→B+ + B-.

The temperature and magnetic field dependencies of the resistance, thermo-emf, specific heat and magnetic susceptibility are evidence of the high temperature superconductivity, Tc = 145 K, that seems to result from the transfer of the small hole bipolarons through these negative-U dipole centers of boron at the Si-QW – δ - barrier interfaces.

The oscillations of the upper critical field and critical temperature vs magnetic field and temperature that result from the quantization of the critical current have been found using the specific heat and magnetic susceptibility techniques.

The value of the superconductor energy gap, 0.044 eV, derived from the measurements of the critical temperature using the different techniques appeared to be practically identical to the data of the current-voltage characteristics and the local tunneling spectroscopy.

The extremely low value of the hole effective mass in the 'sandwich' S-Si-QW-S structures that has been derived from the measurements of the SdH oscillations seems to be the principal argument for the bipolaronic mechanism of high temperature superconductor properties that is based on the coherent tunneling of bipolarons. The high frequency local phonon mode that is revealed with the superconductor energy gap in the infrared transmission spectra seems also to be responsible for the formation and the transfer of small holebipolarons.

The proximity effect in the S-Si-QW-S structure has been identified by the findings of the MAR processes and the quantization of the supercurrent. The value of the superconductor energy gap, 0.044 eV, appeared to be in a good agreement with the data derived from the oscillations of the conductance in normal state and of the zero-resistance supercurrent in superconductor state as a function of the bias voltage. These oscillations have been found tobe correlated by on- and off-resonance tuning the two-dimensional subbands of holes with the Fermi energy in the superconductor δ - barriers.

Finally, the studies of the proximity effect in the 'sandwich' S-Si-QW-S structures have shown that the multiple Andreev reflection (MAR) processes are of great concern in the coherent transfer of the small hole bipolarons both between and along nanostructured δ-barriers confining the Si-QW (Alexandrov, 2010).

3.5 Yi Bing Zhang and Shi Ping Zhou ,(Department of Physics, College of Science, Shanghai University) , MgB2-MgO Compound Superconductor

Concluded That

MgB2-MgO was prepared by a solid-state replacement reaction and vacuum sintering technique. Even the mole fraction of MgO phase was estimated about 75%, the composite exhibited a metallic transport behavior with low resistivity and superconductivity at a high temperature (38.0 K)comparable to a pure-phased MgB2 sample (39

K). The composite superconductor has the history effect in the current-voltage curve. The results indicate that MgB2 superconductor can tolerance a high content of insulating contamination and the superconducting MgB2 MgO composite can be utilized for the superconducting fault current limiter (SFCL). The electrical transport features of the composite are explained by using the statisticalpercolation model and a conductivity expression with temperature for the metal-insulatorMgB2 composite (Abeles, 2010).

3.6 Carlos M. Cruz Inclán, IbrahinPiñera Hernández, Antonio LeyvaFabelo and Yamiel Abreu Alfonso, (Center of Technological Applications and Nuclear Development, CEADEN Cuba), Studies on the Gamma Radiation Responses of High Tc Superconductors

Concluded That

Important improvements have been accomplished recently concerning a detailed description and evaluation of the gamma radiation damage effects in solids, and particularly in high Tc superconductors, where Monte Carlo simulation tools have been introduced in different approaches. In Monte Carlo assisted Classical Method approach, the classical atom displacement rate calculation algorithm was expanded. For this, secondary electron in-depth energy profiles calculated by means of Monte Carlo based codes was introduced, particularly to YBCO superconducting material. On the other side, a new theoretical description of the conditions favoring the occurrence of single fast electron elastic scattering in solids has been developed. Further works in this field are in course, comparing this new atom displacements rate calculation algorithm with previous ones.

On the basis of MCCM approach, gamma quanta induced YBCO in-depth atom displacement rate distributions were calculated up to incident energies lower than 10 MeV. At very low incident energies, oxygen atom displacements take place on CuO chain sites. With increasing incident energy, firstly Oxygen displacements in Cu2-O2 planes and other crystalline sites, while at higher energies Cupper displacements are also induced, which begins to be dominant at about 4 MeV and reaches a maximum contribution of 65% at 10 MeV. The corresponding in-depth profiles at different incident energies due to electrons and positrons were characterized as being very similar.

