

Microelectronic Materials and Processes

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**M. Datta, Tetsuya Osaka, J. Walter
Schultze**



Microelectronic Materials And Processes:

Microelectronic Materials and Processes R.A. Levy, 2012-12-06 The primary thrust of very large scale integration VLS is the miniaturization of devices to increase packing density achieve higher speed and consume lower power The fabrication of integrated circuits containing in excess of four million components per chip with design rules in the submicron range has now been made possible by the introduction of innovative circuit designs and the development of new microelectronic materials and processes This book addresses the latter challenge by assessing the current status of the science and technology associated with the production of VLSI silicon circuits It represents the cumulative effort of experts from academia and industry who have come together to blend their expertise into a tutorial overview and cohesive update of this rapidly expanding field A balance of fundamental and applied contributions cover the basics of microelectronics materials and process engineering Subjects in materials science include silicon silicides resists dielectrics and interconnect metallization Subjects in process engineering include crystal growth epitaxy oxidation thin film deposition fine line lithography dry etching ion implantation and diffusion Other related topics such as process simulation defects phenomena and diagnostic techniques are also included This book is the result of a NATO sponsored Advanced Study Institute AS held in Castelvecchio Pascoli Italy Invited speakers at this institute provided manuscripts which were edited updated and integrated with other contributions solicited from non participants to this AS

Microelectronic Materials and Processes R a Levy, 1989-01-31 Chemical Mechanical Planarization of Microelectronic Materials Joseph M. Steigerwald, Shyam P. Murarka, Ronald J. Gutmann, 1997 The concluding chapter describes post CMP cleaning techniques and most chapters feature problem sets to assist readers in developing a more practical understanding of CMP The only comprehensive reference to one of the fastest growing integrated circuit manufacturing technologies Chemical Mechanical Planarization of Microelectronic Materials is an important resource for research scientists and engineers working in the microelectronics industry

Defects in Microelectronic Materials and Devices Daniel M Fleetwood, Ronald D. Schrimpf, 2019-08-30 Uncover the Defects that Compromise Performance and Reliability As microelectronics features and devices become smaller and more complex it is critical that engineers and technologists completely understand how components can be damaged during the increasingly complicated fabrication processes required to produce them A comprehensive survey of defects that occur in silicon based metal oxide semiconductor field effect transistor MOSFET technologies this book also discusses flaws in linear bipolar technologies silicon carbide based devices and gallium arsenide materials and devices These defects can profoundly affect the yield performance long term reliability and radiation response of microelectronic devices and integrated circuits ICs Organizing the material to build understanding of the problems and provide a quick reference for scientists engineers and technologists this text reviews yield and performance limiting defects and impurities in the device silicon layer in the gate insulator and or at the critical Si SiO₂ interface It then examines defects that impact production yield and long term

reliability including Vacancies interstitials and impurities especially hydrogen Negative bias temperature instabilities Defects in ultrathin oxides SiO₂ and silicon oxynitride Take A Proactive Approach The authors condense decades of experience and perspectives of noted experimentalists and theorists to characterize defect properties and their impact on microelectronic devices They identify the defects offering solutions to avoid them and methods to detect them These include the use of 3 D imaging as well as electrical analytical computational spectroscopic and state of the art microscopic methods This book is a valuable look at challenges to come from emerging *Plasma Electronics* Toshiaki Makabe,Zoran Lj. Petrovic,2006-03-27 Without plasma processing techniques recent advances in microelectronics fabrication would not have been possible But beyond simply enabling new capabilities plasma based techniques hold the potential to enhance and improve many processes and applications They are viable over a wide range of size and time scales and can be used for deposition **Materials for Information Technology** Ehrenfried Zschech,Caroline Whelan,Thomas Mikolajick,2006-07-02 This book provides an up to date survey of the state of the art of research into the materials used in information technology and will be bought by researchers in universities institutions as well as research workers in the semiconductor and IT industries

