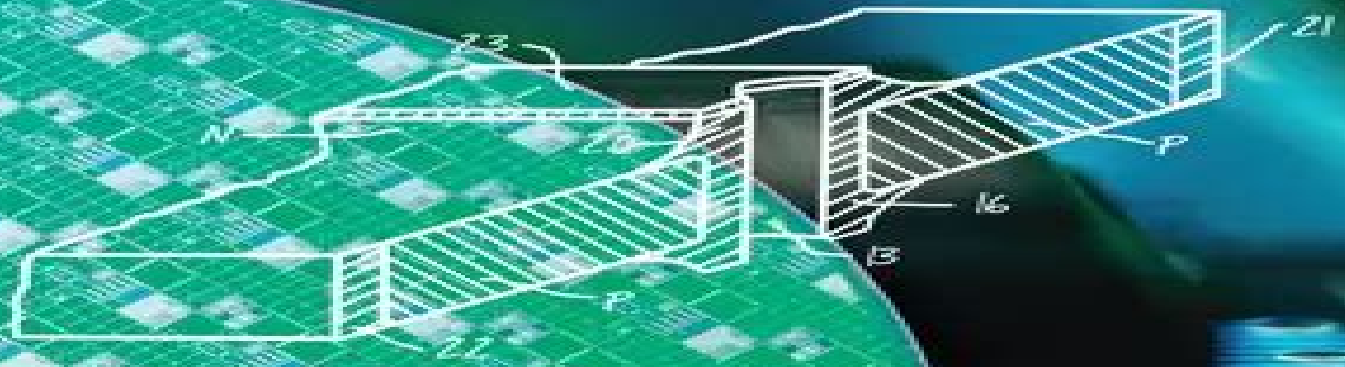


THROUGH-SILICON VIAS FOR 3D INTEGRATION



JOHN H. LAU



Through Silicon Vias For 3d Integration

Muhannad S. Bakir, James D. Meindl



Through Silicon Vias For 3d Integration:

Through-Silicon Vias for 3D Integration John H. Lau, 2012-08-05 A comprehensive guide to TSV and other enabling technologies for 3D integration Written by an expert with more than 30 years of experience in the electronics industry Through Silicon Vias for 3D Integration provides cutting edge information on TSV wafer thinning thin wafer handling microbumping and assembly and thermal management technologies Applications to highperformance high density low power consumption wide bandwidth and small form factor electronic products are discussed This book offers a timely summary of progress in all aspects of this fascinating field for professionals active in 3D integration research and development those who wish to master 3D integration problem solving methods and anyone in need of a low power wide bandwidth design and high yield manufacturing process for interconnect systems Coverage includes Nanotechnology and 3D integration for the semiconductor industry TSV etching dielectric barrier and seed layer deposition Cu plating CMP and Cu revealing TSVs mechanical thermal and electrical behaviors Thin wafer strength measurement Wafer thinning and thin wafer handling Microbumping assembly and reliability Microbump electromigration Transient liquid phase bonding C2C C2W and W2W 2 5D IC integration with interposers 3D IC integration with interposers Thermal management of 3D IC integration 3D IC packaging 3D Integration with Coaxial Through Silicon Vias Stephen Adamshick, 2015 Stress Management for 3D ICS Using Through Silicon Vias: Ehrenfried Zschech, Riko Radojicic, Valeriy Sukharev, Larry Smith, 2011-11-23 Scientist and engineers as well as graduate students in the fields of This conference will be of interest to anyone involved in Physics Electrical Engineering Materials Science and Engineering Reliability and Quality Management both in industry and academia One current challenge to micro and nanoelectronics is the understanding of stress related phenomena in 3D IC integration Stresses arising in 3D TSV interconnects and in the surrounding materials due to thermal mismatch microstructure changes or process integration can lead to performance reduction reliability limiting degradation and failure of microelectronic products Understanding stress related phenomena in new materials used for 3D integration and packaging particularly using through silicon vias and microbumps is critical for future microelectronic products Management of mechanical stress is one of the key enablers for the successful implementation of 3D integrated circuits using through silicon vias TSVs The potential stress related impact of the 3D integration process on the device characteristics must be understood and shared and designers need a solution for managing stress The Proceedings summarize new research results and advances in basic understanding of stress induced phenomena in 3D IC integration Modelling and simulation capabilities as well as materials characterization are demonstrated to evaluate the effect of stress on product performance Through-Silicon Vias for 3D Integration John Lau, 2012-09-20 A comprehensive guide to TSV and other enabling technologies for 3D integration Written by an expert with more than 30 years of experience in the electronics industry Through Silicon Vias for 3D Integration provides cutting edge information on TSV wafer thinning thin wafer handling microbumping and assembly and thermal

