

# Solder Joint Reliability

Theory and Applications



Edited by John H. Lau

# Solder Joint Reliability Theory And Applications

**Ephraim Suhir, Y.C. Lee, C.P. Wong**



## **Solder Joint Reliability Theory And Applications:**

**Solder Joint Reliability** John H. Lau, 2013-11-27 Solders have given the designer of modern consumer commercial and military electronic systems a remarkable flexibility to interconnect electronic components The properties of solder have facilitated broad assembly choices that have fueled creative applications to advance technology Solder is the electrical and mechanical glue of electronic assemblies This pervasive dependency on solder has stimulated new interest in applications as well as a more concerted effort to better understand materials properties We need not look far to see solder being used to interconnect ever finer geometries Assembly of micropassive discrete devices that are hardly visible to the unaided eye of silicon chips directly to ceramic and plastic substrates and of very fine peripheral leaded packages constitute a few of solder's uses There has been a marked increase in university research related to solder New electronic packaging centers stimulate applications and materials engineering and science departments have demonstrated a new vigor to improve both the materials and our understanding of them Industrial research and development continues to stimulate new application and refreshing new packaging ideas are emerging New handbooks have been published to help both the neophyte and seasoned packaging engineer

Solder Joint Reliability John H. Lau, 1991-05-31 Looks at how solder joint reliability is influenced by flux reactions solder paste reflow methods wave soldering and cleaning Explores failure mechanisms and includes practical methods for testing analysis and life prediction of solder joints subjected to conditions of fatigue creep stress relaxation shock and vibration For engineers and designers involved in electronics packaging Annotation copyrighted by Book News Inc Portland OR

Solder Joint Reliability John H. Lau, 2014-09-01      Assembly and Reliability of Lead-Free Solder Joints John H. Lau, Ning-Cheng Lee, 2020-05-29 This book focuses on the assembly and reliability of lead free solder joints Both the principles and engineering practice are addressed with more weight placed on the latter This is achieved by providing in depth studies on a number of major topics such as solder joints in conventional and advanced packaging components commonly used lead free materials soldering processes advanced specialty flux designs characterization of lead free solder joints reliability testing and data analyses design for reliability and failure analyses for lead free solder joints Uniquely the content not only addresses electronic manufacturing services EMS on the second level interconnects but also packaging assembly on the first level interconnects and the semiconductor back end on the 3D IC integration interconnects Thus the book offers an indispensable resource for the complete food chain of electronics products

Micro- and Opto-Electronic Materials and Structures: Physics, Mechanics, Design, Reliability, Packaging Ephraim Suhir, Y.C. Lee, C.P. Wong, 2007-05-26 This handbook provides the most comprehensive up to date and easy to apply information on the physics mechanics reliability and packaging of micro and opto electronic materials It details their assemblies structures and systems and each chapter contains a summary of the state of the art in a particular field The book provides practical recommendations on how to apply current knowledge and technology to design and manufacture It further describes how to operate a viable reliable

and cost effective electronic component or photonic device and how to make such a device into a successful commercial product

***Microelectronics Packaging Handbook*** Rao Tummala, Eugene J. Rymaszewski, Alan G. Klopfenstein, 1997-01-31 This thoroughly revised and updated three volume set continues to be the standard reference in the field providing the latest in microelectronics design methods modeling tools simulation techniques and manufacturing procedures Unlike reference books that focus only on a few aspects of microelectronics packaging these outstanding volumes discuss state of the art packages that meet the power cooling protection and interconnection requirements of increasingly dense and fast microcircuitry Providing an excellent balance of theory and practical applications this dynamic compilation features step by step examples and vital technical data simplifying each phase of package design and production In addition the volumes contain over 2000 references 900 figures and 250 tables Part I Technology Drivers covers the driving force of microelectronics packaging electrical thermal and reliability It introduces the technology developer to aspects of manufacturing that must be considered during product development Part II Semiconductor Packaging discusses the interconnection of the IC chip to the first level of packaging and all first level packages Electrical test sealing and encapsulation technologies are also covered in detail Part III Subsystem Packaging explores board level packaging as well as connectors cables and optical packaging

**Avoiding Inelastic Strains in Solder Joint Interconnections of IC Devices** Ephraim Suhir, 2021-01-27 Avoiding Inelastic Strains in Solder Joint Interconnections of IC Devices addresses analytical mathematical modeling approaches aimed at understanding the underlying physics and mechanics of the behavior and performance of solder materials and solder joint interconnections of IC devices The emphasis is on design for reliability including probabilistic predictions of the solder lifetime Describes how to use the developed methods of analytical predictive modeling to minimize thermal stresses and strains in solder joint of IC devices Shows how to build the preprocessing models in finite element analyses FEA by comparing the FEA and analytical data Covers how to design the most effective test vehicles for testing solder joints Details how to design and organize in addition to or sometimes even instead of highly accelerated life tests HALT highly focused and highly cost effective failure oriented accelerated testing FOAT to understand the physic of failure of solder joint interconnections Outlines how to convert the low cycle fatigue conditions into elastic fatigue conditions and to assess the fatigue lifetime in such cases Illustrates ways to replace time and labor consuming expensive and possibly misleading temperature cycling tests with simpler and physically meaningful accelerated tests This book is aimed towards professionals in electronic and photonic packaging electronic and optical materials materials engineering and mechanical design

**Reliability Prediction for Microelectronics** Joseph B. Bernstein, Alain Bensoussan, Emmanuel Bender, 2024-02-20 RELIABILITY PREDICTION FOR MICROELECTRONICS Wiley Series in Quality Reliability Engineering REVOLUTIONIZE YOUR APPROACH TO RELIABILITY ASSESSMENT WITH THIS GROUNDBREAKING BOOK Reliability evaluation is a critical aspect of engineering without which safe performance within

desired parameters over the lifespan of machines cannot be guaranteed With microelectronics in particular the challenges to evaluating reliability are considerable and statistical methods for creating microelectronic reliability standards are complex With nano scale microelectronic devices increasingly prominent in modern life it has never been more important to understand the tools available to evaluate reliability Reliability Prediction for Microelectronics meets this need with a cluster of tools built around principles of reliability physics and the concept of remaining useful life RUL It takes as its core subject the physics of failure combining a thorough understanding of conventional approaches to reliability evaluation with a keen knowledge of their blind spots It equips engineers and researchers with the capacity to overcome decades of errant reliability physics and place their work on a sound engineering footing Reliability Prediction for Microelectronics readers will also find Focus on the tools required to perform reliability assessments in real operating conditions Detailed discussion of topics including failure foundation reliability testing acceleration factor calculation and more New multi physics of failure on DSM technologies including TDDDB EM HCI and BTI Reliability Prediction for Microelectronics is ideal for reliability and quality engineers design engineers and advanced engineering students looking to understand this crucial area of product design and testing

**Fatigue of Electronic Materials** Scott A. Schroeder, Michael R. Mitchell, 1994 Unlike earlier electronic circuits today s microelectronic devices demand that solder serve structural as well as electrical ends and do so at relatively high temperature for years Fatigue and failure of the solder has therefore become an issue in the industry Nine studies from a May 1993 sympos

*Labs on Chip* Eugenio Iannone, 2018-09-03 *Labs on Chip Principles Design and Technology* provides a complete reference for the complex field of labs on chip in biotechnology Merging three main areas fluid dynamics monolithic micro and nanotechnology and out of equilibrium biochemistry this text integrates coverage of technology issues with strong theoretical explanations of design techniques Analyzing each subject from basic principles to relevant applications this book Describes the biochemical elements required to work on labs on chip Discusses fabrication microfluidic and electronic and optical detection techniques Addresses planar technologies polymer microfabrication and process scalability to huge volumes Presents a global view of current lab on chip research and development Devotes an entire chapter to labs on chip for genetics Summarizing in one source the different technical competencies required *Labs on Chip Principles Design and Technology* offers valuable guidance for the lab on chip design decision making process while exploring essential elements of labs on chip useful both to the professional who wants to approach a new field and to the specialist who wants to gain a broader perspective

**Constrained Deformation of Materials** Y.-L. Shen, 2010-08-09 *Constrained Deformation of Materials Devices Heterogeneous Structures and Thermo Mechanical Modeling* is an in depth look at the mechanical analyses and modeling of advanced small scale structures and heterogeneous material systems Mechanical deformations in thin films and miniaturized materials commonly found in microelectronic devices and packages MEMS nanostructures and composite and multi phase materials are heavily influenced by the external or internal physical confinement A continuum

mechanics based approach is used together with discussions on micro mechanisms to treat the subject in a systematic manner under the unified theme Readers will find valuable information on the proper application of thermo mechanics in numerical modeling as well as in the interpretation and prediction of physical material behavior along with many case studies Additionally particular attention is paid to practical engineering relevance Thus real life reliability issues are discussed in detail to serve the needs of researchers and engineers alike

**Mechanics of Solder Alloy Interconnects** Darrel R. Frear, Steven N. Burchett, Harold S. Morgan, John H. Lau, 1994-01-31 The Mechanics of Solder Alloy Interconnects is a resource to be used in developing a solder joint reliability assessment Each chapter is written to be used as a stand alone resource for a particular aspect of materials and modeling issues With this gained understanding the reader in search of a solution to a solder joint reliability problem knows where in the materials and modeling communities to go for the appropriate answer

Failure Modes and Mechanisms in Electronic Packages P. Singh, Puligandla Viswanadham, 2012-12-06 Those of us who grew up in the through hole age of electronic packaging are probably more amazed and appreciative than are our children at the incredible growth of electronic performance capability My son an electrical engineering student seems almost to take for granted the innovations that leave me somewhat awestruck at times Electronic circuit designers delight in packing more punch into less volume while reminding us that their job has become increasingly challenging The lay person also has learned from the media that the industry has been working wonders in shrinking the transistor and expanding the power of the chip Much attention is focussed on the silicon and on the marvelous production and entertainment tools we now see in our offices and homes Between the silicon and the end product lies the less publicized world of circuit level packaging We leave it to a cadre of technologists to take the schematics and parts lists and to develop the processes that turn the designers concepts into physical reality And while the silicon transistor is shrinking the engineering challenges of packaging multiple chips and associated components into increasingly dense subsystems are growing Further the transistor may have to function without failure through severe industrial or military environments over the lifetime of the product

**Processing and Fabrication of Advanced Materials XIII**, 2005 *Advanced MEMS Packaging* John H. Lau, Cheng Kuo Lee, C. S. Premachandran, Yu Aibin, 2009-10-22 A comprehensive guide to 3D MEMS packaging methods and solutions Written by experts in the field Advanced MEMS Packaging serves as a valuable reference for those faced with the challenges created by the ever increasing interest in MEMS devices and packaging This authoritative guide presents cutting edge MEMS microelectromechanical systems packaging techniques such as low temperature C2W and W2W bonding and 3D packaging This definitive resource helps you select reliable creative high performance robust and cost effective packaging techniques for MEMS devices The book will also aid in stimulating further research and development in electrical optical mechanical and thermal designs as well as materials processes manufacturing testing and reliability Among the topics explored Advanced IC and MEMS packaging trends MEMS devices commercial

applications and markets More than 360 MEMS packaging patents and 10 3D MEMS packaging designs TSV for 3D MEMS packaging MEMS wafer thinning dicing and handling Low temperature C2C C2W and W2W bonding Reliability of RoHS compliant MEMS packaging Micromachining and water bonding techniques Actuation mechanisms and integrated micromachining Bubble switch optical switch and VOA MEMS packaging Bolometer and accelerometer MEMS packaging Bio MEMS and biosensor MEMS packaging RF MEMS switches tunable circuits and packaging Thermal Stress and Strain in Microelectronics Packaging John Lau, 2012-12-06 Microelectronics packaging and interconnection have experienced exciting growth stimulated by the recognition that systems not just silicon provide the solution to evolving applications In order to have a high density performance yield quality reliability low cost and light weight system a more precise understanding of the system behavior is required Mechanical and thermal phenomena are among the least understood and most complex of the many phenomena encountered in microelectronics packaging systems and are found on the critical path of nearly every design and process in the electronics industry The last decade has witnessed an explosive growth in the research and development efforts devoted to determining the mechanical and thermal behaviors of microelectronics packaging With the advance of very large scale integration technologies thousands to tens of thousands of devices can be fabricated on a silicon chip At the same time demands to further reduce packaging signal delay and increase packaging density between communicating circuits have led to the use of very high power dissipation single chip modules and multi chip modules The result of these developments has been a rapid growth in module level heat flux within the personal workstation midrange mainframe and super computers Thus thermal temperature stress and strain management is vital for microelectronics packaging designs and analyses How to determine the temperature distribution in the electronics components and systems is outside the scope of this book which focuses on the determination of stress and strain distributions in the electronics packaging Modeling and Simulation for Microelectronic Packaging Assembly Shen Liu, Yong Liu, 2011-08-24 Although there is increasing need for modeling and simulation in the IC package design phase most assembly processes and various reliability tests are still based on the time consuming test and try out method to obtain the best solution Modeling and simulation can easily ensure virtual Design of Experiments DoE to achieve the optimal solution This has greatly reduced the cost and production time especially for new product development Using modeling and simulation will become increasingly necessary for future advances in 3D package development In this book Liu and Liu allow people in the area to learn the basic and advanced modeling and simulation skills to help solve problems they encounter Models and simulates numerous processes in manufacturing reliability and testing for the first time Provides the skills necessary for virtual prototyping and virtual reliability qualification and testing Demonstrates concurrent engineering and co design approaches for advanced engineering design of microelectronic products Covers packaging and assembly for typical ICs optoelectronics MEMS 2D 3D SiP and nano interconnects Appendix and color images available for download from the book's companion website Liu and

Liu have optimized the book for practicing engineers researchers and post graduates in microelectronic packaging and interconnection design assembly manufacturing electronic reliability quality and semiconductor materials Product managers application engineers sales and marketing staff who need to explain to customers how the assembly manufacturing reliability and testing will impact their products will also find this book a critical resource Appendix and color version of selected figures can be found at [www.wiley.com/go/liu\\_packaging](http://www.wiley.com/go/liu_packaging)

**Failures and the Law** H.P. Rossmanith, 2003-09-02 The interaction between engineering and the law is undergoing dramatic changes Product liability laws have been introduced in Japan patent claims over living organisms have been made in bioengineering and the differing national laws of copyright protection and liability are in the process of harmonisation especially in the European Union The pace and complexity of these changes make it essential for technologists lawyers engineers and insurance experts to establish a common basis for understanding co operation and exchange of expertise The recently founded International Society for Technology Law and Insurance aims to foster such co operation This volume features 46 selected contributions which address various topical issues and the law The most important issues relate to engineering risks quality assurance and assessment and legal implications associated with them Recent failure cases are explained and the technical legal and insurance related issues discussed in detail

**Reliability of Microtechnology** Johan Liu, Olli Salmela, Jussi Sarkka, James E. Morris, Per-Erik Tegehall, Cristina Andersson, 2011-02-07 Reliability of Microtechnology discusses the reliability of microtechnology products from the bottom up beginning with devices and extending to systems The book's focus includes but is not limited to reliability issues of interconnects the methodology of reliability concepts and general failure mechanisms Specific failure modes in solder and conductive adhesives are discussed at great length Coverage of accelerated testing component and system level reliability and reliability design for manufacturability are also described in detail The book also includes exercises and detailed solutions at the end of each chapter

**Fault Detection, Supervision and Safety of Technical Processes 2006** Hong-Yue Zhang, 2007-03-01 The safe and reliable operation of technical systems is of great significance for the protection of human life and health the environment and of the vested economic value The correct functioning of those systems has a profound impact also on production cost and product quality The early detection of faults is critical in avoiding performance degradation and damage to the machinery or human life Accurate diagnosis then helps to make the right decisions on emergency actions and repairs Fault detection and diagnosis FDD has developed into a major area of research at the intersection of systems and control engineering artificial intelligence applied mathematics and statistics and such application fields as chemical electrical mechanical and aerospace engineering IFAC has recognized the significance of FDD by launching a triennial symposium series dedicated to the subject The SAFEPROCESS Symposium is organized every three years since the first symposium held in Baden Baden in 1991 SAFEPROCESS 2006 the 6th IFAC Symposium on Fault Detection Supervision and Safety of Technical Processes was held in Beijing PR China The program included three plenary



papers two semi plenary papers two industrial talks by internationally recognized experts and 258 regular papers which have been selected out of a total of 387 regular and invited papers submitted Discusses the developments and future challenges in all aspects of fault diagnosis and fault tolerant control 8 invited and 36 contributed sessions included with a special session on the demonstration of process monitoring and diagnostic software tools

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