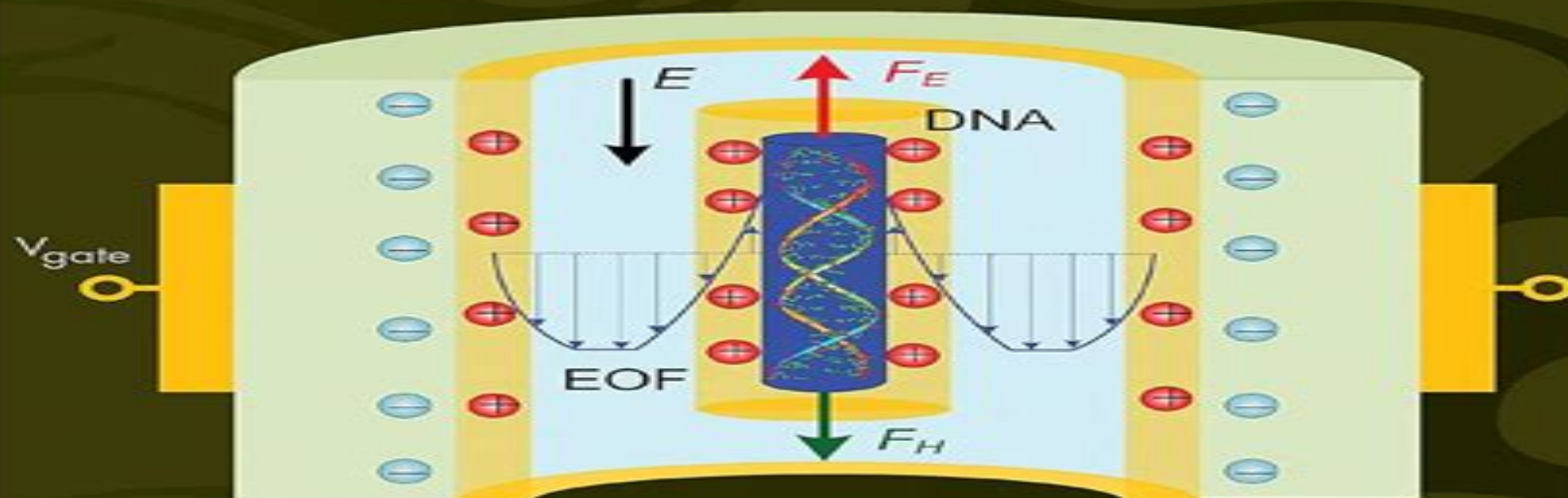


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ELECTROKINETIC PARTICLE TRANSPORT IN MICRO-/NANOFLUIDICS

Direct Numerical Simulation Analysis



Shizhi Qian • Ye Ai



CRC Press
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Electrokinetic Particle Transport In Micro Nanofluidics

Direct Numerical Simulation Analysis Surfactant

Science

Xiangchun Xuan, Shizhi Qian



Electrokinetic Particle Transport In Micro Nanofluidics Direct Numerical Simulation Analysis Surfactant Science:

Electrokinetic Particle Transport in Micro-/Nanofluidics Shizhi Qian, Ye Ai, 2012-06-19 Numerous applications of micro nanofluidics are related to particle transport in micro nanoscale channels and electrokinetics has proved to be one of the most promising tools to manipulate particles in micro nanofluidics Therefore a comprehensive understanding of electrokinetic particle transport in micro nanoscale channels is crucial to the Electrokinetics in Microfluidics Dongqing Li, 2004-08-20 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 Direct Current Electrokinetic Particle Transport in Micro/nano-fluidics Ye Ai, 2011 **Micro/Nano-Chip Electrokinetics, Volume III** Xiangchun Xuan, Shizhi Qian, 2021-02-24 Micro nanofluidics based lab on a chip devices have found extensive applications in the analysis of chemical and biological samples over the past two decades Electrokinetics is the method of choice in these micro nano chips for transporting manipulating and sensing various analyte species e g ions molecules fluids and particles This book aims to highlight the recent developments in the field of micro nano chip electrokinetics ranging from the fundamentals of electrokinetics to the applications of electrokinetics to both chemo and bio sample handling **Essentials of Micro- and Nanofluidics A.** Terrence Conlisk, 2012-12-24 This textbook introduces students to the basic physical principles to analyse fluid flow in micro and nano size devices This is the first book that unifies the thermal sciences with electrostatics and electrokinetics and colloid science electrochemistry and molecular biology Key concepts and principles are discussed such as the essentials of viscous flows introductory electrochemistry heat and mass transfer phenomena elements of molecular and cell biology and much more State of the art analytical and computational approaches to problems in all of these areas are presented

