Concentration of nanoparticles and/or microparticles in flow conditions by dielectrophoresis

A device for concentration of nanoparticles and/or microparticles in liquid flow conditions by dielectrophoresis is disclosed in this invention.

In-situ doped junctionless polysilicon nanowires field effect transistors for low-cost biosensors

Silicon nanowire (SiNW) field effect transistor based biosensors have already been proven to be a promising tool to detect biomolecules. However, the most commonly used fabrication techniques involve expensive Silicon-On-Insulator (SOI) wafers, E-beam lithography and ion-implantation steps. In the work presented here, a top down approach to fabricate SiNW junctionless field effect biosensors using novel in-situ doped polysilicon is demonstrated. The p-type polysilicon is grown with an optimum boron concentration that gives a good metal-silicon electrical contact while maintaining the doping level at a low enough level to provide a good sensitivity for the biosensor. The silicon nanowires are patterned using standard photolithography and a wet etch method. The metal contacts are made from magnetron sputtered TiW and e-beam evaporation of gold. The passivation of electrodes has been done by sputtered Si3N4 which is patterned by a lift-off process. The characterization of the critical fabrication steps is done by Secondary Ion Mass Spectroscopy (SIMS) and by statistical analysis of the measurements made on the width of the SiNWs. The electrical characterization of the SiNW in air is done by sweeping the back gate voltage while keeping the source drain potential to a constant value and surface characterization is done by applying liquid gate in phosphate buffered saline (PBS) solution. The fabricated SiNWs sensors functionalized with (3-aminopropyl)triethoxysilane (APTES) have demonstrated good sensitivity in detecting different pH buffer solutions.
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Technical University of Denmark
Pages: 88-95
Publication date: 2017
Main Research Area: Technical/natural sciences

**System-Level Sensitivity Analysis of SiNW-bioFET-Based Biosensing Using Lockin Amplification**

Although Silicon Nanowire biological Field-Effect Transistors (SiNW-bioFETs) have steadily demonstrated their ability to detect biological markers at ultra-low concentration, they have not yet translated into routine diagnostics applications. One of the challenges inherent to the technology is that it requires an instrumentation capable of recovering ultra-low signal variations from sensors usually designed and operated in a highly-resistive configuration. Often overlooked, the SiNWbioFET/instrument interactions are yet critical factors in determining overall system biodetection performances.

Here, we carry out for the first time the system-level sensitivity analysis of a generic SiNW-bioFET model coupled to a custom-design instrument based on the lock-in amplifier. By investigating a large parametric space spanning over both sensor and instrumentation specifications, we demonstrate that systemwide investigations can be instrumental in identifying the design trade-offs that will ensure the lowest Limits-of-Detection. The generic character of our analytical model allows us to elaborate on the most general SiNW-bioFET/instrument interactions and their overall implications on detection performances. Our model can be adapted to better match specific sensor or instrument designs to either ensure that ultra-high sensitivity SiNW-bioFETs are coupled with an appropriately sensitive and noise-rejecting instrumentation, or to best tailor SiNW-bioFET design to the specifications of an existing instrument.

**General Information**
State: Published
Organisations: Department of Management Engineering, Engineering Systems, Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Center for Bachelor of Engineering Studies, Afdelingen for Elektronik, Copenhagen Center for Health Technology, Department of Applied Mathematics and Computer Science, Embedded Systems Engineering
Authors: Patou, F. (Intern), Dimaki, M. (Intern), Kjaergaard, C. (Intern), Madsen, J. (Intern), Svendsen, W. E. (Intern)
Pages: 6295-6311
Publication date: 2017
Main Research Area: Technical/natural sciences

**Publication Information**
Journal: IEEE Sensors Journal
Volume: 17
Issue number: 19
ISSN (Print): 1530-437X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.12 SJR 0.706 SNIP 1.689
Evolvable Smartphone-Based Platforms for Point-Of-Care In-Vitro Diagnostics Applications

The association of smart mobile devices and lab-on-chip technologies offers unprecedented opportunities for the emergence of direct-to-consumer in vitro medical diagnostics applications. Despite their clear transformative potential, obstacles remain to the large-scale disruption and long-lasting success of these systems in the consumer market. For instance, the increasing level of complexity of instrumented lab-on-chip devices, coupled to the sporadic nature of point-of-care testing, threatens the viability of a business model mainly relying on disposable/consumable lab-on-chips. We argued recently that system evolvability, defined as the design characteristic that facilitates more manageable transitions between system generations via the modification of an inherited design, can help remedy these limitations. In this paper, we discuss how platform-based design can constitute a formal entry point to the design and implementation of evolvable smart device/lab-on-chip systems. We present both a hardware/software design framework and the implementation details of a platform prototype enabling at this stage the interfacing of several lab-on-chip variants relying on current- or impedance-based biosensors. Our findings suggest that several change-enabling mechanisms implemented in the higher abstraction software layers of the system can promote evolvability, together with the design of change-absorbing hardware/software interfaces. Our platform architecture is based on a mobile software application programming interface coupled to a modular hardware accessory. It allows the specification of lab-on-chip operation and post-analytic functions at the mobile software layer. We demonstrate its potential by operating a simple lab-on-chip to carry out the detection of dopamine using various electroanalytical methods.
Evolvable Smartphone-Based Point-of-Care Systems For In-Vitro Diagnostics

Recent developments in the life-science -omics disciplines, together with advances in micro- and nanoscale technologies offer unprecedented opportunities to tackle some of the major healthcare challenges of our time. Lab-on-Chip technologies coupled with smart-devices in particular, constitute key enablers for the decentralization of many in-vitro medical diagnostics applications to the point-of-care, supporting the advent of a preventive and personalized medicine. Although the technical feasibility and the potential of Lab-on-Chip.smart-device systems is repeatedly demonstrated, direct-to-consumer applications remain scarce. This thesis addresses this limitation. After identifying system evolvability as a key enabler to the adoption and long-lasting success of next-generation point-of-care systems by favoring the integration of new technologies, streamlining the reengineering efforts for system upgrades and limiting the risk of premature system obsolescence. Among possible strategies, platform-based design represents a particularly suitable entry point to the development of evolvable systems. One necessary condition, is for change-absorbing and change-enabling mechanisms to be incorporated in the platform architecture at initial design-time. Important considerations arise as to where in Lab-on-Chip/smart-device platforms these mechanisms be integrated, and how to implement them. Our investigation revolves around the silicon-nanowire biological field effect transistor, a promising biosensing technology for the detection of biological analytes at ultra low concentrations. We discuss extensively the sensitivity and instrumentation requirements set by the technology before we present the design and implementation of an evolvable smartphone-based platform capable of interfacing lab-on-chips embedding such sensors. We elaborate on the implementation of various architectural patterns throughout the platform and present how these facilitated the evolution of the system towards one accommodating for electrochemical sensing. Model-based development was undertaken throughout the engineering process. A formal SysML system model fed our evolvability assessment process. We introduce, in particular, a model-based methodology enabling the evaluation of modular scalability: the ability of a system to scale the current value of one of its specification by successively reengineering targeted system modules. The research work presented in this thesis provides a roadmap for the development of evolvable point-of-care systems, including those targeting direct-to-consumer applications. It extends from the early identification of anticipated change, to the assessment of the ability of a system to accommodate for these changes. Our research should thus interest industrials eager not only to disrupt, but also to last in a shifting socio-technical paradigm.
This thesis deals with the development of a novel biosensor for the detection of biomolecules based on a silicon nanowire biologically gated field-effect transistor and its integration into a point-of-care device. The sensor and electrical on-chip integration was developed in a different project. The presented research is based on this sensor structure and investigates its potential as a versatile biomarker detection platform by evaluating different functionalization approaches. The functionalization of the silicon sensor surface with organic molecules was investigated in detail to determine the suitability of different methods for the preparation of organic interfaces for protein attachment. Oxide-free silicon surfaces offer unique possibilities to create highly sensitive sensor surfaces for charge detection due to the lack of an insulating oxide layer, but the highly reactive surface presents a challenge for modification under ambient conditions. Self-assembled monolayer formation by hydrosilylation with alkenes and alkynes was thus investigated under different conditions, both ambient and controlled, and quantified using x-ray photoelectron spectroscopy.

With the aim to create a platform for subsequent immobilization of receptor molecules, amine- and carboxylic acid- as well as alkyne-terminated surfaces were prepared that allow for the conjugation of biomolecules using established cross-linking schemes. Using a receptor-ligand model system protein detection experiments were performed with nanowire sensors functionalized using different modification schemes. To facilitate functionalization and measurement and as a first step towards integration into a point-of-care device, several microfluidic tools were developed for sample delivery to the sensor surface and as a modular platform for the further development of automated functionalization and sample preparation schemes.

The aim of this Ph.D. project was to combine experience within cell and tissue culturing, electrochemistry and microfabrication in order to develop an in vivo-like fluidic culturing platform, challenging the traditional culturing methods. The first goal was to develop a fluidic system for culturing of brain tissue. The second goal was to develop a sensor system with the potential for incorporation into both conventional culture systems and fluidic culturing systems. The third and final goal of this project was to develop a system for culturing of neuronal cells with the possibility of incorporating the developed sensor system. The project was conducted in collaboration with researchers at KU to ensure that the end product is actually desired by the community.

This thesis demonstrates some of the work carried out during the course of this Ph.D. project. First it describes culturing of primary neuronal cells on a Peptide Nano Wires (PNW) modified substrate aiming to bring conventional neuronal cultures closer to mimic the in vivo situation. The work describes both the fabrication of the culture substrates and results comparing the performance of PNW-cultured neurons and conventional cultures. Tests show that the function of neurons cultured on PNWs lies closer to neurons in vivo than neurons cultured on conventional plastic substrates.
The second part of the thesis describes a fluidic system for culturing of brain slices. It describes the fabrication and use of the system as well as results on culturing of hippocampal tissue slices. We found that the tissues cultured in the microfluidic system were of similar or better quality compared to tissues cultured conventionally.

The third part of the thesis is about the development, characterisation and test of a membrane based sensor system. As the membranes are used for culturing, the introduction of electrodes on these will allow for the real time measurement of relevant cell/tissue products during culturing.

The last part of the thesis is about, i.e. the integration of the membrane based sensors with the fluidic system, in a way compatible with mass production. The last part of this thesis also includes perspectives on how to expand the latest designed device to facilitate culturing of tissue and co-culturing of cells.

**General information**
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems
Authors: Bakmand, T. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern), Waagepetersen, H. S. (Ekstern)
Number of pages: 110
Publication date: 2016

**Publication information**
Publisher: DTU Nanotech
Original language: English
Main Research Area: Technical/natural sciences

**Relations**
Projects:
Micro fluidic System for Culturing and Monitoring of Neuronal Cells and Tissue
Source: PublicationPreSubmission
Source-ID: 127667528
Publication: Research › Ph.D. thesis – Annual report year: 2016

**Model-Based Evaluation Of System Scalability: Bandwidth Analysis For Smartphone-Based Biosensing Applications**

Scalability is a design principle often valued for the engineering of complex systems. Scalability is the ability of a system to change the current value of one of its specification parameters. Although targeted frameworks are available for the evaluation of scalability for specific digital systems, methodologies enabling scalability analysis of multidomain, complex systems, are still missing. In acknowledgment of the importance for complex systems to present the ability to change or evolve, we present in this work a system level model-based methodology allowing the multidisciplinary parametric evaluation of scalability. Our approach can be used to determine how a set of limited changes to targeted system modules could affect design specifications of interest. It can also help predict and trace system bottlenecks over several product generations, offering system designers the chance to to better plan re-engineering efforts for scaling a system specification efficaciously.

We demonstrate the value of our methodology by investigating a smartphone-based biosensing instrumentation platform. Specifically, we carry out scalability analysis for the system’s bandwidth specification: the maximum analog voltage waveform excitation frequency the system could output while allowing continuous acquisition and wireless streaming of bioimpedance measurements. We rely on several SysML modelling tools, including dependency matrices, as well as a fault-detection Simulink Stateflow executable model to conclude on how the successive re-engineering of 5 independent system modules, from the replacement of a wireless Bluetooth interface, to the revision of the ADC sample-and-hold operation could help increase system bandwidth.

**General information**
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Department of Applied Mathematics and Computer Science, Embedded Systems Engineering
Authors: Patou, F. (Intern), Madsen, J. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Number of pages: 5
Pages: 718-722
Publication date: 2016

**Host publication information**
Title of host publication: Proceedings of Euromicro Conference on Digital System Design 2016
Publisher: IEEE
ISBN (Electronic): 978-1-5090-2817-7
Main Research Area: Technical/natural sciences
Scalability, Model-based development, SysML, Dependency Matrix, Smartphone
Electronic versions:
DSD2016_Certified_1.pdf
Smartphone-based biosensing platform evolution: implementation of electrochemical analysis capabilities

Lab-on-Chip technologies offer great opportunities for the democratization of in-vitro medical diagnostics to the consumer-market. Despite the limitations set by the strict instrumentation and control requirements of certain families of these devices, new solutions are emerging. Smartphones now routinely demonstrate their potential as an interface of choice for operating complex, instrumented Lab-on-Chips. The sporadic nature of home-based in-vitro medical diagnostics testing calls for the development of systems capable of evolving with new applications or new technologies for Lab-on-Chip devices. We present in this work how we evolved the first generation of a smartphone/Lab-on-Chip platform designed for evolvability. We demonstrate how reengineering efforts can be confined to the mobile-software layer and illustrate some of the benefits of building evolvable systems. We implement electrochemical capabilities on our platform prototype and carry out cyclic voltammetry to measure dopamine concentrations over several orders of magnitude.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Department of Electrical Engineering, Department of Applied Mathematics and Computer Science, Embedded Systems Engineering
Authors: Patou, F. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern), Kjærgaard, C. (Intern), Madsen, J. (Intern)
Number of pages: 5
Publication date: 2016

Host publication information
Title of host publication: Proceedings of the 10th International Symposium on Medical Information and Communication Technology (ISMICT)
Publisher: IEEE
ISBN (Electronic): 9781509028498
Main Research Area: Technical/natural sciences
Conference: 10th International Symposium on Medical Information and Communication Technology, Worcester, MA, United States, 20/03/2016 - 20/03/2016
Electronic versions: ISMICT2016_conf_PATOU.pdf
DOIs:
10.1109/ISMICT.2016.7498881
Source: PublicationPreSubmission
Source-ID: 122818729
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

All Polymer Lab-on-a-chip System for Virus Detection in Water

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Polymer Microsystems for Medical Diagnostics, Nano Bio Integrated Systems
Authors: Kirkegaard, J. (Intern), Olsen, M. H. (Intern), Dimaki, M. (Intern), Rozlosnik, N. (Intern)
Number of pages: 1
Publication date: 2015
Event: Poster session presented at Microfluidics Congress 2015, London, United Kingdom.
Main Research Area: Technical/natural sciences
Electronic versions: MFC15_Poster_Submission_Form_Mark_Olsen.pdf
DOIs:
10.1109/ISMICT.2016.7498881
Source: PublicationPreSubmission
Source-ID: 122818729
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

An easy-to-use microfluidic interconnection system to create quick and reversibly interfaced simple microfluidic devices
The presented microfluidic interconnection system provides an alternative for the individual interfacing of simple microfluidic devices fabricated in polymers such as polymethylmethacrylate, polycarbonate and cyclic olefin polymer. A modification of the device inlet enables the direct attachment of tubing (such as polytetrafluoroethylene tubing) secured and sealed by using a small plug, without the need for additional assembly, glue or o-rings. This provides a very clean connection that does not require additional, potentially incompatible, materials. The tightly sealed connection can
withstand pressures above 250 psi and therefore supports applications with high flow rates or highly viscous fluids. The ease of incorporation, configuration, fabrication and use make this interconnection system ideal for the rapid prototyping of simple microfluidic devices or other integrated systems that require microfluidic interfaces. It provides a valuable addition to the toolbox of individual and small arrays of connectors suitable for micromachined or template-based injection molded devices since it does not require protruding, threaded or glued modifications on the inlet and avoids bulky and expensive fittings.

