

Rainer Waser (Ed.)

Nanoelectronics and Information Technology

Advanced Electronic Materials
and Novel Devices

Third, Completely Revised
and Enlarged Edition



 WILEY-VCH

Nanoelectronics And Information Technology Rainer Waser

Matthew F. Ginobili



Nanoelectronics And Information Technology Rainer Waser:

Nanoelectronics and Information Technology Rainer Waser, 2012-05-29 This outstanding textbook provides an introduction to electronic materials and device concepts for the major areas of current and future information technology. On about 1 000 pages it collects the fundamental concepts and key technologies related to advanced electronic materials and devices. The obvious strength of the book is its encyclopedic character providing adequate background material instead of just reviewing current trends. It focuses on the underlying principles which are illustrated by contemporary examples. The third edition now holds 47 chapters grouped into eight sections. The first two sections are devoted to principles, materials, processing and characterization methods. Following sections hold contributions to relevant materials and various devices: computational concepts, storage systems, data transmission, imaging systems and displays. Each subject area is opened by a tutorial introduction written by the editor and giving a rich list of references. The following chapters provide a concise yet in depth description in a given topic. Primarily aimed at graduate students of physics, electrical engineering and information technology as well as material science, this book is equally of interest to professionals looking for a broader overview. Experts might appreciate the book for having quick access to principles as well as a source for getting insight into related fields.

Nanoelectronics and Information Technology Rainer Waser, 2003-04-09 Providing an introduction to electronic materials and device concepts for the major areas of current and future information technology, the value of this book lies in its focus on the underlying principles. Illustrated by contemporary examples, these basic principles will hold despite the rapid developments in this field, especially emphasizing nanoelectronics. There is hardly any field where the links between basic science and application are tighter than in nanoelectronics and information technology. As an example, the design of resonant tunneling transistors, single electron devices or molecular electronic structures is simply inconceivable without delving deep into quantum mechanics. This textbook is primarily aimed at students of physics, electrical engineering and information technology as well as material science in their 3rd year and higher. It is equally of interest to professionals wanting a broader overview of this hot topic. *Nanoelectronics and Information Technology* by Rainer Waser and his colleagues is an outstanding compendium of information about an exciting new field. Owing to its high quality and complete coverage of the many topics in this area, this well referenced book will have a long and very useful life as a primary text for students, experienced and new in nanoelectronics. It is a very impressive book. Richard Siegel Nanotechnology Rainer Waser, 2008-07-21 This second of two volumes on applications in information technology is divided into two main sections. The first covers logic devices and concepts ranging from advanced and non conventional CMOS and semiconductor nanowire devices via various spin controlled logic devices and concepts involving carbon nanotubes, organic thin films as well as single organic molecules right up to the visionary idea of intramolecular computation. The second part, architectures and computational concepts, discusses biologically inspired structures and quantum cellular automata, finishing off by summarizing the main principles and current

approaches to coherent solid state based quantum computation Resistive Switching Daniele Ielmini, Rainer Waser, 2015-12-28 With its comprehensive coverage this reference introduces readers to the wide topic of resistance switching providing the knowledge tools and methods needed to understand characterize and apply resistive switching memories Starting with those materials that display resistive switching behavior the book explains the basics of resistive switching as well as switching mechanisms and models An in depth discussion of memory reliability is followed by chapters on memory cell structures and architectures while a section on logic gates rounds off the text An invaluable self contained book for materials scientists electrical engineers and physicists dealing with memory research and development

Tip-Enhanced Raman Spectroscopy for Nanoelectronics Mischa Nicklaus, 2014-04-22 This dissertation focuses on the application of Tip Enhanced Raman spectroscopy TERS to non transparent and non conductive samples allowing for the optical characterization of nanoelectronic devices As such nano crystals are analyzed as a model system for the investigation of chemical and structural properties Furthermore a novel method for mapping the refractive index of materials with nanometer resolution is presented The technological progress of electronics through miniaturization has reached the nanoscale while new materials with high performance and functional properties gain importance Quality control and the scientific understanding of size effects in electronic nanostructures are required more than ever to consolidate existing technologies and to determine scaling limits of new materials Conventional techniques including scanning electron and scanning probe microscopy provide topographic information but only very limited chemical information to analyze the physical properties of nanomaterials Chemical and structural sensitivity is available by Raman or infrared spectroscopy but with a spatial resolution limited to the microscale by the diffraction limit of light TERS combines the virtues of scanning probe microscopy with those of optical spectroscopy to overcome the diffraction limit through the excitation of surface plasmons on a scanning probe tip to confine light to nanometers In this work a TERS system was installed to operate on opaque samples by employing optical side access TERS probes were fabricated by electrochemical etching and operated in scanning tunneling microscopy and atomic force microscopy with quartz tuning forks to enable scanning on various surfaces TERS was then applied to ferroelectric lead titanate nano crystals on a platinized silicon substrate as a model system for nanostructured charge based memory devices at the onset of finite size effects *Electromagnetics and Network Theory*

and their Microwave Technology Applications Stefan Lindenmeier, Robert Weigel, 2011-07-13 This volume provides a discussion of the challenges and perspectives of electromagnetics and network theory and their microwave applications in all aspects It collects the most interesting contribution of the symposium dedicated to Professor Peter Russer held in October 2009 in Munich **Leading-edge Semiconductor Research** Thomas B. Elliot, 2005 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

Handbook of Terahertz Technology Neil Sellers, 2018-01-21 Terahertz radiation also known as submillimeter radiation terahertz waves tremendously high frequency THF T rays T waves T light T lux or THz consists of electromagnetic waves within the ITU designated band of frequencies from 0.3 to 3 terahertz Wavelengths of radiation in the terahertz band correspondingly range from 1 mm to 0.1 mm Because terahertz radiation begins at a wavelength of one millimeter and proceeds into shorter wavelengths it is sometimes known as the submillimeter band and its radiation as submillimeter waves especially in astronomy The book presents information about Terahertz science Terahertz photodetectors and Terahertz Lasers A special emphasis is given to room temperature operation of long wavelength photodetectors based on novel quantum dots Moreover a complete analysis of systems based on Quantum Cascade structures to detect far infrared wavelengths is provided Finally the book presents Terahertz laser principles considering multi color lasers in this range of wavelengths It is written as a background for graduate students in the Optics field

New Topics in Nanotechnology Research Matthew F. Ginobili, 2007 Nanotechnology is a catch all description of activities at the level of atoms and molecules that have applications in the real world A nanometer is a billionth of a meter about 1/80 000 of the diameter of a human hair or 10 times the diameter of a hydrogen atom Nanotechnology is now used in precision engineering new materials development as well as in electronics electromechanical systems as well as mainstream biomedical applications in areas such as gene therapy drug delivery and novel drug discovery techniques This book presents the latest research in this frontier field

Photonic Wire Bonding as a Novel Technology for Photonic Chip Interfaces Lindenmann, Nicole, 2018-02-09 To create photonic multi chip modules integrated photonic chips need to be connected internally and to external glass fibers

A novel approach to address this task is the concept of photonic wire bonding where free standing polymer waveguides are printed in situ by two photon polymerization This book contains a detailed description of the methodology of photonic wire bonding together with a number of key experiments *Optical Fibers Telecommunications* Gary Osborne, 2018-04-13 This book is structured into 12 chapters to facilitate a logical progression of material and to enable straightforward access to topics by providing the appropriate background and theoretical support Chapter 1 gives a short introduction to optical fiber communications by considering the historical development the general system and the major advantages provided by this technology Chapter 2 discuss about the quality of service and telecommunication impairments In Chapter 3 the concept of the optical fiber as a transmission medium is introduced using the simple ray theory approach This is followed by discussion of electromagnetic wave theory applied to optical fibers prior to consideration of lightwave transmission within the various fiber types In particular single mode fiber together with a more recent class of microstructured optical fiber referred to as photonic crystal fiber are covered in further detail The major transmission characteristics of optical fibers are then dealt with in Chapter 4 Again there is a specific focus on the properties and characteristics of single mode fibers including in this third edition enhanced discussion of single mode fiber types polarization mode dispersion nonlinear effects and in particular soliton propagation Chapters 5 and 6 deal with the various transmission and switching techniques Also discuss the different transmission aspects of Voice Telephony Chapter 7 describe the light sources employed in optical fiber communications The other important semiconductor optical source namely the light emitting diode is dealt with in Chapter 7 Chapter 8 discuss about the various design features of Optical Fibers for communication systems Chapter 9 provides a general treatment of the major measurements which may be undertaken on optical fibers in both the laboratory and the field The chapter is incorporated at this stage in the book to enable the reader to obtain a more complete understanding of optical fiber subsystems and systems prior to consideration of these issues Chapter 10 on optical networks comprises an almost entirely new chapter for the third edition which provides both a detailed overview of this expanding field and a discussion of all the major aspects and technological solutions currently being explored Chapter 11 discusses about the data communications methods Chapter 12 dealt with the telecommunication lasers techniques **Nanoionics** Inamuddin, Tariq Altalhi, Mohammad Luqman, Jorddy Neves Cruz, 2025-10-07 This book offers a comprehensive and cutting edge overview of nanoionics covering fundamental principles experimental techniques emerging trends and advanced topics making it a one stop resource for both beginners and professionals in the field Nanoionics Fundamentals and Applications provides a comprehensive and cutting edge overview of the field of nanoionics focusing on recent advancements and their practical applications Nanoionics is an interdisciplinary field that explores the behavior and manipulation of ions at the nanoscale with applications spanning various domains including energy storage electronics sensors and biomedical devices This book delves into the fundamental principles experimental techniques and emerging trends in nanoionics highlighting the latest

breakthroughs in the field Beginning with a solid foundation in the principles of nanoionics including ion transport electrochemical processes and nanomaterials the book details advanced topics such as nanoscale characterization techniques interface engineering and ion based devices Throughout the book emphasis is placed on the integration of theory simulations and experimental findings to provide a comprehensive understanding of nanoionics phenomena The book will also explore the interface between nanoionics and related fields such as nanoelectronics nanophotonics and nanomaterials showcasing the potential for cross disciplinary collaborations and technological advancements Readers will find this volume Provides comprehensive coverage of the field of nanoionics encompassing fundamental principles experimental techniques advanced topics and cross disciplinary applications Highlights the latest advancements in nanoionics incorporating recent research findings and breakthroughs by featuring discussions on emerging trends novel materials and innovative device designs Emphasizes the practicality of nanoionics showcasing real world applications in areas such as energy storage electronics sensors and biomedical devices Offers in depth analyses of key concepts and phenomena in nanoionics supported by theoretical models experimental data and simulation results providing readers with a deeper understanding of the underlying principles governing ion transport electrochemical processes and material properties at the nanoscale Audience Researchers graduate students and professionals in the fields of materials science and engineering nanotechnology chemistry electrical engineering and physics

Formation of Ferroelectricity in Hafnium Oxide Based Thin Films Tony

Schenk,2017-03-15 In 2011 B scke et al reported the unexpected discovery of ferroelectric properties in hafnia based thin films which has since initiated many further studies and revitalized research on the topic of ferroelectric memories In spite of many efforts the unveiling of the fundamentals behind this surprising discovery has proven rather challenging In this work the originally claimed Pca21 phase is experimentally proven to be the root of the ferroelectric properties and the nature of this ferroelectricity is classified in the frame of existing concepts of ferroelectric materials Parameters to stabilize this polar phase are examined from a theoretical and fabrication point of view With these very basic questions addressed the application relevant electric field cycling behavior is studied The results of first order reversal curves impedance spectroscopy scanning transmission electron microscopy and piezoresponse force microscopy significantly advance the understanding of structural mechanisms underlying wake up fatigue and the novel phenomenon of split up merging of transient current peaks The impact of field cycling behavior on applications like ferroelectric memories is highlighted and routes to optimize it are derived These findings help to pave the road for a successful commercialization of hafnia based ferroelectrics

Memristive Devices for Brain-Inspired Computing Sabina Spiga,Abu Sebastian,Damien Querlioz,Bipin Rajendran,2020-06-12 Memristive Devices for Brain Inspired Computing From Materials Devices and Circuits to Applications Computational Memory Deep Learning and Spiking Neural Networks reviews the latest in material and devices engineering for optimizing memristive devices beyond storage applications and toward brain inspired computing The book provides

readers with an understanding of four key concepts including materials and device aspects with a view of current materials systems and their remaining barriers algorithmic aspects comprising basic concepts of neuroscience as well as various computing concepts the circuits and architectures implementing those algorithms based on memristive technologies and target applications including brain inspired computing computational memory and deep learning This comprehensive book is suitable for an interdisciplinary audience including materials scientists physicists electrical engineers and computer scientists Provides readers an overview of four key concepts in this emerging research topic including materials and device aspects algorithmic aspects circuits and architectures and target applications Covers a broad range of applications including brain inspired computing computational memory deep learning and spiking neural networks Includes perspectives from a wide range of disciplines including materials science electrical engineering and computing providing a unique interdisciplinary look at the field

Emerging Nanoelectronic Devices An Chen, James Hutchby, Victor Zhirnov, George Bourianoff, 2015-01-27 Emerging Nanoelectronic Devices focuses on the future direction of semiconductor and emerging nanoscale device technology As the dimensional scaling of CMOS approaches its limits alternate information processing devices and microarchitectures are being explored to sustain increasing functionality at decreasing cost into the indefinite future This is driving new paradigms of information processing enabled by innovative new devices circuits and architectures necessary to support an increasingly interconnected world through a rapidly evolving internet This original title provides a fresh perspective on emerging research devices in 26 up to date chapters written by the leading researchers in their respective areas It supplements and extends the work performed by the Emerging Research Devices working group of the International Technology Roadmap for Semiconductors ITRS Key features Serves as an authoritative tutorial on innovative devices and architectures that populate the dynamic world of Beyond CMOS technologies Provides a realistic assessment of the strengths weaknesses and key unknowns associated with each technology Suggests guidelines for the directions of future development of each technology Emphasizes physical concepts over mathematical development Provides an essential resource for students researchers and practicing engineers

Ultrathin Calcium Titanate Capacitors Andreas Krause, 2014-07-04 To enable further scaling for future generations of DRAM capacitors significant efforts to replace Zirconium dioxide as high k dielectric have been undertaken since the 1990s In calculations Calcium titanate has been identified as a potential replacement to allow a significant capacitance improvement This material exhibits a significantly higher permittivity and a sufficient band gap The scope of this thesis is therefore the preparation and detailed physical and electrical characterization of ultrathin Calcium titanate layers The complete capacitor stacks including Calcium titanate have been prepared under ultrahigh vacuum to minimize the influence of adsorbents or contaminants at the interfaces Various electrodes are evaluated regarding temperature stability and chemical reactance to achieve crystalline Calcium titanate An optimal electrode was found to be a stack consisting of Pt on TiN Additionally this thesis presents fundamental results on the

creation physical and electrical characterization of Calcium titanate nanocrystallites embedded in an amorphous matrix Capacitors with these nanocrystallites exhibit an increased permittivity of 55 with low leakage currents comparable to currents in amorphous layers

Top-Down Digital VLSI Design Hubert Kaeslin, 2014-12-07 Top Down VLSI Design From Architectures to Gate Level Circuits and FPGAs represents a unique approach to learning digital design Developed from more than 20 years teaching circuit design Doctor Kaeslin s approach follows the natural VLSI design flow and makes circuit design accessible for professionals with a background in systems engineering or digital signal processing It begins with hardware architecture and promotes a system level view first considering the type of intended application and letting that guide your design choices Doctor Kaeslin presents modern considerations for handling circuit complexity throughput and energy efficiency while preserving functionality The book focuses on application specific integrated circuits ASICs which along with FPGAs are increasingly used to develop products with applications in telecommunications IT security biomedical automotive and computer vision industries Topics include field programmable logic algorithms verification modeling hardware synchronous clocking and more Demonstrates a top down approach to digital VLSI design Provides a systematic overview of architecture optimization techniques Features a chapter on field programmable logic devices their technologies and architectures Includes checklists hints and warnings for various design situations Emphasizes design flows that do not overlook important action items and which include alternative options when planning the development of microelectronic circuits

Computational and Experimental Chemistry Tanmoy Chakraborty, Michael J. Bucknum, Eduardo A. Castro, 2013-09-24 This book covers a range of new research on computational quantum chemistry along with a special section devoted to exotic carbon allotropes and spiro quantum theory The section on spiro quantum theory covers the technical presentation of the ideas surrounding the emergence of a synthetic analytical and theoretical spiro quantum chemistry edifi

Oxygen transport in thin oxide films at high field strength Dieter Weber, 2014 Ionic transport in nanostructures at high eld strength has recently gained attention because novel types of computer memory with potentially superior properties rely on such phenomena The applied voltages are only moderate but they drop over the distance of a few nanometers and lead to extreme eld strengths in the MV cm region Such strong elds contributes signi cantly to the activation energy for ionic jump processes This leads to an exponential increase of transport speed with voltage Conventional high temperature ionic conduction in contrast only relies on thermal activation for such jumps In this thesis the transport of minute amounts of oxygen through a thin dielectric layer sandwiched between two thin conducting oxide electrodes was detected semiquantitatively by measuring the conductance change of the electrodes after applying a current through the dielectric layer The relative conductance change G/G as a function of current I and duration t follows over several orders of magnitude a simple empirical law of the form $G/G = C I A t^B$ with t parameters C , A and B $A \approx 2$, $B \approx 0.1$ This empirical law can be linked to a predicted exponential increase of the transport speed with voltage at high eld strength The behavior in the time

domain can be explained with a spectrum of relaxation processes similar to the relaxation of dielectrics The influence of temperature on the transport is strong but still much lower than expected This contradicts a commonly used law for high field ionic transport The different oxide layers are epitaxial with thicknesses between 5 and 70 nm First large scale test samples were fabricated using shadow masks The general behavior of such devices was studied extensively In an attempt to achieve quantitative results with defect free miniaturized devices a lithographic manufacturing process that uses repeated steps of epitaxial deposition and structuring of the layers was developed It employs newly developed and optimized wet chemical etching processes for the conducting electrodes First high quality devices could be manufactured with this process and confirmed that such devices suffer less from parasitic effects The lithographically structured samples were made from different materials The results from the first test samples and the lithographically structured samples are therefore not directly comparable They do exhibit however in principle the same behavior Further investigation of such lithographically structured samples appears promising

Nanotechnology Rainer Waser, 2008-06-16 This topic could not be hotter the new technology drive of the 21st century paired with existing multibillion dollar markets and fundings With Nanotechnology everywhere of great importance e.g. biology medicine pharmaceuticals chemistry materials science and engineering this authoritative reference addresses IT applications of nanotechnology specifically computer memory and how the technology can be miniaturised The entire reference set of 9 volumes gives an excellent in depth overview of everything you need to know about nanotechnology and or nanoscience Each volume is dedicated to a specific topic which is covered in detail by experts from that particular field

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