especially electrokinetic flows and examples are given of the use of these approaches to design devices used for rapid molecular analysis biochemical sensing drug delivery DNA analysis the design of an artificial kidney and other transport phenomena There are exercise problems and modern examples of applications as well as a solutions manual available for qualified instructors

Electrokinetic Transport Phenomena in Nanochannels and Applications of Nanochannel-based Devices in Nanoparticle Detection and Molecule Sensing Ran Peng, 2018

Nanofluidics investigates transport phenomena manipulation and control of fluids and nano sized objects in fluidic channels with an at least one dimensional size smaller than 100 nm At the nanoscale fluids and objects exhibit lots of unique physical and mechanical behaviors which cannot be observed in micron sized or macro sized structures especially for electrokinetically driven cases Electrokinetic transport phenomena in nanochannels offer promising possibilities for new applications of nanofluidic systems such as drug delivery DNA sequencing and biosensing However the current widely used nanofabrication technologies are complicated time consuming and expensive Fundamental research of electrokinetic transport phenomena at the nanoscale has been focused on analytical and numerical models and very limited experimental studies have been conducted Resistive pulse sensing RPS technology has been integrated with nanofluidics and applied in nanoparticle characterization however traditional nano orifice based RPS detection systems are not suitable for practical applications due to their bulky size low sensitivity and high cost This thesis studies electrokinetic transport phenomena in polydimethylsiloxane PDMS nanochannels as well as applications of nanochannel based nanofluidic devices in nanoparticle detection and molecule sensing At the beginning of this thesis a cost effective productive and simple method for fabricating disposable PDMS nanofluidic devices by the solvent induced cracking method and nanoimprint technique is developed The channel size is controlled by the working parameters of the solvent induced cracking method while the quantity and locations of these nanocracks are determined by artificial defects A detailed guideline for making PDMS nanofluidic chips with single nanochannels or multiple nanochannels of controllable channel size and spacing is provided Nanochannels of 20 nm in depth can be obtained easily by using this method Two fundamental research projects are conducted on single nanochannel based nanofluidic chips to investigate electrokinetically driven fluids and particles in nanochannels Electroosmotic flow EOF in single nanochannels is measured by the current slope method Channel size effects concentration effects and electric field effects upon EOF velocity in nanochannels are investigated systematically The decrease of EOF velocity due to overlapping of electric double layers EDLs is demonstrated by experiments The experimental results are in good agreement with the numerical simulation results Electrokinetic EK motion of single nanoparticles in single PDMS nanochannels is investigated by particle tracing method systematically Effects of ionic concentration of the electrolyte media applied electric field and particle to channel size ratio on particle velocity are studied The velocity of nanoparticles inside the single nanochannels is suppressed by the confined nanospace due to interactions between EDLs Lastly by using the nanochannel based nanofluidic chips two applications are