**General information**

State: Published

Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems

Authors: Pfreundt, A. (Intern), Andersen, K. B. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)

Number of pages: 10

Publication date: 2015

Main Research Area: Technical/natural sciences

**Publication information**

Journal: Journal of Micromechanics and Microengineering

Volume: 25

Issue number: 11

Article number: 115010

ISSN (Print): 0960-1317

Ratings:

BFI (2017): BFI-level 1

Web of Science (2017): Indexed yes

BFI (2016): BFI-level 1

Scopus rating (2016): CiteScore 1.74 SJR 0.595 SNIP 1.017

Web of Science (2016): Indexed yes

BFI (2015): BFI-level 1

Scopus rating (2015): SJR 0.64 SNIP 1.211 CiteScore 1.96

Web of Science (2015): Indexed yes

BFI (2014): BFI-level 1

Scopus rating (2014): SJR 0.725 SNIP 1.224 CiteScore 1.84

Web of Science (2014): Indexed yes

BFI (2013): BFI-level 1

Scopus rating (2013): SJR 0.611 SNIP 1.055 CiteScore 1.74

ISI indexed (2013): ISI indexed yes

Web of Science (2013): Indexed yes

BFI (2012): BFI-level 1

Scopus rating (2012): SJR 0.856 SNIP 1.402 CiteScore 1.92

ISI indexed (2012): ISI indexed yes

Web of Science (2012): Indexed yes

BFI (2011): BFI-level 1

Scopus rating (2011): SJR 1.038 SNIP 1.437 CiteScore 2.43

ISI indexed (2011): ISI indexed yes

Web of Science (2011): Indexed yes

BFI (2010): BFI-level 1

Scopus rating (2010): SJR 1.019 SNIP 1.634

Web of Science (2010): Indexed yes

BFI (2009): BFI-level 1

Scopus rating (2009): SJR 1.17 SNIP 1.517

Web of Science (2009): Indexed yes

BFI (2008): BFI-level 1

Scopus rating (2008): SJR 1.27 SNIP 1.634

Web of Science (2008): Indexed yes

Scopus rating (2007): SJR 1.437 SNIP 1.837

Web of Science (2007): Indexed yes

Scopus rating (2006): SJR 1.341 SNIP 2.118
Unprecedented knowledge levels in life sciences along with technological advances in micro- and nanotechnologies and microfluidics have recently conditioned the advent of Lab-on-Chip (LoC) devices for In-Vitro Medical Testing (IVMT). Combined with smart-mobile technologies, LoCs are pervasively giving rise to opportunities to better diagnose disease, predict and monitor personalised treatment efficacy, or provide healthcare decision-making support at the Point-of-Care (PoC). Although made increasingly available to the consumer market, the adoption of LoC-based PoC In-Vitro Medical Testing (IVMT) systems is still in its infancy. This attrition partly pertains to the intricacy of designing and developing complex systems, destined to be used sporadically, in a fast-pace evolving technological paradigm. System evolvability is therefore key in the design process and constitutes the main motivation for this work.

We introduce a smart-mobile and LoC-based system architecture designed for evolvability. By propagating LoC programmability, instrumentation, and control tools to the highlevel abstraction smart-mobile software layer, our architecture facilitates the realisation of new use-cases and the accommodation for incremental LoC-technology developments. We demonstrate these features with an implementation allowing the interfacing of LoCs embedding current- or impedance-based biosensors such as Silicon Nanowire Field Effect Transistors (SiNW-FETs) or electrochemical transducers. Structural modifications of these LoCs or changes in their specific operation may be addressed by the sole reengineering of the mobile software layer, minimising system upgrade development and validation costs and efforts.
Design and Simulation of Lab-on-a-Chip Devices
Microfluidic channels are an essential part of any lab-on-a-chip system. They usually perform various functions, such as transporting liquids from A to B or mixing or separating liquids. As production costs for such systems are not insignificant, it is essential that the systems are designed properly before the fabrication, in order to avoid unnecessary fabrication repetitions. The use of simulations can give a good idea of how microfluidic systems work, to the point where a significant part of the design optimisation can be done theoretically. This chapter will provide some basic information on how to embark on these types of simulations, explaining the basics of microfluidic modelling and providing examples.

Fabrication and Characterisation of Membrane-Based Gold Electrodes
This work presents a versatile, membrane based electrochemical sensor with thin film electrodes fabricated through Ebeam evaporation directly on porous materials (membranes). Here, the fabrication of the electrodes is described along with possible methods for integration in fluidic systems and characterisation of the electrodes through cyclic voltammetry (CV). The continued porous nature of the membranes after metal deposition is documented and its robustness and stability is investigated. Furthermore, amperometric sensing of dopamine is demonstrated as a proof of concept to validate the usability of the membrane sensor.
Fabrication of polyimide based microfluidic channels for biosensor devices

The ever-increasing complexity of the fabrication process of Point-of-care (POC) devices, due to high demand of functional versatility, compact size and ease-of-use, emphasizes the need of multifunctional materials that can be used to simplify this process. Polymers, currently in use for the fabrication of the often needed microfluidic channels, have limitations in terms of their physicochemical properties. Therefore, the use of a multipurpose biocompatible material with better resistance to the chemical, thermal and electrical environment, along with capability of forming closed channel microfluidics is inevitable. This paper demonstrates a novel technique of fabricating microfluidic devices using polyimide (PI) which fulfills the aforementioned properties criteria. A fabrication process to pattern microfluidic channels, using partially cured PI, has been developed by using a dry etching method. The etching parameters are optimized and compared to those used for fully cured PI. Moreover, the formation of closed microfluidic channel on wafer level by bonding two partially cured PI layers or a partially cured PI to glass with high bond strength has been demonstrated. The reproducibility in uniformity of PI is also compared to the most commonly used SU8 polymer, which is a near UV sensitive epoxy resin. The potential applications of PI processing are POC and biosensor devices integrated with microelectronics.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems
Authors: Zulfiqar, A. (Intern), Pfreundt, A. (Intern), Svendsen, W. E. (Intern), Dimaki, M. (Intern)
Number of pages: 8
Publication date: 2015
Main Research Area: Technical/natural sciences
Brain slice preparations cultured in vitro have long been used as a simplified model for studying brain development, electrophysiology, neurodegeneration and neuroprotection. In this paper an open fluidic system developed for improved long term culturing of organotypic brain slices is presented. The positive effect of continuous flow of growth medium, and thus stability of the glucose concentration and waste removal, is simulated and compared to the effect of stagnant medium that is most often used in tissue culturing. Furthermore, placement of the tissue slices in the developed device was studied by numerical simulations in order to optimize the nutrient distribution. The device was tested by culturing transverse hippocampal slices from 7 days old NMRI mice for a duration of 14 days. The slices were inspected visually and the slices cultured in the fluidic system appeared to have preserved their structure better than the control slices cultured using the standard interface method.
Novel culturing platform for brain slices and neuronal cells

In this paper we demonstrate a novel culturing system for brain slices and neuronal cells, which can control the concentration of nutrients and the waste removal from the culture by adjusting the fluid flow within the device. The entire system can be placed in an incubator. The system has been tested successfully with brain slices and PC12 cells. The culture substrate can be modified using metal electrodes and/or nanostructures for conducting electrical measurements while culturing and for better mimicking the in vivo conditions.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, University of Copenhagen
Number of pages: 4
Pages: 346-349
Publication date: 2015

Host publication information
Title of host publication: 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society
Publisher: IEEE
Main Research Area: Technical/natural sciences
DOIs:
10.1109/EMBC.2015.7318370
Source: FindIt
Source-ID: 276551057
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Novel Diagnostic Method for Personalized Treatment of Cancer

Point-Of-Care (POC) devices, due to their better portability and easy-to-use functions, have already found their way into the domestic household appliances. The technologies developed for these devices have enabled the mankind to monitor the health-related problems at home such as the blood pressure, glucose, hemoglobin, cholesterol level in the blood and many more. The efforts are now being made to develop a Point-Of-Care Technology (POCT) that can detect cancer at an early and potentially treatable stage. To fulfill this requirement, a highly sensitive sensing technology is needed that can detect very small amounts of cancer markers in the blood drop to be used in a POC device.

Silicon Nanowires (SiNW) in a field effect setup have been demonstrated as a highly sensitive tool that can be used to detect very small amounts of biomolecules. However, the manufacturing method to produce them relies on highly expensive tools e.g. e-beam lithography, and expensive substrates e.g. Silicon-On-Insulator (SOI) which poses hurdle in cheap and fast production of the devices that can be used for both research purposes and for domestic use.

In this project, a novel fabrication method, using in-situ doped polysilicon, has been developed for SiNW based devices that does not require the above mentioned expensive tools and resources thereby enabling faster and cost-effective production of devices as compared to the already developed methods. In addition to this, the device has been made even more compact and portable by using a novel polyimide based technology to integrate microfluidics on top of SiNW sensor. Various generations of prototype devices have been used for bio-sensing experiments to detect antibodies and DNA hybridization that has shown very promising results and potential application of the device in clinical and patient-level diagnostics.

In the first part of this thesis, the fabrication process of producing the SiNW based devices is explained in detail where three generations of the process are developed in order to obtain highly sensitive device. Different characterization techniques have been used to ensure better reproducibility and high throughput while keeping the sensitivity of the SiNW to a high level.

In the second part, the fabrication process to produce microfluidic channel on top of bio sensors by using polyimide is developed. The fabrication process to integrate closed-microfluidic system on top of SiNW is demonstrated. The durability of the microfluidic system has also been tested.

In the third part, different functionalization methods are explained and used to demonstrate the bio sensing on the SiNW sensor. The detection of cancer biomarker is also tested on these devices.

Lastly, the alternative fabrication processes developed during this PhD project are discussed along with the problems faced during the development. These devices could not be tested due to time constraints.
A compact microelectrode array chip with multiple measuring sites for electrochemical applications

In this paper we demonstrate the fabrication and electrochemical characterization of a microchip with 12 identical but individually addressable electrochemical measuring sites, each consisting of a set of interdigitated electrodes acting as a working electrode as well as two circular electrodes functioning as a counter and reference electrode in close proximity. The electrodes are made of gold on a silicon oxide substrate and are passivated by a silicon nitride membrane. A method for avoiding the creation of high edges at the electrodes (known as lift-off ears) is presented. The microchip design is highly symmetric to accommodate easy electronic integration and provides space for microfluidic inlets and outlets for integrated custom-made microfluidic systems on top. © 2014 by the authors; licensee MDPI, Basel, Switzerland.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Bioanalytics, University of Canterbury, Politecnico di Milano
Number of pages: 17
Pages: 9505-9521
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Sensors
Volume: 14
Issue number: 6
ISSN (Print): 1424-8220
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.78 SJR 0.576 SNIP 1.393
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.591 SNIP 1.478 CiteScore 2.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.636 SNIP 1.705 CiteScore 2.4
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.627 SNIP 1.826 CiteScore 2.72
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.668 SNIP 1.736 CiteScore 2.53
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.636 SNIP 1.488 CiteScore 2.44
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.574 SNIP 1.196
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.525 SNIP 1.132
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
A compact multifunctional microfluidic platform for exploring cellular dynamics in real-time using electrochemical detection

Downscaling of microfluidic cell culture and detection devices for electrochemical monitoring has mostly focused on miniaturization of the microfluidic chips which are often designed for specific applications and therefore lack functional flexibility. We present a compact microfluidic cell culture and electrochemical analysis platform with in-built fluid handling and detection, enabling complete cell based assays comprising on-line electrode cleaning, sterilization, surface functionalization, cell seeding, cultivation and electrochemical real-time monitoring of cellular dynamics. To demonstrate the versatility and multifunctionality of the platform, we explored amperometric monitoring of intracellular redox activity in yeast (Saccharomyces cerevisiae) and detection of exocytotically released dopamine from rat pheochromocytoma cells (PC12). Electrochemical impedance spectroscopy was used in both applications for monitoring cell sedimentation and adhesion as well as proliferation in the case of PC12 cells. The influence of flow rate on the signal amplitude in the detection of redox metabolism as well as the effect of mechanical stimulation on dopamine release were demonstrated using the programmable fluid handling capability. The here presented platform is aimed at applications utilizing cell based assays, ranging from e.g. monitoring of drug effects in pharmacological studies, characterization of neural stem cell differentiation, and screening of genetically modified microorganisms to environmental monitoring.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Bioanalytics, Nanoprobes, Nano Bio Integrated Systems, Fluidic Array Systems and Technology, University of Genoa, University Autónoma de Madrid, Lund University, Tel Aviv University, Hungarian Academy of Sciences, University College Cork, University of Potsdam, Politecnico di Milano
Pages: 63761–63771
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: R S C Advances
Volume: 4
ISSN (Print): 2046-2069
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.06 SJR 0.875 SNIP 0.743
Web of Science (2016): Indexed yes
A flexible mobile-device biosensing instrumentation platform for point-of-care medical diagnostics applications

The early diagnosis and monitoring of chronic diseases still constitutes today one of the major healthcare challenges in our society. Advances in nanotechnology and microfluidics have been increasingly empowering researchers and engineers with tools to develop integrated biosensing solutions helping to address this challenge. Specifically, Lab-on-Chip (LoC) devices have a key role to play in the advent of Point-of-Care (PoC) medical applications, driving a shift of the medical diagnostics paradigm and the transition from a centralized, technical, high-throughput biological sample analysis process to a diagnostician and patient-oriented field decision-making support system.

