Microfluidics And Microscale Transport Processes Iit Kharagpur Research Monograph Series

Micro- and Nanoscale Fluid MechanicsNanofluidics and MicrofluidicsTransport Phenomena in Microfluidic SystemsModeling and Measurement Methods for Acoustic Waves and for Acoustic MicrodevicesMicrofluidics and Nanofluidics HandbookLab-on-a-chipMicro-Drops and Digital MicrofluidicsLab-on-a-Chip Devices and Micro-Total Analysis SystemsIntroduction to MicrofluidicsProcess Analysis, Design, and Intensification in Microfluidics and Chemical EngineeringHeat Transfer and Fluid Flow in Minichannels and MicrochannelsTransport Processes in Free Surface MicrofluidicsDissertation Abstracts InternationalMicro Process EngineeringMicrofluidics and NanofluidicsDevelopment of a Novel Microfluidic Reactor for Highly Controlled Synthesis of Semiconductor NanocrystalsElectrokinetics in MicrofluidicsTransport Phenomena Fundamentals, Third EditionMicroscale Diagnostic TechniquesEncyclopedia of Microfluidics and NanofluidicsNanofluidicsStudy of Transport Processes from Macroscale to MicroscaleMicrofluidics for Single-Cell AnalysisPhotoproteins in BioanalysisHeat Transfer and Fluid Flow in Minichannels and MicrochannelsJournal of the Indian Institute of ScienceOpen-Space MicrofluidicsModeling of Microscale Transport in Biological

ProcessesMicrofluidics: History, Theory and ApplicationsMicrofluidics for BiotechnologyTransport Phenomena in Micro Process EngineeringMicrofluidics and MicrofabricationMicrofluidics and Microscale Transport ProcessesAdvances in MicrofluidicsMicromixersElectrokinetics in MicrofluidicsMicro Process EngineeringFrontier Research in Microscale and Nanoscale Thermal and Fluid SciencesDigital Geometry in Image ProcessingMicrofluidic Technologies for Human Health

Micro- and Nanoscale Fluid Mechanics

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, 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.

Nanofluidics and Microfluidics

Ch. 1. A microscale bioinspired cochlear-like sensor / Robert D. White, Robert Littrell, and Karl Grosh -- ch. 2. Systematic evaluation of the efficiencies of proteins and chemicals in pharmaceutical applications / Morgan Hamon and Jong Wook Hong -- ch. 3. Microfluidic glucose sensors / Jithesh V. Veetil [et al.] -- ch. 4. Applications of microfabrication and microfluidic techniques in mesenchymal stem cell research / Abhijit Majumder [et al.] -- ch. 5. Patient-specific modeling of low-density lipoprotein transport in coronary arteries / Ufuk Olgac -- ch. 6. Point-of-care microdevices for global health diagnostics of infectious diseases / Sau Yin Chin [et al.] -- ch. 7. Integrated microfluidic sample preparation for chip-based molecular diagnostics / Jane Y. Zhang [et al.] -- ch. 8. Microfluidic devices for cellular proteomic studies / Yihong Zhan and Chang Lu -- ch. 9. Microfluidics for neuroscience: novel tools and future implications / Vivian M. Hernandez and P. Hande Ozdinler -- ch. 10. Microfluidics: on-chip platforms as in vitro disease models / Shan Gao, Erkin Seker, and Martin L. Yarmush -- ch. 11. Application of microfluidics in stem cell and tissue engineering / Sasha H. Bakhru, Christopher Highley, and Stefan Zappe -- ch. 12. Microfluidic "on-the-fly" fabrication of microstructures for biomedical applications / Edward Kang, Sau Fung Wong, and Sang-Hoon Lee -- ch. 13.

Microfluidics as a promising tool toward distributed viral detection / Elodie Sollier and Dino Di Carlo -- ch. 14. Electrophoresis and dielectrophoresis for lab-on-a-chip (LOC) analyses / Yagmur Demircan, Gurkan Yilmaz, and Haluk Kulah -- ch. 15. Ultrasonic embossing of carbon nanotubes for the fabrication of polymer microfluidic chips for DNA sample purification / Puttachat Khuntontong, Min Gong, and Zhiping Wang -- ch. 16. Ferrofluidics / A. Rezzan Kose and Hur Koser -- ch. 17. Antibody-based blood bioparticle capture and separation using microfluidics for global health / ZhengYuan Luo [et al.] -- ch. 18. Applications of quantum dots for fluorescence imaging in biomedical research / ShuQi Wang [et al.]