Microelectronic Materials C.R.M. Grovenor,2017-10-05 This practical book shows how an understanding of structure thermodynamics and electrical properties can explain some of the choices of materials used in microelectronics and can assist in the design of new materials for specific applications It emphasizes the importance of the phase chemistry of semiconductor and metal systems for ensuring the long term stability of new devices The book discusses single crystal and polycrystalline silicon aluminium and gold based metallisation schemes packaging semiconductor devices failure analysis and the suitability of various materials for optoelectronic devices and solar cells It has been designed for senior undergraduates graduates and researchers in physics electronic engineering and materials science **MEMS Materials and Processes Handbook** Reza Ghodssi,Pinyen Lin,2011-03-18 MEMs Materials and Processes Handbook is a comprehensive reference for researchers searching for new materials properties of known materials or specific processes available for MEMS fabrication The content is separated into distinct sections on Materials and Processes The extensive Material Selection Guide and a Material Database guides the reader through the selection of appropriate materials for the required task at hand The Processes section of the book is organized as a catalog of various microfabrication processes each with a brief introduction to the technology as well as examples of common uses in MEMs *The Science and Engineering of Microelectronic Fabrication* Stephen A. Campbell,1996 The Science and Engineering of Microelectronic Fabrication provides an introduction to microelectronic processing Geared towards a wide audience it may be used as a textbook for both first year graduate and upper level undergraduate courses and as a handy reference for professionals The text covers all the basic unit processes used to fabricate integrated circuits including photolithography plasma and reactive ion etching ion implantation diffusion oxidation evaporation vapor phase epitaxial growth sputtering and chemical vapor deposition Advanced processing topics

such as rapid thermal processing nonoptical lithography molecular beam epitaxy and metal organic chemical vapor deposition are also presented The physics and chemistry of each process is introduced along with descriptions of the equipment used for the manufacturing of integrated circuits The text also discusses the integration of these processes into common technologies such as CMOS double poly bipolar and GaAs MESFETs Complexity performance tradeoffs are evaluated along with a description of the current state of the art devices Each chapter includes sample problems with solutions The book also makes use of the process simulation package SUPREM to demonstrate impurity profiles of practical interest

Microelectronics Processing Dennis W. Hess, Klavs F. Jensen, 1989 Although chemical engineering principles are at the heart of solid state process technology until now no reference volume addressing this relationship was available This is the first book of its kind to tie fundamental engineering concepts to solid state process technology Discussing the basic concepts involved liquid phase epitaxy physical and chemical vapor deposition diffusion and oxidation in silicon resists in microlithography etc this volume will be particularly useful in chemical engineering courses It offers a framework within which specialized courses in microelectronics processing can be organized In addition it serves as a valuable reference source for all industrial engineers working with the individual process steps covered

Introduction to Microelectronic Fabrication Richard C. Jaeger, 1988

Microelectronic Test Structures for CMOS Technology Manjul Bhushan, Mark B. Ketchen, 2011-08-26 Microelectronic Test Structures for CMOS Technology and Products addresses the basic concepts of the design of test structures for incorporation within test vehicles scribe lines and CMOS products The role of test structures in the development and monitoring of CMOS technologies and products has become ever more important with the increased cost and complexity of development and manufacturing In this timely volume IBM scientists Manjul Bhushan and Mark Ketchen emphasize high speed characterization techniques for digital CMOS circuit applications and bridging between circuit performance and characteristics of MOSFETs and other circuit elements Detailed examples are presented throughout many of which are equally applicable to other microelectronic technologies as well The authors overarching goal is to provide students and technology practitioners alike a practical guide to the disciplined design and use of test structures that give unambiguous information on the parametrics and performance of digital CMOS technology

Fundamentals of Semiconductor Manufacturing and Process Control Gary S. May, Costas J. Spanos, 2006-05-26 A practical guide to semiconductor manufacturing from process control to yield modeling and experimental design Fundamentals of Semiconductor Manufacturing and Process Control covers all issues involved in manufacturing microelectronic devices and circuits including fabrication sequences process control experimental design process modeling yield modeling and CIM CAM systems Readers are introduced to both the theory and practice of all basic manufacturing concepts Following an overview of manufacturing and technology the text explores process monitoring methods including those that focus on product wafers and those that focus on the equipment used to produce wafers Next the text sets forth some fundamentals of statistics

and yield modeling which set the foundation for a detailed discussion of how statistical process control is used to analyze quality and improve yields. The discussion of statistical experimental design offers readers a powerful approach for systematically varying controllable process conditions and determining their impact on output parameters that measure quality. The authors introduce process modeling concepts including several advanced process control topics such as run by run supervisory control and process and equipment diagnosis. Critical coverage includes the following: Combines process control and semiconductor manufacturing; Unique treatment of system and software technology and management of overall manufacturing systems; Chapters include case studies, sample problems and suggested exercises; Instructor support includes electronic copies of the figures and an instructor's manual. Graduate level students and industrial practitioners will benefit from the detailed examination of how electronic materials and supplies are converted into finished integrated circuits and electronic products in a high volume manufacturing environment. An Instructor's Manual presenting detailed solutions to all the problems in the book is available from the Wiley editorial department. An Instructor Support FTP site is also available.

