

SECOND EDITION

Organometallic Vapor-Phase Epitaxy

Theory and Practice



Gerald B. Stringfellow



Organometallic Vapor Phase Epitaxy Theory And Practice

Jian-Jang Huang, Hao-Chung Kuo, Shyh-Chiang Shen



Organometallic Vapor Phase Epitaxy Theory And Practice:

Organometallic Vapor-Phase Epitaxy Gerald B. Stringfellow, 2012-12-02 Here is one of the first single author treatments of organometallic vapor phase epitaxy OMVPE a leading technique for the fabrication of semiconductor materials and devices Also included are metal organic molecular beam epitaxy MOMBE and chemical beam epitaxy CBE ultra high vacuum deposition techniques using organometallic source molecules Of interest to researchers students and people in the semiconductor industry this book provides a basic foundation for understanding the technique and the application of OMVPE for the growth of both III V and II VI semiconductor materials and the special structures required for device applications In addition a comprehensive summary detailing the OMVPE results observed to date in a wide range of III V and II VI semiconductors is provided This includes a comparison of results obtained through the use of other epitaxial techniques such as molecular beam epitaxy MBE liquid phase epitaxy LPE and vapor phase epitaxy using halide transport Organometallic Vapor Phase Epitaxy , 1992

Metalorganic Vapor Phase Epitaxy (MOVPE) Stuart Irvine, Peter Capper, 2019-10-07 Systematically discusses the growth method material properties and applications for key semiconductor materials MOVPE is a chemical vapor deposition technique that produces single or polycrystalline thin films As one of the key epitaxial growth technologies it produces layers that form the basis of many optoelectronic components including mobile phone components GaAs semiconductor lasers and LEDs III Vs nitrides optical communications oxides infrared detectors photovoltaics II IV materials etc Featuring contributions by an international group of academics and industrialists this book looks at the fundamentals of MOVPE and the key areas of equipment safety precursor chemicals and growth monitoring It covers the most important materials from III V and II VI compounds to quantum dots and nanowires including sulfides and selenides and oxides ceramics Sections in every chapter of Metalorganic Vapor Phase Epitaxy MOVPE Growth Materials Properties and Applications cover the growth of the particular materials system the properties of the resultant material and its applications The book offers information on arsenides phosphides and antimonides nitrides lattice mismatched growth CdTe MCT mercury cadmium telluride ZnO and related materials equipment and safety and more It also offers a chapter that looks at the future of the technique Covers in order the growth method material properties and applications for each material Includes chapters on the fundamentals of MOVPE and the key areas of equipment safety precursor chemicals and growth monitoring Looks at important materials such as III V and II VI compounds quantum dots and nanowires Provides topical and wide ranging coverage from well known authors in the field Part of the Materials for Electronic and Optoelectronic Applications series Metalorganic Vapor Phase Epitaxy MOVPE Growth Materials Properties and Applications is an excellent book for graduate students researchers in academia and industry as well as specialist courses at undergraduate postgraduate level in the area of epitaxial growth MOVPE MOCVD MBE

Fundamental Gas-phase and Surface Chemistry of Vapor-phase Deposition II and Process Control, Diagnostics and Modeling in Semiconductor

Manufacturing IV Electrochemical Society. High Temperature Materials Division, Electrochemical Society. Dielectric Science and Technology Division, 2001

Materials for Optoelectronics Maurice Quillec, 1996-01-31 Optoelectronics ranks one of the highest increasing rates among the different industrial branches This activity is closely related to devices which are themselves extremely dependent on materials Indeed the history of optoelectronic devices has been following closely that of the materials KLUWER Academic Publishers has thus rightly identified *Materials for Optoelectronics* as a good opportunity for a book in the series entitled *Electronic Materials Science and Technology* Although a sound background in solid state physics is recommended the authors have confined their contribution to a graduate student level and tried to define any concept they use to render the book as a whole as self consistent as possible In the first section the basic aspects are developed Here three chapters consider semiconductor materials for optoelectronics under various aspects Prof G E Stillman begins with an introduction to the field from the point of view of the optoelectronic market Then he describes how III V materials especially the Multi Quantum Structures meet the requirements of optoelectronic functions including the support of microelectronics for optoelectronic integrated circuits In chapter 2 Prof

