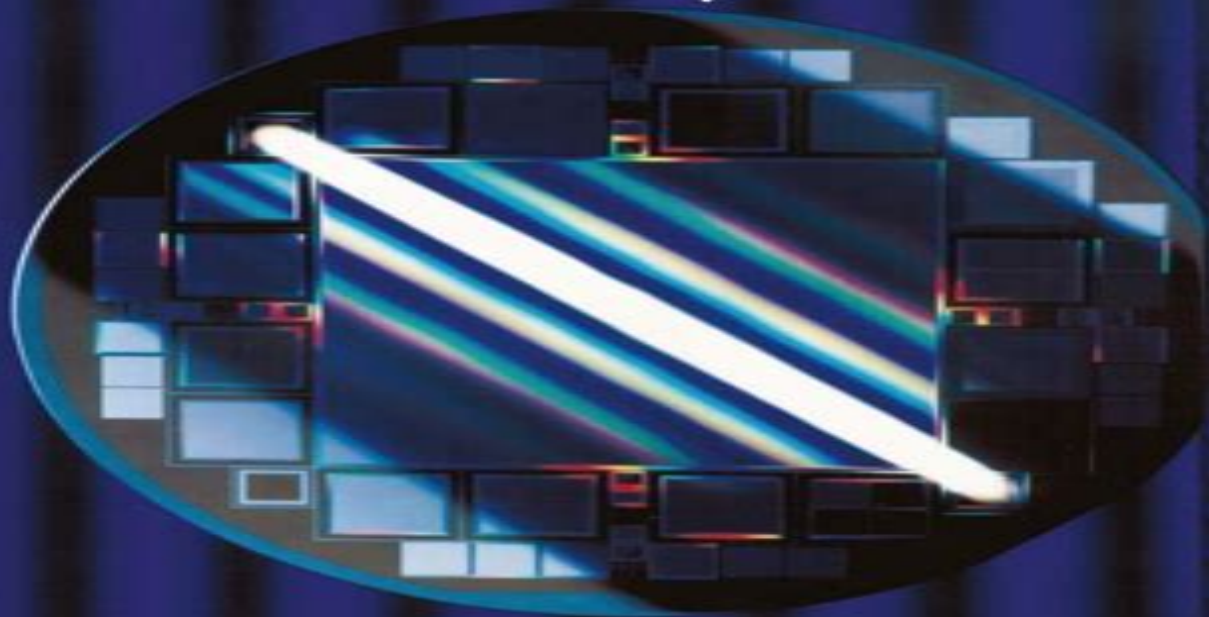


GERHARD LUTZ

# Semiconductor Radiation Detectors

Device Physics



Springer

# Semiconductor Radiation Detectors Device Physics

**Yuri Mikhailovich Tsipenyuk**



## **Semiconductor Radiation Detectors Device Physics:**

**Semiconductor Radiation Detectors** Gerhard Lutz, 2001-11-01 Starting from basic principles this book describes the rapidly growing field of modern semiconductor detectors used for energy and position measurement radiation The author whose own contributions to these developments have been significant explains the working principles of semiconductor radiation detectors in an intuitive way Broad coverage is also given to electronic signal readout and to the subject of radiation damage

*Compound Semiconductor Radiation Detectors* Alan Owens, 2012-04-25 Although elemental semiconductors such as silicon and germanium are standard for energy dispersive spectroscopy in the laboratory their use for an increasing range of applications is becoming marginalized by their physical limitations namely the need for ancillary cooling their modest stopping powers and radiation intolerance Compound semiconductors on the other hand encompass such a wide range of physical and electronic properties that they have become viable competitors in a number of applications Compound Semiconductor Radiation Detectors is a consolidated source of information on all aspects of the use of compound semiconductors for radiation detection and measurement Serious Competitors to Germanium and Silicon Radiation Detectors Wide gap compound semiconductors offer the ability to operate in a range of hostile thermal and radiation environments while still maintaining sub keV spectral resolution at X ray wavelengths Narrow gap materials offer the potential of exceeding the spectral resolution of germanium by a factor of three However while compound semiconductors are routinely used at infrared and optical wavelengths their development in other wavebands has been plagued by material and fabrication problems So far only a few have evolved sufficiently to produce commercial detection systems From Crystal Growth to Spectroscopic Performance Bringing together information scattered across many disciplines this book summarizes the current status of research in compound semiconductor radiation detectors It examines the properties growth and characterization of compound semiconductors as well as the fabrication of radiation sensors with particular emphasis on the X and gamma ray regimes It explores the limitations of compound semiconductors and discusses current efforts to improve spectral performances pointing to where future discoveries may lie A timely resource for the established researcher this book serves as a comprehensive and illustrated reference on material science crystal growth metrology detector physics and spectroscopy It can also be used as a textbook for those new to the field of compound semiconductors and their application to radiation detection and measurement