management technologies Applications to highperformance high density low power consumption wide bandwidth and small form factor electronic products are discussed This book offers a timely summary of progress in all aspects of this fascinating field for professionals active in 3D integration research and development those who wish to master 3D integration problem solving methods and anyone in need of a low power wide bandwidth design and high yield manufacturing process for interconnect systems Coverage includes Nanotechnology and 3D integration for the semiconductor industry TSV etching dielectric barrier and seed layer deposition Cu plating CMP and Cu revealing TSVs mechanical thermal and electrical behaviors Thin wafer strength measurement Wafer thinning and thin wafer handling Microbumping assembly and reliability Microbump electromigration Transient liquid phase bonding C2C C2W and W2W 2 5D IC integration with interposers 3D IC integration with interposers Thermal management of 3D IC integration 3D IC packaging **Arbitrary Modeling of TSVs for 3D Integrated Circuits** Khaled Salah,Yehea Ismail,Alaa El-Rouby,2014-08-21 This book presents a wide band and technology independent SPICE compatible RLC model for through silicon vias TSVs in 3D integrated circuits This model accounts for a variety of effects including skin effect depletion capacitance and nearby contact effects Readers will benefit from in depth coverage of concepts and technology such as 3D integration Macro modeling dimensional analysis and compact modeling as well as closed form equations for the through silicon via parasitics Concepts covered are demonstrated by using TSVs in applications such as a spiral inductor and inductive based communication system and bandpass filtering

Interconnect Technologies for Integrated Circuits and Flexible Electronics Yash Agrawal,Kavicharan Mummaneni,P. Uma Sathyakam,2023-09-21 This contributed book provides a thorough understanding of the basics along with detailed state of the art emerging interconnect technologies for integrated circuit design and flexible electronics It focuses on the investigation of advanced on chip interconnects which match the current as well as future technology requirements The contents focus on different aspects of interconnects such as material physical characteristics parasitic extraction design structure modeling machine learning and neural network based models for interconnects signaling schemes varying signal integrity performance analysis variability reliability aspects associated electronic design automation tools The book also explores interconnect technologies for flexible electronic systems It also highlights the integration of sensors with stretchable interconnects to demonstrate the concept of a stretchable sensing network for wearable and flexible applications This book is a useful guide for those working in academia and industry to understand the fundamentals and application of interconnect technologies *High-Speed Interconnects in VLSI Design, Modeling, and Signal Integrity* Dr. Bhaskar Gugulothu, The rapid advancement in VLSI Very Large Scale Integration technology has ushered in a new era of high performance systems where interconnects have become a critical bottleneck in determining speed power and reliability This textbook provides a comprehensive understanding of high speed interconnect design analytical and simulation based modeling techniques and signal integrity challenges in modern integrated circuits It is intended for graduate students

researchers and industry professionals involved in IC design and signal integrity analysis **Through Silicon Vias** Brajesh Kumar Kaushik, Vobulapuram Ramesh Kumar, Manoj Kumar Majumder, Arsalan Alam, 2016-11-30 Recent advances in semiconductor technology offer vertical interconnect access via that extend through silicon popularly known as through silicon via TSV This book provides a comprehensive review of the theory behind TSVs while covering most recent advancements in materials models and designs Furthermore depending on the geometry and physical configurations different electrical equivalent models for Cu carbon nanotube CNT and graphene nanoribbon GNR based TSVs are presented Based on the electrical equivalent models the performance comparison among the Cu CNT and GNR based TSVs are also discussed **Processing, Materials, and Integration of Damascene and 3D Interconnects** J. C. Flake, 2010-04 This issue focuses on recent advances in damascene interconnects and 3D interconnects Three-Dimensional Integrated Circuit Design Vasilis F. Pavlidis, Ioannis Savidis, Eby G. Friedman, 2017-07-04 Three Dimensional Integrated Circuit Design Second Edition expands the original with more than twice as much new content adding the latest developments in circuit models temperature considerations power management memory issues and heterogeneous integration 3 D IC experts Pavlidis Savidis and Friedman cover the full product development cycle throughout the book emphasizing not only physical design but also algorithms and system level considerations to increase speed while conserving energy A handy comprehensive reference or a practical design guide this book provides effective solutions to specific challenging problems concerning the design of three dimensional integrated circuits Expanded with new chapters and updates throughout based on the latest research in 3 D integration Manufacturing techniques for 3 D ICs with TSVs Electrical modeling and closed form expressions of through silicon vias Substrate noise coupling in heterogeneous 3 D ICs Design of 3 D ICs with inductive links Synchronization in 3 D ICs Variation effects on 3 D ICs Correlation of WID variations for intra tier buffers and wires Offers practical guidance on designing 3 D heterogeneous systems Provides power delivery of 3 D ICs Demonstrates the use of 3 D ICs within heterogeneous systems that include a variety of materials devices processors GPU CPU integration and more Provides experimental case studies in power delivery synchronization and thermal characterization **3D Microelectronic Packaging** Yan Li, Deepak Goyal, 2020-11-23 This book offers a comprehensive reference guide for graduate students and professionals in both academia and industry covering the fundamentals architecture processing details and applications of 3D microelectronic packaging It provides readers an in depth understanding of the latest research and development findings regarding this key industry trend including TSV die processing micro bumps for LMI and MMI direct bonding and advanced materials as well as quality reliability fault isolation and failure analysis for 3D microelectronic packages Images tables and didactic schematics are used to illustrate and elaborate on the concepts discussed Readers will gain a general grasp of 3D packaging quality and reliability concerns and common causes of failure and will be introduced to developing areas and remaining gaps in 3D packaging that can help inspire future research and development *Design of 3D Integrated Circuits*

