Micro Drops And Digital Microfluidics Second Edition Micro And Nano Technologies

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Microfluidics in Detection Science

Microfluidics for Pharmaceutical Applications: From Nano/Micro Systems Fabrication to Controlled Drug Delivery is a concept-orientated reference that features case studies on utilizing microfluidics for drug delivery applications. It is a valuable learning reference on microfluidics for drug delivery applications and assists practitioners developing novel drug delivery platforms using microfluidics. It explores advances in microfluidics for drug delivery applications from different perspectives, covering device fabrication, fluid dynamics, cutting-edge microfluidic technology in the global drug delivery industry, lab-on-chip nano/micro fabrication and drug encapsulation, cell encapsulation and delivery, and cell- drug interaction screening. These microfluidic platforms have revolutionized the drug delivery field, but also show great potential for industrial applications. Presents detailed coverage on the fabrication of novel drug delivery systems with desired characteristics, such as uniform size, Janus particles, and particular or combined responsiveness Includes a variety of case studies that explain principles Focuses on commercialization, cost, safety, society and educational issues of microfluidic

applications, showing how microfluidics is used in the real world

Transport Phenomena in Microfluidic Systems

The collection includes selected, peer reviewed papers from the 2012 International Conference on Mechatronics and Computational Mechanics (ICMCM 2012), 20-21st December,2012, Dubai, UAE. Volume is indexed by Thomson Reuters CPCI-S (WoS). The papers are grouped as follows: Chapter 1: Mechatronics and Control; Chapter 2: Applied Mechanics and Mechanical Engineering; Chapter 3: Applied Materials Engineering; Chapter 4: Organization of Manufacture, Engineering Management and Information Technologies.

Microdrop Generation

The Physics of Microdroplets gives the reader the theoretical and numerical tools to understand, explain, calculate, and predict the often nonintuitive observed behavior of droplets in microsystems. Microdrops and interfaces are now a common feature in most fluidic microsystems, from biology, to biotechnology, materials science, 3D-microelectronics, optofluidics, and mechatronics. On the other hand, the behavior of droplets and interfaces in today's microsystems is complicated and involves complex 3D geometrical considerations. From a

numerical standpoint, the treatment of interfaces separating different immiscible phases is difficult. After a chapter dedicated to the general theory of wetting, this practical book successively details: The theory of 3D liquid interfaces The formulas for volume and surface of sessile and pancake droplets The behavior of sessile droplets The behavior of droplets between tapered plates and in wedges The behavior of droplets in microchannels The effect of capillarity with the analysis of capillary rise The onset of spontaneous capillary flow in open microfluidic systems The interaction between droplets, like engulfment The theory and application of electrowetting The state of the art for the approach of 3D-microelectronics using capillary alignment

Micro-Drops and Digital Microfluidics

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.

Nanotechnology Environmental Health and Safety

Starting from the basic principles of wetting, electrowetting and fluid dynamics all the way up to those engineering aspects relevant for the development of specific devices, this is a comprehensive introduction and overview of the theoretical and practical aspects. Written by two of the most knowledgeable experts in the field, the text covers both current as well as possible future applications, providing basic working principles of lab-on-a-chip devices and such optofluidic devices as adaptive lenses and optical switches. Furthermore, novel e-paper display technology, energy harvesting and supercapacitors as well as electrowetting in the nano-world are discussed. Finally, the book contains a series of exercises and questions for use in courses on microfluidics or electrowetting. With its all-encompassing scope, this book will equally serve the growing community of students and academic and industrial researchers as both an introduction and a standard reference.

Encyclopedia of Microfluidics and Nanofluidics

Robot algorithms are abstractions of computational processes that control or reason about motion and perception in the physical world. Because actions in the physical world are subject to physical laws and geometric constraints, the design and analysis of robot algorithms raise a unique combination of questions in control theory, computational and differential geometry, and computer science. Algorithms serve as a unifying theme in the multi-disciplinary field of robotics. This volume consists of selected contributions to the sixth Workshop on the Algorithmic Foundations of Robotics. This is a highly competitive meeting of experts in the field of algorithmic issues related to robotics and automation.