It was concluded, that gamma radiation induced oxygen displacements in both, Cu2-O2 planes and CuO chains, as well as secondary electrons are eventually trapped in CuO chain sites in basal planes, favoring oxygen rich nearest neighbor configuration around the Cu sites, provoking a strengthening of the orthorhombic structural phase properties, specially at relative low exposition depending on the initial non – stiochiometry parameter. In particular, critical temperature enhancement induced by gamma rays at low exposition doses seems to the connected with foregoing changes on the oxygen basal plane disorder.

Electronic transport properties on the Cu2-O2 in the superconducting state are favored by gamma radiation at higher energies, where an strengthening of vortex pinning energies has been observed. However, gamma radiation induces also the JC radiation suppressing effect through enhanced vacancy diffusive movements in ceramic YBCO samples, which is sharply temperature dependent and in large scale modulates the supercoducting inter boundary properties and its percolative properties.

It may be concluded that gamma radiation induces on high Tc superconductor sysematically crystal structure and superconducting property changes, in a very peculiar way, which deserve future researches in order to get a better understanding of their influence on superconducting mechanisms (Abreu, et al., 2010).

3.7 S.K.Bandyopadhyay (Variable Energy Cyclotron Centre, India), Charged Particle Irradiation Studies on BismuthBased High Temperature Superconductors &MgB2; A Comparative Survey

Concluded That

High temperature Cuprate superconductors (HTCS) are nonstoichimetric based on defects and disorders, which play a great role as carrier concentration and hence control Tc, Jc, resistivity etc. Particle irradiation induced defects modulate the carrier density through change in oxygen stoichiometry. In particular, irradiation induced oxygen vacancies act as flux pinning centres causing enhancement in Jc, pinning potential. Other cationic defects and disorder manifest,where this irradiation induced oxygen knock out is absent. We studied particle irradiation effects on Bi-based superconductors- Bi-2212 and (Bi,Pb)-2223. In Bi-2212 containing loosed excess oxygen needed for structural stability, particle irradiation causes knock-out of loose oxygen. In these systems, this excess oxygen plays the role of hole carrier. Hence, change of excess oxygen content due to particle irradiation causes a change in Tc (increase in the overdoped Bi-2212) and resistivity. Moreover, knocked out oxygen vacancies act as flux pinning centre for the enhancement of Jc. But, in Bi-2223, the presence of larger Pb(II) minimizes the presence of loose excess oxygen, and the irradiation induced oxygen knock-out is not the scenario. Hence there is no significant enhancement of Jc owing to irradiation. There is decrease in Tc and increase in resistivity. Lowering of oxygen carrier concentration is the cause in Bi-2212 and in Bi-2223, localization due to irradiation induced disorder is the prime factor. Thus, HTCS's are in general very much sensitive to particle irradiation, whether by lowering of carrier concentration or, by generation of irradiation induced disorder. On the other hand, MgB2, which is an intermediary between conventional superconductors and HTCS's is fairly insensitive to irradiation. It is a multiband BCS type phonon mediated superconductor. Strong covalent σ-bonding within B-B layer gives rise to σ bands and carriers of σ bands are strongly coupled with the stretching modes, giving rise to superconductivity. Electron- phonon coupling constant along σ bands (λσ) governs Tc, which is not significantly affected by heavy ion like neon irradiation. In two band system, the conductivity can be considered arising from the parallel network of the σ and π bands. As compared to σ bands, conductivity would be large in π bands. Particle irradiation affects the π band network. Hence, there is an appreciable increase in resistivity without any significant decrease in Tc and also, the role of irradiation induced defects in intragranular pinning is insignificant. The grain boundary pinning is the dominant scenario in case of MgB2 as evident from magnetization and magnetoresistance measurements. We also studied the enhancement of Jc by doping Mg with Hf (1%). The enhancement was enormous! The contribution was from other borides precipitating at the grain boundary (S.K.Bandyopadhyay, 2010).

3.8 L.A.Angurel1, N. Andrés2, M. P. Arroyo2, S. Recuero2, E. Martínez1, J. Pelegrín1, F. Lera1 andJ.M. Andrés3 (1Instituto de Ciencia de Materiales de Aragón, CSIC-University of Zaragoza 2Instituto de Investigación en Ingeniería de Aragón, I3A, University of Zaragoza 3Instituto de Carboquímica, CSIC Zaragoza, Spain) , Application of Optical Techniques in the Characterization of Thermal Stability and Environmental Degradation in High Temperature Superconductors Concluded That

optical techniques are valuable tools to obtain information about the behaviour of superconducting materials, relevant to the design of different technological applications. In particular, problems with quench generation and environmental degradation have been studied.

DSPI can be used to visualize different heat generation processes that take place in superconducting materials depending on the cooling conditions. It can be used to detect where a hot spot will take place before damaging the sample. In consequence, it can help to find out which are the microstructural defects that are more important in heat generation and propagation. This has been applied in the analysis of bulk Bi-2212 monoliths and 2G wires. In the case of bulk materials this information can be used to modify the processing parameters in order to eliminate these defects or to distribute them in the sample in order to homogenise the transition to the normal state.This information has been confirmed with the direct measurement of the electric field and temperatures profiles. The main advantage is that DSPI does not require soldering voltage taps or thermocouples in the sample.

One of the objectives for the future research is to obtain quench parameters from the optical observations. This is not a simple task because the deformations that are observed also depend on the sample mechanical constraints. For this reason, in order to obtain quantitative information from these measurements, thermo-mechanical models are being developed in order to be able of determining the temperature profile from the mechanical deformation.

DSP has provided useful information about environmental degradation of bulk superconducting materials. The chemical reactions that take place modify the surface characteristics and, in consequence, reduce the correlation coefficient values. The main advantage of this technique in comparison with other experimental techniques is that it provides 2D local information in the very early stages of the degradation process. In addition, if the reference image is changed from the initial state to any other at a given time,the evolution of the degradation processes from this instant can be determined. This allows evaluating how the degradation process rate evolves at any instant.

In the case of the Bi-2212 monoliths, it has been established that the surface degradation is associated with (Sr,Ca)CuO2 chemical decomposition. DSP has shown that this process is faster in the as-grown samples than in the annealed ones. In addition, this optical technique has also been applied to quantify the change in the degradation rate when the samples are machined with laser ablation techniques (Andres, et al., 2010).

3.9 ÖzdenAslanÇataltepe, (Anatürkler Educational Consultancy and Trading Company Bağdat Cad. No: 258 3/6 Göztepe,İstanbul Turkey), Some Chaotic Points in Cuprate Superconductors

Concluded That

The investigation of the variation of the tunneling probability in high temperature superconductors depending on the oxygen content and that of the geometry of the sample has been realized. Moreover, a new magnetic method to calculate the JPD reliably has been introduced. The determination of chaotic points has a crucial importance for technological applications of the superconductors. Hence, the prediction of the quantum chaotic points of a superconducting system enables the technologists to figure out the reliable working temperature interval for construction of superconducting devices such as bolometers.

Moreover, the appropriately oxygen doped and cut mercury Cuprate samples have the highest Meissner transition temperature of 140K ever obtained among the other superconductors prepared under the normal atmospheric pressure. Furthermore, the stability has been confirmed performed on the mercury based cuprate samples which have been kept in air for several months after being synthesized. From this point of view, the high stability and durability of the superconducting system with the highest Meissner transition temperature make the mercury cuprate family superconductors as a convenient candidate for the advanced and sensitive technological applications (Anderson, 2010).

