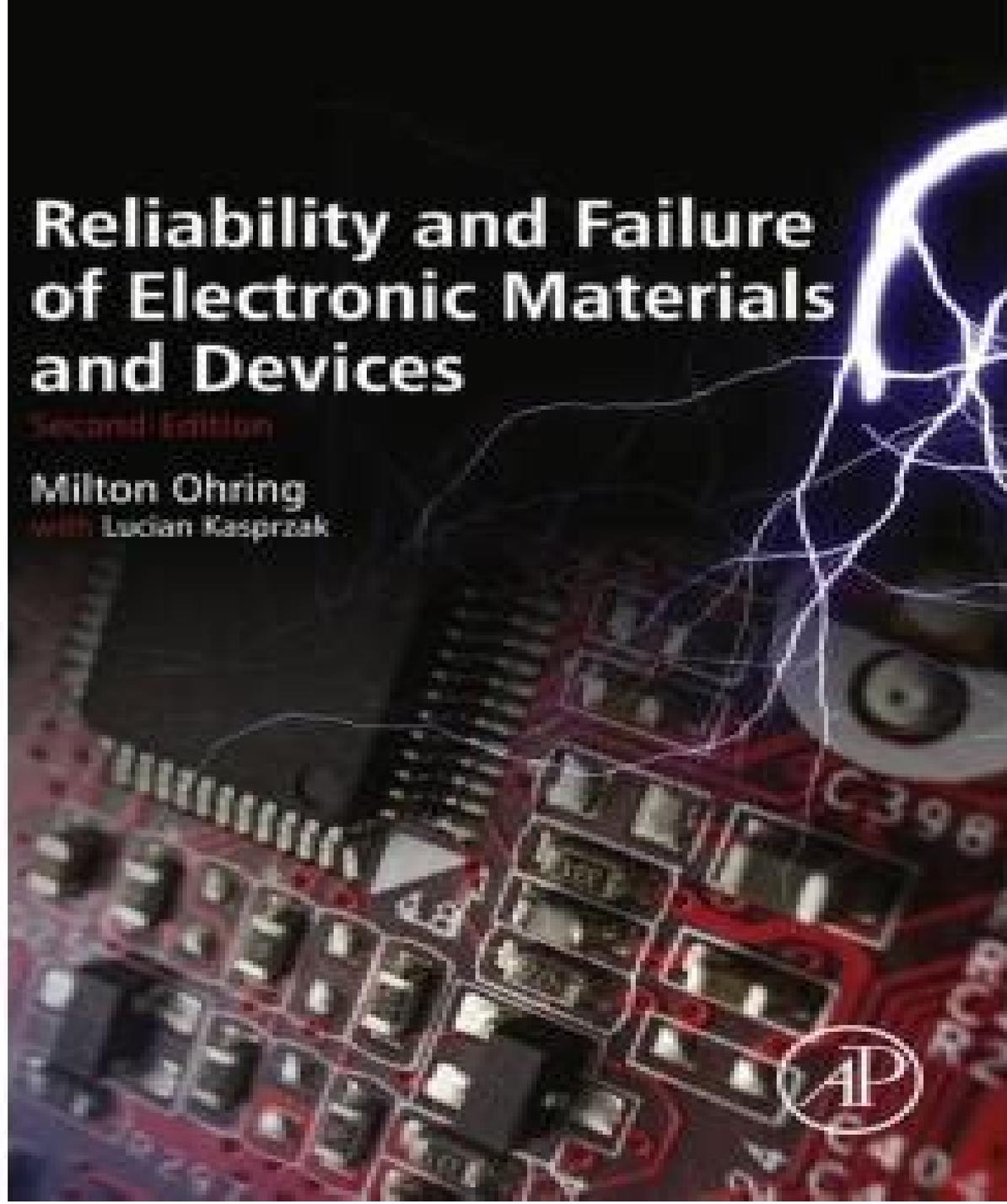


# Reliability and Failure of Electronic Materials and Devices

Second Edition

Milton Ohring  
with Lucian Kasprzak



# Reliability And Failure Of Electronic Materials And Devices

**Daniel F McAuley**



## **Reliability And Failure Of Electronic Materials And Devices:**

*Reliability and Failure of Electronic Materials and Devices* Milton Ohring, Lucian Kasprzak, 2014-10-14 Reliability and Failure of Electronic Materials and Devices is a well established and well regarded reference work offering unique single source coverage of most major topics related to the performance and failure of materials used in electronic devices and electronics packaging With a focus on statistically predicting failure and product yields this book can help the design engineer manufacturing engineer and quality control engineer all better understand the common mechanisms that lead to electronics materials failures including dielectric breakdown hot electron effects and radiation damage This new edition adds cutting edge knowledge gained both in research labs and on the manufacturing floor with new sections on plastics and other new packaging materials new testing procedures and new coverage of MEMS devices Covers all major types of electronics materials degradation and their causes including dielectric breakdown hot electron effects electrostatic discharge corrosion and failure of contacts and solder joints New updated sections on failure physics on mass transport induced failure in copper and low k dielectrics and on reliability of lead free reduced lead solder connections New chapter on testing procedures sample handling and sample selection and experimental design Coverage of new packaging materials including plastics and composites

*Reliability and Failure of electronic Materials and Devices 2/E* Milton Ohring, 2015-04 **Reliability and Failure of Electronic Materials and Devices** Milton Ohring, Lucian Kasprzak, 2015 **Materials and Reliability Handbook for Semiconductor Optical and Electron Devices** Osamu Ueda, Stephen J. Pearton, 2012-09-22 Materials and Reliability Handbook for Semiconductor Optical and Electron Devices provides comprehensive coverage of reliability procedures and approaches for electron and photonic devices These include lasers and high speed electronics used in cell phones satellites data transmission systems and displays Lifetime predictions for compound semiconductor devices are notoriously inaccurate due to the absence of standard protocols Manufacturers have relied on extrapolation back to room temperature of accelerated testing at elevated temperature This technique fails for scaled high current density devices Device failure is driven by electric field or current mechanisms or low activation energy processes that are masked by other mechanisms at high temperature The Handbook addresses reliability engineering for III V devices including materials and electrical characterization reliability testing and electronic characterization These are used to develop new simulation technologies for device operation and reliability which allow accurate prediction of reliability as well as the design specifically for improved reliability The Handbook emphasizes physical mechanisms rather than an electrical definition of reliability Accelerated aging is useful only if the failure mechanism is known The Handbook also focuses on voltage and current acceleration stress mechanisms