Open-Channel Microfluidics

Microfluidics or lab-on-a-chip (LOC) is an important technology suitable for numerous applications from drug delivery to tissue engineering. Microfluidic devices for biomedical applications discusses the fundamentals of microfluidics and explores in detail a wide range of medical applications. The first part of the book reviews the fundamentals of microfluidic technologies for biomedical applications with chapters focussing on the materials and methods for microfabrication, microfluidic actuation mechanisms and digital microfluidic technologies. Chapters in part two examine applications in drug discovery and controlled-delivery including micro needles. Part three considers applications of microfluidic devices in cellular analysis and manipulation, tissue engineering and

their role in developing tissue scaffolds and stem cell engineering. The final part of the book covers the applications of microfluidic devices in diagnostic sensing, including genetic analysis, low-cost bioassays, viral detection, and radio chemical synthesis. Microfluidic devices for biomedical applications is an essential reference for medical device manufacturers, scientists and researchers concerned with microfluidics in the field of biomedical applications and life-science industries. Discusses the fundamentals of microfluidics or lab-on-a-chip (LOC) and explores in detail a wide range of medical applications Considers materials and methods for microfabrication, microfluidic actuation mechanisms and digital microfluidic technologies Considers applications of microfluidic devices in cellular analysis and manipulation, tissue engineering and their role in developing tissue scaffolds and stem cell engineering

Adaptive Cooling of Integrated Circuits Using Digital Microfluidics

Mechatronics and Computational Mechanics

Digital Microfluidic Biochips focuses on the automated design and production of microfluidic-based biochips for large-scale bioassays and safety-critical

applications. Bridging areas of electronic design automation with microfluidic biochip research, the authors present a system-level design automation framework that addresses key issues in the design, analysis, and testing of digital microfluidic biochips. The book describes a new generation of microfluidic biochips with more complex designs that offer dynamic reconfigurability, system scalability, system integration, and defect tolerance. Part I describes a unified design methodology that targets design optimization under resource constraints. Part II investigates cost-effective testing techniques for digital microfluidic biochips that include test resource optimization and fault detection while running normal bioassays. Part III focuses on different reconfiguration-based defect tolerance techniques designed to increase the yield and dependability of digital microfluidic biochips. Expanding upon results from ongoing research on CAD for biochips at Duke University, this book presents new design methodologies that address some of the limitations in current full-custom design techniques. Digital Microfluidic Biochips is an essential resource for achieving the integration of microfluidic components in the next generation of system-on-chip and system-in-package designs.

Microfluidics for Biotechnology

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

Microfluidic Devices for Biomedical Applications

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.

VLSI Design and Test

This book provides an insightful guide to the design, testing and optimization of micro-electrode-dot-array (MEDA) digital microfluidic biochips. The authors focus

on the characteristics specific for MEDA biochips, e.g., real-time sensing and advanced microfluidic operations like lamination mixing and droplet shape morphing. Readers will be enabled to enhance the automated design and use of MEDA and to develop a set of solutions to facilitate the full exploitation of design complexities that are possible with standard CMOS fabrication techniques. The book provides the first set of design automation and test techniques for MEDA biochips. The methods described in this book have been validated using fabricated MEDA biochips in the laboratory. Readers will benefit from an in-depth look at the MEDA platform and how to combine microfluidics with software, e.g., applying biomolecular protocols to software-controlled and cyberphysical microfluidic biochips.

Micro-Electrode-Dot-Array Digital Microfluidic Biochips

Thanks to increasing power consumption and component density, localized hot spots are becoming a serious challenge in IC (integrated circuit) chip design - so serious, in fact, that Intel recently had to yank a circuit because it was literally burning. For IC engineers grappling with high power dissipation and thermal issues, new droplet-based cooling techniques using digital microfluidics technology could provide the solution. This definitive guide paves the way, with design and implementation methodologies and prototypes for utilizing this groundbreaking technology. After reviewing cooling principles and current bulk cooling methods,

the book brings engineers up to speed on emerging droplet-based architectures. Amply illustrated, this milestone work will prove invaluable in tackling IC heat issues that existing methods can no longer address.