The success of such systems requires the development of highly sensitive and specific biosensors to reliably detect small amounts of relevant biological markers. Nevertheless, the socio-technical complexity of the PoC medical diagnostics context necessitates considering broader requirements, notably in terms of usability, flexibility, and integration capabilities. These characteristics call for multi-disciplinary design methodologies inspired from the field of systems engineering and constitute the motivations for this work.

We present a mobile-device based, PoC biosensing instrumentation platform, designed for multiplexed high-impedance sensing and the electrochemical detection of biological species on a LoC. The proposed system is thus designed as a flexible, user-friendly hardware and software platform allowing programmable electrical readout from LoCs potentially comprehending varied transducers addressing different targeted biological markers. A smart-phone/tablet docking-station embeds the hardward interface necessary for the implementation of a smart-phone digital lock-in amplifier. The platform is tested with high-impedimetric measurements from Silicon-nanowire Field Effect Transistors embedded in a LoC. Programmable firmware and flexible hardware will in turn allow for standard voltammetry and electrical impedance spectroscopy to be performed. The design of a mobile app and standard mobile software libraries will ensure system
A novel single-step, multipoint calibration method for instrumented Lab-on-Chip systems

Despite recent and substantial advances in biosensing, information and communication, and Lab-on-Chip (LoC) technologies, the success of Point-of-Care (PoC) diagnostics and monitoring systems is still challenged by stringent requirements for robustness, cost-effectiveness, and system integration.

The pitfalls of PoC system adoption can be addressed early in the system design phase. They require a multidisciplinary design approach supported by systems engineering tools and methods. Considering this, we here present both a model and an implementation of a simple and rapid calibration scheme for instrument-based PoC blood biomarker analysis systems. Motivated by the complexity of associating high-accuracy biosensing using silicon nanowire field effect transistors with ease of use for the PoC system user, we propose a novel one-step, multipoint calibration method for LoC-based systems. Our approach specifically addresses the important interfaces between a novel microfluidic unit to integrate the sensor array and a mobile-device hardware accessory. A multi-point calibration curve is obtained by generating a defined set of reference concentrations from a single input. By consecutively splitting the flow perpendicular to the diffusion interface only one mixing step is required for each of the generated calibration solutions. This results in a compact design with a very small footprint of the microfluidic layout.
AquaVir: Portable Analyzer for Waterborne Infectious Viruses

Viral contamination in waters intended for human consumption or human contact poses a high health risk and can, in worst-case, lead to viral outbreaks. The waterborne virus, norovirus is a major cause of viral gastroenteritis. Conventional detection methods of norovirus rely on microbiological methods like polymerase chain reaction and a variety of sample preparations. These methods are time consuming, expensive and require highly trained personnel. Thus, viral surveillance cannot be done continuously and only provide an instant overview of the water quality. We are developing an all polymer detection system for online viral surveillance of waters. The detection is based on differential impedance measurements between a reference and an electrode functionalized with a biorecognition element. The biorecognition element is an aptamer specific to the target virus. We have previously shown very low detection limits with influenza virus as proof of concept of the technology. The electrode material is the intrinsic conducting polymer PEDOT:PSS screen-printed on TOPAS for easy up scaling of production. Finite element simulations of the electrode potential confirm the electrode viability in waters with conductivities similar to tap water, see figure 1. Substantial pre-concentration is required to reach the limit of detection needed in surface water. We employ both filter and on-chip based concentration techniques to accomplish this. In figure 2, virus presence and successful bio-recognition to the electrodes is established as an initial test. On-chip concentration is done by electric focusing of the virus particles. From extensive finite element modelling, we have designed dielectrophoresis channels with embedded microelectrodes to focus the virus particles in the center and thus facilitate concentration of the particles.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Polymer Microsystems for Medical Diagnostics, Nano Bio Integrated Systems
Number of pages: 1
Publication date: 2014

A Semi-Closed Device for Chromosome Spreading for Cytogenetic Analysis

Metaphase chromosome spreading is the most crucial step required for successful karyotyping and FISH analysis. These two techniques are routinely used in cytogenetics to assess the chromosome abnormalities. The spreading process has been studied for years but it is still considered an art more than a science. The chromosome spreading greatly depends on the environmental conditions such as humidity and temperature, which govern the evaporation of fixative, in which the cells are suspended. The spreading is normally performed manually in ambient conditions on glass slides, which are hydrophilic, and thus allow for better quality spreads. Further cytogenetic analysis depends on the quality of the spreads, which is dependent on the skills of the personnel and is thus limited to laboratory settings. Here, we present a semi-closed microfluidic chip for preparation of the metaphase spreads on a glass and a Topasr substrate rendered more hydrophilic by oxygen plasma treatment coupled with photografting. The device consists of a microfluidic chamber with perfusion holes that facilitate the evaporation of fixative and reliable formation of the spreads. The usability of the chromosome spreads formed on the glass and the Topasr slide is tested by performing FISH analysis.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Amphiphilic Polymers in Biological Sensing, Universidad Autónoma de Madrid, Copenhagen University Hospital, University of Copenhagen
Pages: 158-170
Publication date: 2014
Main Research Area: Technical/natural sciences
Electrochemical detection of chromosome translocation

Cytogenetics is a study of the cell structure with a main focus on chromosomes content and their structure. Chromosome abnormalities, such as translocations may cause various genetic disorders and haematological malignancies. Chromosome translocations are structural rearrangements of two chromosomes that results in formation of derivative chromosomes with a mixed DNA sequence. The method currently used for their detection is Fluorescent In Situ Hybridization, which requires a use of expensive, fluorescently labeled probes that target the derivative chromosomes. We present here a double hybridization approach developed for label-free detection of the chromosome translocations. For specific translocation detection it is necessary to determine that the two DNA sequences forming a derivative chromosome are connected, which is achieved by two subsequent hybridization steps. The electrochemical impedance spectroscopy was selected as the sensing method on a microfabricated chip with array of 12 electrode sets. Two independent chips (Chip1 and Chip2) were used for targeting the chromosomal fragments involved in the translocation. Each chip was differentially functionalized with DNA probes matching the derivative chromosomes. The observed increase in the charge transfer resistance for both chips serves as a way of detection the presence of the selected translocation in the analyzed sample. The developed sensor was reliable and could in the future be implemented in cytogenetic laboratories as a supplementary method for the existing techniques.
Nanoscaled biological gated field effect transistors for cytogenetic analysis

Cytogenetic analysis is the study of chromosome structure and function, and is often used in cancer diagnosis, as many chromosome abnormalities are linked to the onset of cancer. A novel label free detection method for chromosomal translocation analysis using nanoscaled field effect transistors (FET) is presented here. The FET is gated by the hybridization of the target DNA on the semiconducting nanowire. The results show an extreme sensitivity to the hybridization process, so that the hybridization and dehybridisation can be followed in real time. The nanoscaled FET is made of polysilicon using standard UV lithography enabling batch processing of the sensors.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Technical University of Denmark
Number of pages: 5
Pages: 130-134
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 9th IEEE International Conference on Nano/Micro Engineered and Molecular Systems
Publisher: IEEE
Main Research Area: Technical/natural sciences
DOIs: 10.1109/NEMS.2014.6908775
Source: Findit
Source-ID: 271850765
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Novel membrane-based electrochemical sensor for real-time bio-applications.
This article presents a novel membrane-based sensor for real-time electrochemical investigations of cellular- or tissue cultures. The membrane sensor enables recording of electrical signals from a cell culture without any signal dilution, thus avoiding loss of sensitivity. Moreover, the porosity of the membrane provides optimal culturing conditions similar to existing culturing techniques allowing more efficient nutrient uptake and molecule release. The patterned sensor electrodes were fabricated on a porous membrane by electron-beam evaporation. The electrochemical performance of the membrane electrodes was characterized by cyclic voltammetry and chronoamperometry, and the detection of synthetic dopamine was demonstrated down to a concentration of 3.1 pM. Furthermore, to present the membrane-sensor functionality the dopamine release from cultured PC12 cells was successfully measured. The PC12 cells culturing experiments showed that the membrane-sensor was suitable as a cell culturing substrate for bio-applications. Real-time measurements of dopamine exocytosis in cell cultures were performed, where the transmitter release was recorded at the point of release. The developed membrane-sensor provides a new functionality to the standard culturing methods, enabling sensitive continuous in vitro monitoring and closely mimicking the in vivo conditions.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems
Number of pages: 12
Pages: 22128-22139
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Sensors
Volume: 14
Issue number: 11
ISSN (Print): 1424-8220
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.78 SJR 0.576 SNIP 1.393
Real-time multiparameter monitoring of cellular dynamics: an automated microfluidic electrochemical analysis platform

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Bioanalytics, Nanoprobes, Nano Bio Integrated Systems, Fluidic Array Systems and Technology, Technical University of Denmark
Number of pages: 1
Combined Cell Culture-Biosensing Platform Using Vertically Aligned Patterned Peptide Nanofibers for Cellular Studies

This Article presents the development of a combined cell culture–biosensing platform using vertically aligned self-assembled peptide nanofibers. Peptide nanofibers were patterned on a microchip containing gold microelectrodes to provide the cells with a 3D environment enabling them to grow and proliferate. Gold microelectrodes were functionalized with conductive polymers for the electrochemical detection of dopamine released from PC12 cells. The combined cell culture–biosensing platform assured a close proximity of the release site, the cells and the active surface of the sensor, thereby rendering it possible to avoid a loss of sensitivity because of the diffusion of the sample. The obtained results showed that the peptide nanofibers were suitable as a cell culturing substrate for PC12 cells. The peptide nanofibers could be employed as an alternative biological material to increase the adherence properties of PC12 cells. Dopamine was amperometrically detected at a value of 168 fmole.
Dielectrophoretic manipulation and solubility of protein nanofibrils formed from crude crystallins

Protein nanofibrils and nanotubes are now widely accepted as having potential for use in the field of bionanotechnology. For this to be a feasible alternative to existing technologies, there is a need for a commercially viable source. Previous work has identified amyloid fibrils formed from crude crystallin proteins as such a source, since these fibrils can be produced in large quantities at a low cost. Applications include use of fibrils as templates for the formation of nanowires or as biosensing scaffolds. There remains a number of practical considerations, such as stability and the ability to control their arrangement. In this study, crude crystallin amyloid fibrils are shown to be stable in a range of biological and clean room solvents, with the fibril presence confirmed by transmission electron microscopy and the thioflavin T fluorescent assay. The fibrils were also immobilised between microelectrodes using dielectrophoresis, which enabled the recording of I–V curves for small numbers of fibrils. This investigation showed the fibrils to have low conductivity, with current values in the range of 10−10 A recorded. This low conductivity could be increased through modification, or alternately, the fibrils could be used unmodified for applications where they can act as templates or high surface area nanoscaffolds.

General information
State: Published
Organisations: Nano Bio Integrated Systems, Department of Micro- and Nanotechnology, University of Canterbury
Authors: Domigan, L. (Ekstern), Andersen, K. B. (Intern), Sasso, L. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern), Gerrard, J. A. (Ekstern), Castillo, J. (Intern)
Pages: 1105-1112
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Electrophoresis
Volume: 34
Issue number: 7
ISSN (Print): 0173-0835
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.64 SJR 0.85 SNIP 0.777
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.851 SNIP 0.825 CiteScore 2.53
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.056 SNIP 0.892 CiteScore 2.88
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.154 SNIP 0.992 CiteScore 3.13
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.368 SNIP 0.983 CiteScore 3.24
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
DNA hybridization sensing for cytogenetic analysis

Cytogenetic analysis focuses on studying the cell structure, mainly in respect to chromosome content and their structure. Chromosome abnormalities, such as translocations may cause various genetic disorders, but are also associated with haematological malignancies. Chromosome translocations are rearrangements between two chromosome arms that results in two derivative chromosomes having a mixed DNA sequence. The current detection method is a Fluorescent In situ Hybridization, which requires a use of expensive, fluorescently labeled probes that target the DNA sequences of two chromosomes involved in the translocation (Kwasny et al., 2012).

We have developed a new double hybridization assay that allows for sorting of the DNA chromosomal fragments into separate compartment, moreover allowing for detection of the translocation. To detect the translocation it is necessary to determine that the two DNA sequences forming a derivative chromosome are connected, which is achieved by two subsequent hybridization steps. The first example of the translocation detection was presented on lab-on-a-disc using fluorescently labeled DNA fragments, representing the derivative chromosome (Bregger et al., 2012). To allow for cheaper detection a label-free approach has been investigated using electrochemical impedance spectroscopy as a sensing method. We present here our recent results in regards to DNA sensing on metallic and conductive polymer electrodes for translocation detection. Our sensors are inexpensive and can be successfully applied in cytogenetic analysis as a replacement of standard techniques.

General information

State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Polymer Microsystems for Medical Diagnostics, Nanoprobes, Technical University of Denmark
Publication date: 2013
Doped Overoxidized Polypyrrole Microelectrodes as Sensors for the Detection of Dopamine Released from Cell Populations

A surface modification of interdigitated gold microelectrodes (IDEs) with a doped polypyrrole (PPy) film for detection of dopamine released from populations of differentiated PC12 cells is presented. A thin PPy layer was potentiostatically electropolymerized from an 10 aqueous pyrrole solution onto electrode surfaces. The conducting polymer film was doped during electropolymerization by introducing counter ions in the monomer solution. Several counter ions were tested and the resulting electrode modifications were characterized electrochemically to find the optimal dopant that increases sensitivity in dopamine detection. Overoxidation of the PPy films was shown to contribute to a significant enhancement in sensitivity to dopamine. The changes caused by overoxidation in the electrochemical behavior and electrode morphology were investigated using cyclic voltammetry and SEM as well as AFM, respectively. The optimal dopant for dopamine detection was found to be polystyrenesulfonate anion (PSS-15). Rat pheochromocytoma (PC12) cells, a suitable model to study exocytotic dopamine release, were differentiated on IDEs functionalized with an overoxidized PSS-doped PPy film. The modified electrodes were used to amperometrically detect dopamine released by populations of cells upon triggering cellular exocytosis with an elevated K+ concentration. A comparison between the generated current on bare gold electrodes and gold electrodes modified with overoxidized doped PPy illustrates the clear advantage of the modification, yielding 2.6-fold signal amplification. The results also illustrate how to use cell population based dopamine exocytosis measurements to obtain biologically significant information that can be relevant in, for instance, the study of neural stem cell differentiation into dopaminergic neurons.
Chromosome abnormalities, such as translocations may cause various genetic disorders and are also associated with haematological malignancies. The current detection methods such as karyotyping and FISH require a use of expensive reagents and can only be performed in specialized laboratories. This PhD project aims at developing new strategies for point-of-care detection of chromosome translocations by applying micro- and nanotechnologies to increase the sensitivity. The project started with development of a microfluidic device for controlled chromosome spreading. The device, made in Topas®, was used to facilitate the evaporation of the fixative solution to achieve proper spreading. In the device we obtained a comparable spreading efficiency to the traditional methods but with reduced reagents volume.