developed to detect nanoparticles cations as well as DNA molecules by the RPS technique A mathematic model for single gate differential RPS detection systems is developed to evaluate the RPS signals working parameters involved in particle detection by using the nanochannel based differential RPS chips are studied experimentally The signal to noise ratio SNR of the PDMS nanochannel based differential RPS systems is also explored by experiments To enhance the resolution of the nanochannel based RPS devices carbon nanotubes CNTs are integrated into differential RPS nanofluidic chips to work as the sensing gates Novel methods to isolate and cut individual CNTs for CNT based nanofluidic devices are also created The CNT channel based differential RPS chips are used to detect single cations and individual ssDNA molecules Distinguishing of 15 nt ssDNAs and 30 nt ssDNAs with high resolution has been achieved This thesis provides the nanofluidic research community with a comprehensive working procedure for fabricating cost effective PDMS based nanofluidic chips The fundamental studies in this thesis expand our understanding of electrokinetic transport phenomena at the nanoscale and the differential RPS detection systems developed on the nanochannel based nanofluidic chips open a new avenue to nanoparticle detection as well as molecule sensing

Nanofluidics Zhigang Li, 2018-11-05 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 nanococonfinements 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

Microfluidics and Nanofluidics Clement Kleinstreuer, 2013-12-04 Fluidics originated as the description of pneumatic and hydraulic control systems where fluids were employed instead of electric currents for signal transfer and processing Microfluidics and Nanofluidics Theory and Selected Applications offers an accessible broad based coverage of the basics through advanced applications of microfluidics and nanofluidics It is essential reading for upper level undergraduates and graduate students in engineering and professionals in industry

Electrokinetic Microfluidics and Nanofluidics Dongqing Li, 2022-11-18 This book reviews the latest advancement of microfluidics and nanofluidics with a focus on electrokinetic phenomena in microfluidics and nanofluidics It provides fundamental understanding of several new

interfacial electrokinetic phenomena in microfluidics and nanofluidics Chapter 1 gives a brief review of the fundamentals of interfacial electrokinetics Chapter 2 shows induced charge electrokinetic transport phenomena Chapter 3 presents the new advancement in DC dielectrophoresis Chapter 4 introduces a novel nanofabrication method and the systematic studies of electrokinetic nanofluidics Chapter 5 presents electrokinetic phenomena associated with Janus particles and Janus droplets Chapter 6 introduces a new direction of electrokinetic nanofluidics nanofluidic iontronics Chapter 7 discusses an important differential resistive pulse sensor in microfluidics and nanofluidics

Direct Numerical Simulation of Particle Migration in Microfluidic Channels Thomas Eduardt Hafemann, 2023

Microfluidics and Nanofluidics Handbook Sushanta K. Mitra, Suman Chakraborty, 2011-09-21 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 Finite Volume Method for Numerical Simulation Lattice Boltzmann Method and Its Applications in Microfluidics Microparticle and Nanoparticle Manipulation Methane Solubility Enhancement in Water Confined to Nanoscale Pores Volume Two Fabrication Implementation and Applications focuses on topics related to experimental and numerical methods It also covers fabrication and applications in a variety of areas from aerospace to biological systems Reflecting the inherent nature of microfluidics and nanofluidics the book includes as much interdisciplinary knowledge as possible It provides the fundamental science background for newcomers and advanced techniques and concepts for experienced researchers and professionals

Encyclopedia of Microfluidics and Nanofluidics Dongqing Li, 2008-08-06 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

Modeling Electrokinetic Phenomana in Micro- and Nanofluidic Technology Shizhi Qian, Sang W. Joo, 2013-04-30 This book focuses on modeling electrokinetic phenomena including electroosmosis electrophoresis and dielectrophoresis in micro and nanofluidic devices which play important roles in facilitating fluid transport and particle manipulation in micro and nanofluidic devices These have the potential to improve and reduce the cost of healthcare around the globe and revolutionize chemical and biological analysis by integrating and automating sophisticated diagnostic procedures in micro nanofluidic devices This high level treatment offers an essential guide for researchers and advanced students in nanotechnology mechanical engineering and colloid science