Transport Phenomena in Microfluidic Systems

Heat exchangers with minichannel and microchannel flow passages are becoming increasingly popular due to their ability to remove large heat fluxes under single-phase and two-phase applications. Heat Transfer and Fluid Flow in Minichannels and Microchannels methodically covers gas, liquid, and electrokinetic flows, as well as flow boiling and condensation, in minichannel and microchannel applications. Examining biomedical applications as well, the book is an ideal reference for anyone involved in the design processes of microchannel flow passages in a heat exchanger. Each chapter is accompanied by a real-life case study New edition of the first book that solely deals with heat and fluid flow in minichannels and microchannels Presents findings

that are directly useful to designers; researchers can use the information in developing new models or identifying research needs

Modeling and Measurement Methods for Acoustic Waves and for Acoustic Microdevices

Microfluidics and Nanofluidics Handbook

In the present book, various applications of microfluidics and nanofluidics are introduced. Microfluidics and nanofluidics span a broad array of disciplines including mechanical, materials, and electrical engineering, surface science, chemistry, physics and biology. Also, this book deals with transport and interactions of colloidal particles and biomolecules in microchannels, which have great importance to many microfluidic applications, such as drug delivery in life science, microchannel heat exchangers in electronic cooling, and food processing industry. Furthermore, this book focuses on a detailed description of the thermal transport behavior, challenges and implications that involve the development and use of HTFs under the influence of atomistic-scale structures and industrial applications.

Lab-on-a-chip

Exploring theories and applications developed during the last 30 years, Digital Geometry in Image Processing presents a mathematical treatment of the

properties of digital metric spaces and their relevance in analyzing shapes in two and three dimensions. Unlike similar books, this one connects the two areas of image processing and digital geometry,

Micro-Drops and Digital Microfluidics

The advancements in micro- and nano-fabrication techniques, especially in the last couple of decades, have led research communities, over the world, to invest unprecedented levels of attention on the science and technology of micro- and nano-scale devices and the concerned applications. With an intense focus on micro- and nanotechnology from a fluidic perspective, Microfluidics and Microscale Transport Processes provides a broad review of advances in this field. A comprehensive compendium of key indicators to recent developments in some very active research topics in microscale transport processes, it supplies an optimal balance between discussions of concrete applications and development of fundamental understanding. The chapters discuss a wide range of issues in the sub-domains of capillary transport, fluidic resistance, electrokinetics, substrate modification, rotational microfluidics, and the applications of the phenomena of these sub-domains in diverse situations ranging from non-biological to biological ones like DNA hybridization and cellular biomicrofluidics. The book also addresses a generic problem of particle transport in nanoscale colloidal suspensions and includes a chapter on Lattice-Boltzmann methods for phase-changing problems which represents a generic particle based approach

that may be useful to address many microfluidic problems of interdisciplinary relevance.

Lab-on-a-Chip Devices and Micro-Total Analysis Systems

Increasing innovations and applications make microfluidics a versatile choice for researchers in many disciplines. This book consists of multiple review chapters that aim to cover recent advances and new applications of microfluidics in biology, electronics, energy, and materials sciences. It provides comprehensive views of various aspects of microfluidics ranging from fundamentals of fabrication, flow control, and droplet manipulation to the most recent exploration in emerging areas such as material synthesis, imaging and novel spectroscopy, and marriage with electronics. The chapters have many illustrations showcasing exciting results. This book should be useful for those who are eager to learn more about microfluidics as well as researchers who want to pick up new concepts and developments in this fast-growing field.

Introduction to Microfluidics

Microrheology.- Micron-Resolution Particle Image Velocimetry.- Electrokinetic Flow Diagnostics.- Micro- and Nano-Scale Diagnostic Technique for Thermomentry.- Nanoscale Mechanical Characterization of Carbon Nanotubes.- Applications of the Piezoelectric Quartz Crystal Microbalance for Microdevice Development.