To propose a new strategy for chromosome translocation detection we developed a double hybridisation assay. To detect the translocation it is necessary to determine that the two DNA sequences forming a derivative chromosome are connected, which is achieved by two subsequent hybridization steps. The first example of the translocation detection was presented on lab-on-a-disc using fluorescently labeled DNA fragments, representing the derivative chromosome. It allows for sorting of the DNA chromosomal fragments into separate compartments followed by translocation detection.

To allow for cheaper detection an electrical label-free approach has been investigated using silicon nanowires BioFETs, metallic and conductive polymer electrodes. We present here our findings regarding the DNA hybridisation sensing using these sensors. They showed an improved sensitivity and are all label-free, which makes them inexpensive candidates for a novel cytogenetic analysis as a replacement of standard techniques. The metallic electrodes as the most reliable were selected for further development of a complete device for translocation detection. We developed a setup enabling electrochemical measurements on a spinning lab-on-a-disc platform. An electrical swivel was used to provide reliable connections between the electrodes on a disc and a potentiostat. We have demonstrated the applicability of the setup to standard electrochemical techniques. Lab-on-a-chip devices are being constantly developed to improve the analysis at a reduced cost and time. The presented devices that were developed using microand nanotechnologies are label-free and due to their sensitivity show a potential to be applied to chromosome translocation analysis with an improved detection efficiency.
Translating silicon nanowire BioFET sensor-technology to embedded point-of-care medical diagnostics

Silicon nanowire and nanoribbon biosensors have shown great promise in the detection of biomarkers at very low concentrations. Their high sensitivity makes them ideal candidates for use in early-stage medical diagnostics and further disease monitoring where low amounts of biomarkers need to be detected. However, in order to translate this technology from the bench to the bedside, a number of key issues need to be taken into consideration: Integrating nanobiosensors-based technology requires to overcome the difficult tradeoff between imperatives for high device reproducibility and associated rising fabrication costs. Also the translation of nano-scale sensor technology into daily-use point-of-care devices requires acknowledgement of the end-user requirements, making device portability and human-interfacing a focus point in device development. Sample handling or purification for instance, should be addressed in an automated way.

Here, we are presenting the concept of a polysilicon nanoribbon sensor array integrated with multiplexed microfluidic functionalization, automated calibration and sample handling for flexible diagnostics from finger prick blood samples. Functionalization of the sensor surface is performed in a controlled microfluidic environment and can be monitored in real-time to ensure reproducible results. In a simple temporary PDMS device, multiple parallel pathways enable straightforward selective functionalization for different biomarkers. Common diagnostic essays, which require a specific set of biomarkers to be identified and quantified simultaneously, can thus be readily translated onto this platform. After hydrogen termination of the silicon surface an alkyne monolayer is formed based on a hydrosilylation process. Antibodies and other receptor proteins can then be immobilized in a parallel manner without the use of a spotting system using various chemistries depending on the chosen headgroup in the monolayer. The system is designed to work with a single tube at the outlet and is able to mix and deliver immobilization reactants and antibody solution as well as washing buffer to the sensor surface.

Advanced microtechnologies for cytogenetic analysis

Cytogenetic and molecular cytogenetic analyses, which aim to detect chromosome abnormalities, are routinely performed in cytogenetic laboratories all over the world. Traditional cytogenetic studies are performed by analyzing the banding pattern of chromosomes, and are complemented by molecular cytogenetic techniques such as fluorescent in situ
hybridization (FISH). To improve FISH application in cytogenetic analysis the issues with long experimental time, high volumes of expensive reagents and requirement for trained technicians need to be addressed. The protocol has recently evolved towards on chip detection of chromosome abnormalities with the development of microsystems for FISH analysis. The challenges addressed by the developed microsystems are mainly the automation of the assay performance, reduction in probe volume, as well as reduction of assay time. We present here our efforts to introduce automation in the cytogenetic laboratories at a microscale. We have developed membrane based micro perfusion systems capable of expansion of lymphocytes in a shorter time and at a smaller scale. The simulated and experimental results show very efficient exchange of the growth medium to the hypotonic solution and fixative. These are commonly used solutions required for proper preparation of a metaphase chromosomes analysis. Further we developed a microfluidic chip for preparation of metaphase chromosome spreads and their analysis by metaphase FISH on chip. All developed devices are capable of performing the entire metaphase FISH protocol in a shorter time and at the same quality as standard methods.

**Advanced microtechnologies for detection of chromosome abnormalities by fluorescent in situ hybridization.**

Cytogenetic and molecular cytogenetic analyses, which aim to detect chromosome abnormalities, are routinely performed in cytogenetic laboratories all over the world. Traditional cytogenetic studies are performed by analyzing the banding pattern of chromosomes, and are complemented by molecular cytogenetic techniques such as fluorescent in situ hybridization (FISH). To improve FISH application in cytogenetic analysis the issues with long experimental time, high volumes of expensive reagents and requirement for trained technicians need to be addressed. The protocol has recently evolved towards on chip detection of chromosome abnormalities with the development of microsystems for FISH analysis. The challenges addressed by the developed microsystems are mainly the automation of the assay performance, reduction in probe volume, as well as reduction of assay time. The recent focus on the development of automated systems for performing FISH on chip is summarized in this review.

**General information**

State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Kennedy Center, University of Copenhagen
Number of pages: 1
Publication date: 2012
Event: Main Research Area: Technical/natural sciences
Source: du
Source-ID: u::6275
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2012
Fluorescent in situ hybridization, FISH on chip, Microsystems, Cytogenetic analysis

DOIs:
10.1007/s10544-011-9622-7

Source: dtu
Source-ID: n::oai:DTIC-ART:pubmed/364830413::16376
Publication: Research - peer-review › Journal article – Annual report year: 2012

All-polymer microfluidic device for metaphase FISH on chip

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Kennedy Center
Number of pages: 1
Publication date: 2012
Event: Abstract from Lab on a Chip European Congress 2012, Edinburgh, United Kingdom.
Main Research Area: Technical/natural sciences

Bibliographical note
Poster presentation at Lab on a Chip Conference Edinburgh, 2012
Source: dtu
Source-ID: u::6274
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2012

Compact potentiostat for cellular electrochemical imaging with 54 parallel channels
A novel potentiostat containing 54 current amplifiers matched to an array of custom-fabricated 5µm microelectrodes for electrochemical imaging of released neurotransmitters is presented. The board is integrated with a programmable
microfluidic cell culture system and the whole assembly is thin and compact enough to be placed under the objective of a standard microscope for simultaneous optical and electrochemical monitoring. Each channel, scanned every 54μs, features 3pA current resolution over a 5kHz bandwidth, suitable for detecting single exocytotic events. The design and electrical characterization of the system are reported together with its functionality, certified by a 54-pixel electrochemical imaging of the diffusion of a 10μl droplet of a target analyte inside the cell culture chamber.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Bioanalytics, Nano Bio Integrated Systems, Politecnico di Milano
Publication date: 2012

Host publication information
Title of host publication: Proceedings of IEEE Biomedical Circuits and Systems Conference
Main Research Area: Technical/natural sciences
DOIs: 10.1109/BioCAS.2012.6418401
Source: dtu
Source-ID: n::oai:DTIC-ART:inspec/380059708::26910
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Designing Polymeric Microfluidic Platforms for Biomedical Applications
Micro- and Nanotechnology have the potential to offer a smart solution for diagnostics and academia research with rapid, low cost, robust analysis systems to facilitate biological analyses. New, high throughput microfluidic platforms have the potential to surpass in performance the conventional analyses systems in use today. The overall goal of this PhD project is to address two different areas using microfluidics:

i) Chromosome analysis by metaphase FISH such a platform, if successful, can immediately substitute the routine, labor-intensive, glass slide-based FISH analyses in Clinical Cytogenetics laboratories. During the course of this project, initially the suitability of the polymeric chip substrate was tested and a microfluidic device was developed for performing interphase FISH analysis. With this device, the key factors involved in chromosome spreading crucial to FISH analysis were further investigated. Based on the insights gained, a micro splashing device was designed to achieve well-spread chromosomes and a rapidly assembled microFISH device was presented for metaphase analysis. Further, a single polymeric microfluidic device was developed to semi-automate the FISH analysis.

ii) Culturing brain slices and monitoring the integration of neuronal stem cells upon cultured brain slices. These studies will aid to design novel therapeutic approaches for neurodegenerative disease. The aim of this project was to create a microfluidic cell culture chamber and keep a brain slice alive in it for long time under stable conditions. Such a system was developed and tested first with PC12 cell line culture, followed by brain slice culture. This culture system was later adapted to suit long-term culturing and was successfully demonstrated.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Vedarethinam, I. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern), Heiskanen, A. (Intern)
Publication date: 2012

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions: Thesis_Indumath.pdf
Publication: Research › Ph.D. thesis – Annual report year: 2012

Electrochemical evaluation of dopamine detection on pyrolysed carbon and gold electrodes

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nanoprobes, Bioanalytics, Nano Bio Integrated Systems, Lund University
Fabrication of 3D nano/microelectrodes via two-photon-polymerization

The integration of two-photon polymerization technology with standard microfabrication techniques is imperative for the use of this tool in micro- and nanotechnology and especially for the future commercialization of the technology. In this work, we report a novel method for the fabrication of 3D polymeric structures via a two-photon polymerization based system. The method consists of combining a two-photon polymerization system with conventional photolithography techniques in order to create 3D polymer electrodes. The functionality of the final structures was confirmed by electrochemical characterization techniques.

General information
State: Published
Organisations: Nano Bio Integrated Systems, Department of Micro- and Nanotechnology
U. Z. M. H. M. S. (Ekstern)
Pages: 378-381
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Microelectronic Engineering
Volume: 98
ISSN (Print): 0167-9317
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.69 SJR 0.606 SNIP 0.999
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.533 SNIP 0.856 CiteScore 1.35
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.592 SNIP 0.897 CiteScore 1.44
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.602 SNIP 1.001 CiteScore 1.45
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.745 SNIP 0.983 CiteScore 1.44
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.818 SNIP 1.169 CiteScore 1.8
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.946 SNIP 1.119
Fabrication of high-aspect ratio SU-8 micropillar arrays

SU-8 is the preferred photoresist for development and fabrication of high aspect ratio (HAR) three-dimensional patterns. However, processing of SU-8 is a challenging task, especially when the film thickness as well as the aspect ratio is increasing and the size of the features is close to the resolution limit of photolithography. This paper describes process optimization for the fabrication of dense SU-8 micropillar arrays (2.5μm spacing) with nominal height 20μm and nominal diameter 2.5μm (AR 8). Two approaches, differing in temperature, ramping rate and duration of the baking steps were compared as part of the photolithographic processing, in order to evaluate the effect of baking on the pattern resolution. Additionally, during the post-processing, supercritical point drying and hard baking were introduced yielding pillars with diameter 1.8μm, AR=11 and an improved temporal stability.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Bioanalytics, Nanoprobes, Nano Bio Integrated Systems
Authors: Amato, L. (Intern), Keller, S. S. (Intern), Heiskanen, A. (Intern), Dimaki, M. (Intern), Emnéus, J. (Intern), Boisen, A. (Intern), Tenje, M. (Intern)
Pages: 483-487
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Microelectronic Engineering
Volume: 98
ISSN (Print): 0167-9317
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.69 SJR 0.606 SNIP 0.999
Fabrication of single vertically aligned carbon nanotubes for cellular electrochemistry

General information
State: Published
Microtechnologies Enable Cytogenetics

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems
Pages: 25-40
Publication date: 2012

Host publication information
Title of host publication: Recent Trends in Cytogenetic Studies - Methodologies and Applications
Publisher: INTECH OPEN ACCESS PUBLISHER
Editor: Tirunilai, P.
Chapter: 2
Main Research Area: Technical/natural sciences
Electronic versions:
Source: dtu
Source-ID: u::7196
Publication: Research - peer-review › Book chapter – Annual report year: 2013

Multichannel Bipotentiostat Integrated With a Microfluidic Platform for Electrochemical Real-Time Monitoring of Cell Cultures

An electrochemical detection system specifically designed for multi-parameter real-time monitoring of stem cell culturing/differentiation in a microfluidic system is presented. It is composed of a very compact 24-channel electronic board, compatible with arrays of microelectrodes and coupled to a microfluidic cell culture system. A versatile data acquisition software enables performing amperometry, cyclic voltammetry and impedance spectroscopy in each of the 12 independent chambers over a 100 kHz bandwidth with current resolution down to 5 pA for 100 ms measuring time. The design of the platform, its realization and experimental characterization are reported, with emphasis on the analysis of impact of input capacitance (i.e., microelectrode size) and microfluidic pump operation on current noise. Programmable sequences of successive injections of analytes (ferricyanide and dopamine) and rinsing buffer solution as well as the impedimetric continuous tracking for seven days of the proliferation of a colony of PC12 cells are successfully demonstrated.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Bioanalytics, Fluidic Array Systems and Technology, Nano Bio Integrated Systems, Universita Degli Studi Di Genova, University of Potsdam, Politecnico di Milano
Pages: 498-507
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: IEEE Transactions on Biomedical Circuits and Systems
Volume: 6
Issue number: 5
ISSN (Print): 1932-4545
Novel 3D microelectrodes and pipettes by wet and dry etching
The purpose of this work is to develop novel 3D micro- and nanoelectrodes and pipettes by use of carefully optimised standard microfabrication techniques such as wet (by KOH) and dry silicon etching. Two types of electrodes have been fabricated and characterized: small nanoelectrodes to be used for localised measurements on cell cultures and high aspect ratio scalloped microelectrodes for measurements in brain slices. This paper presents improved fabrication processes for both types of electrodes and the pipettes, as well as the electrical and electrochemical characterization of the small electrodes in order to confirm their functionality. Although functional, an increase in the electrode surface area is needed if they are to be used for electrophysiological measurements. Finally, the pipettes fabricated have openings of the order of 500nm, which makes them ideal candidates for localised stimulation of cell or brain slice cultures.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Polymer Microsystems for Cell Processing, University College Cork, Technical University of Denmark
Pages: 33-36
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Microelectronic Engineering
Volume: 100
ISSN (Print): 0167-9317
Ratings:
BFI (2017): BFI-level 2
On-chip cell viability studies using label-free impedance detection

General information
State: Published
Organisations: Office for Study Programmes and Student Affairs, Department of Micro- and Nanotechnology, Nano Bio Integrated Systems, Slovak Academy of Sciences
Number of pages: 1
Publication date: 2012
Event: Poster session presented at III International Workshop on Analytical Miniaturization and NANOtechnologies, Barcelona, Spain.
Main Research Area: Technical/natural sciences
Source: dtu
Source-ID: u::6278
Publication: Research - peer-review › Poster – Annual report year: 2012

Self-assembled peptide nanoparticles: Stiffer than steel?