Extended Defects in Semiconductors D. B. Holt, B. G. Yacobi, 2007-04-12 The elucidation of the effects of structurally extended defects on electronic properties of materials is especially important in view of the current advances in electronic device development that involve defect control and engineering at the nanometer level This book surveys the properties effects roles and characterization of extended defects in semiconductors The basic properties of extended defects dislocations stacking faults grain boundaries and precipitates are outlined and their effect on the electronic properties of semiconductors their role in semiconductor devices and techniques for their characterization are discussed These topics are among the central issues in the investigation and applications of semiconductors and in the operation of semiconductor devices The authors preface their treatment with an introduction to semiconductor materials and conclude with a chapter on point defect maldistributions This text is suitable for advanced undergraduate and graduate students in materials science and engineering and for those studying semiconductor physics

Solid Surfaces, Interfaces and Thin Films Hans Lüth, 2013-04-17 This book emphasises both experimental and theoretical aspects of surface interface and thin film physics Compared to the earlier editions which bore the title *Surfaces and Interfaces of Solid Materials* the book now places more emphasis on thin films including also their superconducting and ferromagnetic properties The present 4th edition thus presents techniques of preparing well defined solid surfaces and interfaces fundamental aspects of adsorption and layer growth as well as basic models for the description of structural vibronic and electronic properties of surfaces interfaces and thin films Because of their importance for modern information technology significant attention is paid to the electronic properties of semiconductor interfaces and heterostructures Collective phenomena such as superconductivity and ferromagnetism also feature prominently Experimental sections covering essential measurement and preparation techniques are presented in separate panels

Photonic Devices and

Systems Robert G. Hunsperger, 2017-10-19 This work describes all the major devices used in photonic systems. It provides a thorough overview of the field of photonics detailing practical examples of photonic technology in a wide range of applications. Photonic systems and devices are discussed with a mathematical rigor that is precise enough for design purposes yet highly readable.

Nitride Semiconductor Light-Emitting Diodes (LEDs) Jian-Jang Huang, Hao-Chung Kuo, Shyh-Chiang Shen, 2014-02-14 The development of nitride based light emitting diodes LEDs has led to advancements in high brightness LED technology for solid state lighting, handheld electronics, and advanced bioengineering applications. Nitride Semiconductor Light Emitting Diodes LEDs reviews the fabrication performance and applications of this technology that encompass the state of the art material and device development and practical nitride based LED design considerations. Part one reviews the fabrication of nitride semiconductor LEDs. Chapters cover molecular beam epitaxy (MBE), growth of nitride semiconductors, modern metalorganic chemical vapor deposition (MOCVD) techniques, and the growth of nitride based materials and gallium nitride (GaN) on sapphire and GaN on silicon technologies for LEDs. Nanostructured non polar and semi polar nitride based LEDs as well as phosphor coated nitride LEDs are also discussed. Part two covers the performance of nitride LEDs including photonic crystal LEDs, surface plasmon enhanced LEDs, color tuneable LEDs, and LEDs based on quantum wells and quantum dots. Further chapters discuss the development of LED encapsulation technology and the fundamental efficiency droop issues in gallium indium nitride (GaInN) LEDs. Finally, part three highlights applications of nitride LEDs including liquid crystal display (LCD) backlighting, infrared emitters, and automotive lighting. Nitride Semiconductor Light Emitting Diodes LEDs is a technical resource for academics, physicists, materials scientists, electrical engineers, and those working in the lighting, consumer electronics, automotive, aviation, and communications sectors. Reviews fabrication performance and applications of this technology that encompass the state of the art material and device development and practical nitride based LED design considerations. Covers the performance of nitride LEDs including photonic crystal LEDs, surface plasmon enhanced LEDs, color tuneable LEDs, and LEDs based on quantum wells and quantum dots. Highlights applications of nitride LEDs including liquid crystal display (LCD) backlighting, infra red emitters, and automotive lighting.