and Systems Rohit Sharma, 2018-09-03 Three dimensional 3D integration of microsystems and subsystems has become essential to the future of semiconductor technology development 3D integration requires a greater understanding of several interconnected systems stacked over each other While this vertical growth profoundly increases the system functionality it also exponentially increases the design complexity Design of 3D Integrated Circuits and Systems tackles all aspects of 3D integration including 3D circuit and system design new processes and simulation techniques alternative communication schemes for 3D circuits and systems application of novel materials for 3D systems and the thermal challenges to restrict power dissipation and improve performance of 3D systems Containing contributions from experts in industry as well as academia this authoritative text Illustrates different 3D integration approaches such as die to die die to wafer and wafer to wafer Discusses the use of interposer technology and the role of Through Silicon Vias TSVs Presents the latest improvements in three major fields of thermal management for multiprocessor systems on chip MPSoCs Explores ThruChip Interface TCI NAND flash memory stacking and emerging applications Describes large scale integration testing and state of the art low power testing solutions Complete with experimental results of chip level 3D integration schemes tested at IBM and case studies on advanced complementary metal oxide semiconductor CMOS integration for 3D integrated circuits ICs Design of 3D Integrated Circuits and Systems is a practical reference that not only covers a wealth of design issues encountered in 3D integration but also demonstrates their impact on the efficiency of 3D systems **Advanced Interconnects for ULSI**

Technology Mikhail Baklanov, Paul S. Ho, Ehrenfried Zschech, 2012-02-17 Finding new materials for copper low k interconnects is critical to the continuing development of computer chips While copper low k interconnects have served well allowing for the creation of Ultra Large Scale Integration ULSI devices which combine over a billion transistors onto a single chip the increased resistance and RC delay at the smaller scale has become a significant factor affecting chip performance Advanced Interconnects for ULSI Technology is dedicated to the materials and methods which might be suitable replacements It covers a broad range of topics from physical principles to design fabrication characterization and application of new materials for nano interconnects and discusses Interconnect functions characterisations electrical properties and wiring requirements Low k materials fundamentals advances and mechanical properties Conductive layers and barriers Integration and reliability including mechanical reliability electromigration and electrical breakdown New approaches including 3D optical wireless interchip and carbon based interconnects Intended for postgraduate students and researchers in academia and industry this book provides a critical overview of the enabling technology at the heart of the future development of computer chips **Carbon Nanotubes for Interconnects** Aida Todri-Sanial, Jean Dijon, Antonio Maffucci, 2016-07-09 This book provides a single source reference on the use of carbon nanotubes CNTs as interconnect material for horizontal on chip and 3D interconnects The authors demonstrate the uses of bundles of CNTs as innovative conducting material to fabricate interconnect through silicon vias TSVs in order to improve the performance reliability and

integration of 3D integrated circuits ICs This book will be first to provide a coherent overview of exploiting carbon nanotubes for 3D interconnects covering aspects from processing modeling simulation characterization and applications Coverage also includes a thorough presentation of the application of CNTs as horizontal on chip interconnects which can potentially revolutionize the nanoelectronics industry This book is a must read for anyone interested in the state of the art on exploiting carbon nanotubes for interconnects for both 2D and 3D integrated circuits

Handbook of Silicon Based MEMS Materials and Technologies Markku Tilli, Mervi Paulasto-Kröckel, Matthias Petzold, Horst Theuss, Teruaki Motooka, Veikko Lindroos, 2020-04-17 Handbook of Silicon Based MEMS Materials and Technologies Third Edition is a comprehensive guide to MEMS materials technologies and manufacturing with a particular emphasis on silicon as the most important starting material used in MEMS The book explains the fundamentals properties mechanical electrostatic optical etc materials selection preparation modeling manufacturing processing system integration measurement and materials characterization techniques of MEMS structures The third edition of this book provides an important up to date overview of the current and emerging technologies in MEMS making it a key reference for MEMS professionals engineers and researchers alike and at the same time an essential education material for undergraduate and graduate students Provides comprehensive overview of leading edge MEMS manufacturing technologies through the supply chain from silicon ingot growth to device fabrication and integration with sensor actuator controlling circuits Explains the properties manufacturing processing measuring and modeling methods of MEMS structures Reviews the current and future options for hermetic encapsulation and introduces how to utilize wafer level packaging and 3D integration technologies for package cost reduction and performance improvements Geared towards practical applications presenting several modern MEMS devices including inertial sensors microphones pressure sensors and micromirrors

Handbook of 3D Integration, Volume 1 Philip Garrou, Christopher Bower, Peter Ramm, 2011-09-22 The first encompassing treatise of this new but very important field puts the known physical limitations for classic 2D electronics into perspective with the requirements for further electronics developments and market necessities This two volume handbook presents 3D solutions to the feature density problem addressing all important issues such as wafer processing die bonding packaging technology and thermal aspects It begins with an introductory part which defines necessary goals existing issues and relates 3D integration to the semiconductor roadmap of the industry Before going on to cover processing technology and 3D structure fabrication strategies in detail This is followed by fields of application and a look at the future of 3D integration The contributions come from key players in the field from both academia and industry including such companies as Lincoln Labs Fraunhofer RPI ASET IMEC CEA LETI IBM and Renesas

Integrated Interconnect Technologies for 3D Nanoelectronic Systems Muhannad S. Bakir, James D. Meindl, 2009 This cutting edge book on off chip technologies puts the hottest breakthroughs in high density compliant electrical interconnects nanophotonics and microfluidics at your fingertips integrating the full range of mathematics physics and technology issues

together in a single comprehensive source You get full details on state of the art I O interconnects and packaging including mechanically compliant I O approaches fabrication and assembly followed by the latest advances and applications in power delivery design analysis and modeling The book explores interconnect structures materials and packages for achieving high bandwidth off chip electrical communication including optical interconnects and chip to chip signaling approaches and brings you up to speed on CMOS integrated optical devices 3D integration wafer stacking technology and through wafer interconnects

3D Interconnect Architectures for Heterogeneous Technologies Lennart Bamberg, Jan Moritz Joseph, Alberto García-Ortiz, Thilo Pionteck, 2022-06-27 This book describes the first comprehensive approach to the optimization of interconnect architectures in 3D systems on chips SoCs specially addressing the challenges and opportunities arising from heterogeneous integration Readers learn about the physical implications of using heterogeneous 3D technologies for SoC integration while also learning to maximize the 3D technology gains through a physical effect aware architecture design The book provides a deep theoretical background covering all abstraction levels needed to research and architect tomorrow s 3D integrated circuits an extensive set of optimization methods for power performance area and yield as well as an open source optimization and simulation framework for fast exploration of novel designs

Optimizing the Integration and Energy Efficiency of Through Silicon Via-based 3D Interconnects Panagiotis Asimakopoulos, University of Newcastle upon Tyne. School of Electrical, Electronic and Computer Engineering, 2011

Thermal and Electro-thermal System Simulation 2020 Márta Rencz, Lorenzo Codecasa, Andras Poppe, 2021-01-12 This book edited by Prof Marta Rencz and Prof Andras Poppe Budapest University of Technology and Economics and by Prof Lorenzo Codecasa Politecnico di Milano collects fourteen papers carefully selected for the thermal and electro thermal system simulation Special Issue of Energies These contributions present the latest results in a currently very hot topic in electronics the thermal and electro thermal simulation of electronic components and systems Several papers here proposed have turned out to be extended versions of papers presented at THERMINIC 2019 which was one of the 2019 stages of choice for presenting outstanding contributions on thermal and electro thermal simulation of electronic systems The papers proposed to the thermal community in this book deal with modeling and simulation of state of the art applications which are highly critical from the thermal point of view and around which there is great research activity in both industry and academia In particular contributions are proposed on the multi physics simulation of families of electronic packages multi physics advanced modeling in power electronics multiphysics modeling and simulation of LEDs batteries and other micro and nano structures

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Through Silicon Vias For 3d Integration Introduction

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