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Christiansen, N. O. (Intern), Dimaki, M. (Intern), Castillo, J. (Intern), Svendsen, W. E. (Intern), Rozlosnik, N. (Intern)
Publication date: 2012
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 318789
Publication: Research › Conference abstract for conference – Annual report year: 2012

Evoluting microfluidics: Moving towards clinical applications

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Shah, P. J. (Intern), Svendsen, W. E. (Intern), Dimaki, M. (Intern), Okkels, F. (Intern)
Publication date: Aug 2011

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
07-02712-64 PJS._thesis._2011 1259135.pdf
Source: orbit
Source-ID: 313862
Publication: Research › Ph.D. thesis – Annual report year: 2011

Three-dimensional electrode array for brain slice culture

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Vazquez Rodriguez, P. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Publication date: May 2011

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Dielectrophoretic manipulation of human chromosomes in microfluidic channels: extracting chromosome dielectric properties

An investigation of the dielectric properties of polyamine buffer prepared human chromosomes is presented in this paper. Chromosomes prepared in this buffer are only a few micrometers in size and shaped roughly like spherical discs. Dielectrophoresis was therefore chosen as the method of manipulation combined with a custom designed microfluidic system containing the required electrodes for dielectrophoresis experiments. Our results show that although this system is presently not able to distinguish between the different chromosomes, it can provide average data for the dielectric properties of human chromosomes in polyamine buffer. These can then be used to optimize system designs for further characterization and even sorting. The experimental data from the dielectrophoretic manipulation were combined with theoretical calculations to extract a range of values for the permittivity and conductivity of human polyamine buffer prepared chromosomes.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, Stanford University
Authors: Clausen, C. H. (Intern), Dimaki, M. (Intern), Buckley, S. (Ekstern), Svendsen, W. E. (Intern)
Pages: 56-62
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: BioChip Journal
Volume: 5
Issue number: 1
ISSN (Print): 1976-0280
Ratings:
Web of Science (2017): Indexed Yes
Scopus rating (2016): SJR 0.358 SNIP 0.507 CiteScore 1.29
Scopus rating (2015): SJR 0.364 SNIP 0.514 CiteScore 1.16
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.356 SNIP 0.566 CiteScore 1.01
Scopus rating (2013): SJR 0.359 SNIP 0.409 CiteScore 0.98
ISI indexed (2013): ISI indexed yes
Scopus rating (2012): SJR 0.281 SNIP 0.265 CiteScore 0.62
ISI indexed (2012): ISI indexed yes
Scopus rating (2011): SJR 0.358 SNIP 0.405 CiteScore 0.87
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 0.363 SNIP 0.285
Scopus rating (2009): SJR 0.496 SNIP 1.338
Original language: English
DOIs:
10.1007/s13206-011-5109-0
Source: orbit
Source-ID: 277903
Publication: Research - peer-review › Journal article – Annual report year: 2010

Electrostatic Force Microscopy of Self Assembled Peptide Structures
In this report electrostatic force microscopy (EFM) is used to study different peptide self-assembled structures, such as tubes and particles. It is shown that not only geometrical information can be obtained using EFM, but also information about the composition of different structures. In particular we use EFM to investigate the structures of diphenylalanine peptide tubes, particles, and CSGAITIG peptide particles placed on pre-fabricated SiO2 surfaces with a backgate. We show that the cavity in the peptide tubes could be to the presence of water residues. Additionally we show that self-
assembled amyloid peptides form spherical solid structures containing the same self-assembled peptide in its interior. In both cases transmission electron microscopy is used to verify these structures. Further, the limitations of the EFM technique are discussed, especially when the observed structures become small compared to the radius of the AFM tip used. Finally, an agreement between the detected signal and the structure of the hollow peptide tubes is demonstrated.

**General information**

State: Published  
Organisations: Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, Nano-Bio Integrated Systems Group, University of Crete  
Pages: 201-207  
Publication date: 2011  
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Scanning  
Volume: 33  
Issue number: 4  
ISSN (Print): 0161-0457  
Ratings:  
BFI (2017): BFI-level 1  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): SJR 0.393 SNIP 0.633 CiteScore 1.27  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 0.361 SNIP 0.689 CiteScore 1.33  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 0.582 SNIP 1.511 CiteScore 1.89  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 0.57 SNIP 0.777 CiteScore 1.41  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): SJR 0.42 SNIP 0.672 CiteScore 1.12  
ISI indexed (2012): ISI indexed yes  
BFI (2011): BFI-level 1  
Scopus rating (2011): SJR 0.594 SNIP 0.805 CiteScore 1.18  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 1  
Scopus rating (2010): SJR 0.615 SNIP 0.812  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 0.565 SNIP 1.135  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 0.34 SNIP 0.813  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 0.278 SNIP 0.364  
Scopus rating (2006): SJR 0.431 SNIP 0.784  
Scopus rating (2005): SJR 0.51 SNIP 0.682  
Scopus rating (2004): SJR 0.244 SNIP 0.667  
Scopus rating (2003): SJR 0.301 SNIP 0.706  
Scopus rating (2002): SJR 0.317 SNIP 0.772  
Scopus rating (2001): SJR 0.273 SNIP 0.767  
Scopus rating (2000): SJR 0.36 SNIP 0.419  
Scopus rating (1999): SJR 0.317 SNIP 0.287
Fabrication of high aspect ratio SU-8 micropillar arrays

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Amato, L. (Intern), Keller, S. S. (Intern), Heiskanen, A. (Intern), Dimaki, M. (Intern), Emnéus, J. (Intern), Boisen, A. (Intern), Tenje, M. (Intern)
Publication date: 2011
Event: Poster session presented at 37th International Conference on Micro and Nano Engineering, Berlin, Germany.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 275926
Publication: Research - peer-review › Journal article – Annual report year: 2011

FISHprep: A Novel Integrated Device for Metaphase FISH Sample Preparation

We present a novel integrated device for preparing metaphase chromosomes spread slides (FISHprep). The quality of cytogenetic analysis from patient samples greatly relies on the efficiency of sample pre-treatment and/or slide preparation. In cytogenetic slide preparation, cell cultures are routinely used to process samples (for culture, arrest and fixation of cells) and/or to expand limited amount of samples (in case of prenatal diagnostics). Arguably, this expansion and other sample pretreatments form the longest part of the entire diagnostic protocols spanning over 3–4 days. We present here a novel device with an integrated expansion chamber to culture, arrest and fix metaphase cells followed by a subsequent splashing protocol leading to ample metaphase chromosome spreads on a glass slide for metaphase FISH analysis. The device provides an easy, disposable, low cost, integrated solution with minimal handling for metaphase FISH slide preparation.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, Kennedy Center, University of Copenhagen
Pages: 116
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Micromachines
Volume: 2
Issue number: 2
ISSN (Print): 2072-666X
Ratings:
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 1.83 SJR 0.382 SNIP 0.766
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.438 SNIP 0.931 CiteScore 1.78
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.638 SNIP 1.384 CiteScore 2.1
Scopus rating (2013): SJR 0.479 SNIP 1.151 CiteScore 1.73
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.477 SNIP 1.34 CiteScore 1.28
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.226 SNIP 0.892
ISI indexed (2011): ISI indexed no
Long-term brain slice culturing in a microfluidic platform

In this work, we present the development of a transparent poly(methyl methacrylate) (PMMA) based microfluidic culture system for handling long-term brain slice cultures independent of an incubator. The different stages of system development have been validated by culturing GFP producing brain slices from 8-day old (P8) mouse pups. Fluorescence microscopic monitoring of GFP was utilized as an indicator of tissue viability. The final format of the developed system, featuring "plug-and-play" technology with a reusable fluidic connection board and easily changeable microfluidic chips, facilitated brain slice culturing for 16 days.

Micro and nano-platforms for biological cell analysis

In this paper some technological platforms developed for biological cell analysis will be presented and compared to existing systems. In brief, we present a novel micro cell culture chamber based on diffusion feeding of cells, into which cells can be introduced and extracted after culturing using normal pipettes, thus making it readily usable for clinical laboratories. To enhance the functionality of such a chamber we have been investigating the use of active or passive 3D surface modifications. Active modifications involve miniature electrodes able to record electrical or electrochemical signals from the cells, while passive modifications involve the presence of a peptide nanotube based scaffold for the cell culturing that mimics the in vivo environment. Two applications involving fluorescent in situ hybridization (FISH) analysis and cancer cell sorting are presented, as examples of further analysis that can be done after cell culturing. A platform able to automate the entire process from cell culturing to cell analysis by means of simple plug and play of various self-contained, individually fabricated modules is finally described.
Publication information
Journal: Sensors and Actuators A: Physical
Volume: 172
Issue number: 1
ISSN (Print): 0924-4247
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.79 SJR 0.803 SNIP 1.655
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.848 SNIP 1.599 CiteScore 2.73
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.878 SNIP 1.798 CiteScore 2.41
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.827 SNIP 1.802 CiteScore 2.53
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.915 SNIP 2.113 CiteScore 2.34
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.907 SNIP 2.111 CiteScore 2.5
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.106 SNIP 1.834
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.029 SNIP 1.674
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.973 SNIP 1.612
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.944 SNIP 1.42
Scopus rating (2006): SJR 0.913 SNIP 1.636
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.955 SNIP 1.736
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.964 SNIP 1.727
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.149 SNIP 1.484
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.055 SNIP 1.458
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.946 SNIP 1.458
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.789 SNIP 1.251
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.578 SNIP 0.875
Original language: English
Cell sorting, Nanoelectrodes, Cell culturing, Peptide nanotubes
Micro and Nano Techniques for the Handling of Biological Samples

Micro and Nano Techniques for the Handling of Biological Samples reviews the different techniques available to manipulate and integrate biological materials in a controlled manner, either by sliding them along a surface (2-D manipulation), or by gripping and moving them to a new position (3-D manipulation). The advantages and drawbacks are mentioned together with examples that reflect the state-of-the-art in manipulation techniques for biological samples.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Number of pages: 255
Publication date: 2011

Microfluidic bioreactors for culture of non-adherent cells

Microfluidic bioreactors (μBR) are becoming increasingly popular for cell culture, sample preparation and analysis in case of routine genetic and clinical diagnostics. We present a novel μBR for non-adherent cells designed to mimic in vivo perfusion of cells based on diffusion of media through a sandwiched membrane. The culture chamber and perfusion chamber are separated by a sandwiched membrane and each chamber has separate inlet/outlets for easy loading/unloading of cells and perfusion of the media. The perfusion of media and exchange of nutrients occur through the sandwiched membrane, which was also verified with simulations. Finally, we present the application of this device for cytogenetic sample preparation, whereby we culture and arrest peripheral T-lymphocytes in metaphase and later fix them in the μBR. The expansion of T-lymphocytes from an unknown patient sample was quantified by means of CFSE staining and subsequent counting in a flow cytometer. To conclude on the applicability of μBR for genetic diagnostics, we prepare chromosome spreads on glass slides from the cultured samples, which is the primary step for metaphase FISH analysis.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, University of Copenhagen
Pages: 1002-1008
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Sensors and Actuators B: Chemical
Volume: 156
Issue number: 2
ISSN (Print): 0925-4005
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 5.07 SJR 1.333 SNIP 1.463
Web of Science (2016): Indexed yes
Microfluidic device as a novel cell transmigration assay

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Cell biology and virology Group, Biomedical Micro Systems
Section
Microfluidic device to study cell transmigration under physiological shear stress conditions

The development of new drug therapies relies on studies of cell transmigration in in vitro systems. Migration has traditionally been studied using two methods, the Boyden chamber and a shear flow chamber assay. Though, commonly applied in cell transmigration studies, they are far from imitating a natural migration process. Here we describe a novel in vitro cell transmigration microfluidic assay, which mimics physiological shear flow conditions in blood vessels. The device was designed to incorporate the principles of both the Boyden chamber and the shear flow chamber assay, i.e. migration through the membrane under flow conditions. The 3D environment of migrating cells is imitated by injecting cell adhesion proteins to coat the membrane in the device. We tested the developed device with Jurkat cells migration towards medium supplemented with serum, and with chemokine induced lymphocytes migration. The applied continuous flow of cell suspension and chemoattractant ensures that the concentration gradient is maintained in time and space. The cell adhesion proteins used to enhance cell migration in the device were fibronectin and VCAM-1. We successfully observed a multistep transmigration process by means of the developed microfluidic migration assay. The presented device is inexpensive, easy to fabricate and disposable, having a potential to be applied in basic research as well as in the drug development process.
**Microsystem for label-free detection of chromosomal translocations**

**General information**

**State:** Published  
**Organisations:** Department of Micro- and Nanotechnology, Kennedy Center, University of Copenhagen  
**Authors:** Kwansy, D. (Intern), Bertelsen, B. (Ekstern), Dimaki, M. (Intern), Silahtaroglu, A. (Ekstern), Tumer, Z. (Ekstern), Svendsen, W. E. (Intern)  
**Publication date:** 2011  
**Event:** Abstract from 8th European Cytogenetics Conference, Porto (PT), 2-5 Jul, .  
**Main Research Area:** Technical/natural sciences  
**Electronic versions:**  
Microsystem for label-free detection.pdf  
**Source:** orbit  
**Source-ID:** 315588  
**Publication:** Research › Conference abstract for conference – Annual report year: 2011

**Real-time monitoring of cellular dynamics using a microfluidic cell culture system with integrated electrode array and potentiostat**

A versatile microfluidic, multichamber cell culture and analysis system with an integrated electrode array and potentiostat suitable for electrochemical detection and microscopic imaging is presented in this paper. The system, which allows online electrode cleaning and modification, was developed for real-time monitoring of cellular dynamics, exemplified in this work by monitoring of redox metabolism inside living yeast cells and dopamine release from PC12 cells.

**General information**

**State:** Published  
**Organisations:** Department of Micro- and Nanotechnology, Technical University of Denmark  
Scalloped electrodes for highly sensitive electrical measurements

In this work we introduce a novel out-of-plane electrode with pronounced scalloped surface and high aspect ratio for electrical recordings of brain tissue in vitro, with the aim to reduce significantly the impedance of the measuring system. The profile and height of the structures is tailored by means of silicon fabrication techniques that sharpen them progressively and in a controlled manner. We will show that the use of the scalloped area achieves a great decrease in impedance, which is very significant for a reduction of noise in electrical measurements. The measured impedance reflects an important improvement in comparison with already available systems. Additionally, first test of durability prove the robustness of these needle-like electrodes during indentation motions. In conclusion, the resulting electrodes are robust, sharp structures that decrease the typical impedance of microelectrodes and are potentially suited for indentation and recording of brain tissue.