Second-Generation HTS Conductors Amit Goyal, 2006-06-26 The third method invented is called the Rolling assisted biaxially textured substrates (RABiTS). The book is divided into four sections. The first section discusses the three methods to fabricate biaxially textured substrates upon which epitaxial YBCO or other HTS materials can be deposited to realize a single crystal like HTS wire. The second section includes chapters on various methods of HTS deposition such as pulsed laser ablation (PLD), thermal co evaporation, sputtering, pulsed electron beam deposition, ex situ BaF₂ by co evaporation, flowed by annealing, chemical solution based ex situ processes, jet vapor deposition, metal organic chemical vapor deposition (MOCVD), and liquid phase epitaxy (LPE). The third section includes detailed chapters on other HTS materials such as the various Tl based and Hg based conductors. These Second Generation HTS conductors also referred to as Coated conductors represent

one of the most exciting developments in HTS technology **Surfaces and Interfaces of Solids** Hans Lüth,2013-11-27 Surfaces and Interfaces of Solids emphasizes both experimental and theoretical aspects of surface and interface physics Beside the techniques of preparing well defined solid surfaces and interfaces basic models for the description of structural vibronic and electronic properties of interfaces are described as well as fundamental aspects of adsorption and layer growth Because of its importance for modern microelectronics special emphasis is placed on the electronic properties of semiconductor interfaces and heterostructures Experimental topics covering the basics of ultrahigh vacuum technology electron optics surface spectroscopies and electrical interface characterization techniques are presented in the form of separate panels **Surfaces and Interfaces of Solid Materials** Hans Lüth,2013-03-09 Surfaces and Interfaces of Solid Materials emphasises both experimental and theoretical aspects of surface and interface physics Beside the techniques of preparing well defined solid surfaces and interfaces basic models for the description of structural vibronic and electronic properties of interfaces are described as well as fundamental aspects of adsorption and layer growth Because of its importance for modern microelectronics special emphasis is placed on the electronic properties of semiconductor interfaces and heterostructures Experimental topics covering the basics of ultrahigh vacuum technology electron optics surface spectroscopies and electrical interface characterization techniques are presented in the form of separate panels The New International System of Units (SI) Ernst O. Göbel,Uwe Siegener,2019-05-29 The International System of Units the SI provides the foundation for all measurements in science engineering economics and society The SI has been fundamentally revised in 2019 The new SI is a universal and highly stable unit system based on invariable constants of nature Its implementation rests on quantum metrology and quantum standards which base measurements on the manipulation and counting of single quantum objects such as electrons photons ions and flux quanta This book explains and illustrates the new SI its impact on measurements and the quantum metrology and quantum technology behind it The book is based on the book Quantum Metrology Foundation of Units and Measurements by the same authors From the contents Measurement The SI System International Unit s Realization of the SI Second Thermal Beam Cs Clock Laser Cooling and the Cs Fountain Clock Flux Quanta Josephson Effect and the SI Volt Quantum Hall Effect the SI Ohm and the SI Farad Single Charge Transfer Devices and the SI Ampere The SI Kilogram the Mole and the Planck constant The SI Kelvin and the Boltzmann Constant Beyond the present SI Optical Clocks and Quantum Radiometry Outlook *Handbook of Crystal Growth* Tatsu Nishinaga,2014-11-04 Volume IAHandbook of Crystal Growth 2nd Edition Fundamentals Thermodynamics and Kinetics Volume IA addresses the present status of crystal growth science and provides scientific tools for the following volumes Volume II Bulk Crystal Growth and III Thin Film Growth and Epitaxy Volume IA highlights thermodynamics and kinetics After historical introduction of the crystal growth phase equilibria defect thermodynamics stoichiometry and shape of crystal and structure of melt are described Then the most fundamental and basic aspects of crystal growth are presented along with the theories of nucleation

