

METALS AND SUPERCONDUCTORS

Thallium-Based High-Temperature 2212 Superconductor with Partial Substitution of Oxygen by Fluorine and of Calcium by Cerium

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Abstract—Fluorine- and cerium-substituted thallium-based high-temperature 2212 superconductors are synthesized, the limits of solubility of the substitutes are investigated, the critical temperatures of the superconducting transitions are measured, and the local structure is refined using the Mössbauer technique.

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1. INTRODUCTION

It is generally accepted that the density of charge carriers (holes) in the Cu–O planes determines the superconducting properties of cuprate superconductors. Successful attempts to reduce the hole density and thereby increase the superconducting transition temperature have been related to either producing oxygen nonstoichiometry or substituting elements with a higher valence for the cations. Partial substitution of fluorine for oxygen in a complex cuprate reduces the hole concentration in the cuprate planes; so most of the

oxyfluorides synthesized in the past years have higher superconducting transition temperatures T_c than do their oxide counterparts (Table 1) [1–12]. High-temperature superconducting oxyfluorides of various compositions (based on Y, Sr, Hg, Bi, or Tl) and structural types (2223, 2212, 2201, 1223, 1234, 123) have been synthesized and studied.

It is known [1, 5] that fluorination of thallium-based superconductors increases the critical currents and is sometimes accompanied by a phase transformation, for example, Tl-2223 into Tl-1223, as shown in [5]. It is

Table 1. Published data on oxyfluorides of cuprate superconductors

Material	Crystal structure	T_c , K	Reference
(Tl _{0.5} Pb _{0.5})Sr _{1.6} Ba _{0.4} Cu ₂ Cu ₀ O ₇ F ₈	1223	128	[1]
(Tl _{0.5} Pb _{0.5})Sr _{1.6} Ba _{0.4} Cu ₂ Cu ₀ O ₇ F ₂	1234	128	[2]
(Tl _{0.6} Pb _{0.4})Sr _{1.4} Ba _{0.2} Cu _{1.9} Cu _{0.1} O ₇ F _{0.6}	1223	116	[3]
Tl _{1.9} Sn _{0.1} Ba ₂ Cu ₀ F _{1.2}	2201	97	[4]
Tl ₂ Ba ₂ Cu ₂ Cu ₀ O ₇ F ₂	2223	119	[5]
Tl ₃ Ba ₂ Cu ₂ Cu ₀ O ₇ F ₂	1212	115	[5]
Bi _{1.2} Sr ₂ CaCu ₂ O ₈ + 2 wt % NH ₄ HF ₂	2212	105	[3]
Bi ₂ Sr ₂ Ca ₂ Cu ₀ O ₈ F ₄	2223	105	[6]
Bi ₂ Sr ₂ Ca ₂ Cu ₀ O ₈ F ₄	2212	75	[6]
HgBa ₂ Ca ₂ Cu ₀ O ₈ F _{0.4}	1223	131.1	[7]
Hg _{0.8} Rc _{0.2} Ba ₂ Ca ₂ Cu ₀ O ₇ F _{0.88}	1223	132	[8]
YBa ₂ Cu ₃ O ₇ F _{1.2}	123	90	[9]
SrBaYCu ₃ F ₂ O ₆	123	105	[10]
YBa ₂ Cu ₃ O ₇ F ₂	123	155	[11]
SrCa ₂ Cu ₃ O ₆ F ₂	–	111	[12]

Thallium Based High Temperature Superconductors

Ivan Nedkov, M. Ausloos



Thallium Based High Temperature Superconductors:

Thallium-Based High-Temperature Superconductors Allen Hermann, 2020-08-26 Provides information on all chemical physical and material aspects of this class of cuprates and covers their applications This work provides data on the chemistry solid state chemistry handling and safety requirements of thallium

High-Temperature Superconductors Ajay Kumar Saxena, 2009-10-09 This book describes the phenomenon of superconductivity and high temperature superconductors discovered by Bednorz and Muller in 1986 It covers all major experimental and theoretical developments in the field as well as many applications

High-temperature Superconductivity (Bhtsc '92) - Proceedings Of The Beijing International Conference Z X Zhao, Z Z Gan, S S Xie, 1993-10-13 This volume will contain both invited and contributed papers which focus on the search for new high T_c materials characterization of their physical properties and microstructures basic applications and the application of high T_c superconductors

Superconducting Materials A. Tampieri, G. Celotti, 2000 This volume consists of lectures highlighting fundamentals of advances in superconducting materials related technologies and applications Theory fundamental aspects advances in materials synthesis processing and properties are featured as well as current developments of superconducting components and devices Both HTC and LTC superconducting materials are discussed Several years after the discovery of high T_c superconductivity and a multinational effort in its study this book collects the main results on the subject and presents a state of the art view of the correlations between crystal chemistry and physical properties

