Cambridge Healthtech Institute's

Mainstreaming Microfluidics

Diffusing Microfluidics Technology in the Marketplace

May 15-16, 2003 - World Trade Center - Boston, Massachusetts

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MAINSTREAMING MICROFLUIDICS immediately follows the Fourth Annual MACRORESULTS FOR MICROARRAYS conference and runs concurrently with the Third Annual GENOMIC AND PROTEOMIC SAMPLE PREPARATION conference.

Advisors and Chairs
Dr. Thomas Laurell, University of Lund
Dr. Albert van den Berg, University of Twente and MESA+ Research Institute
Dr. Bernhard H. Weigl, Micronics, Inc.
Dr. Achim Wixforth, University of Augsburg
Dr. Paul Yager, University of Washington
Preconference Short Course Tutorial: Microfluidics for Lab-on-a-Chip
Dr. Helene Andersson, Life Science Manager, Microfluidics and Biotechnology, Silex Microsystems, AB
Dr. Albert van den Berg, University of Twente and MESA+ Research Institute

All those who register for the Microfluidics for Lab-on-a-Chip tutorial are cordially invited to attend the Closing Plenary Session of Macroresults for Microarrays on Wednesday, May 14, at 1:30.

Microfluidics Chip Technology
Dr. Achim Wixforth, University of Augsburg
Dr. Andrew Gooley,Proteome Systems Ltd.
Dr. Tanya Kanigan, BioTrove, Inc.
Mr. Raymond Pierce, Epocal, Inc.
Dr. Nicolo Manaresi, Silicon Biosystems srl.
Mr. Mike Lucero, Fluidigm Corporation

Analysis at Microscale
Dr. Gerrit J. van den Engh, Institute for Systems Biology
Dr. Per Andersson, Gyros AB
Dr. Albert van den Berg, University of Twente; and MESA+ Research Institute
Dr. Carl Meinhart, University of California, Santa Barbara
Dr. Andreas Gerlach, Greiner Bio-One GmbH
Dr. Hugh McManus, Nanostream, Inc.
Dr. Paul Sweetnam, Surface Logix

Detection and Diagnostics
Dr. Paul Yager, University of Washington
Dr. Victoria VanderNoot, Sandia National Laboratories
Dr. Jeff T. Ives, Xtrana, Inc.
Dr. Helene Andersson, Royal Institute of Technology
Dr. Dieter Braun, Rockefeller University
Dr. Gary Schultz, Advion Biosciences, Inc.

Joint Session: Microfluidics Sample Preparation
Dr. Thomas Laurell, Professor, Department of Electrical Measurements, University of Lund
Dr. Mike McNeely, President and Chief Executive Officer, BioMicro Systems, Inc.
Dr. Dave Rakestraw, Co-Founder, Eksigent Technologies LLC
Dr. Bernhard H. Weigl, Micronics, Inc.

Wednesday, May 14

Preconference Short Course Tutorial

3:00-4:00pm Tutorial Registration

4:00-8:00pm Microfluidics for Lab-on-a-Chip
Dr. Helene Andersson, Life Science Manager, Microfluidics and Biotechnology, Silex Microsystems, ABDr. Albert van den Berg, University of Twente and MESA+ Research Institute
The use of microdevices made by advanced micromachining technologies makes it possible to handle very small quantities or very low flow rates of liquids and gases. This provides new opportunities in the medical instrumentation area, in the pharmaceutical industry, and in many other fields. By the end of the course, the attendees will know the present state of the art in Micro Fluidic Systems (MFS) and have an overview of the application areas. The course will also point out future developments of devices and applications. Special attention will be paid to the most important area of application, that of

bioanalytics or "Lab-on-a-Chip." Different approaches and examples of solutions for real-life problems will be discussed.

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6:00-7:00 Early Conference Registration and Exhibit and Poster Setup

Thursday, May 15

7:30am Registration and Light Continental Breakfast

Microfluidics Chip Technology

8:30 Chairperson's Opening Remarks
Dr. Achim Wixforth, Chair for Experimental Physics I, Institute of Physics, University of Augsburg

8:40 Flat Fluidics: Acoustically Driven Microfluidic Devices for Biological Applications
Dr. Achim Wixforth
For small sample volumes, surface effects represent the dominant forces in fluidic applications. We present a novel approach for liquid handling in the nanoliter regime, where the fluid is confined to virtual beakers and fluidic tracks being prepared directly on the flat surface of a chip. Actuation, mixing, and stirring of such small fluid volumes are achieved by surface acoustic waves propagating on the same substrate. We demonstrate applicability of our technology for biological assays ranging from FISH on a chip to microarray hybridization and SNP analyses.

9:10 CHIP (CHemical Inkjet Printing), an Automated Microfluidics System Bringing the Chemistry to the Protein
Dr. Andrew Gooley, Chief Scientific Officer, Proteome Systems Ltd.
CHIP (CHemical Inkjet Printing) technology is an automated microfluidics system that brings the chemistry to the protein. The fidelity of inkjet technology allows the biochemist to use noncontact microarray dispensing of most, if not all, biochemicals typically used in protein biochemistry. The advantages of the CHIP approach are that authentic proteins are arrayed onto membranes, essentially creating an archive of valuable samples. This enables multiple biochemical reactions to be dispensed over an extended time period.

9:40 Living Chip Technology
Dr. Tanya Kanigan, Director, Chip Technology, BioTrove, Inc.
The Living Chip is a novel nanotiter plate technology consisting of a precisely constructed, high-density array of through-holes in a plate. A combination of manual and robotic sample handling schemes is used to rapidly introduce and retrieve samples into and out of the chips. By aligning and stacking a second chip on top of the first one, mixing of reagents occurs between reagents in coaligned through-holes, thus simultaneously initiating tens of thousands of assays. Reactions are monitored in parallel by a variety of means including colorometric, fluorometric, or luminescent readout. We will present an overview of the technology and recent results from projects related to ultrahigh-throughput screening, storage of chemical drug libraries, genomics, and other applications.

10:10 Refreshment Break, Poster and Exhibit Viewing (Exhibit Hall will close from 11:00am-3:00pm)

10:45 Integrated Electrokinetic Circuit Arrays: Pushing the Envelope of On-Chip Reagent Integration
Mr. Raymond Pierce, Vice President, Biochip Development, Epocal, Inc.
Epocal's solid-state electrokinetic devices are dry hydrophilic matrices and reagents microfabricated as fluidic circuits enclosed within a water-vapor permeable membrane. The company is focused on integrating this enabling fluidic technology into various biochip assay formats. For example, the integration of on-chip, real-time pico-scale reagent injection will enable highly sensitive, quantitative, high-content assays for application in genomics, proteomics, drug development, and clinical diagnostics.

11:15 A Programmable Lab-on-a-Chip for Individual Cell-Biology
Dr. Nicolo Manaresi, Chief Executive Officer, Silicon Biosystems srl.
This presentation will introduce a programmable lab-on-a-chip for cell-biology applications. The sample microchamber (4µl) is delimited by a microelectronic chip and a conductive-glass lid spaced a few tens of microns apart. The chip surface encompasses a two-dimensional array of more than 100,000 20-x-20-µm-wide microsites, each consisting of a superficial electrode, an embedded impedance or optical sensor, and logic. Control of cells' position is based on dielectrophoresis (DEP), the motion of neutral particles in response to nonuniform electric fields. The electrodes induce closed DEP cages in the regions above selected microsites, where single cells or microbeads in liquid suspension may be individually trapped and levitated.

11:45 Enabling a Single Chip to Serve Many Functions through Multilayer Soft Lithography
Mr. Mike Lucero, Senior Vice President of Marketing, Fluidigm Corporation
Fluidigm Corporation has mastered fluidics at the microscale through miniature valves, pumps, and channels that act within a chip as fluidic circuitry. This microcircuitry is fabricated using a proprietary process called Multilayer Soft Lithography, MSL™, which enables a single chip to serve many functions. This versatility gives an unparalleled advantage in transforming microfluidics into integrated systems for protein crystallization. Protein structure studies, the province of the expert crystallographer, has up until now been too esoteric and expensive for routine use in drug discovery and development. MSL™ microfluidics overcomes these obstacles by automating mixing, pumping, and isolation of proteins and precipitating reagents. Protein sample requirements can be reduced to a few nanograms and mixed with 96 screening conditions, at three different concentrations simultaneously. We will discuss how to use MSL™ microfluidics to scale protein structure studies and to generate crystals with miniscule amounts of purified protein.

12:15 Lunch (on your own)

Analysis at Microscale

1:45 Chairperson's Remarks
Dr. Gerrit J. van den Engh, Professor, Institute for Systems Biology

1:50 Developing nL Scale Centrifugal Analyzer
Dr. Gunnar Thorsén, Scientist, Gyros AB
We have developed a nanoliter-scale, microfluidic technology based on the long-established, but little developed, centrifugal analyzer concept. Using a CD format we are able to benefit from working at microscale (saving sample, reagents, and time). Most importantly, we can incorporate new functionalities into the CD format, greatly increasing versatility. We will present results from immunoassays performed in parallel on 100 x 100 nL samples and an example of sample preparation prior to mass spectrometry analysis where 96 samples are concentrated, desalted, and crystallized in parallel.

2:20 Micro- and Nanofluidics for Labs-on-a-Chip
Dr. Albert van den Berg, Professor, Miniaturized Chemical Analysis Systems, University of Twente; and MESA+ Research Institute
Silicon and glass still offer certain advantages for realization of Lab-on-a-Chip devices and systems. An integrated microsystem for ammonia analysis integrated in silicon will be presented, as well as a hydrodynamic chromatography chip for polymer separation. In the area of medical diagm\nostics a capillary electrophoresis chip for measurement of lithium in whole blood is shown, and some new technologies for picoliter dispensing and fabrication of nanometer channels will be discussed. An outlook for future focus on cell analysis using silicon nanoneedles is shown.

2:50 Cell-Sorting Technology for High-Throughput Sample Analysis in Combination with Single Cell Selection Techniques with Carrier Tapes for High-Throughput Process and Evaluation
Dr. Gerrit J. van den Engh
Biological discovery experiments often require that investigators wade through very large numbers of mutants to find a few desirable clones. To speed up this process we are exploring the use of cell sorting onto conveyer tapes that contain a large number of sample wells. Tapes filled with single cells are easily processed in automated machines. We have built a clone selection/PCR amplification process capable of generating 25,000 clones per day. This technology is used in a range of applications varying from genome sequencing and the discovery of regulatory sequences to the analysis of marine microorganisms.

3:20 Refreshment Break, Poster and Exhibit Viewing

4:00 Analysis of Microscale Transport for BioMEMS
Dr. Carl Meinhart, Associate Professor, Department of Mechanical & Environmental Engineering, University of California, Santa Barbara
A fully integrated tunable laser cavity sensor for optical immunoassays is presented. This device incorporates a pair of Distributed Bragg Reflector (DBR) lasers to sense- specific antigen/antibody binding events that occur in the evanescent field of the laser cavity. The binding event modifies the modal index of the laser through coupling of the evanescent field. The modal index can be detected theoretically to within a resolution of n ~ 10-7. Dielectrophoresis (DEP) and the electrothermal effect are proposed as methods for manipulating the antigen concentration fields, thereby enhancing the sensitivity of the device. Micron-resolution Particle Image Velocimetry (micro-PIV) is demonstrated by measuring the flow field in a 30-x-300-micron channel.

By overlapping the interrogation spots by 50%, a velocity-vector spacing of 450 nm is achieved. Surprisingly, the velocity measurements indicate that the well-accepted no-slip boundary condition may not be valid for hydrophobic/hydrophilic boundaries at the microscale. These results represent the first direct experimental measurement of this phenomenon. In addition, flow fields resulting from electrothermally induced motion in microfluidic devices are measured using micro-PIV.

4:30 Plastic Microfluidic Platforms for High-Throughput Applications
Dr. Andreas Gerlach, Project Leader, Microsystem Technology Group, Microfluidic Devices, Greiner Bio-One GmbH
For high-throughput applications, i.e., in drug discovery, plastic microfluidic platforms in the standardized microplate footprint have been developed. Experiments in microfluidic structures were performed with different modified plastic materials to validate the suitability for capillary electrophoresis and enzymatic assays. Experimental results with microplates containing 96 and 384 identically microfluidic structures will be presented. In addition, we will demonstrate nanoliter liquid handling with a new developed plastic 384-fold microfluidic dispensing well plate.

5:00 A Microfluidics Approach to High-Throughput Liquid Chromatography
Dr. Hugh McManus, Vice President, Nanostream, Inc.
This talk will focus on some novel microfluidic technologies aimed at increasing R&D productivity during lead optimization. It will also address the development of two devices of critical importance in drug discovery. The first is a serial dilution chip, which has streamlined routine activities such as the development of IC-50 curves, and results of enzyme and cell-based assays will be presented. The second device is a separations chip, which has 24 chromatographic columns (C-18) coupled to UV/mass spectrometric detection. An application in compound library screening will also be presented.

5:30 Bridging the Widening Gap between Early Drug Discovery and Classical in vivo Pharmacology
Dr. Paul Sweetnam, Chief Scientific Officer, Surface Logix
Today micro- and nanotechnologies target bottlenecks associated with the early stages of drug discovery process, i.e., genomics, proteomics, and chemogenomics. In contrast, Surface Logix is applying soft lithographic microfabrication, surface chemistry, and human cell biology to create high-content in vitro models for drug discovery and development. Using inflammation as an example, we will illustrate our rapid and reliable approach to obtaining a wide range of disease related data, data that are often difficult or impossible to obtain using traditional drug discovery tools. Surface Logix is focused on bridging the widening gap between early drug discovery and classical in vivo pharmacology, resulting in more successful prosecution of preclinical and clinical candidates.

6:00 Joint Networking Reception in Exhibit Hall

7:00 Close of Day One