Microelectronic Packaging M. Datta, Tetsuya Osaka, J. Walter Schultze, 2004-12-20 Microelectronic Packaging analyzes the massive impact of electrochemical technologies on various levels of microelectronic packaging. Traditionally, interconnections within a chip were considered outside the realm of packaging technologies, but this book emphasizes the importance of chip wiring as a key aspect of microelectronic packaging and focuses on electrochemical processing as an enabler of advanced chip metallization. Divided into five parts, the book begins by outlining the basics of electrochemical processing, defining the microelectronic packaging hierarchy and emphasizing the impact of electrochemical technology on packaging. The second part discusses chip metallization topics including the development of robust barrier layers and alternative metallization materials. Part III explores key aspects of chip package interconnect technologies, followed by Part IV's analysis of packages, boards, and connectors, which covers materials development, technology trends in ceramic packages, and multi-chip modules and electroplated contact materials. Illustrating the importance of processing tools in enabling technology development, the book concludes with chapters on chemical mechanical planarization, electroplating, and wet etching/cleaning tools. Experts from industry, universities, and national laboratories submitted reviews on each of these subjects, capturing the technological advances made in each area. A detailed examination of how packaging responds to the challenges of Moore's law, this book serves as a timely and valuable reference for microelectronic packaging and processing professionals and other industrial technologists.

DeGarmo's Materials and Processes in Manufacturing J. T. Black, Ronald A. Kohser, 2011-08-30 Now in its eleventh edition, DeGarmo's Materials and Processes in Manufacturing has been a market-leading text on manufacturing and manufacturing processes courses for more than fifty years. Authors J. T. Black and Ron Kohser have continued this book's long and distinguished tradition of exceedingly clear presentation and highly practical approach to materials and processes, presenting mathematical models and analytical equations only when

they enhance the basic understanding of the material Completely revised and updated to reflect all current practices standards and materials the eleventh edition has new coverage of additive manufacturing lean engineering and processes related to ceramics polymers and plastics

Dielectric Films for Advanced Microelectronics Mikhail Baklanov, Karen Maex, Martin Green, 2007-04-04 The topic of thin films is an area of increasing importance in materials science electrical engineering and applied solid state physics with both research and industrial applications in microelectronics computer manufacturing and physical devices Advanced high performance computers high definition TV broadband imaging systems flat panel displays robotic systems and medical electronics and diagnostics are a few examples of the miniaturized device technologies that depend on the utilization of thin film materials This book presents an in depth overview of the novel developments made by the scientific leaders in the area of modern dielectric films for advanced microelectronic applications It contains clear concise explanations of material science of dielectric films and their problem for device operation including high k low k medium k dielectric films and also specific features and requirements for dielectric films used in the packaging technology A broad range of related topics are covered from physical principles to design fabrication characterization and applications of novel dielectric films

Encapsulation Technologies for Electronic Applications Haleh Ardebili, Michael G. Pecht, 2009-07-22 Electronics are used in a wide range of applications including computing communication biomedical automotive military and aerospace They must operate in varying temperature and humidity environments including indoor controlled conditions and outdoor climate changes Moisture ionic contamination heat radiation and mechanical stresses are all highly detrimental to electronic devices and can lead to device failures Therefore it is essential that the electronic devices be packaged for protection from their intended environments as well as to provide handling assembly electrical and thermal considerations Currently more than 99% of microelectronic devices are plastic encapsulated Improvements in encapsulant materials and cost incentives have stretched the application boundaries for plastic electronic packages Many electronic applications that traditionally used hermetic packages such as military are now using commercial off the shelf COTS plastic packages Plastic encapsulation has the advantages of low cost smaller form factors and improved manufacturability With recent trends in environmental awareness new environmentally friendly or green encapsulant materials i e without brominated additives have emerged Plastic packages are also being considered for use in extreme high and low temperature electronics 3 D packaging and wafer level packaging WLP require unique encapsulation techniques Encapsulant materials are also being developed for micro electro mechanical systems MEMS bio MEMS bio electronics and organic light emitting diodes O LEDs This book offers a comprehensive discussion of encapsulants in electronic applications The main emphasis is on the encapsulation of microelectronic devices however the encapsulation of connectors and transformers is also addressed This book discusses 2 D and 3 D packaging and encapsulation encapsulation materials including environmentally friendly green encapsulants and the properties and characterization of encapsulants Furthermore this book provides an extensive

discussion on defects and failures related to encapsulation how to analyze such defects and failures and how to apply quality assurance and qualification process for encapsulated packages This book also provides information on the trends and challenges of encapsulation and microelectronic packages including application of nanotechnology Guidance on the selection and use of encapsulants in the electronics industry with a particular focus on microelectronics Coverage of environmentally friendly green encapsulants Practical coverage of faults and defects how to analyze them and how to avoid them