Modeling and Simulation of Electrokinetic Manipulation of Biological Particles Talukder Zaki Nuruddin Jubery, 2012 Recent experimental studies show that electrophoretic and dielectrophoretic these two electrokinetic forces can manipulate

biological particles efficiently in micro nanofluidic devices Electrokinetic forces in those devices depend on various parameters related to properties of the particle surrounding fluid and device Therefore to design an effective micro nanofluidic platform for a specific manipulation it is necessary to analyze the effect of the above parameters using mathematical models and numerical simulations To reduce computational cost a point based method or smaller domain or single particle is used in the conventional modeling and simulation However these methods produce erroneous results when particle and device sizes are comparable and often ignore detail physics in the devices

Electrokinetically-Driven Microfluidics and Nanofluidics Hsueh-Chia Chang, Leslie Y. Yeo, 2009-11-09 Electrokinetics is currently the mechanism of choice for fluid actuation and bioparticle manipulation at microscale and nanoscale dimensions There has recently been widespread interest in the use of AC electric fields given the many advantages it offers over DC electrokinetics Nevertheless a fundamental understanding of the governing mechanisms underlying the complex and nonlinear physicochemical hydrodynamics associated with these systems is required before practical microfluidic and nanofluidic devices can be engineered This text aims to provide a comprehensive treatise on both classical equilibrium electrokinetic phenomena as well as the more recent non equilibrium phenomena associated with both DC and AC electrokinetics in the context of their application to the design of microfluidic and nanofluidic technology In particular Leslie Yeo and Hsueh Chia Chang discuss the linear and nonlinear theories underlying electroosmosis electrophoresis and dielectrophoresis pertaining to electrolytes as well as dielectric systems Interfacial electrokinetic phenomena such as electrospraying electrospinning and electrowetting are also discussed

Electrokinetic Phenomena in Micro/Nanofluidics: Flow Field, Ionic Transport, Concentration Polarization Effect and Its Application □□□, 2008

Development and Parallelization of a Direct Numerical Simulation to Study the Formation and Transport of Nanoparticle Clusters in a Viscous Fluid Gregory James Sloan, University of Texas at San Antonio. Department of Mechanical Engineering, 2012

Micro/Nano-Chip Electrokinetics, Volume III. Xiangchun Xuan, Shizhi Qian, 2021 Micro nanofluidics based lab on a chip devices have found extensive applications in the analysis of chemical and biological samples over the past two decades Electrokinetics is the method of choice in these micro nano chips for transporting manipulating and sensing various analyte species e g ions molecules fluids and particles This book aims to highlight the recent developments in the field of micro nano chip electrokinetics ranging from the fundamentals of electrokinetics to the applications of electrokinetics to both chemo and bio sample handling

Electrokinetic Transport, Trapping, and Sensing in Integrated Micro- and Nanofluidic Devices Michelle Lynn Kovarik, 2009

Micro/Nano-Chip Electrokinetics, 2017

Enjoying the Beat of Phrase: An Emotional Symphony within **Electrokinetic Particle Transport In Micro Nanofluidics Direct Numerical Simulation Analysis Surfactant Science**

In some sort of eaten by screens and the ceaseless chatter of instant transmission, the melodic splendor and psychological symphony created by the prepared term usually diminish in to the background, eclipsed by the persistent sound and disturbances that permeate our lives. But, located within the pages of **Electrokinetic Particle Transport In Micro Nanofluidics Direct Numerical Simulation Analysis Surfactant Science** an enchanting fictional treasure brimming with natural thoughts, lies an immersive symphony waiting to be embraced. Crafted by an outstanding musician of language, that charming masterpiece conducts readers on a psychological journey, well unraveling the hidden songs and profound affect resonating within each cautiously crafted phrase. Within the depths of this moving examination, we shall investigate the book is central harmonies, analyze its enthralling writing design, and surrender ourselves to the profound resonance that echoes in the depths of readers souls.

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