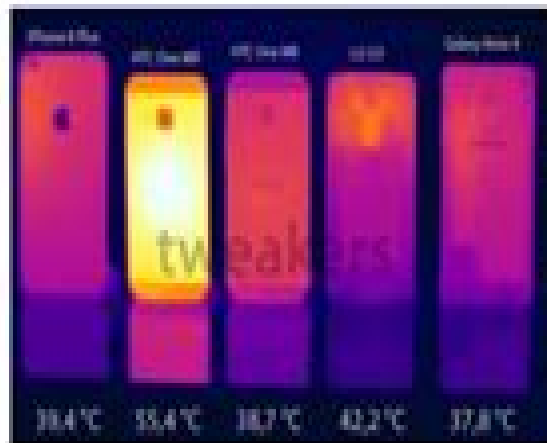


Over-heat in mobile device



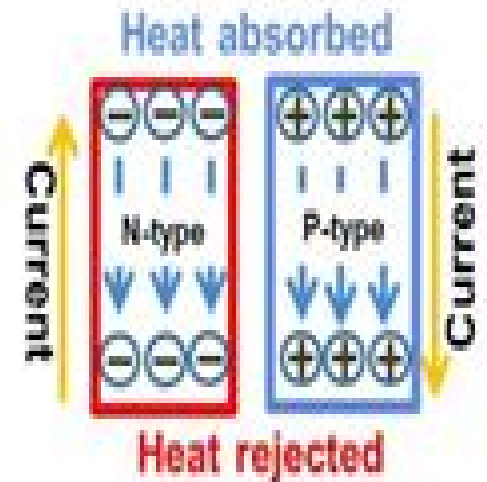
Reliability

Performance

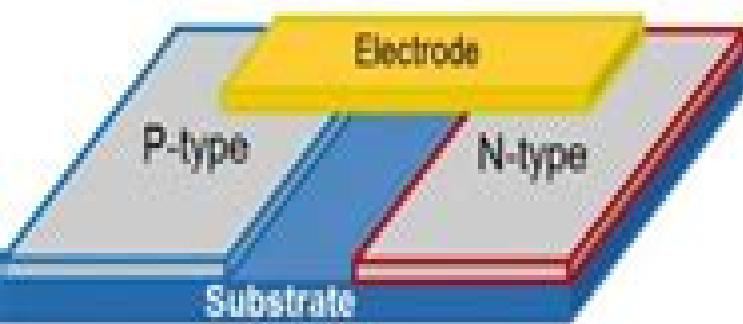
Energy consumption

Thermoelectric(TE) materials

16	S	Sulfur	32.065
34	Se	Selenium	78.972
52	Te	Tellurium	127.6



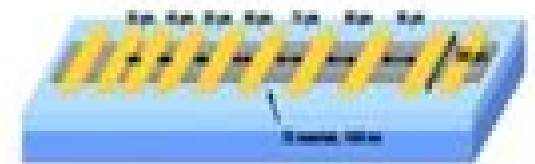
Thin film TE Device



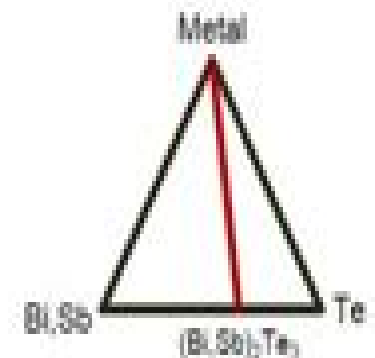
TE performance

$$ZT = \frac{\alpha^2 \sigma}{\kappa} T$$

Contact resistance



Contact Stability



Semiconductor Thermoelectric Devices

PT Brinkman

A red circular graphic with a gradient, appearing as a semi-circle or a partial ring, located to the right of the author's name.

Semiconductor Thermoelectric Devices:

CRC Handbook of Thermoelectrics D.M. Rowe, 2018-12-07 Thermoelectrics is the science and technology associated with thermoelectric converters that is the generation of electrical power by the Seebeck effect and refrigeration by the Peltier effect Thermoelectric generators are being used in increasing numbers to provide electrical power in medical military and deep space applications where combinations of their desirable properties outweigh their relatively high cost and low generating efficiency In recent years there also has been an increase in the requirement for thermoelectric coolers Peltier devices for use in infrared detectors and in optical communications Information on thermoelectrics is not readily available as it is widely scattered throughout the literature The Handbook centralizes this information in a convenient format under a single cover Sixty of the world's foremost authorities on thermoelectrics have contributed to this Handbook It is comprised of fifty five chapters a number of which contain previously unpublished material The contents are arranged in eight sections general principles and theoretical considerations material preparation measurement of thermoelectric properties thermoelectric materials thermoelectric generation generator applications thermoelectric refrigeration and applications of thermoelectric cooling The CRC Handbook of Thermoelectrics has a broad based scope It will interest researchers technologists and manufacturers as well as students and the well informed non specialist reader **Barrier-based**

Semiconductor Thermoelectric Devices Deepak Thimmegowda, 2011 **Semiconductor Thermoelectric Devices** Anatoliĭ Izrailevich Burshtein, 1964 **Physics of Semiconductor Devices** Vikram Kumar, Prasanta Kumar Basu, 2002

Making a Semiconductor Superpower Dong-Won Kim, 2023-09-29 This book provides real stories about the South Korean semiconductor community It explores the lives and careers of six influential semiconductor engineers who all studied at Korea Advanced Institute of Science and Technology KAIST under the mentorship of Dr Kim Choong Ki the most influential semiconductor professor in South Korea during the last quarter of the twentieth century Kim's students became known as Kim's Mafia because of the important positions they went on to hold in industry government and academia This book will be of interest to semiconductor engineers and electronics engineers historians of science and technology and scholars and students of East Asian studies They were called Kim's Mafia Kim Choong Ki himself wouldn't have put it that way But it was true what semiconductor engineers in South Korea whispered about his former students They were everywhere Kim was the first professor in South Korea to systematically teach semiconductor engineering From 1975 when the nation had barely begun producing its first transistors to 2008 when he retired from teaching Kim trained more than 100 students effectively creating the first two generations of South Korean semiconductor experts Source IEEE Spectrum October 2022

Semiconductor Physics and Applications M. Balkanski, Richard Fisher Wallis, 2000-08-31 The textbook combines a thorough theoretical treatment of the basic physics of semiconductors with applications to practical devices by putting special emphasis on the physical principles upon which these devices operate Graduate students and lecturers in

semiconductor physics condensed matter physics electromagnetic theory and quantum mechanics will find this a useful textbook and reference work Jacket **Semiconductor Thermoelectric Devices and Materials** ,1957

Thermoelectrics N. M. Ravindra,Bhakti Jariwala,Asahel Bañobre,Aniket Maske,2018-08-29 This book provides a concise but comprehensive introduction to the fundamentals and current state of the art in thermoelectrics Addressing an audience of materials scientists and engineers the book covers theory materials selection and applications with a wide variety of case studies reflecting the most up to date research approaches from the past decade from single crystal to polycrystalline form and from bulk to thin films to nano dimensions The world is facing major challenges for finding alternate energy sources that can satisfy the increasing demand for energy consumption while preserving the environment The field of thermoelectrics has long been recognized as a potential and ideal source of clean energy However the relatively low conversion efficiency of thermoelectric devices has prevented their utility on a large scale While addressing the need for thermal management in materials device components and systems thermoelectrics provides a fundamental solution to waste heat recovery and temperature control This book summarizes the global efforts that have been made to enhance the figure of merit of various thermoelectric materials by choosing appropriate processes and their influence on properties and performance Because of these advances today thermoelectric devices are found in mainstream applications such as automobiles and power generators as opposed to just a few years ago when they could only be used in niche applications such as in aeronautics infrared imaging and space However the continued gap between fundamental theoretical results and actual experimental data of figure of merit and performance continues to challenge the commercial applications of thermoelectrics This book presents both recent achievements and continuing challenges and represents essential reading for researchers working in this area in universities industry and national labs *Thermoelectric Materials and Devices for Clean Energy Harvesting* Ram Krishna,A. D. Dhass,2025-06-30 This book is designed to demonstrate the need for thermoelectric energy materials including non conventional materials for heating and cooling applications in thermoelectric energy efficient devices In addition to the fundamentals functionalities and classifications associated with thermoelectric energy materials that can be used in industries this book explores how these materials can contribute to high energy efficiency and sustainability even though they are used in waste heat recovery systems Climate change and global warming are also taken into consideration Features Exclusively focuses on non conventional thermoelectric materials Deals with key areas for new generation thermoelectric materials such as nanostructured materials and non traditional materials Highlights the right thermoelectric material selection their design characterization and testing Covers additive manufacturing 3D printing for highly customized and efficient thermoelectric devices Includes case studies based on real world applications This book is aimed at researchers and graduate students in materials science and clean technologies *Semiconductor Heteroepitaxy: Growth Characterization And Device Applications* B Gil,Roger-louis Aulombard,1995-12-15 This book develops the mathematics of

differential geometry in a way more intelligible to physicists and other scientists interested in this field This book is basically divided into 3 levels level 0 the nearest to intuition and geometrical experience is a short summary of the theory of curves and surfaces level 1 repeats comments and develops upon the traditional methods of tensor algebra analysis and level 2 is an introduction to the language of modern differential geometry A final chapter chapter IV is devoted to fibre bundles and their applications to physics Exercises are provided to amplify the text material

Recent Trends in Thermoelectric Materials Research, Part Two, 2000-10-25 Since its inception in 1966 the series of numbered volumes known as Semiconductors and Semimetals has distinguished itself through the careful selection of well known authors editors and contributors The Willardson and Beer series as it is widely known has succeeded in producing numerous landmark volumes and chapters Not only did many of these volumes make an impact at the time of their publication but they continue to be well cited years after their original release Recently Professor Eicke R Weber of the University of California at Berkeley joined as a co editor of the series Professor Weber a well known expert in the field of semiconductor materials will further contribute to continuing the series tradition of publishing timely highly relevant and long impacting volumes Some of the recent volumes such as Hydrogen in Semiconductors Imperfections in III V Materials Epitaxial Microstructures High Speed Heterostructure Devices Oxygen in Silicon and others promise that this tradition will be maintained and even expanded Thermoelectric materials may be used for solid state refrigeration or power generation applications via the large Peltier effect in these materials To be an effective thermoelectric material a material must possess a large Seebeck coefficient a low resistivity and a low thermal conductivity Due to increased need for alternative energy sources providing environmentally friendly refrigeration and power generation thermoelectric materials research experienced a rebirth in the mid 1990 s Semiconductors and Semimetals Volume 70 Recent Trends in Thermoelectric Materials Research Part Two provides an overview of much of this research in thermoelectric materials during the decade of the 1990 s New materials and new material concepts such as quantum well and superlattice structures gave hope to the possibilities that might be achieved An effort was made to focus on these new materials and not on materials such as BiTe alloys since such recent reviews are available Experts in the field who were active researchers during this period were the primary authors to this series of review articles This is the most complete collection of review articles that are primarily focussed on new materials and new concepts that is existence to date

Semiconductor Radiation Detectors Alan Owens, 2019-05-31 Choice Recommended Title July 2020 Bringing together material scattered across many disciplines Semiconductor Radiation Detectors provides readers with a consolidated source of information on the properties of a wide range of semiconductors their growth characterization and the fabrication of radiation sensors with emphasis on the X and gamma ray regimes It explores the promise and limitations of both the traditional and new generation of semiconductors and discusses where the future in semiconductor development and radiation detection may lie The purpose of this book is two fold firstly to serve as a text book

for those new to the field of semiconductors and radiation detection and measurement and secondly as a reference book for established researchers working in related disciplines within physics and engineering Features The only comprehensive book covering this topic Fully up to date with new developments in the field Provides a wide ranging source of further reference material

Defects in Organic Semiconductors and Devices Thien-Phap Nguyen, 2023-08-22 Defects play a key role in the physical properties of semiconductors and devices and their identification is essential in assessing the reliability of electronic devices Defects in Organic Semiconductors and Devices introduces the fundamental aspects of defects in organic semiconductors and devices in relation to the structure of materials and architecture of electronic components It covers the topics of defect formation and evolution defect measurement techniques and their adaption to organic devices the effects of defects on the physical properties of materials and their effects on the performance and lifetime of organic devices Identifying defects and determining their characteristics in the structure of organic devices such as OLEDs OFETs and OPVs make it possible to better understand degradation processes and develop solutions to improve the reliability of such devices This book is intended for researchers and students in university programs or engineering schools who are specializing in electronics energy and materials

Comprehensive Semiconductor Science and Technology, 2024-11-28 Semiconductors are at the heart of modern living Almost everything we do be it work travel communication or entertainment all depend on some feature of semiconductor technology Comprehensive Semiconductor Science and Technology Second Edition Three Volume Set captures the breadth of this important field and presents it in a single source to the large audience who study make and use semiconductor devices Written and edited by a truly international team of experts and newly updated to capture key advancements in the field this work delivers an objective yet cohesive review of the semiconductor world The work is divided into three sections fully updated and expanded from the first edition The first section is concerned with the fundamental physics of semiconductors showing how the electronic features and the lattice dynamics change drastically when systems vary from bulk to a low dimensional structure and further to a nanometer size Throughout this section there is an emphasis on the full understanding of the underlying physics especially quantum phenomena The second section deals largely with the transformation of the conceptual framework of solid state physics into devices and systems which require the growth of high purity or doped bulk and epitaxial materials with low defect density and well controlled electrical and optical properties The third section is devoted to design fabrication and assessment of discrete and integrated semiconductor devices It will cover the entire spectrum of devices we see all around us for telecommunications computing automation displays illumination and consumer electronics Provides a comprehensive global picture of the semiconductor world Written and Edited by an international team of experts Compiles the most important semiconductor knowledge into one comprehensive resource Moves from fundamentals and theory to more advanced knowledge such as applications allowing readers to gain a deeper understanding of the field

Micro Electronic and Mechanical Systems Kenichi

Takahata,2009-12-01 This book discusses key aspects of MEMS technology areas organized in twenty seven chapters that present the latest research developments in micro electronic and mechanical systems The book addresses a wide range of fundamental and practical issues related to MEMS advanced metal oxide semiconductor MOS and complementary MOS CMOS devices SoC technology integrated circuit testing and verification and other important topics in the field Several chapters cover state of the art microfabrication techniques and materials as enabling technologies for the microsystems Reliability issues concerning both electronic and mechanical aspects of these devices and systems are also addressed in various chapters

Recent Trends in Thermoelectric Materials Research III Terry M. Tritt,2001 Since its inception in 1966 the series of numbered volumes known as Semiconductors and Semimetals has distinguished itself through the careful selection of well known authors editors and contributors The Willardson and Beer series as it is widely known has succeeded in producing numerous landmark volumes and chapters Not only did many of these volumes make an impact at the time of their publication but they continue to be well cited years after their original release Recently Professor Eicke R Weber of the University of California at Berkeley joined as a co editor of the series Professor Weber a well known expert in the field of semiconductor materials will further contribute to continuing the series tradition of publishing timely highly relevant and long impacting volumes Some of the recent volumes such as Hydrogen in Semiconductors Imperfections in III V Materials Epitaxial Microstructures High Speed Heterostructure Devices Oxygen in Silicon and others promise that this tradition will be maintained and even expanded Thermoelectric materials may be used for solid state refrigeration or power generation applications via the large Peltier effect in these materials To be an effective thermoelectric material a material must possess a large Seebeck coefficient a low resistivity and a low thermal conductivity Due to increased need for alternative energy sources providing environmentally friendly refrigeration and power generation thermoelectric materials research experienced a rebirth in the mid 1990 s Semiconductors and Semimetals Volume 71 Recent Trends in Thermoelectric Materials Research Part Three provides an overview of much of this research in thermoelectric materials during the decade of the 1990 s New materials and new material concepts such as quantum well and superlattice structures gave hope to the possibilities that might be achieved An effort was made to focus on these new materials and not on materials such as BiTe alloys since such recent reviews are available Experts in the field who were active researchers during this period were the primary authors to this series of review articles This is the most complete collection of review articles that are primarily focussed on new materials and new concepts that is existence to date

Semiconductor Research Trends Kenneth G. Sachs,2007 This book includes within its scope studies of the structural electrical optical and acoustical properties of bulk low dimensional and amorphous semiconductors computational semiconductor physics interface properties including the physics and chemistry of heterojunctions metal semiconductor and insulator semiconductor junctions all multi layered structures involving semiconductor components Dopant incorporation Growth and preparation of materials including both

epitaxial e.g. molecular beam and chemical vapour methods and bulk techniques in situ monitoring of epitaxial growth processes also included are appropriate aspects of surface science such as the influence of growth kinetics and chemical processing on layer and device properties. The physics of semiconductor electronic and optoelectronic devices are examined including theoretical modelling and experimental demonstration all aspects of the technology of semiconductor device and circuit fabrication. Relevant areas of molecular electronics and semiconductor structures incorporating Langmuir Blodgett films resists lithography and metallisation where they are concerned with the definition of small geometry structure. The structural electrical and optical characterisation of materials and device structures are also included. The scope encompasses materials and device reliability reliability evaluation of technologies failure analysis and advanced analysis techniques such as SEM E beam optical emission microscopy acoustic microscopy techniques liquid crystal techniques noise measurement reliability prediction and simulation reliability indicators failure mechanisms including charge migration trapping oxide breakdown hot carrier effects electro migration stress migration package related failure mechanisms effects of operational and environmental stresses on reliability.

Heavily Doped Semiconductors V. I. Fistul, 2012-12-06 Recently there has been a considerable upsurge of interest in heavily doped semiconductors. This interest is due primarily to the expanding range of applications of such materials. Moreover the heavy doping of semiconductors produces new effects the formation of impurity aggregates the appearance of allowed states in the forbidden band etc. which are of great interest in solid state physics. The rapid growth in the number of papers on heavily doped semiconductors makes it difficult to review the results obtained so far. Therefore many investigations carried out in 1966-7 particularly those on III-V semiconductors are not discussed in the present monograph which represents the state of the knowledge in 1965. Nevertheless the author hopes that in spite of this the book will be useful. An attempt is made first to review investigations of heavily doped semiconductors from a certain viewpoint and secondly to suggest some ideas. Chap. 5 which may be controversial but which are intended to stimulate further studies of heavily doped semiconductors which can be regarded as a special case of disordered systems. The work of American scientists investigating heavily doped semiconductors in particular the efforts of E. O. Kane, J. L. Pankove, R. N. Hall, R. A. Logan, W. G. Spitzer, F. A. Trumbore and many others is well known to Soviet investigators. It gives me pleasure to learn that Western readers will now have an opportunity to become acquainted with the work done in the USSR.

Nanostructured Semiconductors Konstantinos Termentzidis, 2017-09-01 The book is devoted to nanostructures and nanostructured materials containing both amorphous and crystalline phases with a particular focus on their thermal properties. It is the first time that theoreticians and experimentalists from different domains gathered to treat this subject. It contains two distinct parts: the first combines theory and simulations methods with specific examples while the second part discusses methods to fabricate nanomaterials with crystalline and amorphous phases and experimental techniques to measure the thermal conductivity of such materials. Physical insights are given in the first part of the book related with the

existing theoretical models and the state of art simulations methods molecular dynamics ab initio simulations kinetic theory of gases In the second part engineering advances in the nanofabrication of crystalline amorphous heterostructures heavy ion irradiation electrochemical etching aging recrystallization ball milling PVD laser crystallization and magnetron sputtering and adequate experimental measurement methods are analyzed Scanning Thermal Microscopy Raman thermal wave methods and x rays neutrons spectroscopy

New Materials for Thermoelectric Applications: Theory and Experiment Veljko Zlatic, Alex Hewson, 2012-10-17 Thermoelectric devices could play an important role in making efficient use of our energy resources but their efficiency would need to be increased for their wide scale application There is a multidisciplinary search for materials with an enhanced thermoelectric responses for use in such devices This volume covers the latest ideas and developments in this research field covering topics ranging from the fabrication and characterization of new materials particularly those with strong electron correlation use of nanostructured layered materials and composites through to theoretical work to gain a deeper understanding of thermoelectric behavior It should be a useful guide and stimulus to all working in this very topical field

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