Formal Modeling and Verification of Cyber-Physical Systems

An increasing number of technologies are being used to detect minute quantities of biomolecules and cells. However, it can be difficult to determine which technologies show the most promise for high-sensitivity and low-limit detection in different applications. Microfluidics and Nanotechnology: Biosensing to the Single Molecule Limit details proven approaches for the detection of single cells and even single molecules—approaches employed by the world's foremost microfluidics and nanotechnology laboratories. While similar books concentrate only on microfluidics or nanotechnology, this book focuses on the combination of soft materials (elastomers and other polymers) with hard materials (semiconductors, metals, and glass) to form integrated detection systems for biological and chemical targets. It explores physical and chemical—as well as contact and noncontact—detection methods, using case studies to demonstrate system capabilities. Presenting a snapshot of the current state of the art, the text: Explains the theory behind different detection techniques, from mechanical resonators for detecting cell density to fiber-optic methods for detecting DNA hybridization, and beyond Examines microfluidic advances, including droplet microfluidics, digital

microfluidics for manipulating droplets on the microscale, and more Highlights an array of technologies to allow for a comparison of the fundamental advantages and challenges of each, as well as an appreciation of the power of leveraging scalability and integration to achieve sensitivity at low cost Microfluidics and Nanotechnology: Biosensing to the Single Molecule Limit not only serves as a quick reference for the latest achievements in biochemical detection at the single-cell and single-molecule levels, but also provides researchers with inspiration for further innovation and expansion of the field.

Finger-powered Digital Microfluidics for Micro Droplet Manipulation

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.

Micro- and Nanoscale Fluid Mechanics

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.

Micro-Drops and Digital Microfluidics

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

Electrokinetics and Electrohydrodynamics in Microsystems

This volume contains an archival record of the NATO Advanced Study Institute on Microfluidics Based Microsystems – Fundamentals and App- cations held in Çe ?me-Izmir, Turkey, August 23–September 4, 2009. ASIs are intended to be high-level teaching activity in scientific and technical areas of current concern. In this volume, the reader may find interesting chapters and various microsystems fundamentals and applications. As the world becomes increasingly concerned with terrorism, early - spot detection of terrorist's weapons, particularly bio-weapons agents such as bacteria and viruses are extremely important. NATO Public Diplomacy division, Science for Peace and Security section support research, Advanced Study Institutes and workshops related to security. Keeping this policy of NATO in mind, we made such a proposal on Microsystems for security. We are very happy that leading experts agreed to come and lecture in this important NATO ASI. We will see many examples that will show us Microfluidics usefulness for rapid diagnostics following a bioterrorism attack. For the applications in national security and anti-terrorism, microfluidic system technology must meet the challenges. To

develop microsystems for security and to provide a comprehensive state-of-the-art assessment of the existing research and applications by treating the subject in considerable depth through lectures from eminent professionals in the field, through discussions and panel sessions are very beneficial for young scientists in the field.

Microfluidics

Texturing surfaces at micro- and/or nano-scales modifies the interactions of liquids and solids. This book is a summary of the state of the art concerning the development and use of micro/nano-technologies for the design of synthetic liquid repellent surfaces with a particular focus on super-omniphobic materials. It proposes a comprehensive understanding of the physical mechanisms involved in the wetting of these surfaces and reviews emerging applications in various fields such as energy harvesting and biology, as well as highlighting the current limitations and challenges which are yet to be overcome.

Interfacial Fluid Mechanics

Open microfluidics or open-surface is becoming fundamental in scientific domains such as biotechnology, biology and space. First, such systems and devices based

on open microfluidics make use of capillary forces to move fluids, without any need for external energy. Second, the “openness” of the flow facilitates the accessibility to the liquid in biotechnology and biology, and reduces the weight in space applications. This book has been conceived to give the reader the fundamental basis of open microfluidics. It covers successively The theory of spontaneous capillary flow, with the general conditions for spontaneous capillary flow, and the dynamic aspects of such flows. The formation of capillary filaments which are associated to small contact angles and sharp grooves. The study of capillary flow in open rectangular, pseudo-rectangular and trapezoidal open microchannels. The dynamics of open capillary flows in grooves with a focus on capillary resistors. The case of very viscous liquids is analyzed. An analysis of suspended capillary flows: such flows move in suspended channels devoid of top cover and bottom plate. Their accessibility is reinforced, and such systems are becoming fundamental in biology. An analysis of “rails” microfluidics, which are flows that move in channels devoid of side walls. This geometry has the advantage to be compatible with capillary networks, which are now of great interest in biotechnology, for molecular detection for example. Paper-based microfluidics where liquids wick flat paper matrix. Applications concern bioassays such as point of care devices (POC). Thread-based microfluidics is a new domain of investigation. It is seeing presently many new developments in the domain of separation and filtration, and opens the way to smart bandages and tissue engineering. The book is intended to cover the theoretical aspects of open microfluidics, experimental approaches, and examples

of application.