Process Analysis, Design, and Intensification in Microfluidics and Chemical Engineering

Heat Transfer and Fluid Flow in Minichannels and Microchannels

Modeling of Microscale Transport in Biological Processes provides a compendium of recent advances in theoretical and computational modeling of biotransport phenomena at the microscale. The simulation strategies presented range from molecular to continuum models and consider both numerical and exact solution method approaches to coupled systems of equations. The biological processes covered in this book include digestion, molecular transport, microbial swimming, cilia mediated flow, microscale heat transfer, micro-vascular flow, vesicle dynamics, transport through bio-films and bio-membranes, and microscale growth dynamics. The book is written for an advanced academic research audience in the fields of engineering (encompassing biomedical, chemical, biological, mechanical, and electrical), biology and mathematics. Although written for, and by, expert researchers, each chapter provides a strong introductory section to ensure accessibility to readers at all levels. Features recent developments in theoretical and computational modeling for clinical researchers and engineers Furthers researcher understanding of fluid flow in biological media and focuses on biofluidics at the microscale Includes chapters expertly authored by

internationally recognized authorities in the fundamental and applied fields that are associated with microscale transport in living media

Transport Processes in Free Surface Microfluidics

The application of microfluidics to biotechnology is an exciting new area that has already begun to revolutionize how researchers study and manipulate macromolecules like DNA, proteins and cells in vitro and within living organisms. Now in a newly revised and expanded second edition, the Artech House bestseller, Microfluidics for Biotechnology brings you to the cutting edge of this burgeoning field. Among the numerous updates, the second edition features three entirely new chapters on: non-dimensional numbers in microfluidics; interface, capillarity and microdrops; and digital, two-phase and droplet microfluidics.Presenting an enlightening balance of numerical approaches, theory, and experimental examples, this book provides a detailed look at the mechanical behavior of the different types of micro/nano particles and macromolecules that are used in biotechnology. You gain a solid understanding of microfluidics theory and the mechanics of microflows and microdrops. The book examines the diffusion of species and nanoparticles, including continuous flow and discrete Monte-Carlo methods.This unique volume describes the transport and dispersion of biochemical species and particles. You learn how to model biochemical reactions, including DNA hybridization and enzymatic reactions.

Moreover, the book helps you master the theory, applications, and modeling of magnetic beads behavior and provides an overview of self-assembly and magnetic composite. Other key topics include the electric manipulation of micro/nanoparticles and macromolecules and the experimental aspects of biological macromolecule manipulation.

Dissertation Abstracts International

Microfluidics is a microtechnological field dealing with the precise transport of fluids (liquids or gases) in small amounts (e.g. microliters, nanoliters or even picoliters). This book provides a useful introduction into this burgeoning field, and a specific application of microfluidics is presented. It also gives a survey of microfluidics.

Micro Process Engineering

To provide an interdisciplinary readership with the necessary toolkit to work with micro- and nanofluidics, this book provides basic theory, fundamentals of microfabrication, advanced fabrication methods, device characterization methods and detailed examples of applications of nanofluidics devices and systems. Case studies describing fabrication of complex micro- and nanoscale systems help the reader gain a practical understanding of developing and fabricating such systems. The resulting work covers the fundamentals, processes and applied challenges of functional engineered nanofluidic systems for a variety of different applications,

including discussions of lab-on-chip, bio-related applications and emerging technologies for energy and environmental engineering. The fundamentals of micro- and nanofluidic systems and micro- and nanofabrication techniques provide readers from a variety of academic backgrounds with the understanding required to develop new systems and applications. Case studies introduce and illustrate state-of-the-art applications across areas, including lab-on-chip, energy and bio-based applications. Prakash and Yeom provide readers with an essential toolkit to take micro- and nanofluidic applications out of the research lab and into commercial and laboratory applications.

Microfluidics and Nanofluidics

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.

Development of a Novel Microfluidic Reactor for Highly Controlled Synthesis of Semiconductor Nanocrystals

Microfluidics represent great potential for chemical processes design, development, optimization, and

chemical engineering bolsters the project design of industrial processes often found in large chemical plants. Together, microfluidics and chemical engineering can lead to a more complete and comprehensive process. Process Analysis, Design, and Intensification in Microfluidics and Chemical Engineering provides emerging research exploring the theoretical and practical aspects of microfluidics and its application in chemical engineering with the intention of building pathways for new processes and product developments in industrial areas. Featuring coverage on a broad range of topics such as design techniques, hydrodynamics, and numerical modelling, this book is ideally designed for engineers, chemists, microfluidics and chemical engineering companies, academicians, researchers, and students.