*Reliability and Failure of Electronic Materials and Devices* Milton Ohring, Lucian Kasprzak, James R Lloyd, 2017-11-13 Reliability and Failure of Electronic Materials and Devices is a well established and well regarded reference work offering unique single source coverage of most major topics related to the performance and failure

of materials used in electronic devices and electronics packaging With a focus on statistically predicting failure and product yields this book can help the design engineer manufacturing engineer and quality control engineer all better understand the common mechanisms that lead to electronics materials failures including dielectric breakdown hot electron effects and radiation damage This new edition adds cutting edge knowledge gained both in research labs and on the manufacturing floor with new sections on plastics and other new packaging materials new testing procedures and new coverage of MEMS devices Covers all major types of electronics materials degradation and their causes including dielectric breakdown hot electron effects electrostatic discharge corrosion and failure of contacts and solder joints New updated sections on failure physics on mass transport induced failure in copper and low k dielectrics and on reliability of lead free reduced lead solder connections New chapter on testing procedures sample handling and sample selection and experimental design Coverage of new packaging materials including plastics and composites

**Semiconductor Device Reliability** A. Christou, B.A. Unger, 2012-12-06 This publication is a compilation of papers presented at the Semiconductor Device Reliability Workshop sponsored by the NATO International Scientific Exchange Program The Workshop was held in Crete Greece from June 4 to June 9 1989 The objective of the Workshop was to review and to further explore advances in the field of semiconductor reliability through invited paper presentations and discussions The technical emphasis was on quality assurance and reliability of optoelectronic and high speed semiconductor devices The primary support for the meeting was provided by the Scientific Affairs Division of NATO We are indebted to NATO for their support and to Dr Craig Sinclair who administers this program The chapters of this book follow the format and order of the sessions of the meeting Thirty six papers were presented and discussed during the five day Workshop In addition two panel sessions were held with audience participation where the particularly controversial topics of burn in and reliability modeling and prediction methods were discussed A brief review of these sessions is presented in this book

