

Cmos Mems Advanced Micro And Nanosystems

In the past decades, the mainstream of microelectronics progression was mainly powered by Moore's law focusing on IC miniaturization down to nano scale. However, there is a fast increasing need for "More than Moore" (MtM) products and technology that are based upon or derived from silicon technologies, but do not simply scale with Moore's law. This book provides new vision, strategy and guidance for the future technology and business development of micro/nanoelectronics.

Taken as a whole, this series covers all major fields of application for commercial sensors, as well as their manufacturing techniques and major types. As such the series does not treat bulk sensors, but rather places strong emphasis on microsensors, microsystems and integrated electronic sensor packages. Each of the individual volumes is tailored to the needs and queries of readers from the relevant branch of industry. A review of applications for point-of-care diagnostics, their integration into portable systems and the comfortable, easy-to-use sensors that allow patients to monitor themselves at home. The book covers such advanced topics as minimal invasive surgery, implantable sensors and prostheses, as well as biocompatible sensing. The book will address the-state-of-the-art in integrated Bio-Microsystems that integrate microelectronics with fluidics, photonics, and mechanics. New exciting opportunities in emerging applications that will take system performance beyond offered by traditional CMOS based circuits are discussed in detail. The book is a must for anyone serious about microelectronics integration possibilities for future technologies. The book is written by top notch international

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experts in industry and academia. The intended audience is practicing engineers with electronics background that want to learn about integrated microsystems. The book will be also used as a recommended reading and supplementary material in graduate course curriculum.

Les propriétés physico-chimiques et électromécaniques des nanosystèmes mécaniques (NEMS) permettent de sonder le monde de la physique moléculaire et supramoléculaire. La réalisation de ces démonstrations scientifiques demande un soin particulier dans le choix de l'instrumentation à utiliser et pour la conception des nano-objets. Cet ouvrage présente les démarches scientifiques ad hoc requises pour optimiser ces conditions de réalisation. Étudiant les nanosystèmes sous l'angle de l'automatique, de l'électronique et de la physique, il traite à la fois leurs aspects théoriques et technologiques. Nanosystèmes électromécaniques expose les principes de base des NEMS et les méthodes de transduction des déplacements nanométriques, et ensuite il décrit les techniques d'interfaçage avec le monde macroscopique basées sur leur co-intégration avec des circuits. Les principaux travaux théoriques et expérimentaux sur les effets d'échelle sont également présentés ainsi que de nouveaux paradigmes d'application des NEMS.

Microstructures, electronics, nanotechnology - these vast fields of research are growing together as the size gap narrows and many different materials are combined. Current research, engineering successes and newly commercialized products hint at the immense innovative potentials and future applications that open up once mankind controls shape and function from the atomic level right up to the visible world without any gaps. Sensor systems, microreactors, nanostructures, nanomachines, functional surfaces, integrated optics, displays, communications technology, biochips, human/machine interfaces, prosthetics, miniaturized

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medical and surgery equipment and many more opportunities are being explored.

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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.

This book comprises a selection of the presentations made at the “Workshop on Dynamics and Control of Micro and Nanoscale Systems” held at IBM Research – Zurich, Switzerland, on the 10th and 11th of December 2009. The aim of the workshop was to bring together some of the leading researchers in the field of dynamics and control of micro- and nanoscale systems. It proved an excellent forum for discussing new ideas and approaches.

This issue of ECS Transactions covers emerging materials, process and technology options for large-area silicon wafers to enhance advanced IC performance or to enable revolutionary device structures with entirely new

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functionalities. Topics : high-mobility channel materials, (e.g. strained Si/Ge, compound semiconductors and graphene), high-performance gate stacks and low-resistivity junctions and contacts on new, Si-compatible materials; new materials and processes for 3-D (TSV) integration ; synthesis of nano-structures including wires, pores and membranes of Si-compatible materials; novel MEMS/NEMS structures and their integration with the mainstream Si-IC technology.

In this book, the fundamentals of chemical engineering are presented with respect to applications in micro system technology, microfluidics, and transport processes within microstructures. Special features of the book include the state-of-the-art in micro process engineering, a detailed treatment of transport phenomena for engineers, and a design methodology from transport effects to economic considerations.

Resonant microelectromechanical systems (MEMS) are characterized by sub-millimeter-sized components that are able to oscillate. Depending on the actuation method, these resonant MEMS are implemented, e.g., as electrostatic, electrothermal, magnetostatic or piezoelectric devices. The distinct characteristics of these devices such as a wide frequency range, favorable signal-to-noise ratios, reliability, low power consumption and small size make them useful for a variety of applications ranging from sensors to timing devices. The book covers the principles, modeling and implementation as well as applications of resonant MEMS from a unified viewpoint. It starts out with the fundamental equations and phenomena that govern the behavior of resonant

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MEMS and then gives a detailed overview of their implementation in capacitive, piezoelectric, thermal and organic devices, complemented by chapters addressing the packaging of the devices and their stability. The last part of the book is devoted to the cutting-edge applications of resonant MEMS such as inertial, chemical and biosensors, fluid properties sensors, and energy harvesting systems.

Our mission is to provide a forum for world experts to discuss technologies, address the growing needs associated with silicon technology, and exchange their discoveries and solutions for current issues of high interest. We encourage collaboration, open discussion, and critical reviews at this conference. Furthermore, we hope that this conference will also provide collaborative opportunities for those who are interested in the semiconductor industry in Asia, particularly in China. Micro and nano-electro-mechanical system (M/NEMS) devices constitute key technological building blocks to enable increased additional functionalities within Integrated Circuits (ICs) in the More-Than-Moore era, as described in the International Technology Roadmap for Semiconductors. The CMOS ICs and M/NEMS dies can be combined in the same package (SiP), or integrated within a single chip (SoC). In the SoC approach the M/NEMS devices are monolithically integrated together with CMOS circuitry allowing the development of compact and low-cost CMOS-M/NEMS devices for multiple applications (physical sensors, chemical sensors, biosensors, actuators, energy actuators, filters, mechanical relays, and others). On-chip CMOS

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electronics integration can overcome limitations related to the extremely low-level signals in sub-micrometer and nanometer scale electromechanical transducers enabling novel breakthrough applications. This Special Issue aims to gather high quality research contributions dealing with MEMS and NEMS devices monolithically integrated with CMOS, independently of the final application and fabrication approach adopted (MEMS-first, interleaved MEMS, MEMS-last or others).]

Drawing on their experiences in successfully executing hundreds of MEMS development projects, the authors present the first practical guide to navigating the technical and business challenges of MEMS product development, from the initial concept stage all the way to commercialization. The strategies and tactics presented, when practiced diligently, can shorten development timelines, help avoid common pitfalls, and improve the odds of success, especially when resources are limited. MEMS Product Development illuminates what it really takes to develop a novel MEMS product so that innovators, designers, entrepreneurs, product managers, investors, and executives may properly prepare their companies to succeed.

This book will present the theoretical and technological elements of nanosystems. Among the different topics discussed, the authors include the electromechanical properties of NEMS, the scaling effects that give these their interesting properties for different applications and the current manufacturing processes. The authors aim to provide useful tools for future readers and will provide an accurate picture of current and future research in the field.

The first comprehensive text on microhotplate-based chemical sensor systems in CMOS-technology covers all aspects of successful sensor prototyping: theoretical

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considerations for modelling, controller- and system design, simulation of circuits and microsensors, design considerations, microfabrication, packaging and testing. A whole family of metal-oxide based microsensor systems with increasing complexity is presented, including fully integrated sensor arrays. This represents one of the first examples of integrated nanomaterials, microtechnology and embedded circuitry.