Silicon Nanowire as Virus Sensor in a Total Analysis System

Silicon nanowires are very promising candidates for the sensitive detection of viruses or even early detection of cancer. Due to their small dimensions the attachment of even one particle on their surface leads to detectable changes in their conductivity. In this paper we describe the development (fabrication and testing) of a silicon nanowire biosensor equipped with microfluidic channels and automatized data aquisition for the detection of antibodies against a small virus (Aleutian Disease Virus) causing plasmacytosis on mink and ferrets.
Biological and non-biological nanostructures for biomedical applications

General information
State: Published
Organisations: Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, Nano-Bio Integrated Systems Group
Publication date: 2010

Controlled synthesis and manipulation of self-assembled peptide nano spheres by microfluidic dielectrophoresis (DEP)

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Christiansen, N. O. (Intern), Ajine, M. A. (Intern), Castillo, J. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Publication date: 2010

Disposable micro-fluidic biosensor array for online parallelized cell adhesion kinetics analysis on quartz crystal resonators

In this contribution we present a new disposable micro-fluidic biosensor array for the online analysis of adherent Madin Darby canine kidney (MDCK-II) cells on quartz crystal resonators (QCRs). The device was conceived for the parallel cultivation of cells providing the same experimental conditions among all the sensors of the array. As well, dedicated sensor interface electronics were developed and optimized for fast spectra acquisition of all 16 QCRs with a miniaturized impedance analyzer. This allowed performing cell cultivation experiments for the observation of fast cellular reaction kinetics with focus on the comparison of the resulting sensor signals influenced by different cell distributions on the sensor surface. To prove the assumption of equal flow circulation within the symmetric micro-channel network and support the hypothesis of identical cultivation conditions for the cells living above the sensors, the influence of fabrication tolerances on the flow regime has been simulated. As well, the shear stress on the adherent cell layer due to the flowing media was characterized. Injection molding technology was chosen for the cheap mass production of disposable devices. Furthermore, the injection molding process was simulated in order to optimize the mold geometry and minimize the
shrinkage and the warpage of the parts. MDCK-II cells were cultivated in the biosensor array. Parallel cultivation of cells on the gold surface of the QCRs led to first observations of the impact of the cell distribution on the sensor signals during cell cultivation. Indeed, the initial cell distribution revealed a significant influence on the changes in the measured acoustic load on the QCRs suggesting dissimilar cell migrations as well as proliferation kinetics of a non-confluent MDCK-II cell layer.

**General information**

State: Published

Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, Otto-von-Guericke University Magdeburg

Authors: Cama, G. (Ekstern), Jacobs, T. (Ekstern), Dimaki, M. (Intern), Svendsen, W. E. (Intern), Hauptmann, P. (Ekstern), Naumann, M. (Ekstern)

Publication date: 2010

Main Research Area: Technical/natural sciences

**Publication information**

Journal: Measurement Science and Technology

Volume: 21

Issue number: 8

ISSN (Print): 0957-0233

Ratings:

BFI (2017): BFI-level 2

Web of Science (2017): Indexed yes

BFI (2016): BFI-level 2

Scopus rating (2016): CiteScore 1.75 SJR 0.668 SNIP 1.173

BFI (2015): BFI-level 2

Scopus rating (2015): SJR 0.687 SNIP 1.303 CiteScore 1.71

Web of Science (2015): Indexed yes

BFI (2014): BFI-level 2

Scopus rating (2014): SJR 0.657 SNIP 1.319 CiteScore 1.58

Web of Science (2014): Indexed yes

BFI (2013): BFI-level 2

Scopus rating (2013): SJR 0.555 SNIP 1.244 CiteScore 1.53

ISI indexed (2013): ISI indexed yes

Web of Science (2013): Indexed yes

BFI (2012): BFI-level 2

Scopus rating (2012): SJR 0.716 SNIP 1.529 CiteScore 1.65

ISI indexed (2012): ISI indexed yes

Web of Science (2012): Indexed yes

BFI (2011): BFI-level 2

Scopus rating (2011): SJR 0.844 SNIP 1.703 CiteScore 1.77

ISI indexed (2011): ISI indexed yes

Web of Science (2011): Indexed yes

BFI (2010): BFI-level 2

Scopus rating (2010): SJR 0.679 SNIP 1.462

Web of Science (2010): Indexed yes

BFI (2009): BFI-level 1

Scopus rating (2009): SJR 0.919 SNIP 1.573

BFI (2008): BFI-level 1

Scopus rating (2008): SJR 0.881 SNIP 1.494

Web of Science (2008): Indexed yes

Scopus rating (2007): SJR 0.823 SNIP 1.492

Web of Science (2007): Indexed yes

Scopus rating (2006): SJR 0.744 SNIP 1.58

Web of Science (2006): Indexed yes

Scopus rating (2005): SJR 0.82 SNIP 1.584

Web of Science (2005): Indexed yes
Fabrication and Characterization of 3D Micro- and Nanoelectrodes for Neuron Recordings

In this paper we discuss the fabrication and characterization of three dimensional (3D) micro- and nanoelectrodes with the goal of using them for extra- and intracellular studies. Two different types of electrodes will be described: high aspect ratio microelectrodes for studying the communication between cells and ultimately for brain slice recordings and small nanoelectrodes for highly localized measurements and ultimately for intracellular studies. Electrical and electrochemical characterization of these electrodes as well as the results of PC12 cell differentiation on chip will be presented and discussed.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Pages: 10339-10355
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Sensors
Volume: 10
Issue number: 11
ISSN (Print): 1424-8220
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.78 SJR 0.576 SNIP 1.393
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.591 SNIP 1.478 CiteScore 2.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.636 SNIP 1.705 CiteScore 2.4
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.627 SNIP 1.826 CiteScore 2.72
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Metaphase FISH on a Chip: Miniaturized Microfluidic Device for Fluorescence in situ Hybridization

Fluorescence in situ Hybridization (FISH) is a major cytogenetic technique for clinical genetic diagnosis of both inherited and acquired chromosomal abnormalities. Although FISH techniques have evolved and are often used together with other cytogenetic methods like CGH, PRINS and PNA-FISH, the process continues to be a manual, labour intensive, expensive and time consuming technique, often taking over 3-5 days, even in dedicated labs. We have developed a novel microFISH device to perform metaphase FISH on a chip which overcomes many shortcomings of the current laboratory protocols. This work also introduces a novel splashing device for preparing metaphase spreads on a microscope glass slide, followed by a rapid adhesive tape-based bonding protocol leading to rapid fabrication of the microFISH device. The microFISH device allows for an optimized metaphase FISH protocol on a chip with over a 20-fold reduction in the reagent volume. This is the first demonstration of metaphase FISH on a microfluidic device and offers a possibility of automation and significant cost reduction of many routine diagnostic tests of genetic anomalies.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Pages: 9831-9846
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Sensors
Micro and nanoplatforms for biological cell analysis

In this paper some of the technological platforms developed in our group for biological cell analysis will be highlighted. The paper first presents a short introduction pinpointing the advantages of using micro and nano technology in cellular studies. The issues of requiring transient analysis while working in a biological environment maintaining the cells viability and adding analyte are addressed and discussed. An example of a cell culturing chamber useful for both adherent and non-adherent cells, with the capability of adding analyte is given, a small discussion of in vitro cellular studies mimicking the in vivo situation is presented and an example of surface modification for cellular growth is described. Then novel electronic sensor platforms are discussed and an example of a nanosensor with electronic readout is given utilizing both micro- and nanotechnology. Finally an example of sorting cells using dielectrophoresis will be given, aiming at early cancer detection.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Pages: 33-36
Publication date: 2010
Conference: Eurosensors 24, Linz, Austria, 05/09/2010 - 05/09/2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Procedia Engineering
Volume: 5
ISSN (Print): 1877-7058
Ratings:
Scopus rating (2016): CiteScore 0.74
Scopus rating (2015): CiteScore 0.56
Scopus rating (2014): CiteScore 0.53
Scopus rating (2013): CiteScore 0.4
ISI indexed (2013): ISI indexed no
Scopus rating (2012): CiteScore 0.28
ISI indexed (2012): ISI indexed no
Scopus rating (2011): CiteScore 0.45
ISI indexed (2011): ISI indexed no
Web of Science (2010): Indexed yes
Original language: English
DOIs:
10.1016/j.proeng.2010.09.041
Source: orbit
Source-ID: 276021
Publication: Research - peer-review › Conference article – Annual report year: 2010

Peptide self-assembled nanostructures: advances and challenges for their use in nanobiotechnology applications

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Castillo, J. (Intern), Andersen, K. B. (Intern), Christiansen, N. O. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Publication date: 2010

Host publication information
Title of host publication: 3rd International Conference on Advanced Nano Materials
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 269135
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010
An integrated microfluidic system to isolate leukocytes from whole blood

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Shah, P. J. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Publication date: 2009
Event: Poster session presented at MMB2009, Quebec City, Canada.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 249692
Publication: Research - peer-review » Poster – Annual report year: 2009

A novel passive microfluidic device for preprocessing whole blood for point of care diagnostics
A novel strategy to sort the cells of interest (White Blood Cells (leukocytes)) by selectively lysing the Red Blood Cells (erythrocytes) in a miniaturized microfluidic device is presented. Various methods to lyse cells on a chip exist i.e. electrical, mechanical, chemical and thermal but they need integration of electrodes, traps, reservoirs, heaters, etc which is often difficult at micorscale [1 – 4]. On the other hand, FACSlyse protocol uses only osmotic pressure to lyse erythrocytes allowing further isolation of leukocytes. This motivated us to develop a novel herringbone based lyser which works on the principle of mixing whole blood with pure water in time controlled manner to lyse erythrocytes osmotically on a chip.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Shah, P. J. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Publication date: 2009

Host publication information
Publisher: IEEE
ISBN (Electronic): 978-1-4244-4193-8
Main Research Area: Technical/natural sciences
Electronic versions:
Shah.pdf
DOIs:
10.1109/SENSOR.2009.5285475

Bibliographical note
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Source: orbit
Source-ID: 251976
Publication: Research - peer-review » Article in proceedings – Annual report year: 2009

Digging deep with microtools

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Castillo, J. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Pages: 7-7
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy & Environmental Science
Fabrication and integration of 3D nanoelectrodes into microfluidics for cell studies

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, DTU Danchip
Authors: Dimaki, M. (Intern), Vazquez, P. (Intern), Svendsen, W. E. (Intern), Lindhard, J. (Ekstern), Larsen, P. V. (Ekstern), Jensen, F. (Ekstern)
Publication date: 2009
Event: Poster session presented at Annual Lab-on-a-chip European Congress, Stockholm, Sweden, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 248614
Publication: Research - peer-review › Journal article – Annual report year: 2009

Manipulation of biological samples using micro and nano techniques
The constant interest in handling, integrating and understanding biological systems of interest for the biomedical field, the pharmaceutical industry and the biomaterial researchers demand the use of techniques that allow the manipulation of biological samples causing minimal or no damage to their natural structure. Thanks to the advances in micro- and nanofabrication during the last decades several manipulation techniques offer us the possibility to image, characterize and manipulate biological material in a controlled way. Using these techniques the integration of biomaterials with remarkable properties with physical transducers has been possible, giving rise to new and highly sensitive biosensing devices. This article reviews the different techniques available to manipulate and integrate biological materials in a controlled manner either by sliding them along a surface (2-D manipulation), by grappling them and moving them to a flew position (3-D
manipulation), or by manipulating and relocating them applying external forces. The advantages and drawbacks are mentioned together with examples that reflect the state of the art of manipulation techniques for biological samples (171 references).

**General information**

State: Published  
Organisations: Nanoprobes Group, NanoSystems Engineering Section, Department of Micro- and Nanotechnology, Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section  
Authors: Castillo, J. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)  
Pages: 30-42  
Publication date: 2009  
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Integrative Biology  
Volume: 1  
Issue number: 1  
ISSN (Print): 1757-9694  
Ratings:  
BFI (2017): BFI-level 1  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): SJR 0.983 SNIP 0.77 CiteScore 2.66  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 1.132 SNIP 0.841 CiteScore 2.85  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 1.56 SNIP 1.011 CiteScore 3.67  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 1.507 SNIP 1.034 CiteScore 3.93  
ISI indexed (2013): ISI indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): SJR 1.687 SNIP 1.011 CiteScore 4.23  
ISI indexed (2012): ISI indexed yes  
Scopus rating (2011): SJR 1.796 SNIP 1.388 CiteScore 4.27  
ISI indexed (2011): ISI indexed no  
Scopus rating (2010): SJR 1.772 SNIP 1.236  
Web of Science (2009): Indexed yes  
Original language: English  
DOIs:  
10.1039/b814549k  
Source: orbit  
Source-ID: 249293  
Publication: Research - peer-review › Journal article – Annual report year: 2009

**Metallization of high aspect ratio, out of plane structures**

This work is dedicated to developing a novel three dimensional structure for electrochemical measurements in neuronal studies. The final prototype will allow not only for the study and culture on chip of neuronal cells, but also of brain tissue. The use of out-of-plane electrodes instead of planar ones increases the sensitivity of the system and increases the signal-to-noise ratio in the recorded signals, due to the higher availability of surface area. The main bottleneck of the out-of-plane electrode fabrication lies in the metallization process for transforming them into active electrodes, since the coverage of the side walls of almost vertical pillars is not trivial by standard processes in a clean room facility. This paper will discuss the different steps taken towards this goal and present the results that we have obtained so far.