**Component Reliability for Electronic Systems** Titu I. Băjenescu, Marius I. Băzu, 2010 The main reason for the premature breakdown of today's electronic products computers cars tools appliances etc is the failure of the components used to build these products Today professionals are looking for effective ways to minimize the degradation of electronic components to help ensure longer lasting more technically sound products and systems This practical book offers engineers specific guidance on how to design more reliable components and build more reliable electronic systems Professionals learn how to optimize a virtual component prototype accurately monitor product reliability during the entire production process and add the burn in and selection procedures that are the most appropriate for the intended applications Moreover the book helps system designers ensure that all components are correctly applied margins are adequate wear out failure modes are prevented during the expected duration of life and system interfaces cannot lead to failure

Failure Analysis Marius Bazu, Titu Băjenescu, 2011-03-08 Failure analysis is the preferred method to investigate product or process reliability and to ensure optimum performance of electrical components and

systems The physics of failure approach is the only internationally accepted solution for continuously improving the reliability of materials devices and processes The models have been developed from the physical and chemical phenomena that are responsible for degradation or failure of electronic components and materials and now replace popular distribution models for failure mechanisms such as Weibull or lognormal Reliability engineers need practical orientation around the complex procedures involved in failure analysis This guide acts as a tool for all advanced techniques their benefits and vital aspects of their use in a reliability programme Using twelve complex case studies the authors explain why failure analysis should be used with electronic components when implementation is appropriate and methods for its successful use Inside you will find detailed coverage on a synergistic approach to failure modes and mechanisms along with reliability physics and the failure analysis of materials emphasizing the vital importance of cooperation between a product development team involved the reasons why failure analysis is an important tool for improving yield and reliability by corrective actions the design stage highlighting the concurrent engineering approach and DfR Design for Reliability failure analysis during fabrication covering reliability monitoring process monitors and package reliability reliability testing after fabrication including reliability assessment at this stage and corrective actions a large variety of methods such as electrical methods thermal methods optical methods electron microscopy mechanical methods X Ray methods spectroscopic acoustical and laser methods new challenges in reliability testing such as its use in microsystems and nanostructures This practical yet comprehensive reference is useful for manufacturers and engineers involved in the design fabrication and testing of electronic components devices ICs and electronic systems as well as for users of components in complex systems wanting to discover the roots of the reliability flaws for their products

**Modern Power Electronic Devices** Francesco Iannuzzo,2020-10 Power devices are key to modern power systems performing functions such as inverting and changing voltages buffering and switching Following a device centric approach this book covers power electronic applications semiconductor physics materials science application engineering and key technologies such as MOSFET IGBT and WBG

**Reliability of Semiconductor Lasers and Optoelectronic Devices** Robert Herrick,Osamu Ueda,2021-03-11 Front Cover Reliability of Semiconductor Lasers and Optoelectronic Devices Copyright Page Dedication Contents List of contributors Preface Acknowledgments 1 Introduction to optoelectronic devices 1 1 Introduction 1 2 Optoelectronic applications 1 2 1 InGaN based light emitting diodes for high efficiency lighting 1 2 2 Lasers for sensing arrays 1 2 3 Lasers for data and telecommunications 1 2 4 The history of the laser 1 3 Principles of operation for optoelectronic components 1 3 1 Light emission 1 3 1 1 Light emission in gas plasmas a review 1 3 1 2 Stimulated emission in gas lasers 1 3 1 3 Spontaneous and stimulated emission from semiconductors 1 3 2 Light emitting diodes 1 3 2 1 Carrier confinement 1 3 2 2 Light extraction 1 3 2 3 Heat extraction 1 3 2 4 Rollover or droop 1 3 2 5 The green gap 1 3 3 Lasers 1 3 3 1 What additional design features exist with lasers that are not present with an light emitting diode Adding a population inversion Adding waveguiding Adding mirrors 1 3 3 2 Vertical cavity surface emitting

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*Reliability Characterisation of Electrical and Electronic Systems* Jonathan Swingler, 2020-11-15 The book charts how reliability engineering has moved from the use of sometimes arbitrary standards to an empirical scientific approach of understanding operating conditions failure mechanisms the need for testing for a more realistic characterisation and new for the second edition includes the monitoring of performance robustness in the field Reliability Characterisation of Electrical and Electronic Systems brings together a number of experts and key players in the discipline to concisely present the fundamentals and background to reliability theory elaborate on the current thinking and developments behind reliability characterisation and give a detailed account of emerging issues across a wide range of applications The second edition has a new section titled Reliability Condition Monitoring and Prognostics for Specific Application which provides a guide to critical issues in key industrial sectors such as automotive and aerospace There are also new chapters on areas of growing importance such as reliability methods in high temperature electronics and reliability and testing of electric aircraft power systems Reviews emerging areas of importance such as reliability methods in high temperature electronics and reliability testing of electric vehicles Looks at the failure mechanisms testing methods failure analysis characterisation techniques and prediction models that can be used to increase reliability Facilitates a greater understanding of operating conditions failure mechanisms and the need for testing

**Reliability of Electronic Packages and Semiconductor Devices** Giulio Di Giacomo, 1997 This text looks at predicting and extending the functional life of semiconductor components Using empirical modelling the author covers major types of failure mechanisms that can greatly reduce the active life of semiconductor components including interconnection fatigue and electromigration

**Electronic Failure Analysis Handbook** Perry L. Martin, 1999 Annotation In the Electronic Failure Analysis Handbook you ll find top to bottom coverage of this rapidly developing field encompassing breakthrough techniques and technologies for both components and systems reliability testing performance evaluation and liability avoidance BOOK JACKET Title Summary field provided by Blackwell North America Inc All Rights Reserved

*Influence of Temperature on Microelectronics and System Reliability* Pradeep Lall, Michael G. Pecht, Edward B. Hakim, 2020-07-09 This book raises the level of understanding of thermal design criteria It provides the design team with sufficient knowledge to help them evaluate device architecture trade offs and the effects of operating temperatures The author provides readers a sound scientific basis for system operation at realistic steady state temperatures without reliability penalties Higher temperature performance than is commonly recommended is shown to be

cost effective in production for life cycle costs The microelectronic package considered in the book is assumed to consist of a semiconductor device with first level interconnects that may be wirebonds flip chip or tape automated bonds die attach substrate substrate attach case lid lid seal and lead seal The temperature effects on electrical parameters of both bipolar and MOSFET devices are discussed and models quantifying the temperature effects on package elements are identified Temperature related models have been used to derive derating criteria for determining the maximum and minimum allowable temperature stresses for a given microelectronic package architecture The first chapter outlines problems with some of the current modeling strategies The next two chapters present microelectronic device failure mechanisms in terms of their dependence on steady state temperature temperature cycle temperature gradient and rate of change of temperature at the chip and package level Physics of failure based models used to characterize these failure mechanisms are identified and the variabilities in temperature dependence of each of the failure mechanisms are characterized Chapters 4 and 5 describe the effects of temperature on the performance characteristics of MOS and bipolar devices Chapter 6 discusses using high temperature stress screens including burn in for high reliability applications The burn in conditions used by some manufacturers are examined and a physics of failure approach is described The Electronic Thin-Film Reliability King-Ning Tu, 2010-11-25 Thin films are widely used in the electronic device industry As the trend for miniaturization of electronic devices moves into the nanoscale domain the reliability of thin films becomes an increasing concern Building on the author's previous book *Electronic Thin Film Science* by Tu Mayer and Feldman and based on a graduate course at UCLA given by the author this new book focuses on reliability science and the processing of thin films Early chapters address fundamental topics in thin film processes and reliability including deposition surface energy and atomic diffusion before moving onto systematically explain irreversible processes in interconnect and packaging technologies Describing electromigration thermomigration and stress migration with a closing chapter dedicated to failure analysis the reader will come away with a complete theoretical and practical understanding of electronic thin film reliability Kept mathematically simple with real world examples this book is ideal for graduate students researchers and practitioners *Corrosion and Reliability of Electronic Materials and Devices* Robert B. Comizzoli, Robert Peter Frankenthal, James Douglas Sinclair, 1999

**Electronic Materials Handbook**, 1989-11-01 Volume 1 Packaging is an authoritative reference source of practical information for the design or process engineer who must make informed day to day decisions about the materials and processes of microelectronic packaging Its 117 articles offer the collective knowledge wisdom and judgement of 407 microelectronics packaging experts authors co authors and reviewers representing 192 companies universities laboratories and other organizations This is the inaugural volume of ASMAs all new *Electronic Materials Handbook* series designed to be the *Metals Handbook* of electronics technology In over 65 years of publishing the *Metals Handbook* ASM has developed a unique editorial method of compiling large technical reference books ASMAs access to leading materials technology experts

enables to organize these books on an industry consensus basis Behind every article Is an author who is a top expert in its specific subject area This multi author approach ensures the best most timely information throughout Individually selected panels of 5 and 6 peers review each article for technical accuracy generic point of view and completeness Volumes in the Electronic Materials Handbook series are multidisciplinary to reflect industry practice applied in integrating multiple technology disciplines necessary to any program in advanced electronics Volume 1 Packaging focusing on the middle level of the electronics technology size spectrum offers the greatest practical value to the largest and broadest group of users Future volumes in the series will address topics on larger integrated electronic assemblies and smaller semiconductor materials and devices size levels Oxide Reliability D. J. Dumin,2002 Presents in summary the state of our knowledge of oxide reliability

### **Reliability in Power Electronics and Electrical Machines: Industrial Applications and Performance Models**

Kaboli, Shahriyar,Oraee, Hashem,2016-03-08 In modern industries electrical energy conversion systems consist of two main parts electrical machines and power electronic converters With global electricity use at an all time high uninterrupted operation of electrical power converters is essential Reliability in Power Electronics and Electrical Machines Industrial Applications and Performance Models provides an in depth analysis of reliability in electrical energy converters as well as strategies for designing dependable power electronic converters and electrical machines Featuring a comprehensive discussion on the topics of reliability design and measurement failure mechanisms and specific issues pertaining to quality efficiency and durability this timely reference source offers practical examples and research based results for use by engineers researchers and advanced level students **Reliability Technology** Norman Pascoe,2011-04-25 A unique book that describes the practical processes necessary to achieve failure free equipment performance for quality and reliability engineers design manufacturing process and environmental test engineers This book studies the essential requirements for successful product life cycle management It identifies key contributors to failure in product life cycle management and particular emphasis is placed upon the importance of thorough Manufacturing Process Capability reviews for both in house and outsourced manufacturing strategies The readers attention is also drawn to the many hazards to which a new product is exposed from the commencement of manufacture through to end of life disposal Revolutionary in focus as it describes how to achieve failure free performance rather than how to predict an acceptable performance failure rate reliability technology rather than reliability engineering Author has over 40 years experience in the field and the text is based on classroom tested notes from the reliability technology course he taught at Massachusetts Institute of Technology MIT USA Contains graphical interpretations of mathematical models together with diagrams tables of physical constants case studies and unique worked examples

## Whispering the Techniques of Language: An Psychological Journey through **Reliability And Failure Of Electronic Materials And Devices**

In a digitally-driven earth where monitors reign great and quick communication drowns out the subtleties of language, the profound techniques and mental nuances hidden within phrases frequently move unheard. Yet, situated within the pages of **Reliability And Failure Of Electronic Materials And Devices** a captivating literary prize sporting with natural emotions, lies a fantastic journey waiting to be undertaken. Written by a skilled wordsmith, that enchanting opus encourages readers on an introspective trip, delicately unraveling the veiled truths and profound affect resonating within ab muscles material of each and every word. Within the mental depths with this poignant evaluation, we shall embark upon a heartfelt exploration of the book is core subjects, dissect its charming writing style, and yield to the effective resonance it evokes heavy within the recesses of readers hearts.

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