Advanced Nanomaterials for Inexpensive Gas Microsensors presents full coverage of the area of gas sensing nanomaterials, from materials, transducers and applications to the latest advanced results and future directions. A number of experts in the field present work on gas sensing nanomaterials including metal oxides, carbon based and hybrid materials, together with their fabrication and application. The book brings together three major themes: Several chapters address synthesis, functionalization, characterization of advanced nanomaterials, with emphasis on synthesis techniques to ease the integration of nanomaterials in transducers. These chapters encompass a wide spectrum of sensing technologies including advanced nanomaterials such as metal oxides, carbon materials and graphene, organic molecular materials, and atomic layers such as MoS₂. The authors examine the coupling of sensitive nanomaterials to different types of transducer elements and their applications, including direct growth and additive fabrication techniques as a way to obtain inexpensive gas microsensors, principal transduction schemes, and advanced operating methods. Assess the value of major applications for gas microsensors, including air quality monitoring both indoors (buildings and vehicles) and outdoors, monitoring perishable goods and medical. For each application, potential issues are clearly identified, research directions to overcome these are suggested, and market analysis data is included.

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Advanced Nanomaterials for Inexpensive Gas Microsensors presents the latest research and most comprehensive coverage in the field of gas micro and nano sensors for research scientists, academics, graduate students, and R&D managers working on synthesis of nanomaterials and fabrication of sensing systems, in a wide range of areas in electrical and material engineering, physical chemistry, electrochemistry and physics. Presents technological solutions and applications of gas sensors in varied areas of chemistry, physics, material science, and engineering Examines advanced operating methods (e.g., temperature modulation, self-heating, light-activated response, noise methods) to enhance stability, sensitivity, selectivity and reduce power consumption Provides a critical review of current applications and their expected future evolution, demonstrating which are the most promising approaches and what can be expected from the development of inexpensive gas micro- and nanosensors

This first book to cover exclusively and in detail the principles, tools and methods for determining the reliability of microelectromechanical materials, components and devices covers both component materials as well as entire MEMS devices. Divided into two major parts, following a general introductory chapter to reliability issues, the first part looks at the mechanical properties of the materials used in MEMS, explaining in detail the necessary measuring technologies -- nanoindenters, bulge methods, bending tests, tensile tests, and others. Part Two treats the actual devices, organized by important device categories such as pressure sensors, inertial sensors, RF MEMS, and optical MEMS.

Microsystems technologies have found their way into an impressive variety of applications, from mobile phones, computers, and displays to smart grids, electric cars, and space shuttles. This multidisciplinary field of research extends

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the current capabilities of standard integrated circuits in terms of materials and designs and complements them by creating innovative components and smaller systems that require lower power consumption and display better performance. Novel Advances in Microsystems Technologies and their Applications delves into the state of the art and the applications of microsystems and microelectronics-related technologies. Featuring contributions by academic and industrial researchers from around the world, this book:

- Examines organic and flexible electronics, from polymer solar cell to flexible interconnects for the co-integration of micro-electromechanical systems (MEMS) with complementary metal oxide semiconductors (CMOS)
- Discusses imaging and display technologies, including MEMS technology in reflective displays, the fabrication of thin-film transistors on glass substrates, and new techniques to display and quickly transmit high-quality images
- Explores sensor technologies for sensing electrical currents and temperature, monitoring structural health and critical industrial processes, and more
- Covers biomedical microsystems, including biosensors, point-of-care devices, neural stimulation and recording, and ultra-low-power biomedical systems

Written for researchers, engineers, and graduate students in electrical and biomedical engineering, this book reviews groundbreaking technology, trends, and applications in microelectronics. Its coverage of the latest research serves as a source of inspiration for anyone interested in further developing microsystems technologies and creating new applications.

Electrostatic discharge (ESD) continues to impact semiconductor manufacturing, semiconductor components and systems, as technologies scale from micro- to nano electronics. This book introduces the fundamentals of ESD, electrical overstress (EOS), electromagnetic interference (EMI), electromagnetic compatibility (EMC), and latchup, as

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well as provides a coherent overview of these semiconductor manufacturing environment and the final system assembly. It provides an illuminating look into the integration of ESD protection networks followed by examples in specific technologies, circuits, and chips. The text is unique in covering semiconductor chip manufacturing issues, ESD semiconductor chip design, and system problems confronted today as well as the future of ESD phenomena and nano-technology. Look inside for extensive coverage on: The fundamentals of electrostatics, triboelectric charging, and how they relate to present day manufacturing environments of micro-electronics to nano-technology Semiconductor manufacturing handling and auditing processing to avoid ESD failures ESD, EOS, EMI, EMC, and latchup semiconductor component and system level testing to demonstrate product resilience from human body model (HBM), transmission line pulse (TLP), charged device model (CDM), human metal model (HMM), cable discharge events (CDE), to system level IEC 61000-4-2 tests ESD on-chip design and process manufacturing practices and solutions to improve ESD semiconductor chip solutions, also practical off-chip ESD protection and system level solutions to provide more robust systems System level concerns in servers, laptops, disk drives, cellphones, digital cameras, hand held devices, automobiles, and space applications Examples of ESD design for state-of-the-art technologies, including CMOS, BiCMOS, SOI, bipolar technology, high voltage CMOS (HVCMOS), RF CMOS, smart power, magnetic recording technology, micro-machines (MEMs) to nano-structures ESD Basics: From Semiconductor Manufacturing to Product Use complements the author's series of books on ESD protection. For those new to the field, it is an essential reference and a useful insight into the issues that confront modern technology as we enter the Nano-electronic Era.

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Presenting unified coverage of the design and modeling of smart micro- and macrosystems, this book addresses fabrication issues and outlines the challenges faced by engineers working with smart sensors in a variety of applications. Part I deals with the fundamental concepts of a typical smart system and its constituent components. Preliminary fabrication and characterization concepts are introduced before design principles are discussed in detail. Part III presents a comprehensive account of the modeling of smart systems, smart sensors and actuators. Part IV builds upon the fundamental concepts to analyze fabrication techniques for silicon-based MEMS in more detail. Practicing engineers will benefit from the detailed assessment of applications in communications technology, aerospace, biomedical and mechanical engineering. The book provides an essential reference or textbook for graduates following a course in smart sensors, actuators and systems.

Over half a century after the discovery of the piezoresistive effect, microsystem technology has experienced considerable developments. Expanding the opportunities of microelectronics to non-electronic systems, its number of application fields continues to increase. Microsensors are one of the most important fields, used in medical applications and micromechanics. Microfluidic systems are also a significant area, most commonly used in ink-jet printer heads. This textbook focuses on the essentials of microsystems technology, providing a knowledgeable grounding and a clear path through this well-established scientific discipline. With a methodical, student-orientated approach, Introduction to Microsystem Technology covers the following: microsystem materials (including silicon, polymers and thin films), and the scaling effects of going micro; fabrication techniques based on different material properties, descriptions of their limitations and functional and shape elements produced by

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these techniques; sensors and actuators based on elements such as mechanical, fluidic, and thermal (yaw rate sensor components are described); the influence of technology parameters on microsystem properties, asking, for example, when is the function of a microsystem device robust and safe? The book presents problems at the end of each chapter so that you may test your understanding of the key concepts (full solutions for these are given on an accompanying website). Practical examples are included also, as well as case studies that enable a better understanding of the technology as a whole. With its extensive treatment on the fundamentals of microsystem technology, this book also serves as a compendium for engineers and technicians working with microsystem technology.

A NATO Advanced Research Workshop (ARW) entitled "Advanced Materials and Technologies for Micro/Nano Devices, Sensors and Actuators" was held in St. Petersburg, Russia, from June 29 to July 2, 2009. The main goal of the Workshop was to examine (at a fundamental level) the very complex scientific issues that pertain to the use of micro- and nano-electromechanical systems (MEMS and NEMS), devices and technologies in next generation commercial and defen- related applications. Micro- and nano-electromechanical systems represent rather broad and diverse technological areas, such as optical systems (micromirrors, waveguides, optical sensors, integrated subsystems), life sciences and lab equipment (micropumps, membranes, lab-on-chip, membranes, microfluidics), sensors (bio-sensors, chemical sensors, gas-phase sensors, sensors integrated with electronics) and RF applications for signal transmission (variable capacitors, tunable filters and antennas, switches, resonators). From a scientific viewpoint, this is a very multi-disciplinary field, including micro- and nano-mechanics (such as stresses in structural materials),

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electronic effects (e. g. charge transfer), general electrostatics, materials science, surface chemistry, interface science, (nano)tribology, and optics. It is obvious that in order to overcome the problems surrounding next-generation MEMS/NEMS devices and applications it is necessary to tackle them from different angles: theoreticians need to speak with mechanical engineers, and device engineers and modelers to listen to surface physicists. It was therefore one of the main objectives of the workshop to bring together a multidisciplinary team of distinguished researchers.

The microelectromechanical systems (MEMS) industry has experienced explosive growth over the last decade. Applications range from accelerometers and gyroscopes used in automotive safety to high-precision on-chip integrated oscillators for reference generation and mobile phones.

MEMS: Fundamental Technology and Applications brings together groundbreaking research in MEMS technology and explores an eclectic set of novel applications enabled by the technology. The book features contributions by top experts from industry and academia from around the world. The contributors explain the theoretical background and supply practical insights on applying the technology. From the historical evolution of nano micro systems to recent trends, they delve into topics including:

- Thin-film integrated passives as an alternative to discrete passives
- The possibility of piezoelectric MEMS
- Solutions for MEMS gyroscopes
- Advanced interconnect technologies
- Ambient energy harvesting
- Bulk acoustic wave resonators
- Ultrasonic receiver arrays using MEMS sensors
- Optical MEMS-based spectrometers
- The integration of MEMS resonators with conventional circuitry
- A wearable inertial and magnetic MEMS sensor assembly to estimate rigid body movement patterns
- Wireless microactuators to enable implantable MEMS devices for drug delivery
- MEMS technologies for tactile sensing and

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actuation in robotics MEMS-based micro hot-plate devices Inertial measurement units with integrated wireless circuitry to enable convenient, continuous monitoring Sensors using passive acousto-electric devices in wired and wireless systems Throughout, the contributors identify challenges and pose questions that need to be resolved, paving the way for new applications. Offering a wide view of the MEMS landscape, this is an invaluable resource for anyone working to develop and commercialize MEMS applications.

Advanced Packaging serves the semiconductor packaging, assembly and test industry. Strategically focused on emerging and leading-edge methods for manufacturing and use of advanced packages.

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Combining robotics with nanotechnology, this ready reference summarizes the fundamentals and emerging applications in this fascinating research field. This is the first book to introduce tools specifically designed and made for manipulating micro- and nanometer-sized objects, and presents such examples as semiconductor packaging and clinical diagnostics as well as surgery. The first part discusses various topics of on-chip and device-based micro- and nanomanipulation, including the use of acoustic, magnetic, optical or dielectrophoretic fields, while surface-driven and high-speed microfluidic manipulation for biophysical applications are also covered. In the second part of the book, the main focus is on microrobotic tools. Alongside magnetic micromanipulators, bacteria and untethered, chapters also discuss silicon nano- and integrated optical tweezers. The book closes with a number of chapters on nanomanipulation using AFM and nanocoils under optical and electron microscopes. Exciting images from the tiniest robotic systems at the nano-level are used to illustrate the examples