**General information**

State: Published  
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology  
Authors: Vazquez, P. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)  
Publication date: 2009
Novel Integrated Lab-on-Chip System for Chromosome Translocations Analysis

This presentation will focus on the development of a chromosome total analysis system (C-TAS) starting from the design strategy and simulations to the integration into a final monolithic plug and play device. Individual modules which perform the sample preprocessing and analysis tasks like - cell isolation, cell culture, cell lysing, chromosome extraction and Fluorescence In-Situ Hybridization will be presented. How we solved connecting the individual chips and adjusting the microfluidic flows, by using simulations will be discussed.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Publication date: 2009

Three dimensional electrochemical system for neurobiological studies

In this work we report a novel three dimensional electrode array for electrochemical measurements in neuronal studies. The main advantage of working with these out-of-plane structures is the enhanced sensitivity of the system in terms of measuring electrochemical changes in the environment of a cell culture in real time. In addition, the system is devised to offer a compact solution that helps to obtain a homogeneous distribution of current density among the active electrodes.
A Microfabricated Platform for Chromosome Separation and Analysis

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Pages: 052047
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Physics - Conference Series
Volume: 100
Issue number: 5
ISSN (Print): 1742-6588
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.45 SJR 0.24 SNIP 0.383
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.24 SNIP 0.373 CiteScore 0.35
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.253 SNIP 0.344 CiteScore 0.32
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.231 SNIP 0.272 CiteScore 0.25
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
A Microfluidic Lyser to Extract Blood Cells

**General information**

State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, Silicon Microtechnology Group, MicroElectroMechanical Systems Section, Theoretical Microfluidics Group, Theory Section
Authors: Shah, P. J. (Intern), Remma, S. (Intern), Dimaki, M. (Intern), Okkels, F. (Intern), Svendsen, W. E. (Intern)
Publication date: 2008
Event: Poster session presented at Nanotech Northern Europe 2008, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 231264
Publication: Research - peer-review › Poster – Annual report year: 2008

Comsol Multiphysics Simulations of Microfluidic Systems for Biomedical Applications

**General information**

State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, Silicon Microtechnology Group, MicroElectroMechanical Systems Section, Theoretical Microfluidics Group, Theory Section
Publication date: 2008

**Host publication information**

Title of host publication: Proceeding of The Comsol User Conference
Main Research Area: Technical/natural sciences
Conference: The Comsol User Conference, Hannover, Germany, 01/01/2008
Source: orbit
Source-ID: 231198
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008
Fabrication of Rocket Tip 3D Nanoelectrodes for Neuron Metabolic Studies

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, DTU Danchip
Number of pages: 176
Publication date: 2008
Event: Poster session presented at Nanotech Northern Europe 2008, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 231262
Publication: Research - peer-review › Poster – Annual report year: 2008

FISH (Fluorescent in Situ Hybridisation) on Chip

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Publication date: 2008
Host publication information
Title of host publication: Proceeding of The 12th Annual European Conference on Micro & Nanoscale Technologies for the Biosciences
Place of publication: Switzerland
Main Research Area: Technical/natural sciences
Conference: The 12th Annual European Conference on Micro & Nanoscale Technologies for the Biosciences, Switzerland, 01/01/2008
Source: orbit
Source-ID: 231237
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

FISH (Fluorescent in Situ Hybridisation) on Chip

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Publication date: 2008
Event: Poster session presented at The 12th Annual European Conference on Micro & Nanoscale Technologies for the Biosciences, Switzerland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 231294
Publication: Research - peer-review › Poster – Annual report year: 2008

FISH on Polymer

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Publication date: 2008
Host publication information
Investigation of parameters controlling the dielectrophoretic assembly of carbon nanotubes on microelectrodes

Networks of single-walled carbon nanotubes were assembled onto microelectrodes by dielectrophoresis. The dependence of the obtained networks on several assembly parameters such as bias voltage, field application time, frequency, electrode geometry and the nanotube solvent were investigated both structurally and electrically. Reproducible differences in morphological and electrical properties were observed for the parameters investigated. Application of a bias voltage above 10 V for more than 30 seconds with nanotubes in an SDS solution, resulted in dense networks with a relatively low resistance in the 10 k Ohm regime. On the other hand, individual nanotubes and bundles were assembled with lower voltages applied for less than 10 seconds and with other nanotubes solutions. The experimental results were combined with theoretical calculations in order to find a geometry and voltage independent threshold field for the successful assembly of nanotubes between electrodes using dielectrophoresis.
Manipulation and Integration of Biological Nanofibers with Electronic Micro Structures for the Development of Biosensing Devices

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Castillo, J. (Intern), Clausen, C. H. (Intern), Andersen, K. B. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Publication date: 2008

Host publication information
Title of host publication: 34th International Conference on Micro & Nano Engineering
Main Research Area: Technical/natural sciences
Conference: 34th International Conference on Micro & Nano Engineering, Athens, Greece, 01/01/2008
Source: orbit
Source-ID: 269138
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Manipulation of Self-Assembly Amyloid Peptide Nanotubes by Dielectrophoresis (DEP)
Self-assembled amyloid peptide nanotubes (SAPNT) were manipulated and immobilized using dielectrophoresis. Micro-patterned electrodes of Au were fabricated by photolithography and lifted off on a silicon dioxide layer. SAPNT were manipulated by adjusting the amplitude and frequency of the applied voltage. The immobilized SAPNT were evaluated by SEM and atomic force microscopy. The conductivity of the immobilized SAPNT was studied by I-V characterization, for both single SAPNT and bundles. This work illustrates a way to manipulate and integrate biological nanostructures into novel bio-nanoassemblies with concrete applications, such as field-effect transistors, microprobes, microarrays, and biosensing devices.

General information
State: Published
Organisations: Nanoprobes Group, NanoSystemsEngineering Section, Department of Micro- and Nanotechnology, Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section
Authors: Castillo, J. (Intern), Tanzi, S. (Ekstern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Pages: 5026-5032
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Electrophoresis
Volume: 29
Issue number: 24
ISSN (Print): 0173-0835
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.64 SJR 0.85 SNIP 0.777
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.851 SNIP 0.825 CiteScore 2.53
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.056 SNIP 0.892 CiteScore 2.88
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.154 SNIP 0.992 CiteScore 3.13
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.368 SNIP 0.983 CiteScore 3.24
Biological self-assembled structures are receiving increasing focus within micro- and nanotechnology, for example, as sensing devices, due to the fact that they are cheap to produce and easy to functionalize. Therefore, methods for the characterization of these structures are much needed. In this paper, electrostatic force microscopy (EFM) was used to distinguish between hollow nanotubes formed by self-assembly by a simple aromatic dipeptide, L-phenylalanine, silver-filled peptide-based nanotubes, and silver wires placed on prefabricated SiO(2) surfaces with a backgate. The investigation shows that it is possible to distinguish between these three types of structures using this method. Further, an
agreement between the detected signal and the structure of the hollow peptide was demonstrated; however only quantitative agreement with the mathematical expressing of the tubes is shown.
Spatially Optimized Mixers to Enhance Mixing of Whole Blood with Water to Lyse Red Blood Cells

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology, Silicon Microtechnology Group, MicroElectroMechanical Systems Section, Theoretical Microfluidics Group, Theory Section
Authors: Shah, P. J. (Intern), Remma, S. (Intern), Dimaki, M. (Intern), Okkels, F. (Intern), Svendsen, W. E. (Intern)
Publication date: 2008

Host publication information
Title of host publication: Proceedings of NanoBioEurope
Place of publication: Barcelona, Spain
Main Research Area: Technical/natural sciences
Source: orbıt
Source-ID: 231228
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Three-dimensional Electrodes for the study of Neurotransmitters in a Microfluidic System

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Vazquez, P. (Intern), Castillo, J. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Publication date: 2008

Host publication information
Title of host publication: Proceeding of "The Tenth World Congress on Biosensors"
Place of publication: Shanghai, China
Publisher: Elsevier
A Microfluidic Chip for Sorting of Chromosomes

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2007
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206518
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2007

Amyloid peptide nanowires separation and manipulation using dielectrophoresis and microfluidics. Protein Assembly

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Castillo, J. (Intern), Prosperi, G. (Intern), Dimaki, M. (Intern), Kasotakis, M. (Ekstern), Adler-Abramovich, L. (Ekstern), Mitraiki, A. (Ekstern), Gazit, E. (Ekstern), Svendsen, W. E. (Intern)
Publication date: 2007
Event: Poster session presented at Materials Biology and Medicine, Crete, Greece.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206536
Publication: Research - peer-review › Poster – Annual report year: 2007

Biolithographic Patterning of Antibodies to Capture Human Chromosomes

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Bioprobe, POEM
Publication date: 2007
Event: Poster session presented at Lab-on-a-Chip World congress, Edinburgh, United Kingdom.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206524
Publication: Research - peer-review › Poster – Annual report year: 2007

Chromosome Total Analysis System

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2007
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 199137
Publication: Research - peer-review › Poster – Annual report year: 2007
C-TAS: A lab-on-a-chip system for the analysis of chromosomal translocations

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2007
Event: Poster session presented at 3rd Workshop for Nordic Network for Women in Physics, Lyngby, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206535
Publication: Research - peer-review › Poster – Annual report year: 2007

C-TAS: A lab-on-a-chip system for the analysis of chromosomal translocations

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2007
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206534
Publication: Research - peer-review › Poster – Annual report year: 2007

C-TAS: A lab-on-a-chip system for the analysis of chromosomal translocations

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2007
Event: Abstract from DFS & KIF.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206798
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2007

Fabrication of polymeric microstructures to capture chromosomes on monolayer of antibodies

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Bioprobes, POEM
Publication date: 2007
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206525
Publication: Research - peer-review › Poster – Annual report year: 2007

Manipulation of amyloid peptide nanowires using dielectrophoresis and microfluidics

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Castillo, J. (Intern), Prosperi, G. (Intern), Dimaki, M. (Intern), Adler-Abramovich, L. (Ekstern), Gazit, E. (Ekstern), Svendsen, W. E. (Intern)
Manipulation of peptide nanotubes by dielectrophoresis (DEP)*,

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Castillo, J. (Intern), Tanzi, S. (Ekstern), Prosperi, G. (Intern), Dimaki, M. (Intern), Svendsen, W. E. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206530
Publication: Research - peer-review › Poster – Annual report year: 2007

Scanning Conductance Microscopy of Chromosomes

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2007
Host publication information
Title of host publication: Proceedings of the AFM BioMed Conference 2007
Main Research Area: Technical/natural sciences
Conference: AFM BioMed Conference 2007, 01/01/2007
Source: orbit
Source-ID: 199136
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

Separation of white blood cells from a whole blood sample using pinched flow

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2007
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 206526
Publication: Research - peer-review › Poster – Annual report year: 2007

Separation of white blood cells from a whole blood sample using pinched flow

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Publication date: 2007
Event: Poster session presented at 33rd International Conference on Micro- and Nano-Engineering, Copenhagen, Denmark.
Temperature response of carbon nanotube networks

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nanointegration
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern), Svendsen, W. E. (Intern)
Pages: 247-251
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Physics: Conference Series (Online)
Volume: 61
ISSN (Print): 1742-6596
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.45 SJR 0.24 SNIP 0.383
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.24 SNIP 0.373 CiteScore 0.35
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.253 SNIP 0.344 CiteScore 0.32
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.231 SNIP 0.272 CiteScore 0.25
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.28 SNIP 0.354 CiteScore 0.33
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.292 SNIP 0.352 CiteScore 0.43
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.288 SNIP 0.344
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.253 SNIP 0.321
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.265 SNIP 0.294
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.257 SNIP 0.39
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.267 SNIP 0.284
Web of Science (2006): Indexed yes
Original language: English
DOIs:
10.1088/1742-6596/61/1/050
Source: orbit
Totalanalyse-systemer med biologiske anvendelser

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Svendsen, W. E. (Intern), Dimaki, M. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Kvant
Issue number: 1
ISSN (Print): 0905-8893
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Source: orbit
Source-ID: 197458
Publication: Research - peer-review › Journal article – Annual report year: 2007

Carbon nanotube sensors

General information
State: Published
Organisations: Bioprobes, Department of Micro- and Nanotechnology, Nanointegration
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern), Svendsen, W. E. (Intern)
Publication date: 2006

Host publication information
Title of host publication: Proceedings of ICNT 2006
Main Research Area: Technical/natural sciences
Conference: ICNT 2006, 01/01/2006
Source: orbit
Source-ID: 191966
Publication: Research - peer-review › Article in proceedings – Annual report year: 2006

Characterisation Of Mechanical Sensors Using A Custom Built Characterisation System

General information
State: Published
Organisations: Bioprobes, Department of Micro- and Nanotechnology
Publication date: 2006

Host publication information
Title of host publication: Proceedings of NanSens 2006
Main Research Area: Technical/natural sciences
Conference: NanSens 2006, 01/01/2006
Source: orbit
Source-ID: 191965
Publication: Research - peer-review › Article in proceedings – Annual report year: 2006

Chromosomel Total Analysis System

General information
State: Published
Organisations: Bioprobes, Department of Micro- and Nanotechnology
Waferscale assembly of Field-Aligned nanotube Networks (FANs)

We demonstrate the integration of nanotube networks on 512 individual devices on a full 4-inch wafer in less than 60 seconds with a roughly 80% yield using dielectrophoresis. We present here investigations of the morphology and electrical resistance of such field aligned networks for different frequencies of the electrical field used to attract the nanotubes to the electrodes. Preliminary data of response to visible light irradiation as well as changes in the humidity indicate that the field aligned networks could be used as sensor components that may well integrate with CMOS due to mild assembly conditions. (c) 2006 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

General information
State: Published
Organisations: Bioprobes, Department of Micro- and Nanotechnology, Nanointegration
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern)
Pages: 1088-1093
Publication date: 2006
Main Research Area: Technical/natural sciences
Cell Total Analysis System

General information
State: Published
Organisations: Bioprobes, Department of Micro- and Nanotechnology
Publication date: 2005
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 186058
Publication: Research › Poster – Annual report year: 2005

Cromosome Total Analysis System

General information
State: Published
Organisations: Bioprobes, Department of Micro- and Nanotechnology
Publication date: 2005
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 186057
Publication: Research › Poster – Annual report year: 2005

Frequency dependence of the structure and electrical behaviour of carbon nanotube networks assembled by dielectrophoresis

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern)
Pages: 759-763
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication Information
Journal: Nanotechnology
Volume: 16
Issue number: 6
ISSN (Print): 0957-4484
Single- and multiwalled carbon nanotubes and bundles assembled on microelectrodes

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern)
Pages: 1-7
Publication date: 2005
Main Research Area: Technical/natural sciences

Wafer-scale Assembly of Nanotube Network Devices using Dielectrophoresis

General information
State: Published
Organisations: Bioprobes, Department of Micro- and Nanotechnology, Nanointegration
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern)
Publication date: 2005
Event: Poster session presented at Danish Physical Society Annual Meeting 2005, Nyborg, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 186184
Publication: Research - peer-review › Journal article – Annual report year: 2005

Wafer-scale Assembly of Nanotube Network Devices using Dielectrophoresis

General information
State: Published
Organisations: Bioprobes, Department of Micro- and Nanotechnology, Nanointegration
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern)
Publication date: 2005
Event: Poster session presented at Trends in Nanotechnology,.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 186185
Dielectrophoresis of carbon nanotubes using microelectrodes: a numerical study

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern)
Pages: 1095-1102
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Nanotechnology
Volume: 15
Issue number: 8
ISSN (Print): 0957-4484
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.87 SJR 1.096 SNIP 0.814
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.18 SNIP 0.966 CiteScore 3.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.465 SNIP 1.258 CiteScore 3.09
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.585 SNIP 1.244 CiteScore 2.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.846 SNIP 1.306 CiteScore 3.34
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.892 SNIP 1.461 CiteScore 3.86
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.844 SNIP 1.259
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.819 SNIP 1.28
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.875 SNIP 1.333
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.91 SNIP 1.36
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.934 SNIP 1.378
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.925 SNIP 1.445
Web of Science (2005): Indexed yes
Dielectrophoretic assembly of carbon nanotube devices

The purpose of this project has been to assemble single-walled carbon nanotubes on electrodes at the tip of a biocompatible cantilever and use these for chemical species sensing in air and liquid, for example in order to measure the local activity from ion channels in the cell membrane. The electrical resistance of carbon nanotubes has been shown to be extremely sensitive to gas molecules. Dielectrophoresis is a method capable of quickly attracting nanotubes on microelectrodes by using an electric field, thus enabling nanotube integration in microsystems. Dielectrophoresis offers also the potential of distinguishing between nanotubes of different electrical properties, which is very important for the optimisation of the properties of the carbon nanotube sensors. Various cantilever and planar structures were designed, fabricated and tested both with multi-walled and single-walled carbon nanotubes dispersed in a number of different liquids. As a result of these test experiments a cantilever probe was designed specifically for the dielectrophoretic assembly of carbon nanotubes and a prototype was fabricated in the MIC (now Danchip) cleanroom. The prototype is not yet fully operational. A model for the dielectrophoretic assembly of carbon nanotubes on microelectrodes was developed and several simulations were conducted using values from the available literature for the various key parameters. The model can give qualitative results regarding the parameters dominating the dielectrophoretic process and assist in the design of future experiments. Based on the literature and the simulation results, several of the parameters governing the dielectrophoretic assembly of carbon nanotubes were investigated and the results generally agree with the theory. During heating and cooling of the nanotube networks their resistance changes following a pattern that could be explained by oxygen desorption and adsorption. Moreover, the resistance of the networks is generally unstable, which could indicate that the networks are responding to normal changes in the environmental conditions. The response of the assembled carbon nanotube networks to heat, nitrogen, humidity and light was also investigated and the results point once again to oxygen desorption and adsorption as important factors in determining the conductance of a nanotube. Finally an attempt was made to sort carbon nanotubes into metallic and semiconducting. Raman spectra taken from samples assembled at different frequencies directly contradicted theoretical predictions as well as previously published experimental results.