Electrowetting

This unique volume presents leading-edge microfluidics methods used to handle, manipulate, and analyze cells, particles, and biological components (e.g., proteins and DNA) for microdiagnostics. The authors offer clear and detailed guidance on microfabrication techniques utilized to create microfluidic devices and on-chip flow control and mixing Microsystems, protein and DNA handling devices for electrophoretic and isoelectric separations in microchromatography columns, microfluidic manipulations of droplets via electrowetting and particles via dielectrophoresis for separations and chemical reactions, integrated optical characterization of microfluidic devices, controlling chemical gradients within devices, microimmunoassay diagnostics, multiphase microfluidics used in droplet formation for controlled chemical reactions, particle separation and analysis in Micro-FACS systems, flow characterization techniques in microfluidic devices and patterning and utilizing cytoskeletal filaments and cellular transport protein within microstructures.

The Physics of Microdroplets

Open microfluidics, the study of microflows having a boundary with surrounding air, encompasses different aspects such as paper or thread-based microfluidics, droplet microfluidics and open-channel microfluidics. Open-channel microflow is a flow at the micro-scale, guided by solid structures, and having at least a free boundary (with air or vapor) other than the advancing meniscus. This book is devoted to the study of open-channel microfluidics which (contrary to paper or thread or droplet microfluidics) is still very sparsely documented, but bears many new applications in biology, biotechnology, medicine, material and space sciences. Capillarity being the principal force triggering an open microflow, the principles of capillarity are first recalled. The onset of open-channel microflow is next analyzed and the fundamental notion of generalized Cassie angle (the apparent contact angle which accounts for the presence of air) is presented. The theory of the dynamics of open-channel microflows is then developed, using the notion of averaged friction length which accounts for the presence of air along the boundaries of the flow domain. Different channel morphologies are studied and geometrical features such as valves and capillary pumps are examined. An introduction to two-phase open-channel microflows is also presented showing that immiscible plugs can be transported by an open-channel flow. Finally, a selection of interesting applications in the domains of space, materials, medicine and biology is presented, showing the potentialities of open-channel microfluidics.

Microdroplet Technology

Design Automation Methods and Tools for Microfluidics-Based Biochips deals with all aspects of design automation for microfluidics-based biochips. Experts have contributed chapters on many aspects of biochip design automation. Topics covered include: device modeling; adaptation of bioassays for on-chip implementations; numerical methods and simulation tools; architectural synthesis, scheduling and binding of assay operations; physical design and module placement; fault modeling and testing; and reconfiguration methods.

Introduction to Microfluidics

Interfacial Fluid Mechanics: A Mathematical Modeling Approach provides an introduction to mathematical models of viscous flow used in rapidly developing fields of microfluidics and microscale heat transfer. The basic physical effects are first introduced in the context of simple configurations and their relative importance in typical microscale applications is discussed. Then, several configurations of importance to microfluidics, most notably thin films/droplets on substrates and confined bubbles, are discussed in detail. Topics from current research on electrokinetic phenomena, liquid flow near structured solid surfaces,evaporation/condensation, and surfactant phenomena are discussed in the later chapters.

Digital Microfluidic Biochips

This book is a printed edition of the Special Issue "Advances in Optofluidics" that was published in Micromachines

Advances in Optofluidics

Algorithmic Foundations of Robotics VI

The concept of a miniaturised laboratory on a disposable chip is now a reality, and in everyday use in industry, medicine and defence. New devices are launched all the time, prompting the need for a straightforward guide to the design and manufacture of lab-on-a-chip (LOC) devices. This book presents a modular approach to the construction and integration of LOC components in detection science. The editors have brought together some of the leading experts from academia and industry to present an accessible guide to the technology available and its potential. Several chapters are devoted to applications, presenting both the sampling regime and detection methods needed. Further chapters describe the integration of LOC devices, not only with each other but also into existing technologies. With insights into LOC applications, from biosensing to molecular and

chemical analysis, and presenting scaled-down versions of existing technology alongside unique approaches that exploit the physics of the micro and nano-scale, this book will appeal to newcomers to the field and practitioners requiring a convenient reference.