and growth kinetics In addition the simulations of crystal growth by Monte Carlo ab initio based approach and colloidal assembly are thoroughly investigated Volume IB Handbook of Crystal Growth 2nd Edition Fundamentals Transport and Stability Volume IB discusses pattern formation a typical problem in crystal growth In addition an introduction to morphological stability is given and the phase field model is explained with comparison to experiments The field of nanocrystal growth is rapidly expanding and here the growth from vapor is presented as an example For the advancement of life science the crystal growth of protein and other biological molecules is indispensable and biological crystallization in nature gives many hints for their crystal growth Another subject discussed is pharmaceutical crystal growth To understand the crystal growth in situ observation is extremely powerful The observation techniques are demonstrated Volume IA Explores phase equilibria defect thermodynamics of Si stoichiometry of oxides and atomistic structure of melt and alloys Explains basic ideas to understand crystal growth equilibrium shape of crystal rough smooth transition of step and surface nucleation and growth mechanisms Focuses on simulation of crystal growth by classical Monte Carlo ab initio based quantum mechanical approach kinetic Monte Carlo and phase field model Controlled colloidal assembly is presented as an experimental model for crystal growth Volume IIB Describes morphological stability theory and phase field model and comparison to experiments of dendritic growth Presents nanocrystal growth in vapor as well as protein crystal growth and biological crystallization Interprets mass production of pharmaceutical crystals to be understood as ordinary crystal growth and explains crystallization of chiral molecules Demonstrates in situ observation of crystal growth in vapor solution and melt on the ground and in space **Handbook of Crystal Growth** Tom Kuech, 2014-11-02 Volume IIIA Basic

Techniques Handbook of Crystal Growth Second Edition Volume IIIA Basic Techniques edited by chemical and biological engineering expert Thomas F Kuech presents the underpinning science and technology associated with epitaxial growth as well as highlighting many of the chief and burgeoning areas for epitaxial growth Volume IIIA focuses on major growth techniques which are used both in the scientific investigation of crystal growth processes and commercial development of advanced epitaxial structures Techniques based on vacuum deposition vapor phase epitaxy and liquid and solid phase epitaxy are presented along with new techniques for the development of three dimensional nano and micro structures Volume IIIB Materials Processes and Technology Handbook of Crystal Growth Second Edition Volume IIIB Materials Processes and Technology edited by chemical and biological engineering expert Thomas F Kuech describes both specific techniques for epitaxial growth as well as an array of materials specific growth processes The volume begins by presenting variations on epitaxial growth process where the kinetic processes are used to develop new types of materials at low temperatures Optical and physical characterizations of epitaxial films are discussed for both in situ and exit to characterization of epitaxial materials The remainder of the volume presents both the epitaxial growth processes associated with key technology materials as well as unique structures such as monolayer and two dimensional materials Volume IIIA Basic Techniques

Provides an introduction to the chief epitaxial growth processes and the underpinning scientific concepts used to understand and develop new processes Presents new techniques and technologies for the development of three dimensional structures such as quantum dots nano wires rods and patterned growth Introduces and utilizes basic concepts of thermodynamics transport and a wide cross section of kinetic processes which form the atomic level text of growth process Volume IIIB Materials Processes and Technology Describes atomic level epitaxial deposition and other low temperature growth techniques Presents both the development of thermal and lattice mismatched streams as the techniques used to characterize the structural properties of these materials Presents in depth discussion of the epitaxial growth techniques associated with silicone silicone based materials compound semiconductors semiconducting nitrides and refractory materials

Semiconductor Nanostructures for Optoelectronic Applications Todd D. Steiner, 2004 Annotation Tiny structures measurable on the nanometer scale one billionth of a meter are known as nanostructures and nanotechnology is the emerging application of these nanostructures into useful nanoscale devices As we enter the 21st century more and more professional are using nanotechnology to create semiconductors for a variety of applications including communications information technology medical and transportation devices Written by today s best researchers of semiconductor nanostructures this cutting edge resource provides a snapshot of this exciting and fast changing field The book covers the latest advances in nanotechnology and discusses the applications of nanostructures to optoelectronics photonics and electronics *Handbook of Distributed Feedback Laser Diodes, Second Edition* Geert Morthier, Patrick Vankwikelberge, 2013-09-01 Since the first edition of this book was published in 1997 the photonics landscape has evolved considerably and so has the role of distributed feedback DFB laser diodes Although tunable laser diodes continue to be introduced in advanced optical communication systems DFB laser diodes are still widely applied in many deployed systems This also includes wavelength tunable DFB laser diodes and DFB laser diode arrays usually integrated with intensity or phase modulators and semiconductor optical amplifiers This valuable resource gives professionals a comprehensive description of the different effects that determine the behavior of a DFB laser diode Special attention is given to two new chapters on wavelength tunable DFB laser diodes and bistable and unstable DFB laser diodes Among many other updates throughout the reference semi conductor and electromagnetic professionals are also provided two new appendices This book fully covers the underlying theory commercial applications necessary design criteria and future direction of this technology **Fabrication, Properties and Applications of Low-Dimensional Semiconductors** M. Balkanski, Ivan Yanchev, 2012-12-06 A recent major development in high technology and one which bears considerable industrial potential is the advent of low dimensional semiconductor quantum structures The research and development activity in this field is moving fast and it is thus important to afford scientists and engineers the opportunity to get updated by the best experts in the field The present book draws together the latest developments in the fabrication technology of quantum structures as well as a competent and extensive

review of their fundamental properties and some remarkable applications The book is based on a set of lectures that introduce different aspects of the basic knowledge available it has a tutorial content and could be used as a textbook Each aspect is reviewed from elementary concepts up to the latest developments Audience Undergraduates and graduates in electrical engineering and physics schools Also for active scientists and engineers updating their knowledge and understanding of the frontiers of the technology

Low-Dimensional Structures in Semiconductors A.R. Peaker, H.G. Grimmeiss, 2013-06-29 This volume contains a sequence of reviews presented at the NATO Advanced Study Institute on Low Dimensional Structures in Semiconductors from Basic Physics to Applications This was part of the International School of Materials Science and 1990 at the Ettore Majorana Centre in Sicily Technology held in July Only a few years ago Low Dimensional Structures was an esoteric concept but now it is apparent they are likely to play a major role in the next generation of electronic devices The theme of the School acknowledged this rapidly developing maturity The contributions to the volume consider not only the essential physics but take a wider view of the topic starting from material growth and processing then progressing right through to applications with some discussion of the likely use of low dimensional devices in systems The papers are arranged into four sections the first of which deals with basic concepts of semiconductor and low dimensional systems The second section is on growth and fabrication reviewing MBE and MOVPE methods and discussing the achievements and limitations of techniques to reduce structures into the realms of one and zero dimensions The third section covers the crucial issue of interfaces while the final section deals with devices and device physics

Isotope-Based Quantum Information Vladimir G. Plekhanov, 2012-05-26 The present book provides to the main ideas and techniques of the rapidly progressing field of quantum information and quantum computation using isotope mixed materials It starts with an introduction to the isotope physics and then describes of the isotope based quantum information and quantum computation The ability to manipulate and control electron and or nucleus spin in semiconductor devices provides a new route to expand the capabilities of inorganic semiconductor based electronics and to design innovative devices with potential application in quantum computing One of the major challenges towards these objectives is to develop semiconductor based systems and architectures in which the spatial distribution of spins and their properties can be controlled For instance to eliminate electron spin decoherence resulting from hyperfine interaction due to nuclear spin background isotopically controlled devices are needed i.e. nuclear spin depleted In other emerging concepts the control of the spatial distribution of isotopes with nuclear spins is a prerequisite to implement the quantum bits or qubits Therefore stable semiconductor isotopes are important elements in the development of solid state quantum information There are not only different algorithms of quantum computation discussed but also the different models of quantum computers are presented With numerous illustrations this small book is of great interest for undergraduate students taking courses in mesoscopic physics or nanoelectronics as well as quantum information and academic and industrial researches working in this field

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