Microelectronic Applications of Chemical Mechanical Planarization Yuzhuo Li, 2007-12-04 An authoritative systematic and comprehensive description of current CMP technology Chemical Mechanical Planarization CMP provides the greatest degree of planarization of any known technique The current standard for integrated circuit IC planarization CMP is playing an increasingly important role in other related applications such as microelectromechanical systems MEMS and computer hard drive manufacturing This reference focuses on the chemical aspects of the technology and includes contributions from the foremost experts on specific applications After a detailed overview of the fundamentals and basic science of CMP

Microelectronic Applications of Chemical Mechanical Planarization Provides in depth coverage of a wide range of state of the art technologies and applications Presents information on new designs capabilities and emerging technologies including topics like CMP with nanomaterials and 3D chips Discusses different types of CMP tools pads for IC CMP modeling and the applicability of tribometry to various aspects of CMP Covers nanotopography CMP performance and defect profiles CMP waste treatment and the chemistry and colloidal properties of the slurries used in CMP Provides a perspective on the opportunities and challenges of the next fifteen years Complete with case studies this is a valuable hands on resource for professionals including process engineers equipment engineers formulation chemists IC manufacturers and others With systematic organization and questions at the end of each chapter to facilitate learning it is an ideal introduction to CMP and an excellent text for students in advanced graduate courses that cover CMP or related semiconductor manufacturing processes

Sputtering Materials for VLSI and Thin Film Devices Jaydeep Sarkar, 2010-12-13 An important resource for students engineers and researchers working in the area of thin film deposition using physical vapor deposition e g sputtering for semiconductor liquid crystal displays high density recording media and photovoltaic device e g thin film solar cell manufacturing This book also reviews microelectronics industry topics such as history of inventions and technology trends recent developments in sputtering technologies manufacturing steps that require sputtering of thin films the properties of thin films and the role of sputtering target performance on overall productivity of various processes Two unique chapters of this book deal with productivity and troubleshooting issues The content of the book has been divided into two sections a the first section Chapter 1 to Chapter 3 has been prepared for the readers from a range of disciplines e g electrical chemical chemistry physics trying to get an insight into use of sputtered films in various devices e g semiconductor display photovoltaic data storage basic of sputtering and performance of sputtering target in relation to productivity and b the

second section Chapter 4 to Chapter 8 has been prepared for readers who already have background knowledge of sputter deposition of thin films materials science principles and interested in the details of sputtering target manufacturing methods sputtering behavior and thin film properties specific to semiconductor liquid crystal display photovoltaic and magnetic data storage applications In Chapters 5 to 8 a general structure has been used i e a description of the applications of sputtered thin films sputtering target manufacturing methods including flow charts sputtering behavior of targets e g current voltage relationship deposition rate and thin film properties e g microstructure stresses electrical properties in film particles While discussing these topics attempts have been made to include examples from the actual commercial processes to highlight the increased complexity of the commercial processes with the growth of advanced technologies In addition to personnel working in industry setting university researchers with advanced knowledge of sputtering would also find discussion of such topics e g attributes of target design chamber design target microstructure sputter surface characteristics various troubleshooting issues useful Unique coverage of sputtering target manufacturing methods in the light of semiconductor displays data storage and photovoltaic industry requirements Practical information on technology trends role of sputtering and major OEMs Discussion on properties of a wide variety of thin films which include silicides conductors diffusion barriers transparent conducting oxides magnetic films etc Practical case studies on target performance and troubleshooting Essential technological information for students engineers and scientists working in the semiconductor display data storage and photovoltaic industry

Electronic Materials and Processes Handbook Charles A. Harper, 2003-08-07 Electronic materials are the actual semiconductors plastics metals and ceramics that make up the chips and packages from which we construct today s cell phones palmtops and PDAs The switch in applications from PCs to smaller communications devices has driven the micro miniaturization trend in electronics which in turn has created a new set of challenges in creating materials to meet their specifications This new edition the first update of the handbook since 1993 is a complete rewrite reflecting the great importance of engineering materials for thermal management and flexibility and micro miniature sizes This new handbook will be an invaluable tool to anyone working electronic packaging fabrication or assembly design

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Microelectronic Materials And Processes Introduction

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