Open Microfluidics

This book tackles the debate over nanotechnology's environmental health and safety (EHS) by thoroughly explaining EHS issues, financial implications, foreseeable risks (i.e. exposure, dose, hazards of nanomaterials), and the implications of occupational hygiene precautions and consumer protections. Real-world case studies are included, e.g. the discussion of a leading chemical company's unusual pairing with the USA's largest environmental NGO, and an innovative program designed for small- to mid-sized businesses, which became a model approach for proactive nanotechnology EHS risk management. Considers the potential of nanotechnology from multiple perspectives (NGO, insurance industry, small business, etc) Provides guidance and advice for appropriate, proactive risk management strategies Reviews toxicological studies and industrial initiatives, documented with actual case studies Of significant interest to CEOs/CTOs of technology companies (SMEs), Health and Safety officers of technology companies (SMEs), Government officials (HSE), Toxicology experts, and venture capitalists

Proceedings of the 4th International Conference on Nanochannels, Microchannels and Minichannels-- 2006

After spending over 12 years developing new microsystems for biotechnology – especially concerned with the microfluidic aspects of these devices – Jean Berthier is considered a leading authority in the field. Now, following the success of his book, Microfluidics for Biotechnology, Dr. Berthier returns to explain how new miniaturization techniques have dramatically expanded the area of microfluidic applications and microsystems into microdrops and digital microfluidics. Engineers interested in designing more versatile microsystems and students who seek to learn the fundamentals of microfluidics will all appreciate the wide-range of information found within Microdrops and Digital Microfluidics. The most recent developments in digital microfluidics are described in clear detail, with a specific focus on the computational, theoretical and experimental study of microdrops. • Over 500 equations and more than 400 illustrations. • 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.

Electrowetting-based Microactuation of Droplets for Digital Microfluidics

In this book, the authors discuss the control, manipulation and behavioral applications of microfluidics. Topics include dielectrophoresis based droplet microfluidic devices for on-chip bioassays; microfluidic biosensor systems for cell biology and drug discovery; controllable microfluidic generation of monodisperse multiple emulsion droplets; an alternative method to predict wettability for microfluidics; integration of capacitive micromachined ultrasound transducers to microfluidic devices; selection of easily accessible PCR-and bio-compatible materials for microfluidic chips; and electrokinetic manipulation of biomolecules.

Microfluidics for Pharmaceutical Applications

The first book offering a global overview of fundamental microfluidics and the wide range of possible applications, for example, in chemistry, biology, and biomedical science. As such, it summarizes recent progress in microfluidics, including its origin

and development, the theoretical fundamentals, and fabrication techniques for microfluidic devices. The book also comprehensively covers the fluid mechanics, physics and chemistry as well as applications in such different fields as detection and synthesis of inorganic and organic materials. A useful reference for non-specialists and a basic guideline for research scientists and technicians already active in this field or intending to work in microfluidics.

Nanotechnologies for Synthetic Super Non-wetting Surfaces

Microfluidic devices that do not require bulky peripheral hardware, such as pumps and external battery/power supplies, are a suitable technology for portable applications in resource-constrained settings, such as point-of-care (POC) diagnosis in developed countries, environmental monitoring, and on-site forensic analysis, etc. The existing portable microfluidic devices are mostly based on microchannel structures, in which the pre-defined channels limit their functional flexibility, rendering them difficult to scale up. Digital microfluidics, on the other hand, can tackle this problem since they deal with discrete droplets individually and can therefore provide more on-demand flexibility and versatility. Most digital microfluidic devices, however, require external electric power sources. We first propose finger-powered digital microfluidic (F-DMF) based on electrowetting on dielectric (EWOD). Instead of requiring an external power supply, our F-DMF uses piezoelectric elements to convert the mechanical energy produced by human

fingers into electric voltage pulses for droplet manipulation. The voltage outputs of piezoelectric element mounted in cantilever beam configuration are studied theoretically and experimentally. Using this energy conversion scheme, the basic modes of droplet operations, such as droplet transport, splitting, and merging on EWOD devices are confirmed. The key assay steps involved in glucose detection and immunoassay are also successfully performed using F-DMF-EWOD. Exploiting the same energy conversion scheme, F-DMF based on the electrophoretic transport of discrete droplets (EPD), which has the potential to overcome pinning and surface contamination often encountered in EWOD, is then presented. Successful EPD actuation, however, requires the piezoelectric elements to provide both sufficient charge and voltage pulse duration. These requirements are quantified using numerical models to predict the electrical charges induced on the droplets and the subsequent electrophoretic forces. The transport and merging of aqueous droplets as well as direct manipulation of body fluids is experimentally demonstrated using F-EPD-DMF. Further, a mechanical system and an efficient pin-assignment scheme are explored to facilitate the practical implementation of pre-programmed and functional actuation of droplets in the EPD-based system. For the second part of this thesis, one practical issue in digital microfluidics biochip (DMFB) design is discussed: the droplet routing problem, which largely decides the performance and correctness of the system. The problem is formulated to a multi-agent path finding problem (MAPF) and an approximate algorithm based on Independent Detection (ID) is applied to solve the problem. The modified ID

algorithm shows promising performance on selected benchmark problems with medium number of droplets (12). Overall, it achieves better timing result (~15% reduction) and total routing length (~50% reduction) with no compromise in fault tolerance (indicated by the total number of used cells), when compared with the previous best known results.

Methods in Bioengineering

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.

Design Automation Methods and Tools for Microfluidics-Based

Biochips

Microdroplet technology has recently emerged to provide new and diverse applications via microfluidic functionality, especially in various areas of biology and chemistry. This book, then, gives an overview of the principle components and wide-ranging applications for state-of-the-art of droplet-based microfluidics. Chapter authors are internationally-leading researchers from chemistry, biology, physics and engineering that present various key aspects of micrdroplet technology -- fundamental flow physics, methodology and components for flow control, applications in biology and chemistry, and a discussion of future perspectives. This book acts as a reference for academics, post-graduate students, and researcher wishing to deepen their understand of microfluidics and introduce optimal design and operation of new droplet-based microfluidic devices for more comprehensive analyte assessments.

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

Microfluidics introduces the theory and practice of fluid flow on small scales. The exquisite control of such flow at low Reynolds numbers allows liquids to be processed in either a well-defined co-flow or a well-defined segmented-flow fashion. Both lays a ground for high-throughput analytics and advanced materials

design. With that, this book is ideal for research scientists and Ph.D. students in the fields of chemistry, chemical engineering, biotechnology, and materials science.

Microfluidics and Nanotechnology

This book presents the lecture notes of the 1st Summer School on Methods and Tools for the Design of Digital Systems, 2015, held in Bremen, Germany. The topic of the summer school was devoted to modeling and verification of cyber-physical systems. This covers several aspects of the field, including hybrid systems and model checking, as well as applications in robotics and aerospace systems. The main chapters have been written by leading scientists, who present their field of research, each providing references to introductory material as well as latest scientific advances and future research directions. This is complemented by short papers submitted by the participating PhD students.

Advances in Microfluidics

The applications and use of inkjet-like microfluidic drop ejectors have grown rapidly in many fields, including biotechnology, drug discovery, combinatorial chemistry, and microfabrication. Yet to date, end users and even designers of microdrop

systems for scientific applications have had no books to reference on the subject. Microdrop Generation meets the needs of all those who need to understand the physics and engineering behind microdrop technology. It also contains detailed, how-to information on the practical construction, operation, troubleshooting, and fluid formulation for microdrop ejection systems. Written by a highly experienced practitioner of the art, the book is organized as a self-contained tutorial of microdrop technology ideal for those new to the field.

Microfluidics

This book constitutes the refereed proceedings of the 21st International Symposium on VLSI Design and Test, VDAT 2017, held in Roorkee, India, in June/July 2017. The 48 full papers presented together with 27 short papers were carefully reviewed and selected from 246 submissions. The papers were organized in topical sections named: digital design; analog/mixed signal; VLSI testing; devices and technology; VLSI architectures; emerging technologies and memory; system design; low power design and test; RF circuits; architecture and CAD; and design verification.

Microfluidics Based Microsystems

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.

Microfluidics

Among the most promising techniques to handle small objects at the micrometer scale are those that employ electrical forces, which have the advantages of voltage-based control and dominance over other forces. The book provides a state-of-the-art knowledge on both theoretical and applied aspects of the electrical

manipulation of colloidal particles and fluids in microsystems and covers the following topics: dielectrophoresis, electrowetting, electrohydrodynamics in microsystems, and electrokinetics of fluids and particles. The book is addressed to doctoral students, young or senior researchers, chemical engineers and/or biotechnologists with an interest in microfluidics, lab-on-chip or MEMS.