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throughout the work. A must-have book for readers with a background ranging from engineering to nanotechnology. Micromachining is used to fabricate three-dimensional microstructures and it is the foundation of a technology called Micro-Electro-Mechanical-Systems (MEMS). Bulk micromachining and surface micromachining are two major categories (among others) in this field. This book presents advances in micromachining technology. For this, we have gathered review articles related to various techniques and methods of micro/nano fabrications, like focused ion beams, laser ablation, and several other specialized techniques, from esteemed researchers and scientists around the world. Each chapter gives a complete description of a specific micromachining method, design, associated analytical works, experimental set-up, and the final fabricated devices, followed by many references related to this field of research available in other literature. Due to the multidisciplinary nature of this technology, the collection of articles presented here can be used by scientists and researchers in the disciplines of engineering, materials sciences, physics, and chemistry. This edition of 'Micro Process Engineering' was originally published in the successful series 'Advanced Micro & Nanosystems'. Authors from leading industrial players and research institutions present a concise and didactical introduction to Micro Process Engineering, the combination of microtechnology and process engineering into a most promising and powerful tool for revolutionizing chemical processes and industrial mass production of bulk materials, fine chemicals, pharmaceuticals and many other products. The book takes the readers from the fundamentals of engineering methods, transport processes, and fluid dynamics to device conception, simulation and modelling, control interfaces and issues of modularity and compatibility. Fabrication strategies and techniques are examined next,

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focused on the fabrication of suitable microcomponents from various materials such as metals, polymers, silicon, ceramics and glass. The book concludes with actual applications and operational aspects of micro process systems, giving broad coverage to industrial efforts in America, Europe and Asia as well as laboratory equipment and education.

A new high-level book for professionals from Atlantis Press providing an overview of nanotechnologies now and their applications in a broad variety of fields, including information and communication technologies, environmental sciences and engineering, societal life, and medicine, with provision of customized treatments. The book shows where nanotechnology is now - a fascinating time when the science is transitioning into complex systems with impact on new products. Present and future developments are addressed, as well as a larger number of new industrial and research opportunities deriving from this domain. An overview for professionals, researchers and policy-makers of this very rapidly expanding field. Brief chapters and colour figures with a contained overall length make the book attractive at an attractive price - a must for every professional's shelf. Mihail C. Roco, National Science Foundation and National Nanotechnology Initiative, wrote the preface underlying the importance and weight of the present book to this exciting and epoch-awakening field of research and applications: "Nanotechnology is well recognized as a science and technology megatrend for the beginning of the 21st century. This book aims to show where nanotechnology is now - transitioning to complex systems and fundamentally new products - and communicates the societal promise of nanotechnology to specialists and the public. Most of what has already made it into the marketplace is in the form of "First Generation" products, passive nanostructures with steady behaviour. Many companies have "Second

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Generation” products, active nanostructures with changing behaviour during use, and embryonic “Third Generation” products, including 3-dimensional nanosystems. Concepts for “Fourth Generation” products, including heterogeneous molecular nanosystems, are only in research.”

The main objective of this International Workshop in Vigo is to target this major problem by bringing together scientists and engineers specialized on various different topics related to group IV semiconductors. In five consecutive sessions dedicated to - Group IV materials: CMOS and further extension of the roadmap - Group IV materials: Nanophotonics - Material aspects and characterization on nano-scale - Nanostructures and material processing on atomic scale

Microstructures, electronics, nanotechnology - these vast fields of research are growing together as the size gap narrows and many different materials are combined. Current research, engineering successes and newly commercialized products hint at the immense innovative potentials and future applications that open up once mankind controls shape and function from the atomic level right up to the visible world without any gaps. In this volume, authors from three major competence centres for microengineering illustrate step by step the process from designing and simulating microcomponents of metallic and ceramic materials to replicating micro-scale components by injection molding.

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