General information
State: Published
Organisations: Nano-Bio Integrated Systems Group, Biomedical Micro Systems Section, Department of Micro- and Nanotechnology
Authors: Dimaki, M. (Intern), Bøggild, P. (Intern)
Number of pages: 211
Publication date: 2004

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
ISBN (Print): 978-87-91797-02-6
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Dimaki_PhD_Thesis_11jan11.pdf
Source: orbit
Source-ID: 274429
Publication: Research › Ph.D. thesis – Annual report year: 2004

Polymer cantilever platform for dielectrophoretic assembly of carbon nanotubes
A polymer cantilever platform for dielectrophoretic assembly of carbon nanotubes has been designed and realized. Multi-walled carbon nanotubes from aqueous solution have been assembled between two metal electrodes that are separated by 2 μm and embedded in the polymer cantilever. The entire chip, except for the metallic electrodes and wiring, was
fabricated in the photoresist SU-8. SU-8 allows for an inexpensive, flexible and fast fabrication method, and the cantilever platform provides a hydrophobic surface that should be well suited for nanotube assembly. The device can be integrated in a micro-total analysis system and has the potential to be used as a scanning sensor for biochemical applications.

**General information**

State: Published
Organisations: Department of Micro- and Nanotechnology, Nanointegration, Bioprobes
Authors: Johansson, A. (Intern), Calleja, M. (Ekstern), Dimaki, M. (Intern), Rasmussen, P. A. (Intern), Bøggild, P. (Intern), Boisen, A. (Intern)
Pages: 117-120
Publication date: 2004
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Sensor Letters
Volume: 2
ISSN (Print): 1546-198X
Ratings:
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.169 SNIP 0.234 CiteScore 0.43
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.157 SNIP 0.274 CiteScore 0.37
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.223 SNIP 0.47 CiteScore 0.59
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.229 SNIP 0.507 CiteScore 0.68
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.241 SNIP 0.484 CiteScore 0.62
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.239 SNIP 0.561 CiteScore 0.87
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.25 SNIP 0.28
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.235 SNIP 0.471
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.502 SNIP 0.769
Scopus rating (2007): SJR 0.575 SNIP 0.554
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.336 SNIP 0.396
Scopus rating (2005): SJR 0.25 SNIP 0.979
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2003): Indexed yes
Original language: English
dielectrophoresis, carbon nanotubes, SU-8, polymer cantilever, biosensor
Source: orbit
Source-ID: 198467
Publication: Research - peer-review › Journal article – Annual report year: 2004

**Sorting and Assembly of Single-walled Carbon Nanotubes by Dielectrophoresis in Microliquid Channels: a Numerical Study**

**General information**

State: Published
SU-8 cantilever platform for dielectrophoretic assembly of carbon nanotubes

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Johansson, A. (Intern), Gomez, M. (Intern), Dimaki, M. (Intern), Rasmussen, P. (Intern), Bøggild, P. (Intern), Boisen, A. (Intern)
Pages: 117-120
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Sensor Letters
ISSN (Print): 1546-198X
Ratings:
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.169 SNIP 0.234 CiteScore 0.43
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.157 SNIP 0.274 CiteScore 0.37
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.223 SNIP 0.47 CiteScore 0.59
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.229 SNIP 0.507 CiteScore 0.68
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.241 SNIP 0.484 CiteScore 0.62
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.239 SNIP 0.561 CiteScore 0.87
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.25 SNIP 0.28
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.235 SNIP 0.471
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.502 SNIP 0.769
Scopus rating (2007): SJR 0.575 SNIP 0.554
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.336 SNIP 0.396
Scopus rating (2005): SJR 0.25 SNIP 0.979
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2003): Indexed yes
Original language: English
Source: orbit
Source-ID: 61810
Publication: Research - peer-review › Journal article – Annual report year: 2004
Assembly of Carbon Nanotubes on Microelectrodes by Nanomanipulation

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Molhave, K. (Intern), Mateiu, R. V. (Intern), Dimaki, M. (Intern), Hansen, T. M. (Intern), Madsen, D. N. (Intern), Bøggild, P. (Intern)
Publication date: 2002

Host publication information
Title of host publication: Proceedings of Nano-7/Ecoss-21
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 154319
Publication: Research - peer-review › Article in proceedings – Annual report year: 2002

Design of microfabricated biocompatible multi-electrode for single ion channel activity

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Dimaki, M. (Intern), Ruseng, H. (Intern), Fleron, R. (Intern), Boubour, E. (Intern), Bøggild, P. (Intern)
Publication date: 2002

Host publication information
Title of host publication: Proceedings of Nano-7/Ecoss-21 Malmö
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 61327
Publication: Research - peer-review › Article in proceedings – Annual report year: 2002

Projects:

Novel methods for detection of contaminants in the environment
Department of Micro- and Nanotechnology
Period: 01/09/2016 → 31/08/2019
Number of participants: 4
Phd Student:
Noori, Jafar Safaa (Intern)
Supervisor:
Dimaki, Maria (Intern)
Mortensen, John (Ekstern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Ansat eksternt
Project: PhD

Optical detection of Non-viable cells
Department of Micro- and Nanotechnology
Period: 15/11/2015 → 14/11/2018
Number of participants: 4
Phd Student:
Preus, Susan Ibi (Intern)
Supervisor:
Larsen, Niels Agersnap (Intern)
Svendsen, Winnie Edith (Intern)
Main Supervisor:
Dimaki, Maria (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Industrial PhD
Project: PhD

**Evolvable Smartphone-based Point-of-Care Systems for In-Vitro Diagnostics**
Department of Micro- and Nanotechnology
Period: 01/02/2013 → 02/11/2016
Number of participants: 7
Phd Student:
Patou, François (Intern)
Supervisor:
Dimaki, Maria (Intern)
Madsen, Jan (Intern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)
Examiner:
Pop, Paul (Intern)
Romano-Rodriguez, Albert (Ekstern)
Shah, Pranjul Jaykumar (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Marie Curie (EU-stipendium)

**Relations**
Publications:
Evolvable Smartphone-Based Point-of-Care Systems For In-Vitro Diagnostics
Project: PhD

**Micro Fluidic System for Tissue Culturing an Live Monitoring of Analytes**
Department of Micro- and Nanotechnology
Period: 01/10/2012 → 11/01/2017
Number of participants: 7
Phd Student:
Bakmand, Tanya (Intern)
Supervisor:
Svendsen, Winnie Edith (Intern)
Waagepeteren, Helle S. (Ekstern)
Main Supervisor:
Dimaki, Maria (Intern)
Examiner:
Keller, Stephan Sylvest (Intern)
Svenningsen, Åsa Fex (Ekstern)
Rodriguez-Trujillo, Romén (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)

**Relations**
Publications:
Micro fluidic System for Culturing and Monitoring of Neuronal Cells and Tissue
Project: PhD
Microfluidic integration of different nanowires and nanotubes for NanoBioFETs

Department of Micro- and Nanotechnology
Period: 01/04/2012 → 16/03/2016
Number of participants: 7
Phd Student:
Pfreundt, Andrea (Intern)
Supervisor:
Andresen, Lars (Intern)
Dimaki, Maria (Intern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)
Examiner:
Jakobsen, Mogens Havsteen (Intern)
Martinez, Karen (Ekstern)
Vellekoop, Michael Johannes (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Marie Curie (EU-stipendium)
Project: PhD

Novel Diagnostic methods and devices for personalised treatment of cancer

Department of Micro- and Nanotechnology
Period: 01/01/2012 → 18/09/2015
Number of participants: 6
Phd Student:
Zulfiqar, Azeem (Intern)
Supervisor:
Dimaki, Maria (Intern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)
Examiner:
Jensen, Flemming (Intern)
Kjelstrup-Hansen, Jakob (Intern)
Prinz, Christelle (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Marie Curie (EU-stipendium)
Project: PhD

Application of Microsystems and nanotechnology in the cytogenetic diagnosis of haematological malignancies

Department of Micro- and Nanotechnology
Period: 01/09/2010 → 11/12/2013
Number of participants: 7
Phd Student:
Kwasny, Dorota (Intern)
Supervisor:
Dimaki, Maria (Intern)
Tümer, Zeynep (Ekstern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)
Examiner:
Kutter, Jörg Peter (Intern)
Castillo, Jaime (Intern)
Merkoçi, Arben (Ekstern)
Designing a Polymeric Microfluidic Platform for Neuronal Cell Cultivation

Department of Micro- and Nanotechnology
Period: 15/07/2008 → 22/03/2012
Number of participants: 7
PhD Student:
Vedarethinam, Indumathi (Intern)
Supervisor:
Dimaki, Maria (Intern)
Heiskanen, Arto (Intern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)
Examiner:
Almdal, Kristoffer (Intern)
Gramsbergen, Jan Bert P. (Ekstern)
Mir, Kalim U. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

On-Chip Electrogenic Cell Handling and Analysis

Department of Micro- and Nanotechnology
Period: 01/11/2007 → 25/05/2011
Number of participants: 6
PhD Student:
Vazquez Rodriguez, Patricia (Intern)
Supervisor:
Dimaki, Maria (Intern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)
Examiner:
Jensen, Flemming (Ekstern)
Makohliso, Solomzi (Ekstern)
Prinz, Christelle (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Microfluidic System for Chromosome Analysis System

Department of Micro- and Nanotechnology
Period: 15/01/2007 → 24/08/2011
Number of participants: 7
PhD Student:
Shah, Pranjal Jaykumar (Intern)
Supervisor:
Dimaki, Maria (Intern)
Okkels, Fridolin (Intern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)
Examiner:
Almdal, Kristoffer (Intern)
Becker, Holger (Ekstern)
Geschke, Oliver (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

**Integrated sorting of chromosomes**
Department of Micro- and Nanotechnology
Period: 01/11/2006 → 16/06/2010
Number of participants: 6
Phd Student:
Clausen, Casper Hyttel (Intern)
Supervisor:
Dimaki, Maria (Intern)
Main Supervisor:
Svendsen, Winnie Edith (Intern)
Examiner:
Berg-Sørensen, Kirstine (Intern)
Allen, Stephanie (Ekstern)
Morgan, Hywel (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Eksternt finansieret virksomhed
Project: PhD

**Detection of single ion channel activity in neurons with multipoint probes**
Department of Micro- and Nanotechnology
Period: 01/10/2001 → 22/04/2005
Number of participants: 5
Phd Student:
Dimaki, Maria (Intern)
Main Supervisor:
Bøggild, Peter (Intern)
Examiner:
Christensen, Claus H. (Intern)
Morgan, Hywel (Ekstern)
Nygård, Jesper (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

**Activities:**

**Microfluidics Congress 2015**
Maria Dimaki (Participant)

Department of Micro- and Nanotechnology
Nano Bio Integrated Systems
**Description**
Poster presentation at Microfluidics Congress

**Related event**

**Microfluidics Congress 2015**
20/10/2015 → 21/10/2015
London, United Kingdom
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**4th International Workshop on Analytical Miniaturization and NANOtechnologies**
Period: 23 Jun 2014 → 24 Jun 2014
Maria Dimaki (Participant)
Department of Micro- and Nanotechnology
Nano Bio Integrated Systems

**Description**
Lab-on-a-chip system for virus detection in water, Poster

**Related event**

**4th International Workshop on Analytical Miniaturization and NANOtechnologies**
23/06/2014 → 24/06/2014
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Individual addressable 3D nanoelectrodes for neural metabolic studies, NanoToday, Singapore 2009**
Maria Dimaki (Speaker)
Department of Micro- and Nanotechnology
Biomedical Micro Systems Section
Nano-Bio Integrated Systems Group

**Description**
Place: Singapore

**Related external organisation**

**Unknown external organisation**
Activity: Talks and presentations › Conference presentations

**34th International Conference on Micro and Nano Engineering**
Period: 14 Sep 2008 → 18 Sep 2008
Maria Dimaki (Participant)
Biomedical Micro Systems Section
Nano-Bio Integrated Systems Group
Department of Micro- and Nanotechnology

**Description**
Talk about "Manipulation and Integration of Biological Nanofibers with Electronic Micro Structures for the Development of Biosensing Devices" presented at "34th International Conference on Micro and Nano Engineering"
Place: Athens, Greece
Degree of recognition: International

**Related event**

**34th International Conference on Micro and Nano Engineering**
14/09/2008 → 18/09/2008
Athens, Greece
Activity: Attending an event › Participating in or organising a conference

Talk about "Comsol Multiphysics Simulation of Microfluidic Systems for Biomedical Applications" presented at Comsol User Conference
Period: 1 Jan 2008 → …
Maria Dimaki (Speaker)
Department of Micro- and Nanotechnology
Biomedical Micro Systems Section
Nano-Bio Integrated Systems Group

Description
Place: Hannover, Germany

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations