Vertical 3d Memory Technologies

Vertical 3D Memory Technologies NAND Flash Memory Technologies 3D Flash Memories **Emerging Memory Technologies Advances in Non-volatile Memory and Storage Technology** Nonvolatile Memory Technologies with Emphasis on Flash **Stacked-3D and Processing-in-memory Solutions for Data-intensive and Persistent Applications Exploring Memory Hierarchy Design with Emerging Memory Technologies NAND Flash Memory Technologies Emerging Non-volatile Memory Technologies** 3D Stacked Memory **Advances in Non-volatile Memory and Storage Technology** Semiconductor Memories and Systems Integrated Interconnect Technologies for 3D Nanoelectronic Systems *NANO-CHIPS 2030* **Semiconductor Memory Devices and Circuits** Beyond-CMOS Technologies for Next Generation Computer Design *3D Integration in VLSI Circuits Advances in Non-volatile Memory and Storage Technology Metal Oxides for Non-volatile Memory* **Neuromorphic Computing and Beyond** Handbook of 3D Integration, Volume 1 *Silicon Compatible Materials, Processes, and Technologies for Advanced Integrated Circuits and Emerging Applications 6* Emerging Computing: From Devices to Systems **Inside NAND Flash Memories Wafer Level 3-D ICs Process Technology** Electronic Packaging Science and Technology **3D Flash Memories** *Memory Bytes* Digital Storage in Consumer Electronics *3D Integration in VLSI Circuits* 3D IC Stacking Technology **IP Cores Design from Specifications to Production** *Sixth Biennial IEEE International Nonvolatile Memory Technology Conference* Advances In 3d Integrated Circuits And Systems **More-than-Moore 2.5D and 3D SiP Integration** Carbon Nanotubes for Interconnects **Nanomaterials-Based Charge Trapping Memory Devices Architecture of Computing Systems - ARCS 2012 Handbook of 3D Integration, Volume 4**

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Emerging Non-volatile Memory Technologies Jan 27 2022 This book offers a balanced and comprehensive guide to the core principles, fundamental properties, experimental approaches, and state-of-the-art applications of two major groups of emerging non-volatile memory technologies, i.e. spintronics-based devices as well as resistive switching devices, also known as Resistive Random Access Memory (RRAM). The first section presents different types of spintronic-based devices, i.e. magnetic tunnel junction (MTJ), domain wall, and skyrmion memory devices. This section describes how their developments have led to various promising applications, such as microwave oscillators, detectors, magnetic logic, and neuromorphic engineered systems. In the second half of the book, the underlying device physics supported by different experimental observations and modelling of RRAM devices are presented with memory array level implementation. An insight into RRAM desired properties as synaptic element in neuromorphic computing platforms from material and algorithms viewpoint is also discussed with specific example in automatic sound classification framework.
Emerging Computing: From Devices to Systems Nov 12 2020 The book covers a range of topics dealing with emerging computing technologies which are being developed in response to challenges faced due to scaling CMOS technologies. It provides a sneak peek into the capabilities unleashed by these technologies across the complete system stack, with contributions by experts discussing device technology, circuit, architecture and design automation flows. Presenting a gradual progression of

the individual sub-domains and the open research and adoption challenges, this book will be of interest to industry and academic researchers, technocrats and policymakers. Chapters "Innovative Memory Architectures Using Functionality Enhanced Devices" and "Intelligent Edge Biomedical Sensors in the Internet of Things (IoT) Era" are available open access under a Creative Commons Attribution 4.0 International License via link.springer.com.

Handbook of 3D Integration, Volume 4 Jun 27 2019 This fourth volume of the landmark handbook focuses on the design, testing, and thermal management of 3D-integrated circuits, both from a technological and materials science perspective. Edited and authored by key contributors from top research institutions and high-tech companies, the first part of the book provides an overview of the latest developments in 3D chip design, including challenges and opportunities. The second part focuses on the test methods used to assess the quality and reliability of the 3D-integrated circuits, while the third and final part deals with thermal management and advanced cooling technologies and their integration. This fourth volume of the landmark handbook focuses on the design, testing, and thermal management of 3D-integrated circuits, both from a technological and materials science perspective. Edited and authored by key contributors from top research institutions and high-tech companies, the first part of the book provides an overview of the latest developments in 3D chip design, including challenges and opportunities. The second part focuses on the test methods used to assess the quality and reliability of the 3D-integrated circuits, while the third and final part deals with thermal management and advanced cooling technologies and their integration.

More-than-Moore 2.5D and 3D SiP Integration Oct 31 2019 This book presents a realistic and a holistic review of the microelectronic and semiconductor technology options in the post Moore’s Law regime. Technical tradeoffs, from architecture down to manufacturing processes, associated with the 2.5D and 3D integration technologies, as well as the business and product management considerations encountered when faced by disruptive technology options, are presented. Coverage includes a discussion of Integrated Device Manufacturer (IDM) vs Fabless, vs Foundry, and Outsourced Assembly and Test (OSAT) barriers to implementation of disruptive technology options. This book is a must-read for any IC product team that is considering getting off the Moore’s Law track, and leveraging some of the More-than-Moore technology options for their next microelectronic product.

Integrated Interconnect Technologies for 3D Nanoelectronic Systems Sep 22 2021 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.

Advances in Non-volatile Memory and Storage Technology Jul 01 2022 New solutions are needed for future scaling down of nonvolatile memory. Advances in Non-volatile Memory and Storage Technology provides an overview of developing technologies and explores their strengths and weaknesses. After an overview of the current market, part one introduces improvements in flash technologies, including developments in 3D NAND flash technologies and flash memory for ultra-high density storage devices. Part two looks at the advantages of designing phase change memory and resistive random access memory technologies. It looks in particular at the fabrication, properties, and performance of nanowire phase change memory technologies. Later chapters also consider modeling of both metal oxide and resistive random access memory switching mechanisms, as well as conductive bridge random access memory technologies. Finally, part three looks to the future of alternative technologies. The areas covered include molecular, polymer, and hybrid organic memory devices, and a variety of random access memory devices such as nano-electromechanical, ferroelectric, and spin-transfer-torque magnetoresistive devices. Advances in Non-volatile Memory and Storage Technology is a key resource for postgraduate students and academic researchers in physics, materials science, and electrical engineering. It is a valuable tool for research and development managers concerned with electronics, semiconductors, nanotechnology, solid-state memories, magnetic materials, organic materials, and portable electronic devices. Provides an overview of developing nonvolatile memory and storage technologies and explores their strengths and weaknesses Examines improvements to flash technology, charge trapping, and resistive random access memory Discusses emerging devices such as those based on polymer and molecular electronics, and nanoelectromechanical random access memory (RAM)

3D Integration in VLSI Circuits May 19 2021 Currently, the term 3D integration includes a wide variety of different integration methods, such as 2.5-dimensional (2.5D) interposer-based integration, 3D integrated circuits (3D ICs), 3D systems-in-package (SiP), 3D heterogeneous integration, and monolithic 3D ICs. The goal of this book is

to provide readers with an understanding of the latest challenges and issues in 3D integration. TSVs are not the only technology element needed for 3D integration. There are numerous other key enabling technologies required for 3D integration, and the speed of the development in this emerging field is very rapid. To provide readers with state-of-the-art information on 3D integration research and technology developments, each chapter has been contributed by some of the world's leading scientists and experts from academia, research institutes, and industry from around the globe. Covers chip/wafer level 3D integration technology, memory stacking, reconfigurable 3D, and monolithic 3D IC. Discusses the use of silicon interposer and organic interposer. Presents architecture, design, and technology implementations for 3D FPGA integration. Describes oxide bonding, Cu/SiO2 hybrid bonding, adhesive bonding, and solder bonding. Addresses the issue of thermal dissipation in 3D integration.
NAND Flash Memory Technologies Oct 04 2022 Offers a comprehensive overview of NAND flash memories, with insights into NAND history, technology, challenges, evolutions, and perspectives Describes new program disturb issues, data retention, power consumption, and possible solutions for the challenges of 3D NAND flash memory Written by an authority in NAND flash memory technology, with over 25 years' experience
IP Cores Design from Specifications to Production Feb 02 2020 This book describes the life cycle process of IP cores, from specification to production, including IP modeling, verification, optimization, and protection. Various trade-offs in the design process are discussed, including those associated with many of the most common memory cores, controller IPs and system-on-chip (SoC) buses. Readers will also benefit from the author's practical coverage of new verification methodologies. such as bug localization, UVM, and scan-chain. A SoC case study is presented to compare traditional verification with the new verification methodologies. Discusses the entire life cycle process of IP cores, from specification to production, including IP modeling, verification, optimization, and protection; Introduce a deep introduction for Verilog for both implementation and verification point of view. Demonstrates how to use IP in applications such as memory controllers and SoC buses. Describes a new verification methodology called bug localization; Presents a novel scan-chain methodology for RTL debugging; Enables readers to employ UVM methodology in straightforward, practical terms.
Vertical 3D Memory Technologies Nov 05 2022 The large scale integration and planar scaling of individual system chips is reaching an expensive limit. If individual chips now, and later terrabyte memory blocks, memory macros, and processing cores, can be tightly linked in optimally designed and processed small footprint vertical stacks, then performance can be increased, power reduced and cost contained. This book reviews for the electronics industry engineer, professional and student the critical areas of development for 3D vertical memory chips including: gate-all-around and junction-less nanowire memories, stacked thin film and double gate memories, terrabit vertical channel and vertical gate stacked NAND flash, large scale stacking of Resistance RAM cross-point arrays, and 2.5D/3D stacking of memory and processor chips with through-silicon-via connections now and remote links later. Key features: Presents a review of the status and trends in 3-dimensional vertical memory chip technologies. Extensively reviews advanced vertical memory chip technology and development Explores technology process routes and 3D chip integration in a single reference
Handbook of 3D Integration, Volume 1 Jan 15 2021 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.
NAND Flash Memory Technologies Feb 25 2022 Offers a comprehensive overview of NAND flash memories, with insights into NAND history, technology, challenges, evolutions, and perspectives Describes new program disturb issues, data retention, power consumption, and possible solutions for the challenges of 3D NAND flash memory Written by an authority in NAND flash memory technology, with over 25 years' experience
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experts from academia, research institutes, and industry from around the globe. Covers chip/wafer level 3D integration technology, memory stacking, reconfigurable 3D, and monolithic 3D IC. Discusses the use of silicon interposer and organic interposer. Presents architecture, design, and technology implementations for 3D FPGA integration. Describes oxide bonding, Cu/SiO2 hybrid bonding, adhesive bonding, and solder bonding. Addresses the issue of thermal dissipation in 3D integration.

Advances in Non-volatile Memory and Storage Technology Nov 24 2021 Advances in Non-volatile Memory and Storage Technology, Second Edition addresses recent developments in the non-volatile memory spectrum, from fundamental understanding, to technological aspects. The book provides up-to-date information on the current memory technologies as related by leading experts in both academia and industry. To reflect the rapidly changing field, many new chapters have been included to feature the latest in RRAM technology, STT-RAM, memristors and more. The new edition describes the emerging technologies including oxide-based ferroelectric memories, MRAM technologies, and 3D memory. Finally, to further widen the discussion on the applications space, neuromorphic computing aspects have been included. This book is a key resource for postgraduate students and academic researchers in physics, materials science and electrical engineering. In addition, it will be a valuable tool for research and development managers concerned with electronics, semiconductors, nanotechnology, solid-state memories, magnetic materials, organic materials and portable electronic devices. Discusses emerging devices and research trends, such as neuromorphic computing and oxide-based ferroelectric memories Provides an overview on developing nonvolatile memory and storage technologies and explores their strengths and weaknesses Examines improvements to flash technology, charge trapping and resistive random access memory

Emerging Memory Technologies Aug 02 2022 This book explores the design implications of emerging, non-volatile memory (NVM) technologies on future computer memory hierarchy architecture designs. Since NVM technologies combine the speed of SRAM, the density of DRAM, and the non-volatility of Flash memory, they are very attractive as the basis for future universal memories. This book provides a holistic perspective on the topic, covering modeling, design, architecture and applications. The practical information included in this book will enable designers to exploit emerging memory technologies to improve significantly the performance/power/reliability of future, mainstream integrated circuits.

Inside NAND Flash Memories Oct 12 2020 Digital photography, MP3, digital video, etc. make extensive use of NAND-based Flash cards as storage media. To realize how much NAND Flash memories pervade every aspect of our life, just imagine how our recent habits would change if the NAND memories suddenly disappeared. To take a picture it would be necessary to find a film (as well as a traditional camera...), disks or even magnetic tapes would be used to record a video or to listen a song, and a cellular phone would return to be a simple mean of communication rather than a multimedia console. The development of NAND Flash memories will not be set down on the mere evolution of personal entertainment systems since a new killer application can trigger a further success: the replacement of Hard Disk Drives (HDDs) with Solid State Drives (SSDs). SSD is made up by a microcontroller and several NANDs. As NAND is the technology driver for IC circuits, Flash designers and technologists have to deal with a lot of challenges. Therefore, SSD (system) developers must understand Flash technology in order to exploit its benefits and countermeasure its weaknesses. Inside NAND Flash Memories is a comprehensive guide of the NAND world: from circuits design (analog and digital) to Flash reliability (including radiation effects), from testing issues to high-performance (DDR) interface, from error correction codes to NAND applications like Flash cards and SSDs.

Nonvolatile Memory Technologies with Emphasis on Flash May 31 2022 Presented here is an all-inclusive treatment of Flash technology, including Flash memory chips, Flash embedded in logic, binary cell Flash, and multilevel cell Flash. The book begins with a tutorial of elementary concepts to orient readers who are less familiar with the subject. Next, it covers all aspects and variations of Flash technology at a mature engineering level: basic device structures, principles of operation, related process technologies, circuit design, overall design tradeoffs, device testing, reliability, and applications.

Digital Storage in Consumer Electronics May 07 2020 This book provides an introduction to digital storage for consumer electronics. It discusses the various types of digital storage, including emerging non-volatile solid-state storage technologies and their advantages and disadvantages. It discusses the best practices for selecting, integrating, and using storage devices for various applications. It explores the networking of devices into an overall organization that results in always-available home storage combined with digital storage in the cloud to create an infrastructure to support emerging consumer applications and the Internet of Things. It also looks at the role of digital storage devices in creating security and privacy in consumer products.

Semiconductor Memory Devices and Circuits Jul 21 2021 This book covers semiconductor memory technologies from device bit-cell structures to memory array design with an emphasis on recent industry scaling trends and cutting-edge technologies. The first part of the book discusses the mainstream semiconductor memory technologies.

The second part of the book discusses the emerging memory candidates that may have the potential to change the memory hierarchy, and surveys new applications of memory technologies for machine/deep learning applications. This book is intended for graduate students in electrical and computer engineering programs and researchers or industry professionals in semiconductors and microelectronics. Explains the design of basic memory bit-cells including 6-transistor SRAM, 1-transistor-1-capacitor DRAM, and floating gate/charge trap FLASH transistor Examines the design of the peripheral circuits including the sense amplifier and array-level organization for the memory array Examines industry trends of memory technologies such as FinFET based SRAM, High-Bandwidth-Memory (HBM), 3D NAND Flash, and 3D X-point array Discusses the prospects and challenges of emerging memory technologies such as PCM, RRAM, STT-MRAM/SOT-MRAM and FeRAM/FeFET Explores the new applications such as in-memory computing for AI hardware acceleration.

3D Flash Memories Sep 03 2022 This book walks the reader through the next step in the evolution of NAND flash memory technology, namely the development of 3D flash memories, in which multiple layers of memory cells are grown within the same piece of silicon. It describes their working principles, device architectures, fabrication techniques and practical implementations, and highlights why 3D flash is a brand new technology. After reviewing market trends for both NAND and solid state drives (SSDs), the book digs into the details of the flash memory cell itself, covering both floating gate and emerging charge trap technologies. There is a plethora of different materials and vertical integration schemes out there. New memory cells, new materials, new architectures (3D Stacked, BiCS and P-BiCS, 3D FG, 3D VG, 3D advanced architectures); basically, each NAND manufacturer has its own solution. Chapter 3 to chapter 7 offer a broad overview of how 3D can materialize. The 3D wave is impacting emerging memories as well and chapter 8 covers 3D RRAM (resistive RAM) crosspoint arrays. Visualizing 3D structures can be a challenge for the human brain: this is way all these chapters contain a lot of bird’s-eye views and cross sections along the 3 axes. The second part of the book is devoted to other important aspects, such as advanced packaging technology (i.e. TSV in chapter 9) and error correction codes, which have been leveraged to improve flash reliability for decades. Chapter 10 describes the evolution from legacy BCH to the most recent LDPC codes, while chapter 11 deals with some of the most recent advancements in the ECC field. Last but not least, chapter 12 looks at 3D flash memories from a system perspective. Is 14nm the last step for planar cells? Can 100 layers be integrated within the same piece of silicon? Is 4 bit/cell possible with 3D? Will 3D be reliable enough for enterprise and datacenter applications? These are some of the questions that this book helps answering by providing insights into 3D flash memory design, process technology and applications.

Metal Oxides for Non-volatile Memory Mar 17 2021 Metal Oxides for Non-volatile Memory: Materials, Technology and Applications covers the technology and applications of metal oxides (MOx) in non-volatile memory (NVM) technology. The book addresses all types of NVMs, including floating-gate memories, 3-D memories, charge-trapping memories, quantum-dot memories, resistance switching memories and memristors, Mott memories and transparent memories. Applications of MOx in DRAM technology where they play a crucial role to the DRAM evolution are also addressed. The book offers a broad scope, encompassing discussions of materials properties, deposition methods, design and fabrication, and circuit and system level applications of metal oxides to non-volatile memory. Finally, the book addresses one of the most promising materials that may lead to a solution to the challenges in chip size and capacity for memory technologies, particular for mobile applications and embedded systems. Systematically covers metal oxides materials and their properties with memory technology applications, including floating-gate memory, 3-D memory, memristors, and much more Provides an overview on the most relevant deposition methods, including sputtering, CVD, ALD and MBE Discusses the design and fabrication of metal oxides for wide breadth of non-volatile memory applications from 3-D flash technology, transparent memory and DRAM technology

3D Stacked Memory Dec 26 2021 Our report on 3D stacked memory technology covers the Intellectual Property (Patent) landscape of this rapidly evolving technology and monitors its various sub-domains for licensing activity. We have analyzed the IP portfolios of SanDisk, Micron, Samsung, IBM and other major players to find the focus areas of their patenting efforts. Using our proprietary patent analytics tool, LexScore™, we identify the front runners in this technology domain with strong patent portfolio quality as well as a heavy patent filing activity. Using our proprietary Licensing Heat-map framework, we also predict licensing activity trend in various technology sub domains.

Architecture of Computing Systems - ARCS 2012 Jul 29 2019 This book constitutes the refereed proceedings of the 25th International Conference on Architecture of Computing Systems, ARCS 2012, held in Munich, Germany, in February/March 2012. The 20 revised full papers presented in 7 technical sessions were carefully reviewed and selected from 65 submissions. The papers are organized in topical sections on robustness and fault tolerance, power-aware processing, parallel processing, processor cores, optimization, and communication and memory.

Beyond-CMOS Technologies for Next Generation Computer Design Jun 19 2021 This book describes the bottleneck faced soon by designers of traditional CMOS devices, due to device scaling, power and energy consumption, and variability limitations. This book aims at bridging the gap between device technology and architecture/system design. Readers will learn about challenges and opportunities presented by “beyond-CMOS devices” and gain insight into how these might be leveraged to build energy-efficient electronic systems.

Wafer Level 3-D ICs Process Technology Sep 10 2020 This book focuses on foundry-based process technology that enables the fabrication of 3-D ICs. The core of the book discusses the technology platform for pre-packaging wafer lever 3-D ICs. However, this book does not include a detailed discussion of 3-D ICs design and 3-D packaging. This is an edited book based on chapters contributed by various experts in the field of wafer-level 3-D ICs process technology. They are from academia, research labs and industry.

Sixth Biennial IEEE International Nonvolatile Memory Technology Conference Jan 03 2020

Nanomaterials-Based Charge Trapping Memory Devices Aug 29 2019 Rising consumer demand for low power consumption electronics has generated a need for scalable and reliable memory devices with low power consumption. At present, scaling memory devices and lowering their power consumption is becoming more difficult due to unresolved challenges, such as short channel effect, Drain Induced Barrier Lowering (DIBL), and sub-surface punch-through effect, all of which cause high leakage currents. As a result, the introduction of different memory architectures or materials is crucial. Nanomaterials-based Charge Trapping Memory Devices provides a detailed explanation of memory device operation and an in-depth analysis of the requirements of future scalable and low powered memory devices in terms of new materials properties. The book presents techniques to fabricate nanomaterials with the desired properties. Finally, the book highlights the effect of incorporating such nanomaterials in memory devices. This book is an important reference for materials scientists and engineers, who are looking to develop low-powered solutions to meet the growing demand for consumer electronic products and devices. Explores in depth memory device operation, requirements and challenges Presents fabrication methods and characterization results of new nanomaterials using techniques, including laser ablation of nanoparticles, ALD growth of nano-islands, and agglomeration-based technique of nanoparticles Demonstrates how nanomaterials affect the performance of memory devices

Silicon Compatible Materials, Processes, and Technologies for Advanced Integrated Circuits and Emerging Applications 6 Dec 14 2020

Neuromorphic Computing and Beyond Feb 13 2021 This book discusses and compares several new trends that can be used to overcome Moore’s law limitations, including Neuromorphic, Approximate, Parallel, In Memory, and Quantum Computing. The author shows how these paradigms are used to enhance computing capability as developers face the practical and physical limitations of scaling, while the demand for computing power keeps increasing. The discussion includes a state-of-the-art overview and the essential details of each of these paradigms.

Electronic Packaging Science and Technology Aug 10 2020 Must-have reference on electronic packaging technology! The electronics industry is shifting towards system packaging technology due to the need for higher chip circuit density without increasing production costs. Electronic packaging, or circuit integration, is seen as a necessary strategy to achieve a performance growth of electronic circuitry in next-generation electronics. With the implementation of novel materials with specific and tunable electrical and magnetic properties, electronic packaging is highly attractive as a solution to achieve denser levels of circuit integration. The first part of the book gives an overview of electronic packaging and provides the reader with the fundamentals of the most important packaging techniques such as wire bonding, tap automatic bonding, flip chip solder joint bonding, microbump bonding, and low temperature direct Cu-to-Cu bonding. Part two consists of concepts of electronic circuit design and its role in low power devices, biomedical devices, and circuit integration. The last part of the book contains topics based on the science of electronic packaging and the reliability of packaging technology.

Carbon Nanotubes for Interconnects Sep 30 2019 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.

NANO-CHIPS 2030 Aug 22 2021 In this book, a global team of experts from academia, research institutes and industry presents their vision on how new nano-chip architectures will enable the performance and energy efficiency needed for AI-driven advancements in autonomous mobility, healthcare, and man-machine cooperation. Recent reviews of the status quo, as presented in CHIPS 2020 (Springer), have prompted the need for an urgent reassessment of opportunities in nanoelectronic information technology. As such, this book explores the foundations of a new era in nanoelectronics that will drive progress in intelligent chip systems for energy-efficient information technology, on-chip deep learning for data analytics, and quantum computing. Given its scope, this book provides a timely compendium that hopes to inspire and shape the future of nanoelectronics in the decades to come.

3D IC Stacking Technology Mar 05 2020 The latest advances in three-dimensional integrated circuit stacking technology With a focus on industrial applications, 3D IC Stacking Technology offers comprehensive coverage of design, test, and fabrication processing methods for three-dimensional device integration. Each chapter in this authoritative guide is written by industry experts and details a separate fabrication step. Future industry applications and cutting-edge design potential are also discussed. This is an essential resource for semiconductor engineers and portable device designers. 3D IC Stacking Technology covers: High density through silicon stacking (TSS) technology Practical design ecosystem for heterogeneous 3D IC products Design automation and TCAD tool solutions for through silicon via (TSV)-based 3D IC stack Process integration for TSV manufacturing High-aspect-ratio silicon etch for TSV Dielectric deposition for TSV Barrier and seed deposition Copper electrodeposition for TSV Chemical mechanical polishing for TSV applications Temporary and permanent bonding Assembly and test aspects of TSV technology

Stacked-3D and Processing-in-memory Solutions for Data-intensive and Persistent Applications Apr 29 2022 With the dominance of data-intensive workloads and applications, the current von-Neumann-based architectures suffer from memory bandwidth problems, popularly known as the "memory wall". In order to alleviate the problem of memory bandwidth, processing-in-memory (PiM) has gained a lot of attention in recent years. In the PiM architectures, the compute logics are moved closer to or within the memory where the data resides, enabling the PiM architectures to exploit the high internal bandwidth of the memories. This dissertation explores the opportunities provided by the recent advancements in-memory technologies to design highly efficient PiM architectures for mainly deep-learning, database, and persistence applications. The first work in this dissertation presents a novel 3D-SRAM circuit design using a Monolithic 3D Integration process (M3D) for realizing beyond-Boolean in-memory compare operation without any area overheads compared to the standard 6T-SRAM. We also showcase measurement results from the fabricated PiM macro with the same circuit design for performing massively parallel compare operation used in the database, machine learning, and scientific applications. The proposed PiM technique supports operations like data filtering, sorting, and index handling of sparse matrix-matrix multiplication (SpGEMM). The second work presents a Look-Up Table (LUT) based PiM technique for conventional SRAM memory technology (i.e., single layer) with the potential for running Neural Network inference tasks. We implement a bitline computing free technique to avoid frequent bitline accesses to the cache sub-arrays and thereby considerably reducing the memory access energy overhead. Our proposed LUT-based PiM methodology exploits substantial parallelism using look-up tables, which do not alter the memory structure/organization. This methodology showcases a PiM architecture for current memory technologies with minimal changes to the monolithic custom memory blocks. The third work deals with crash consistency for critical applications like financial trading, cyber threat analysis, IoT, etc. At present, non-volatile memory technologies promise the opportunity for maintaining persistent data in memory. However, providing crash consistency in such systems can be costly as any update to the persistent data has to reach the persistent hard drive in a specific order, imposing a high overhead. In this work, we propose an architecture design that employs a hybrid volatile, non-volatile memory cell employing M3D and Ferroelectric technology in the L1 data cache to guarantee crash consistency with almost no performance overhead. Memory technologies like high bandwidth memory (HBM), and solid-state drives (SSD) make use of parallel-3D integration process to stack memory layers in order to increase the density per mm2. The final work presents cost-effective potential N-layer logic designs realized by the same process. This work discusses the stricter rules and constraints enforced by the fabrication process when designing N-layer designs and then explores different adder designs.

Advances In 3d Integrated Circuits And Systems Dec 02 2019 3D integration is an emerging technology for the design of many-core microprocessors and memory integration. This book, Advances in 3D Integrated Circuits and Systems, is written to help readers understand 3D integrated circuits in three stages: device basics, system level management, and real designs.Contents presented in this book include fabrication techniques for 3D TSV and 2.5D TSI; device modeling; physical designs; thermal, power and I/O management; and 3D designs of sensors, I/Os, multi-core processors, and memory.Advanced undergraduates, graduate students, researchers and engineers may find this text useful for understanding the many challenges faced in the development and building of 3D integrated circuits and systems.

Memory Bytes Jun 07 2020 DIVEssays on digital culture--what it is, its historical context, and its uses in the media, the film industry, and the sciences./div
3D Flash Memories Jul 09 2020 This book walks the reader through the next step in the evolution of NAND flash memory technology, namely the development of 3D flash memories, in which multiple layers of memory cells are grown within the same piece of silicon. It describes their working principles, device architectures, fabrication techniques and practical implementations, and highlights why 3D flash is a brand new technology. After reviewing market trends for both NAND and solid state drives (SSDs), the book digs into the details of the flash memory cell itself, covering both floating gate and emerging charge trap technologies. There is a plethora of different materials and vertical integration schemes out there. New memory cells, new materials, new architectures (3D Stacked, BiCS and P-BiCS, 3D FG, 3D VG, 3D advanced architectures); basically, each NAND manufacturer has its own solution. Chapter 3 to chapter 7 offer a broad overview of how 3D can materialize. The 3D wave is impacting emerging memories as well and chapter 8 covers 3D RRAM (resistive RAM) crosspoint arrays. Visualizing 3D structures can be a challenge for the human brain: this is way all these chapters contain a lot of bird's-eye views and cross sections along the 3 axes. The second part of the book is devoted to other important aspects, such as advanced packaging technology (i.e. TSV in chapter 9) and error correction codes, which have been leveraged to improve flash reliability for decades. Chapter 10 describes the evolution from legacy BCH to the most recent LDPC codes, while chapter 11 deals with some of the most recent advancements in the ECC field. Last but not least, chapter 12 looks at 3D flash memories from a system perspective. Is 14nm the last step for planar cells? Can 100 layers be integrated within the same piece of silicon? Is 4 bit/cell possible with 3D? Will 3D be reliable enough for enterprise and datacenter applications? These are some of the questions that this book helps answering by providing insights into 3D flash memory design, process technology and applications.
Advances in Non-volatile Memory and Storage Technology Apr 17 2021 Advances in Nonvolatile Memory and Storage Technology, Second Edition, addresses recent developments in the non-volatile memory spectrum, from fundamental understanding, to technological aspects. The book provides up-to-date information on the current memory technologies as related by leading experts in both academia and industry. To reflect the rapidly changing field, many new chapters have been included to feature the latest in RRAM technology, STT-RAM, memristors and more. The new edition describes the emerging technologies including oxide-based ferroelectric memories, MRAM technologies, and 3D memory. Finally, to further widen the discussion on the applications space, neuromorphic computing aspects have been included. This book is a key resource for postgraduate students and academic researchers in physics, materials science and electrical engineering. In addition, it will be a valuable tool for research and development managers concerned with electronics, semiconductors, nanotechnology, solid-state memories, magnetic materials, organic materials and portable electronic devices. Discusses emerging devices and research trends, such as neuromorphic computing and oxide-based ferroelectric memories Provides an overview on developing nonvolatile memory and storage technologies and explores their strengths and weaknesses Examines improvements to flash technology, charge trapping and resistive random access memory
Exploring Memory Hierarchy Design with Emerging Memory Technologies Mar 29 2022 This book equips readers with tools for computer architecture of high performance, low power, and high reliability memory hierarchy in computer systems based on emerging memory technologies, such as STTRAM, PCM, FBDRAM, etc. The techniques described offer advantages of high density, near-zero static power, and immunity to soft errors, which have the potential of overcoming the "memory wall." The authors discuss memory design from various perspectives: emerging memory technologies are employed in the memory hierarchy with novel architecture modification; hybrid memory structure is introduced to leverage advantages from multiple memory technologies; an analytical model named "Moguls" is introduced to explore quantitatively the optimization design of a memory hierarchy; finally, the vulnerability of the CMPs to radiation-based soft errors is improved by replacing different levels of on-chip memory with STT-RAMs.
Semiconductor Memories and Systems Oct 24 2021 Semiconductor Memories and Systems provides a comprehensive overview of the current state of semiconductor memory at the technology and system levels. After an introduction on market trends and memory applications, the book focuses on mainstream technologies, illustrating their current status, challenges and opportunities, with special attention paid to scalability paths. Technologies discussed include static random access memory (SRAM), dynamic random access memory (DRAM), non-volatile memory (NVM), and NAND flash memory. Embedded memory and requirements and system level needs for storage class memory are also addressed. Each chapter covers physical operating mechanisms, fabrication technologies, and the main challenges to scalability. Finally, the work reviews the emerging trends for storage class memory, mainly focusing on the advantages and opportunities of phase change based memory technologies. Features contributions from experts from leading companies in semiconductor memory Discusses physical operating mechanisms, fabrication technologies and paths to scalability

for current and emerging semiconductor memories Reviews primary memory technologies, including SRAM, DRAM, NVM and NAND flash memory Includes emerging storage class memory technologies such as phase change memory