Electrokinetics in Microfluidics

Microfluidics is a young discipline which enables scientists and engineers to handle fluids in the biochips of the future.The book is an introduction to this discipline. It presents in simple terms the most important notions of the domain: how fluids move on the chip, conveying materials, molecules, electrical charges, and heat.

Transport Phenomena Fundamentals, Third Edition

This book covers all the steps in order to fabricate a lab-on-a-chip device starting from the idea, the design, simulation, fabrication and final evaluation.

Additionally, it includes basic theory on microfluidics essential to understand how fluids behave at such reduced scale. Examples of successful histories of lab-on-a-chip systems that made an impact in fields like biomedicine and life sciences are also provided. This book also: · Provides readers with a unique approach and toolset for lab-on-a-chip development in terms of materials, fabrication techniques, and components · Discusses novel materials and techniques, such as paper-based devices and synthesis of chemical compounds on-chip · Covers the four key aspects of development: basic theory, design, fabrication, and testing · Provides readers with a comprehensive list of the most important journals, blogs, forums, and conferences where microfluidics and lab-on-a-chip news, methods, techniques and challenges are presented and discussed, as well as a list of companies providing design and simulation support, components, and/or developing lab-on-a-chip and microfluidic devices.

Microscale Diagnostic Techniques

The Microfluidics and Nanofluidics Handbook: Two-Volume Set comprehensively captures the cross-disciplinary breadth of the fields of micro- and nanofluidics, which encompass the biological sciences, chemistry, physics and engineering applications. To fill the knowledge gap between engineering and the basic sciences, the editors pulled together key individuals, well known in their respective areas, to author chapters that help graduate students, scientists, and practicing

engineers understand the overall area of microfluidics and nanofluidics. Topics covered include Cell Lysis Techniques in Lab-on-a-Chip Technology Electrodics in Electrochemical Energy Conversion Systems: Microstructure and Pore-Scale Transport Microscale Gas Flow Dynamics and Molecular Models for Gas Flow and Heat Transfer Microscopic Hemorheology and Hemodynamics Covering physics and transport phenomena along with life sciences and related applications, Volume One: Chemistry, Physics, and Life Science Principles provides readers with the fundamental science background that is required for the study of microfluidics and nanofluidics. Both volumes include as much interdisciplinary knowledge as possible to reflect the inherent nature of this area, valuable to students and practitioners.

Encyclopedia of Microfluidics and Nanofluidics

An investigation was conducted to examine the dominant fluid transport physics at the macro, micro, and molecular scale. Three novel techniques were developed to elucidate the fluid flow fields occurring in microscale and nanoscale fluidic systems. These techniques were then used to design and investigate a novel free-surface microfluidic system capable of delivering sustained and controlled flows ranging from 0 -- 1000 mum/s. The microsystem was then used to develop a sensitive and selective chemical detector capable of identifying certain gas-phase molecules present in the nearby atmosphere. The detector performs molecular recognition of gaseous

compounds in the adjacent atmosphere by surface enhanced Raman spectroscopy and the transport properties of the microfluidic system are designed to maximize vapor detection capability. Chemical detection sensitivity of gaseous compounds is better than PPT. Vapors emanated from some nearby solid compounds are also detected at room temperature, including the gas-phase molecules naturally emitted from the explosive compounds: TNT, TATP, picric acid, RDX; and from narcotic samples such as cocaine.

Nanofluidics

In the past ten years there has been a rapid growth of the research and application area known as Lab-on-a-Chip. After an initial focus on electrokinetic separation techniques on chip, the scope of the field has widened to include topics like microfluidics, DNA analysis, cell analysis, microreactors and mass spectrometer interfacing. As well as the analytical chemistry community, synthetic chemists, chemical engineers, biochemists and biomedical engineers are now also becoming more and more interested in using new micro- and nanotechnological techniques. This first Lab-on-a-Chip book contains a broad collection of papers on microtechnology, microfluidics, analytical methods and applications. All contributions are written by leading researchers in their respective fields, and provide new scientists with an overview of the field, to make him/her aware of the enormous opportunities offered by modern technology. The work presented in this book will definitely stimulate readers to new ideas and concepts, and lead to

further innovations in this area. - Provides a quick introduction into the different aspects of this field - Describes technology that has already revolutionized the world of chemical and biochemical analysis and synthesis - All contributions are written by leading researchers in their respective fields

Study of Transport Processes from Macroscale to Microscale

This book summarizes the various microfluidic-based approaches for single-cell capture, isolation, manipulation, culture and observation, lysis, and analysis. Single-cell analysis reveals the heterogeneities in morphology, functions, composition, and genetic performance of seemingly identical cells, and advances in single-cell analysis can overcome the difficulties arising due to cell heterogeneity in the diagnostics for a targeted model of disease. This book provides a detailed review of the state-of-the-art techniques presenting the pros and cons of each of these methods. It also offers lessons learned and tips from front-line investigators to help researchers overcome bottlenecks in their own studies. Highlighting a number of techniques, such as microfluidic droplet techniques, combined microfluidics-mass-spectrometry systems, and nanochannel sampling, it describes in detail a new microfluidic chip-based live single-cell extractor (LSCE) developed in the editor's laboratory, which opens up new avenues to use open microfluidics in single-cell extraction, single-cell mass spectrometric analysis, single-cell adhesion analysis and subcellular

operations. Serving as both an elementary introduction and advanced guidebook, this book interests and inspires scholars and students who are currently studying or wish to study microfluidics-based cell analysis methods.

Microfluidics for Single-Cell Analysis

The use of light-emitting proteins for the detection of biomolecules provides fast and sensitive methods which overcome the disadvantages of radioactive labels and the high cost of fluorescent dyes. This reference work summarizes modern advanced techniques and their applications and includes practical examples of assays based on photoproteins. The book presents contemporary key topics like luminescent marine organisms, DNA probes, reporter gene assays and photoproteins, ratiometric sensing, use of photoproteins for in vivo functional imaging and luminescent proteins in binding assays, to name just a few, and is complemented by recent advances in instrumentation. Includes an introductory chapter by 2008 Chemistry Nobel laureate Osamu Shimomura.

Photoproteins in Bioanalysis

This text focuses on the physics of fluid transport in micro- and nanofabricated liquid-phase systems, with consideration of gas bubbles, solid particles, and macromolecules. This text was designed with the goal of bringing together several areas that are often taught separately - namely, fluid mechanics,

electrodynamics, and interfacial chemistry and electrochemistry - with a focused goal of preparing the modern microfluidics researcher to analyse and model continuum fluid mechanical systems encountered when working with micro- and nanofabricated devices. This text serves as a useful reference for practising researchers but is designed primarily for classroom instruction. Worked sample problems are included throughout to assist the student, and exercises at the end of each chapter help facilitate class learning.

Heat Transfer and Fluid Flow in Minichannels and Microchannels

This three-volume handbook provides an overview of the key aspects of micro process engineering. Volume 1 covers the fundamentals, operations and catalysts, volume 2 examines devices, reactions and applications, with volume 3 rounding off the trilogy with system, process and plant engineering. Fluid dynamics, mixing, heat/mass transfer, purification and separation microstructured devices and microstructured reactors are explained in the first volume. Volume 2 segments microreactor design, fabrication and assembly, bulk and fine chemistry, polymerisation, fuel processing and functional materials into understandable parts. The final volume of the handbook addresses microreactor systems design and scale-up, sensing, analysis and control, chemical process engineering, economic and eco-efficiency analyses as well as microreactor plant case studies in one book. Together, this 3-volume

handbook explains the science behind micro process engineering to the scale-up and their real life industrial applications.

Journal of the Indian Institute of Science

This book provides an introduction to nanofluidics in a simple manner and can be easily followed by senior undergraduate students, graduate students, and other researchers who have some background in fluid mechanics. The book covers the main topics about the fundamentals of nanofluidics and how it differs from classic fluid mechanics. It also describes the methodologies of nanofluidics, including numerical approaches, e.g., molecular dynamics simulation and experimental techniques. Fundamental physics and new phenomena in nanofluidics are the major concerns of this book. The author goes on to discuss nanocofinements and the parameters that affect the fluid dynamics at the nanoscale and make flow analysis complex. These parameters accommodate rich, new flow phenomena that may not be observed at the macro- and microscale. Although not all of the new phenomena will find widespread applications, the physics underlying these new phenomena may offer insights for other fields. This is one of the reasons why this book emphasizes the mechanisms of various flow fashions. Explores the unique characteristics of nanoscale flows and related properties Reviews the latest research of nanoscale ion transport and its applications Discusses the fluid flows in nanoconfinements in a unique manner based on the author's original research Incorporates important

applications of nanofluidics throughout.

Open-Space Microfluidics

Modeling of Microscale Transport in Biological Processes

Microfluidics and Microfabrication discusses the interconnect between microfluidics, microfabrication and the life sciences. Specifically, this includes fundamental aspects of fluid mechanics in micro-scale and nano-scale confinements and microfabrication. Material is also presented discussing micro-textured engineered surfaces, high-performance AFM probe-based, micro-grooving processes, fabrication with metals and polymers in bio-micromanipulation and microfluidic applications. Editor Suman Chakraborty brings together leading minds in both fields who also: Cover the fundamentals of microfluidics in a manner accessible to multi-disciplinary researchers, with a balance of mathematical details and physical principles Discuss the explicit interconnection between microfluiodics and microfabrication from an application perspective Detail the amalgamation of microfluidics with logic circuits and applications in micro-electronics Microfluidics and Microfabrication is an ideal book for researchers, engineers and senior-level graduate students interested in learning more about the two fields.

Microfluidics: History, Theory and Applications

In this 2nd edition of Micro-Drops and Digital Microfluidics, Jean Berthier explores the fundamentals and applications of digital microfluidics, enabling engineers and scientists to design this important enabling technology into devices and harness the considerable potential of digital microfluidics in testing and data collection. This book describes the most recent developments in digital microfluidics, with a specific focus on the computational, theoretical and experimental study of microdrops. Unique in its emphasis on digital microfluidics and with diverse applications ranging from drug delivery to point-of-care diagnostic chips, organic synthesis to microreactors, Micro-Drops and Digital Microfluidics meets the needs of audiences across the fields of bioengineering and biotechnology, and electrical and chemical engineering. Authoritative reporting on the latest changes in microfluidic science, where microscopic liquid volumes are handled as ""microdrops"" and separately from ""nanodrops." A methodical examination of how liquid microdrops behave in the complex geometries of modern miniaturized systems and interact with different morphological (micro-fabricated, textured) solid substrates A thorough explanation of how capillary forces act on liquid interfaces in contact with micro-fabricated surfaces Analysis of how droplets can be manipulated, handled, or transported using electric fields (electrowetting), acoustic actuation (surface acoustic waves), or by a carrier liquid (microflow) A fresh perspective on the future of microfluidics

Microfluidics for Biotechnology

The third edition of Transport Phenomena Fundamentals continues with its streamlined approach to the subject of transport phenomena, based on a unified treatment of heat, mass, and momentum transport using a balance equation approach. The new edition makes more use of modern tools for working problems, such as COMSOL®, Maple®, and MATLAB®. It introduces new problems at the end of each chapter and sorts them by topic for ease of use. It also presents new concepts to expand the utility of the text beyond chemical engineering. The text is divided into two parts, which can be used for teaching a two-term course. Part I covers the balance equation in the context of diffusive transport—momentum, energy, mass, and charge. Each chapter adds a term to the balance equation, highlighting that term's effects on the physical behavior of the system and the underlying mathematical description. Chapters familiarize students with modeling and developing mathematical expressions based on the analysis of a control volume, the derivation of the governing differential equations, and the solution to those equations with appropriate boundary conditions. Part II builds on the diffusive transport balance equation by introducing convective transport terms, focusing on partial, rather than ordinary, differential equations. The text describes paring down the microscopic equations to simplify the models and solve problems, and it introduces macroscopic versions of the balance equations for when the microscopic approach fails or is too cumbersome. The text discusses the momentum, Bournoulli, energy, and species

continuity equations, including a brief description of how these equations are applied to heat exchangers, continuous contactors, and chemical reactors. The book also introduces the three fundamental transport coefficients: the friction factor, the heat transfer coefficient, and the mass transfer coefficient in the context of boundary layer theory. The final chapter covers the basics of radiative heat transfer, including concepts such as blackbodies, graybodies, radiation shields, and enclosures. The third edition incorporates many changes to the material and includes updated discussions and examples and more than 70 new homework problems.

Transport Phenomena in Micro Process Engineering

Acoustics is a mature field which enjoys a never ending youth. New developments are induced by either the search for a better understanding, or by technological innovations. Micro-fabrication techniques introduced a whole new class of microdevices, which exploit acoustic waves for various tasks, and in particular for information processing and for sensing purposes. Performance improvements are achievable by better modelling tools, able to deal with more complex configurations, and by more refined techniques of fabrication and of integration in technological systems, like wireless communications. Several chapters of this book deal with modelling and fabrication techniques for microdevices, including unconventional phenomena and configurations. But this is far from exhausting the

research lines in acoustics. Theoretical analyses and modelling techniques are presented, for phenomena ranging from the detection of cracks to the acoustics of the oceans. Measurement methods are also discussed, which probe by acoustic waves the properties of widely different systems.

Microfluidics and Microfabrication

The ability to mix minute quantities of fluids is critical in a range of recent and emerging techniques in engineering, chemistry and life sciences, with applications as diverse as inkjet printing, pharmaceutical manufacturing, specialty and hazardous chemical manufacturing, DNA analysis and disease diagnosis. The multidisciplinary nature of this field – intersecting engineering, physics, chemistry, biology, microtechnology and biotechnology – means that the community of engineers and scientists now engaged in developing microfluidic devices has entered the field from a variety of different backgrounds. Micromixers is uniquely comprehensive, in that it deals not only with the problems that are directly related to fluidics as a discipline (aspects such as mass transport, molecular diffusion, electrokinetic phenomena, flow instabilities, etc.) but also with the practical issues of fabricating micomixers and building them into microsystems and lab-on-chip assemblies.With practical applications to the design of systems vital in modern communications, medicine and industry this book has already established itself as a key reference in an emerging and important field. The 2e includes

coverage of a broader range of fabrication techniques, additional examples of fully realized devices for each type of micromixer and a substantially extended section on industrial applications, including recent and emerging applications. Introduces the design and applications of micromixers for a broad audience across chemical engineering, electronics and the life sciences, and applications as diverse as lab-on-a-chip, ink jet printing, pharmaceutical manufacturing and DNA analysis Helps engineers and scientists to unlock the potential of micromixers by explaining both the scientific (microfluidics) aspects and the engineering involved in building and using successful microscale systems and devices with micromixers The author's applied approach combines experience-based discussion of the challenges and pitfalls of using micromixers, with proposals for how to overcome them

Microfluidics and Microscale Transport Processes

Heat exchangers with minichannel and microchannel flow passages are becoming increasingly popular due to their ability to remove large heat fluxes under single-phase and two-phase applications. Heat Transfer and Fluid Flow in Minichannels and Microchannels methodically covers gas, liquid, and electrokinetic flows, as well as flow boiling and condensation, in minichannel and microchannel applications. Examining biomedical applications as well, the book is an ideal reference for anyone

involved in the design processes of microchannel flow passages in a heat exchanger. Each chapter is accompanied by a real-life case study New edition of the first book that solely deals with heat and fluid flow in minichannels and microchannels Presents findings that are directly useful to designers; researchers can use the information in developing new models or identifying research needs

Advances in Microfluidics

Fully comprehensive introduction to the rapidly emerging area of micro systems technology Transport Phenomena in Micro Systems explores the fundamentals of the new technologies related to Micro-Electro-Mechanical Systems (MEMS). It deals with the behavior, precise control and manipulation of fluids that are geometrically constrained to a small, typically sub-millimeter, scale, such as nl, pl, fl, small size, low energy consumption, effects of the micro domain and heat transfer in the related devices. The author describes in detail and with extensive illustration micro fabrication, channel flow, transport laws, magnetophoresis, micro scale convection and micro sensors and activators, among others. This book spans multidisciplinary fields such as material science and mechanical engineering, engineering, physics, chemistry, microtechnology and biotechnology. Brings together in one collection recent and emerging developments in this fast-growing area of micro systems Covers multidisciplinary fields such as materials science, mechanical engineering, microtechnology and

biotechnology, et al Comprehensive coverage of analytical models in microfluidics and MEMS technology Introduces micro fluidics applications include the development of inkjet printheads, micro-propulsion, and micro thermal technologies Presented in a very logical format Supplies readers with problems and solutions

Micromixers

Electrokinetics in Microfluidics

A lab-on-a-chip device is a microscale laboratory on a credit-card sized glass or plastic chip with a network of microchannels, electrodes, sensors and electronic circuits. These labs on a chip can duplicate the specialized functions as performed by their room-sized counterparts, such as clinical diagnoses, PCR and electrophoretic separation. The advantages of these labs on a chip include significant reduction in the amounts of samples and reagents, very short reaction and analysis time, high throughput and portability. Generally, a lab-on-a-chip device must perform a number of microfluidic functions: pumping, mixing, thermal cycling/incubating, dispensing, and separating. Precise manipulation of these microfluidic processes is key to the operation and performance of labs on a chip. The objective of this book is to provide a fundamental understanding of the interfacial electrokinetic phenomena in several key microfluidic processes, and to show how these phenomena can be utilised to control the microfluidic processes. For this

purpose, this book emphasises the theoretical modelling and the numerical simulation of these electrokinetic phenomena in microfluidics. However, experimental studies of the electrokinetic microfluidic processes are also highlighted in sufficient detail. The first book which systematically reviews electrokinetic microfluidics processes for lab-on-a chip applications Covers modelling and numerical simulation of the electrokinetic microfluidics processes Providing information on experimental studies and details of experimental techniques, which are essential for those who are new to this field

Micro Process Engineering

This book provides a vehicle for the exchange and dissemination of original research results, technical notes, and state-of-the-art reviews pertaining to thermal and fluid transport phenomena at microscales and nanoscales. It covers a wide range of topics on fundamentals and applications of microscale and nanoscale transfer processes of mass, momentum, and energy such as microscale and nanoscale heat transfer and fluid flow, nanofluid heat transfer and flow, microfluidics, nanofluidics, and technologies based on these transport processes such as various microscale and nanoscale thermal and fluid devices.

Frontier Research in Microscale and Nanoscale Thermal and Fluid Sciences

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of microchannels, electrodes, sensors and electronic circuits. These labs on a chip can duplicate the specialized functions as performed by their room-sized counterparts, such as clinical diagnoses, PCR and electrophoretic separation. The advantages of these labs on a chip include significant reduction in the amounts of samples and reagents, very short reaction and analysis time, high throughput and portability. Generally, a lab-on-a-chip device must perform a number of microfluidic functions: pumping, mixing, thermal cycling/incubating, dispensing, and separating. Precise manipulation of these microfluidic processes is key to the operation and performance of labs on a chip. The objective of this book is to provide a fundamental understanding of the interfacial electrokinetic phenomena in several key microfluidic processes, and to show how these phenomena can be utilised to control the microfluidic processes. For this purpose, this book emphasises the theoretical modelling and the numerical simulation of these electrokinetic phenomena in microfluidics. However, experimental studies of the electrokinetic microfluidic processes are also highlighted in sufficient detail. The first book which systematically reviews electrokinetic microfluidics processes for lab-on-a chip applications Covers modelling and numerical simulation of the electrokinetic microfluidics processes Providing information on experimental studies and details of experimental techniques, which are essential for those who are new to this field

Digital Geometry in Image Processing

Covering all aspects of transport phenomena on the nano- and micro-scale, this encyclopedia features over 750 entries in three alphabetically-arranged volumes including the most up-to-date research, insights, and applied techniques across all areas. Coverage includes electrical double-layers, optofluidics, DNC lab-on-a-chip, nanosensors, and more.

Microfluidic Technologies for Human Health

Summarizing the latest trends and the current state of this research field, this up-to-date book discusses in detail techniques to perform localized alterations on surfaces with great flexibility, including microfluidic probes, multifunctional nanopipettes and various surface patterning techniques, such as dip pen nanolithography. These techniques are also put in perspective in terms of applications and how they can be transformative of numerous (bio)chemical processes involving surfaces. The editors are from IBM Zurich, the pioneers and pacesetters in the field at the forefront of research in this new and rapidly expanding area.