**Semiconductor Radiation Detection Systems** Krzysztof Iniewski, 2018-10-03 Semiconductor Radiation Detection Systems addresses the state of the art in the design of semiconductor detectors and integrated circuit design in the context of medical imaging using ionizing radiation It addresses exciting new opportunities in X ray detection Computer Tomography CT bone dosimetry and nuclear medicine PET SPECT In addition to medical imaging the book explores other applications of semiconductor radiation detection systems in security applications such as luggage scanning dirty bomb detection and border control Features a chapter written by well known Gamma Ray Imaging authority

Tadayuki Takahashi Assembled by a combination of top industrial experts and academic professors this book is more than just a product manual It is practical enough to provide a solid explanation of presented technologies incorporating material that offers an optimal balance of scientific and academic theory With less of a focus on math and physical details the author concentrates more on exploring exactly how technologies are being used With its combined coverage of new materials and innovative new system approaches as well as a succinct overview of recent developments this book is an invaluable tool for any engineer professional or student working in electronics or an associated field 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 Radiation Detection Douglas McGregor,J. Kenneth Shultis,2020-08-19 Radiation Detection Concepts Methods and Devices provides a modern overview of radiation detection devices and radiation measurement methods The book topics have been selected on the basis of the authors many years of experience designing radiation detectors and teaching radiation detection and measurement in a classroom environment This book is designed to give the reader more than a glimpse at radiation detection devices and a few packaged equations Rather it seeks to provide an understanding that allows the reader to choose the appropriate detection technology for a particular application to design detectors and to competently perform radiation measurements The authors describe assumptions used to derive frequently encountered equations used in radiation detection and measurement thereby providing insight when and when not to apply the many approaches used in different aspects of radiation detection Detailed in many of the chapters are specific aspects of radiation detectors including comprehensive reviews of the historical development and current state of each topic Such a review necessarily entails citations to many of the important discoveries providing a resource to find quickly additional and more detailed information This book generally has five main themes Physics and Electrostatics needed to Design Radiation Detectors Properties and Design of Common Radiation Detectors Description and Modeling of the Different Types of Radiation Detectors Radiation Measurements and Subsequent Analysis Introductory Electronics Used for Radiation Detectors Topics covered include atomic and nuclear physics radiation interactions sources of radiation and background radiation Detector operation is addressed with chapters on radiation counting statistics radiation source and detector effects

electrostatics for signal generation solid state and semiconductor physics background radiations and radiation counting and spectroscopy Detectors for gamma rays charged particles and neutrons are detailed in chapters on gas filled scintillator semiconductor thermoluminescence and optically stimulated luminescence photographic film and a variety of other detection devices *Silicon Solid State Devices And Radiation Detection* Claude Leroy, Pier-giorgio Rancoita, 2012-07-24 This book addresses the fundamental principles of interaction between radiation and matter the principles of working and the operation of particle detectors based on silicon solid state devices It covers a broad scope in the fields of application of radiation detectors based on silicon solid state devices from low to high energy physics experiments including in outer space and in the medical environment This book also covers state of the art detection techniques in the use of radiation detectors based on silicon solid state devices and their readout electronics including the latest developments on pixelated silicon radiation detector and their application The content and coverage of the book benefit from the extensive experience of the two authors who have made significant contributions as researchers as well as in teaching physics students in various universities

Electronics for Radiation Detection Krzysztof Iniewski, 2018-09-03 There is a growing need to understand and combat potential radiation damage problems in semiconductor devices and circuits Assessing the billion dollar market for detection equipment in the context of medical imaging using ionizing radiation Electronics for Radiation Detection presents valuable information that will help integrated circuit IC designers and other electronics professionals take full advantage of the tremendous developments and opportunities associated with this burgeoning field Assembling contributions from industrial and academic experts this book Addresses the state of the art in the design of semiconductor detectors integrated circuits and other electronics used in radiation detection Analyzes the main effects of radiation in semiconductor devices and circuits paying special attention to degradation observed in MOS devices and circuits when they are irradiated Explains how circuits are built to deal with radiation focusing on practical information about how they are being used rather than mathematical details Radiation detection is critical in space applications nuclear physics semiconductor processing and medical imaging as well as security drug development and modern silicon processing techniques The authors discuss new opportunities in these fields and address emerging detector technologies circuit design techniques new materials and innovative system approaches Aimed at postgraduate researchers and practicing engineers this book is a must for those serious about improving their understanding of electronics used in radiation detection The information presented here can help you make optimal use of electronic detection equipment and stimulate further interest in its development use and benefits

**Radiation and Detectors** Lucio Cerrito, 2017-05-11 This textbook provides an introduction to radiation the principles of interaction between radiation and matter and the exploitation of those principles in the design of modern radiation detectors Both radiation and detectors are given equal attention and their interplay is carefully laid out with few assumptions made about the prior knowledge of the student Part I is dedicated to radiation broadly interpreted in terms of energy and type

starting with an overview of particles and forces an extended review of common natural and man made sources of radiation and an introduction to particle accelerators Particular attention is paid to real life examples which place the types of radiation and their energy in context Dosimetry is presented from a modern user led point of view and relativistic kinematics is introduced to give the basic knowledge needed to handle the more formal aspects of radiation dynamics and interaction The explanation of the physics principles of interaction between radiation and matter is given significant space to allow a deeper understanding of the various technologies based on those principles Following an introduction to the ionisation mechanism detectors are introduced in Part II grouped according to the physical principle that underpins their functionality with chapters covering gaseous detectors semiconductor detectors the scintillation process and light detectors The final two chapters describe the phenomenology of showers and the design of calorimeters and cover additional phenomena including Cherenkov and transition radiation and the detection of neutrinos An appendix offers the reader a useful review of statistics and probability distributions The mathematical formalism is kept to a minimum throughout and simple derivations are presented to guide the reasoning and facilitate understanding of the working principles The book is unique in its wide scope and introductory level and is suitable for undergraduate and graduate students in physics and engineering The reader will acquire an awareness of how radiation and its exploitation are becoming increasingly relevant in the modern world with over 140 experimental figures detector schematics and photographs helping to relate the material to a broader research context

**Radiation Detection** Douglas McGregor,J. Kenneth Shultis,2020-08-19 Radiation Detection Concepts Methods and Devices provides a modern overview of radiation detection devices and radiation measurement methods The book topics have been selected on the basis of the authors many years of experience designing radiation detectors and teaching radiation detection and measurement in a classroom environment This book is designed to give the reader more than a glimpse at radiation detection devices and a few packaged equations Rather it seeks to provide an understanding that allows the reader to choose the appropriate detection technology for a particular application to design detectors and to competently perform radiation measurements The authors describe assumptions used to derive frequently encountered equations used in radiation detection and measurement thereby providing insight when and when not to apply the many approaches used in different aspects of radiation detection Detailed in many of the chapters are specific aspects of radiation detectors including comprehensive reviews of the historical development and current state of each topic Such a review necessarily entails citations to many of the important discoveries providing a resource to find quickly additional and more detailed information This book generally has five main themes Physics and Electrostatics needed to Design Radiation Detectors Properties and Design of Common Radiation Detectors Description and Modeling of the Different Types of Radiation Detectors Radiation Measurements and Subsequent Analysis Introductory Electronics Used for Radiation Detectors Topics covered include atomic and nuclear physics radiation interactions sources of radiation and background radiation Detector operation is

addressed with chapters on radiation counting statistics radiation source and detector effects electrostatics for signal generation solid state and semiconductor physics background radiations and radiation counting and spectroscopy Detectors for gamma rays charged particles and neutrons are detailed in chapters on gas filled scintillator semiconductor thermoluminescence and optically stimulated luminescence photographic film and a variety of other detection devices

**Radiation, Ionization, and Detection in Nuclear Medicine** Tapan K. Gupta, 2013-03-20 This book will serve as the definitive source of detailed information on radiation ionization and detection in nuclear medicine It opens by considering fundamental aspects of nuclear radiation including dose and energy sources and shielding Subsequent chapters cover the full range of relevant topics including the detection and measurement of radiation exposure with detailed information on mathematical modelling medical imaging the different types of radiation detector and their working principles basic principles of and experimental techniques for deposition of scintillating materials device fabrication the optical and electrical behaviors of radiation detectors and the instrumentation used in nuclear medicine and its application The book will be an invaluable source of information for academia industry practitioners and researchers     Radiation Sensors with 3D Electrodes Cinzia Da Vià, Gian-Franco Dalla Betta, Sherwood Parker, 2019-01-17 Written by the leading names in this field this book introduces the technical properties design and fabrication details measurement results and applications of three dimensional silicon radiation sensors Such devices are currently used in the ATLAS experiment at the European Centre for Particle Physics CERN for particle tracking in high energy physics These sensors are the radiation hardest devices ever fabricated and have applications in ground breaking research in neutron detection medical dosimetry and space technologies and more Chapters explore the essential features of silicon particle detectors interactions of radiation with matter radiation damage effects and micro fabrication in addition to a providing historical overview of the field This book will be a key reference for students and researchers working with sensor technologies Features The first book dedicated to this unique and growing subject area which is also widely applicable in high energy physics medical physics space science and beyond Authored by Sherwood Parker the inventor of the concept of 3D detectors Cinzia Da Vi who has brought 3DSi technology to application and Gian Franco Dalla Betta a leading figure in the design and fabrication technology of these devices Explains to non experts the essential features of silicon particle detectors interactions of radiation with matter radiation damage effects and micro fabrication     Ion Beams in Materials Processing and Analysis Bernd Schmidt, Klaus Wetzig, 2012-12-13 A comprehensive review of ion beam application in modern materials research is provided including the basics of ion beam physics and technology The physics of ion solid interactions for ion implantation ion beam synthesis sputtering and nano patterning is treated in detail Its applications in materials research development and analysis developments of special techniques and interaction mechanisms of ion beams with solid state matter result in the optimization of new material properties which are discussed thoroughly Solid state properties optimization for functional materials such as doped

semiconductors and metal layers for nano electronics metal alloys and nano patterned surfaces is demonstrated The ion beam is an important tool for both materials processing and analysis Researchers engaged in solid state physics and materials research engineers and technologists in the field of modern functional materials will welcome this text

Semiconductor Radiation Detectors Salim Reza, 2017-10-23 The aim of this book is to educate the reader on radiation detectors from sensor to read out electronics to application Relatively new detector materials such as CdZTe and Cr compensated GaAs are introduced along with emerging applications of radiation detectors This X ray technology has practical applications in medical industrial and security applications It identifies materials based on their molecular composition not densities as the traditional transmission equipment does With chapters written by an international selection of authors from both academia and industry the book covers a wide range of topics on radiation detectors which will satisfy the needs of both beginners and experts in the field

**Device Physics** Cyril Hilsum, 1993 The first edition of this volume was published 12 years ago Since many of the devices described in it were invented 20 years or more earlier it might have been thought that the field had reached maturity However the power of semiconductor physics and the ingenuity of device designers has demonstrated to the contrary Semiconductor devices have changed so markedly in the intervening decade that this volume is effectively a new book in its own right Less than one third of the old material remains and that naturally is largely the fundamental physics The descriptions of devices are unique and original in each case The basic layout of the volume is unchanged and most of the original chapter authors have personally made many of the new advances in design and performance which they describe as well as incorporating overviews of world progress in both the context of traditional practice and the latest discoveries There are two significant changes in this new edition The progress in the physics of panel electroluminescence no longer justifies an entire chapter Whereas superlattices have become so significant recently that the last chapter summarises this field reporting on the latest advances in preparing semiconductor layers on an atomic scale The volume includes descriptions of all today's important semiconductor devices at a level appropriate to the physicist or engineer who is not an expert on that particular device

**Handbook of Measurement in Science and Engineering,**

**Volume 3** Myer Kutz, 2016-06-20 A multidisciplinary reference of engineering measurement tools techniques and applications When you can measure what you are speaking about and express it in numbers you know something about it but when you cannot measure it when you cannot express it in numbers your knowledge is of a meager and unsatisfactory kind it may be the beginning of knowledge but you have scarcely in your thoughts advanced to the stage of science Lord Kelvin Measurement is at the heart of any engineering and scientific discipline and job function Whether engineers and scientists are attempting to state requirements quantitatively and demonstrate compliance to track progress and predict results or to analyze costs and benefits they must use the right tools and techniques to produce meaningful data The Handbook of Measurement in Science and Engineering is the most comprehensive up to date reference set on engineering and scientific



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**SiC based Miniaturized Devices** Stephen Edward Saddow, Daniel Alquier, Jing Wang, Francesco LaVia, Mariana Fraga, 2020-06-18 MEMS devices are found in many of today's electronic devices and systems from air bag sensors in cars to smart phones embedded systems etc Increasingly the reduction in dimensions has led to nanometer scale devices called NEMS The plethora of applications on the commercial market speaks for itself and especially for the highly precise manufacturing of silicon based MEMS and NEMS While this is a tremendous achievement silicon as a material has some drawbacks mainly in the area of mechanical fatigue and thermal properties Silicon carbide SiC a well known wide bandgap semiconductor whose adoption in commercial products is experiencing exponential growth especially in the power electronics arena While SiC MEMS have been around for decades in this Special Issue we seek to capture both an overview of the devices that have been demonstrated to date as well as bring new technologies and progress in the MEMS processing area to the forefront Thus this Special Issue seeks to showcase research papers short communications and review articles that focus on 1 novel designs fabrication control and modeling of SiC MEMS and NEMS based on all kinds of actuation mechanisms and 2 new developments in applying SiC MEMS and NEMS in consumer electronics optical communications industry medicine agriculture space and defense

**An Introduction to Ultra-Fast Silicon Detectors** Marco Ferrero, Roberta Arcidiacono, Marco Mandurrino, Valentina Sola, Nicolò Cartiglia, 2021-07-07 The book describes the development of innovative silicon sensors known as ultra fast silicon detectors for use in the space time tracking of charge particles The first comprehensive collection of information on the topic otherwise currently scattered in existing literature this book presents a comprehensive introduction to the development of ultra fast silicon detectors with the latest technology and applications from the field It will be an ideal reference for graduate and postgraduates studying high energy and particle physics and engineering in addition to researchers in the area Key features Authored by a team of subject area specialists whose research group first invented ultra fast silicon detectors The first book on the topic to explain the details of the design of silicon sensors for 4 dimensional

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**PHYSICAL METHODS, INSTRUMENTS AND MEASUREMENTS - Volume II** Yuri Mikhailovich Tsipenyuk, 2009-04-15 Physical Methods Instruments and Measurements theme is a component of the Encyclopedia of Physical Sciences Engineering and Technology Resources which is part of the global Encyclopedia of Life Support Systems EOLSS an integrated compendium of twenty Encyclopedias The Theme provides a complete survey of the present status of our knowledge of modern physical instruments and measurements It is organized in the following main topics Measurements and Measurement Standards Sources of Particles and Radiation Detectors and Sensors Imaging and Characterizing Trace Element Analysis Technology of Physical Experiments Applications of Measurements and Instrumentation which are then expanded into multiple subtopics each as a chapter These four volumes are aimed at the following five major target audiences University and College Students Educators Professional Practitioners Research Personnel and Policy Analysts Managers and Decision Makers and NGOs

**Optical Properties and Applications of Semiconductors** Inamuddin, Mohd Imran Ahamed, Rajender Boddula, Tariq Altalhi, 2022-07-18 Semiconductors with optical characteristics have found widespread use in evolving semiconductor photovoltaics where optical features are important The industrialization of semiconductors and their allied applications have paved the way for optical measurement techniques to be used in new ways Due to their unique properties semiconductors are key components in the daily employed technologies in healthcare computing communications green energy and a range of other uses This book examines the fundamental optical properties and applications of semiconductors It summarizes the information as well as the optical characteristics and applicability of semiconductors through an in depth review of the literature Accomplished experts in the field share their knowledge and examine new developments

**FEATURES**

Comprehensive coverage of all types of optical applications using semiconductors Explores relevant composite materials and devices for each application Addresses the optical properties of crystalline and amorphous semiconductors Describes new developments in the field and future potential applications

**Optical Properties and Applications of Semiconductors** is a comprehensive reference and an invaluable resource for engineers scientists academics and industry R D teams working in applied physics

**Solid-State Radiation Detectors** Salah Awadalla, 2017-12-19 Integrating aspects of engineering application physics and medical science Solid State Radiation Detectors Technology and Applications offers a comprehensive review of new and emerging solid state materials based technologies for radiation detection Each chapter is structured to address the current advantages and challenges of each material and technology presented as well as to discuss novel research and applications Featuring contributions from leading experts in industry and academia this authoritative text Covers modern semiconductors used for radiation monitoring Examines CdZnTe and CdTe technology for imaging

applications including three dimensional capability detectors Highlights interconnect technology for current pixel detectors Describes hybrid pixel detectors and their characterizations Tackles the integrated analog signal processing read out front ends for particle detectors Considers new organic materials with direct bandgap for direct energy detection Summarizes recent developments involving lanthanum halide and cerium bromide scintillators Analyzes the potential of recent progress in the field of crystallography quantum dots and photonics crystals toward a new concept of x and gamma ray detectors based on metamaterials Explores position sensitivity photomultipliers and silicon photomultipliers for scintillation crystals Solid State Radiation Detectors Technology and Applications provides a valuable reference for engineers and scientists looking to enhance the performance of radiation detector technology for medical imaging and other applications

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