3.10 Ülker Onbaşlı1 and ZeynepGüven Özdemir2

3.11 ,(1University of Marmara, Physics Department 2Yıldız Technical University, Physics Department 1,2Turkey), Superconductors and Quantum Gravity , Concluded That

The concept of the phase, φ of the order parameter, which is the unique invariant parameter in the universe, has been utilized to derive the net effective mass of the quasi-particles. The net effective mass of the quasi-particles has been reinterpreted in the relativistic manner. The corresponding relativistic energy values for the net effective mass coincide with some part of the unexplored energy gap of high energy physics,The unexplored energy gap of the hierarchic scale of high energy physics finds an opportunity to be investigated by the superconducting frame of reference for the first time. In this context, we hope that, this method enlightens the secret reality behind the origin and the formation of mass.

Moreover, in this work, the influence of the quantum gravity has been made clear without any doubt in the superconducting condensed matter media. Furthermore, we believe that the discussion of the symmetry breakings in the context of force unification procedure may also give a positive feedback about the dilemma about the force unification efforts that has been going on for many decades.

Ultimately, we hope that this work will unveil the mystery about the universal realities in nature such as the origin of having a mass, force unification process which have been accepted as some of the unsolved problems in physics in 21st century (Adachi, et al., 2010).

3.12 Saxon Liou and Watson Kuo , (Department of Physics, National Chung Hsing University, Taichung Taiwan), Phase Dynamics of Superconducting Junctions under Microwave Excitation inPhase Diffusive Regime Concluded That

The phase diffusion regime theoretically as well as summarized recent experimental findings. In relative low impedance cases, the classical description (in phase) is plausible to explain the incoherent photon absorption. The quantum mechanical approaches may provide a more precise description for the experimental results of higher impedance cases such as Bloch oscillations and photon-assisted tunneling. In extremely high impedance cases, single charge tunneling prevails and a classical description in charge, such as charging effect can be an ideal approach (Andersson, 2010).

Chapter four

Review findings and conclusion

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Review findings and conclusion

4.1 Analysis

This research discussed the way of checking a method which gives full details of any selected subject, and then discuss the superconductivity and study difference papers handling the same subject in different topics and used separate methods and gained many results.

4.2 Discussion

The research introduced a number of scientific papers regarding the superconductour, it could be seen from that the research is limited for indication of magnetic characteristics and those of electric minerals regarding resistant and it’s relation to temperature.

So it was found that most of researches give results regarding the superconductivity phenomena for different minerals specially (polymer and Cerameek Compounds) which show that it will lead to find superconductorsat room temperature.

4.3 conclusions

Properties of high-Tc superconductors

The anisotropy is explained considering that the electrons involved in the hopping mechanisms are 3d-electrons, The order of magnitude of the coherence length (the mean distance between two electron pairs) is in accordance with the order of magnitude of the distance between the electron clouds of two neighboring ions,and the no monotonic dependence of Tc on the carrier concentration is explained by the hypothesis of double charge fluctuations and optimal doping.

A composite superconductor, MgB_2-MgO, which was prepared by a solid-state replacement reaction and vacuum technique. Even the mole fraction of MgO phase was estimated about 75%, the composite exhibited a metallic transport behavior with low resistivity and superconductivity at a high temperature (38.0 K) comparable to a pure-phased MgB_2 sample (39 K).

Superconductivity of the sandwich' S-Si-QW-S structures that represent the p-type high mobility silicon quantum wells confined by the nanostructured δ - barriers heavily doped with boron on the n-type Si (100) surface has been demonstrated in the measurements of the temperature and magnetic field dependencies of the resistance, thermo, specific heat and magnetic susceptibility.

Gamma radiation induces on high Tc superconductor systematically crystal structure and superconducting property changes, in a very peculiar way.

High temperature Cuprate superconductors (HTCS) are nonstoichimetric based on defects and disorders, which play a great role as carrier concentration and hence control Tc, Jc, resistivity etc. Particle irradiation induced defects modulate the carrier density through change in oxygen stoichiometry.

Optical techniques are valuable tools to obtain information about the behavior of superconducting materials, relevant to the design of different technological applications. In particular, problems with quench generation and environmental degradation have been studied.

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