Physical Properties of High-Temperature Superconductors Rainer Wesche, 2015-05-13 A much needed update on complex high temperaturesuperconductors focusing on materials aspects this timely bookcoincides with a recent major break through of the discovery of iron based superconductors It provides an overview of materials aspects of high temperaturesuperconductors combining introductory aspects description of newphysics material aspects and a description of the materialproperties This title is suitable for researchers inmaterials science physics and engineering Also for techniciansinterested in the applications of superconductors e g asbiomagnets

Thermoelectric Properties of Thallium Based High Temperature Superconductors William Carl Kiehl, 1994 Bismuth-Based High-Temperature Superconductors Hiroshi Maeda, 1996-07-09 Provides coverage of the ongoing investigations on bismuth based high temperature cuprate superconductors integrating scattered research activities and literature from 70 leading scientists throughout the world The text covers crystal structures and microstructures reversible or equilibrium magnetic and thermal properties atomic site tunnel spe

Magnetic Studies of Thallium-based High Temperature Superconductors Stephan Venzke, 1992

High-Temperature Superconductors: Materials, Properties, and Applications Rainer Wesche, 2013-11-27 The discovery by J G Bednorz and K A Mtlrier in 1986 that the superconducting state can exist in oxides at temperatures above 30 K stimulated research in the field of superconductivity and opened up a new field of research Within a few years a large number of cuprate superconductors with transition temperatures well above the boiling point of liquid nitrogen have been found The possibility

of using liquid nitrogen as coolant re stimulated interest in power applications of superconductivity In this book an overview of the known high T_c superconductors and their physical properties is presented Aspects related to conductor fabrication and high current applications are emphasised The material should be suitable for use in graduate level courses on superconductivity Researchers in the field may profit from the large number of tables and references describing its status at the end of 1997 An introduction to high T_c superconductivity must be based on the fundamental physical principles of normal state electrical conductivity and the well known characteristics of conventional superconductors In Chapter 2 this background is provided Crystal structures anisotropic properties and general trends of the critical temperatures of the cuprate superconductors are described in Chapters 3 and 4 The processing of superconductor powders addressed in Chapter 5 affects considerably the current carrying capacity of high T_c wires In Chapter 6 several fabrication techniques for superconducting wires are described In addition the factors limiting the transport critical currents of high T_c wires are discussed

Organic Conductors Jean-Pierre Farges, 2022-09-16 This work examines all aspects of organic conductors detailing recent theoretical concepts and current laboratory methods of synthesis measurement control and analysis It describes advances in molecular scale engineering including switching and memory systems Schottky and electroluminescent diodes field effect transistors and photovoltaic devices and solar cells

Physical Properties of High Temperature Superconductors III Donald M. Ginsberg, 1992 This volume brings the reader up to date on transport phenomena including electrical and thermal conductivity and infrared properties In addition electron tunneling and the characteristics and applications of films are discussed the preparation of the necessary samples has proceeded and a sizeable body of reproducible data has become available Pressure effects are also presented considerable progress has been made in relating them to the crystallographic and electronic structure of high temperature superconductors The preparation and characterization of bulk samples is also reviewed

Handbook of Superconductivity David A. Cardwell, David C. Larbalestier, Aleksander Braginski, 2022-07-05 This is the first of three volumes of the extensively revised and updated second edition of the Handbook of Superconductivity The past twenty years have seen rapid progress in superconducting materials which exhibit one of the most remarkable physical states of matter ever to be discovered Superconductivity brings quantum mechanics to the scale of the everyday world where a single coherent quantum state may extend over a distance of metres or even kilometres depending on the size of a coil or length of superconducting wire Viable applications of superconductors rely fundamentally on an understanding of this intriguing phenomena and the availability of a range of materials with bespoke properties to meet practical needs This first volume covers the fundamentals of superconductivity and the various classes of superconducting materials which sets the context and background for Volumes 2 and 3 Key Features Covers the depth and breadth of the field Includes contributions from leading academics and industry professionals across the world Provides hands on guidance to the manufacturing and processing technologies A comprehensive reference this handbook is suitable

for both graduate students and practitioners in experimental physics materials science and multiple engineering disciplines including electronic and electrical chemical mechanical metallurgy and others

Thin Film Physics And Devices: Fundamental Mechanism, Materials And Applications For Thin Films Jianguo Zhu,Xiaohong Zhu,Hong Liu,Jie Xing,2021-06-18 Thin films have an extremely broad range of applications from electronics and optics to new materials and devices Collaborative and multidisciplinary efforts from physicists materials scientists engineers and others have established and advanced a field with key pillars constituting i the synthesis and processing of thin films ii the understanding of physical properties in relation to the nanometer scale iii the design and fabrication of nano devices or devices with thin film materials as building blocks and iv the design and construction of novel tools for characterization of thin films Against the backdrop of the increasingly interdisciplinary field this book sets off to inform the basics of thin film physics and thin film devices Readers are systematically introduced to the synthesis processing and application of thin films they will also study the formation of thin films their structure and defects and their various properties mechanical electrical semiconducting magnetic and superconducting With a primary focus on inorganic thin film materials the book also ventures on organic materials such as self assembled monolayers and Langmuir Blodgett films This book will be effective as a teaching or reference material in the various disciplines ranging from Materials Science and Engineering Electronic Science and Engineering Electronic Materials and Components Semiconductor Physics and Devices to Applied Physics and more The original Chinese publication has been instrumental in this purpose across many Chinese universities and colleges

Metal/metal Oxide Additions to Thallium Based High Temperature Superconductors Daniel Burness Marsh,1989 *Nano-Crystalline and Thin Film Magnetic Oxides* Ivan Nedkov,M. Ausloos,2012-12-06 Proceedings of the NATO Advanced Research Workshop on Ferrimagnetic Nano crystalline and Thin Film Magneto optical and Microwave Materials Sozopol Bulgaria 27 September 3 October 1998

Advanced Materials 1991-1992 J. Binner,2013-10-22 Advanced Materials 1991 1992 I Source Book focuses on the properties characteristics reactions applications and composition of ceramics composites and plastics The publication first elaborates on ceramics including markets materials applications processing equipment standards health safety the environment research initiatives and industry news Topics include joint ventures agreements powder processing furnaces bioceramics electronics superconductors oxide films silica sensors and superconductors The manuscript also takes a look at composites as well as markets materials applications processing non destructive evaluation testing health safety and the environment research initiatives and industry news Concerns include restructuring takeovers and mergers recycling health and safety test development data generation manufacturing processes tooling coatings general engineering aerospace automotive and boom in advanced composites The book then ponders on plastics including markets materials applications processing equipment health safety the environment and industry news The publication is a valuable reference for readers interested in the properties applications processing and composition of ceramics composites and plastics

Frontiers Of

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Studies of High Temperature Superconductors A. V. Narlikar, 1990 Superconductivity has been transformed into a rich field of intensive and highly competitive research encompassing diverse disciplines such as structural chemistry ceramic engineering metallurgy solid state electronics as well as experimental and theoretical condensed matter physics The high temperature superconductors HTSCs discovered are from the family of ceramic oxides Their large scale utilisation in electrical utilities and in microelectronic devices are challenges which can perhaps be effectively met only through consolidated efforts and expertise of a multidisciplinary nature The growth of the new field has occurred on an international scale and perhaps has been more rapid than in most other fields Each chapter in these volumes comprises a detailed review or an extended paper focussing on one or more of the aspects of research and applications including state of art technology pertaining to HTSCs

Superconductivity: A New Approach Based On The Bethe-salpeter Equation In The Mean-field Approximation G P Malik, 2016-02-29 Given the Debye temperature of an elemental superconductor SC and its T_c BCS theory enables one to predict the value of its gap Δ at $T = 0$ or vice versa This monograph shows that non elemental SCs can be similarly dealt with via the generalized BCS equations GBCSEs which given any two parameters of the set T_c, Δ, ρ enable one to predict the third Also given herein are new equations for the critical magnetic field and critical current density of an elemental and a non elemental SC equations that are derived directly from those that govern pairing in them The monograph includes topics that are usually not covered in any one text on superconductivity e g BCS BEC crossover physics the long standing puzzle posed by SrTiO_3 and heavy fermion superconductors all of which are still imperfectly understood and therefore continue to avidly engage theoreticians It suggests that addressing the T_c s and other properties e g number densities of charge carriers of high T_c SCs via GBCSEs incorporating chemical potential may lead to tangible clues about raising their T_c s The final chapter in this monograph deals with solar emission lines and quarkonium spectra because of a feature common between them and superconductivity existence of a bound state in a medium at finite temperature This is a problem on which the author has worked for more than

25 years The treatment in the text is elementary even those who have only a cursory familiarity with Feynman diagrams should be able to follow it without much difficulty **High Temperature Superconductivity 1** Anant V.

Narlikar,2004-01-12 In contrast to research on the fundamental mechanisms of High Temperature Superconductivity in recent years we have seen enormous developments in the fabrication and application of High Tc superconductors The two volumes of High Temperature Superconductivity provide a survey of the state of the technology and engineering applications of these materials They comprise extended original research papers and technical review articles written by physicists chemists materials scientists and engineers all of them noted experts in their fields The interdisciplinary and strictly application oriented coverage should benefit graduate students and academic researchers in the mentioned areas as well as industrial experts Volume 1 Materials focuses on major technical advancements in High Tc materials processing for applications Volume 2 Engineering Applications covers numerous application areas where High Tc superconductors are making tremendous impact

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