



# SiGe

## Heterojunction Bipolar Transistors



Peter Ashburn

 WILEY

# Sige Heterojunction Bipolar Transistors

**Michele Joan Mitchell**



### **SiGe Heterojunction Bipolar Transistors:**

SiGe Heterojunction Bipolar Transistors Peter Ashburn, 2004-02-06 SiGe HBTs is a hot topic within the microelectronics community because of its applications potential within integrated circuits operating at radio frequencies Applications range from high speed optical networking to wireless communication devices The addition of germanium to silicon technologies to form silicon germanium SiGe devices has created a revolution in the semiconductor industry These transistors form the enabling devices in a wide range of products for wireless and wired communications This book features SiGe products include chip sets for wireless cellular handsets as well as WLAN and high speed wired network applications Describes the physics and technology of SiGe HBTs with coverage of Si and Ge bipolar transistors Written with the practising engineer in mind this book explains the operating principles and applications of bipolar transistor technology Essential reading for practising microelectronics engineers and researchers Also optical communications engineers and communication technology engineers An ideal reference tool for masters level students in microelectronics and electronics engineering

**SiGe, GaAs, and InP Heterojunction Bipolar Transistors** Jiann S. Yuan, 1999-04-12 An up to date comprehensive guide to heterojunction bipolar transistor technology Owing to their superior performance in microwave and millimeter wave applications heterojunction bipolar transistors HBTs have become a major force in mobile and wireless communications This book offers an integrated treatment of SiGe GaAs and InP HBTs presenting a much needed overview of HBTs based on different materials systems their fabrication analysis and testing procedures Highly respected expert Jiann S Yuan discusses in depth the dc and RF performance and modeling of HBT devices including simulation thermal instability reliability low temperature and high temperature performance and HBT analog and digital circuits He provides step by step presentations of HBT materials including Si HBTs and III V and IV IV compound HBTs which are rarely described in the literature Also covered are device and circuit interaction as well as specific high speed devices in mobile and wireless communications This immensely useful guide to a rapidly expanding field includes more than 200 figures tables of different material systems in terms of their physical parameters and up to date experimental results culled from the latest research An essential resource for circuit and device designers in the semiconductor industry SiGe GaAs and InP Heterojunction Bipolar Transistors is also useful for graduate students in electrical engineering applied physics and materials science **Silicon-germanium**

**Heterojunction Bipolar Transistors** John D. Cressler, Guofu Niu, 2003 This informative new resource presents the first comprehensive treatment of silicon germanium heterojunction bipolar transistors SiGe HBTs It offers you a complete from the ground up understanding of SiGe HBT devices and technology from a very broad perspective The book covers motivation history materials fabrication device physics operational principles and circuit level properties associated with this new cutting edge semiconductor device technology Including over 400 equations and more than 300 illustrations this hands on reference shows you in clear and concise language how to design simulate fabricate and measure a SiGe HBT *Strained Si*

*Heterojunction Bipolar Transistors* Mouhsine Fjer, 2011 This dissertation addresses the world's first demonstration of strained Si Heterojunction Bipolar Transistors sSi HBTs The conventional SiGe Heterojunction Bipolar Transistor SiGe HBT which was introduced as a commercial product in 1999 after its first demonstration in 1988 has become an established device for high speed applications This is due to its excellent RF performance and compatibility with CMOS processing It has enabled silicon based technology to penetrate the rapidly growing market for wide bandwidth and wireless telecommunications once reserved for more expensive III V technologies SiGe HBTs is realised by the pseudomorphic growth of SiGe on a Si substrate which allows engineering of the base region to improve performance In this way the base has a smaller energy band gap than the emitter which increases the gain The energy band gap of SiGe reduces with increasing Ge composition but the maximum Ge composition is limited by the amount of strain that can be accommodated within a given base layer thickness Therefore a new innovation is necessary to overcome this limitation and meet the continuous demand for high speed devices Growing the SiGe base layer over a relaxed SiGe layer Strain Relaxed Buffer can increase the amount of Ge that can be incorporated in the base hence increasing the device performance In this thesis experimental data is presented to demonstrate the realisation of sSi HBTs The performance of this novel device has been also investigated and explained using TCAD tool

**Operation of Silicon-germanium Heterojunction Bipolar Transistors** on Marco Bellini, 2009 Recently several SiGe HBT devices fabricated on CMOS compatible silicon on insulator SOI substrates SiGe HBTs on SOI have been demonstrated combining the well known SiGe HBT performance with the advantages of SOI substrates These new devices are especially interesting in the context of extreme environments highly challenging surroundings that lie outside commercial and even military electronics specifications However fabricating HBTs on SOI substrates instead of traditional silicon bulk substrates requires extensive modifications to the structure of the transistors and results in significant trade offs The present work investigates with measurements and TCAD simulations the performance and reliability of SiGe heterojunction bipolar transistors fabricated on silicon on insulator substrates with respect to operation in extreme environments such as at extremely low or extremely high temperatures or in the presence of radiation both in terms of total ionizing dose and single effect upset

**Silicon-germanium Heterojunction Bipolar Transistors** John D. Cressler, Guofu Niu, 2003 This informative new resource presents the first comprehensive treatment of silicon germanium heterojunction bipolar transistors SiGe HBTs It offers you a complete from the ground up understanding of SiGe HBT devices and technology from a very broad perspective The book covers motivation history materials fabrication device physics operational principles and circuit level properties associated with this new cutting edge semiconductor device technology Including over 400 equations and more than 300 illustrations this hands on reference shows you in clear and concise language how to design simulate fabricate and measure a SiGe HBT

**High Frequency Characterization and Modeling of SiGe Heterojunction Bipolar Transistors** B. Gunnar Malm, Kungliga tekniska högskolan. Institutionen för

mikroelektronik och informationsteknik,2002      *Device Simulation of High-performance SiGe Heterojunction Bipolar Transistors* Julian Korn,2018      *SiGe Heterojunction Bipolar Transistors and Their Application to Integrated Injection Logic* Andrew Carl Lamb,University of Liverpool,2001      *SiGe Heterojunction Bipolar Transistors with Schottky Collector Contacts* Gianpaolo Lorito,2014      **Silicon-Germanium Heterojunction Bipolar Transistors for Mm-wave Systems Technology, Modeling and Circuit Applications** Niccolò Rinaldi,Michael Schröter,2022-09-01 The semiconductor industry is a fundamental building block of the new economy there is no area of modern life untouched by the progress of nanoelectronics The electronic chip is becoming an ever increasing portion of system solutions starting initially from less than 5% in the 1970 microcomputer era to more than 60% of the final cost of a mobile telephone 50% of the price of a personal computer representing nearly 100% of the functionalities and 30% of the price of a monitor in the early 2000 s Interest in utilizing the sub mm wave frequency spectrum for commercial and research applications has also been steadily increasing Such applications which constitute a diverse but sizeable future market span a large variety of areas such as health material science mass transit industrial automation communications and space exploration Silicon Germanium Heterojunction Bipolar Transistors for mm Wave Systems Technology Modeling and Circuit Applications provides an overview of results of the DOTSEVEN EU research project and as such focusses on key material developments for mm Wave Device Technology It starts with the motivation at the beginning of the project and a summary of its major achievements The subsequent chapters provide a detailed description of the obtained research results in the various areas of process development device simulation compact device modeling experimental characterization reliability sub mm wave circuit design and systems

**Heterojunction Bipolar Transistors for Circuit Design** Jianjun Gao,2015-04-27 A highly comprehensive summary on circuit related modeling techniques and parameter extraction methods for heterojunction bipolar transistors Heterojunction Bipolar Transistor HBT is one of the most important devices for microwave applications The book details the accurate device modeling for HBTs and high level IC design using HBTs Provides a valuable reference to basic modeling issues and specific semiconductor device models encountered in circuit simulators with a thorough reference list at the end of each chapter for onward learning Offers an overview on modeling techniques and parameter extraction methods for heterojunction bipolar transistors focusing on circuit simulation and design Presents electrical RF engineering related theory and tools and include equivalent circuits and their matrix descriptions noise small and large signal analysis methods      *Fabrication of SiGe HBT BiCMOS Technology* John D. Cressler,2018-10-03 SiGe HBT BiCMOS technology is the obvious groundbreaker of the Si heterostructures application space To date virtually every major player in the communications electronics market either has SiGe up and running in house or is using someone else s SiGe fab as foundry for their designers Key to this success lies in successful integration of the SiGe HBT and Si CMOS with no loss of performance from either device Filled with contributions from leading experts *Fabrication of SiGe HBT BiCMOS Technologies* brings together a complete discussion of these topics

into a single resource Drawn from the comprehensive and well reviewed Silicon Heterostructure Handbook this volume examines the design fabrication and application of silicon heterostructure transistors A novel aspect of this book the inclusion of numerous snapshot views of the industrial state of the art for SiGe HBT BiCMOS technology It has been carefully designed to provide a useful basis of comparison for the current status and future course of the global industry In addition to the copious technical material and the numerous references contained in each chapter the book includes easy to reference appendices on the properties of Si and Ge the generalized Moll Ross relations integral charge control relations and sample SiGe HBT compact model parameters

*Computer Simulation and Device Physics of SiGe Heterojunction Bipolar Transistors* Troy T. Herman,1991 The computer model allows the user to explore internal device physics as well as terminal characteristics of a device Field dependent mobility has been added to the program in order to more accurately compute high field transport phenomena The simulation tool is used to study the performance of silicon bipolar transistors and Si SiGe HBT s and these results are presented in chapter 4

The Role of the Silicon Germanium (SiGe) Heterojunction Bipolar Transistor (HBT) in Mobile Technology Platforms Gregory A. Mitchell,2011

**Advanced Modeling of Silicon-Germanium Heterojunction Bipolar Transistors** Andreas Pawlak,2015-10-14 Silicon Germanium Heterojunction Bipolar Transistors SiGe HBTs are perfectly suited for high speed electronics Since the fabrication costs per design cycle are rapidly increasing with progressing frequency and complexity of the systems accurate compact models are essential in order to enable robust circuit design This thesis focuses on selected important physical effects in advanced SiGe HBTs which have been either insufficiently modeled or completely missing in conventional compact models New compact model equations for the transfer current were derived and successfully applied to a large set of different technologies Hereby the Generalized Integral Charge Control Relation was used as a foundation A physics based model utilizing small signal parameters obtained from measurements is derived for modeling the current dependent collector charge A brief chapter about substrate effects in bipolar transistors comprises the derivation of a compact model for the bias dependent substrate resistance as well as a proper partitioning of the substrate capacitance New extraction methods for compact model parameters are introduced and the application of existing methods to advanced processes is discussed The derived joint extraction method for the emitter and thermal resistance as well as a scalable model for the transfer current have been successfully applied to experimental data of fast HBTs The derived model equations were applied to a selected very advanced SiGe HBT process developed by IHP Highly accurate models for DC and small signal as well as for large signal characteristics are presented

High-Frequency Bipolar Transistors Michael Reisch,2012-12-06 This book provides a rather comprehensive presentation of the physics and modeling of high frequency bipolar transistors with particular emphasis given to silicon based devices I hope it will be found useful by those who do as well as by those who intend to work in the field as it compiles and extends material presented in numerous publications in a coherent fashion I ve worked on this project for years and did my best to avoid errors De spite all

efforts it is possible that something has been overlooked during copy editing and proof reading If you find a mistake please let me know Michael Reisch Kempten December 2002 Notation It is intended here to use the most widely employed notation in cases where the standard textbook notation is different from the SPICE notation the latter is used In order to make formulas more readable model parameters represented in SPICE by a series of capital letters are written here as one capital letter with the rest in the form of a subscript e g XCJC is used here instead of the XCJC used in the SPICE input Concerning the use of lower case and capital letters the following rules are applied Time dependent large signal quantities are represented by lower case letters The variables  $t$ ,  $v$  and  $p$  therefore denote time dependent current voltage and power values

The Inverse SiGe Heterojunction Bipolar Transistor Léon Cornelis Maria van den Oever, 2002      *Current Trends in Heterojunction Bipolar Transistors* M. F. Chang, 1996 Recent advances in communication digital signal processing and computational systems demand very high performance electronic circuits Heterojunction Bipolar Transistors HBTs have the potential of providing a more efficient solution to many key system requirements through intrinsic device advantages This book reviews the present status of GaAs InP and silicon based HBT technologies and their applications to digital analog microwave and mixed signal circuits and systems It represents the first major effort to cover the complete scope of the HBT technology development in the past decade starting from the fundamental device physics material growth device reliability scaling processing modeling to advanced HBT integrated circuit design for various system applications      Fabrication and Characterisation of SiGe Heterojunction Bipolar Transistors Formed by Germanium Implantation Michele Joan Mitchell, 2001

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