Conference Scene

NanoBioTech Montreux 2009

The 13th Annual European Conference on Micro & Nanoscale Technologies for the Biosciences
Montreux, Switzerland, 16–18 November 2009.

The 13th Annual European Conference on Micro & Nanoscale Technologies for the Biosciences (NanoBioTech) was held on the picturesque shores of Lake Geneva in Montreux, Switzerland from 16–18th November, 2009. The Eden Palace au Lac Hotel, with its stunning views of the Alps across the Lake, once again provided an exquisite venue. The NanoBioTech conference focuses on the biological, chemical and medical applications of nano- and micro-technologies, with topics ranging from the development of nanomaterials for cell and tissue engineering to the use of integrated microfluidic systems for single biomolecule analysis. With over 130 delegates from more than 25 countries worldwide, NanoBioTech 2009 provided a diverse and invigorating forum for discussion.

The format for NanoBioTech 2009 included oral presentations by invited speakers and poster 'snapshot' sessions, in which presenters were given 2 min to entice delegates to their posters during the open sessions. Similar short presentations were also given by exhibitors such as Nanoscribe, Microfluidics and BioAlps.

Professor Hywel Morgan (University of Southampton, UK), the Conference Chair, opened the meeting and welcomed Professor Mehmet Toner (Harvard Medical School, MA, USA) to give the first keynote lecture. His presentation gave an overview of the use of microscale technologies for exploring cellular systems, followed by examples of their clinical application in areas such as cancer and HIV/AIDS research. Circulating tumor cells in the blood – 90% of which originate from epithelial tissue – can be captured by antibody-coated micropillars on a fluidic device the size of a business card. While these tumor cells account for only ten in every 10 billion blood cells, their capture and enumeration can lead to the early detection and diagnosis of many cancer types. CD4⁺ T lymphocytes can also be counted using this technique, providing a cost-effective method of monitoring the progression of HIV/AIDS. Recent advances in the technology have led to more accurate cell counts through a reduction of contaminating CD4⁺ monocytes by the incorporation of a monocyte-depletion stage into the microfluidic device.

In the following sessions Johan Elf (Uppsala University, Sweden) reported how his group have directly observed

interactions between transcription factors and their DNA binding sites in *Escherichia coli* cells using single-molecule fluorescence microscopy techniques. Transcription factors regulate gene expression, however, the *in vivo* kinetics are usually only studied indirectly via mRNA or protein expression. By labeling the transcription factor with a fluorescent tag they can study the molecule's search for the specific binding site as it diffuses along the DNA segment. This has highlighted a new role for DNA looping, which allows the transcription factors to bypass certain DNA-bound proteins that block their path, thus speeding up the search process. Thomas Laurell (Lund University, Sweden) presented his work on the use of acoustophoresis to control cell or particle suspensions in a microfluidic device. The technique is based on the principle that particles can be focused by 1–20 MHz ultrasonic waves in a size-dependent manner, hence, separation of mixed particle or cell suspensions can be achieved. This concept has been applied to the separation of contaminating lipid particles from blood during bypass surgery, which could otherwise lead to microemboli in the brain.

Exhibitors from Nanoscribe GmbH and Trimaco Systeme GmbH followed the invited speakers. Nanoscribe presented their 3D laser lithography system for the fabrication of micro- and nano-structures. With the ability to achieve 100 nm resolutions in a variety of materials, applications include photonics, microfluidics and the life sciences. Trimaco Systeme presented

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the Microfluidizer from Microfluidics, Inc., a high shear processor used for a wide range of applications, such as cell disruption for protein recovery, reduction of particles to nano sizes and encapsulation of particles using nanoemulsions for drug-delivery purposes.

The second day opened with a keynote lecture from Professor David Beebe (University of Wisconsin, MI, USA) on the development of microscale environments for research into cancer biology. He reviewed how microfluidics can provide new insights into cancer research by linking *in vitro* to *in vivo* models, extending the use of rare samples and adding functionality such as co-culture and 3D capability. His group have developed a simple passive pumping approach to microfluidics based on the principle that when liquid drops of different sizes are connected via a fluid-filled tube, differences in droplet surface tensions induce a flow along the tube. Using this technique they created a 3D compartmentalized model of the transition from ductal carcinoma *in situ* to invasive ductal carcinoma, the most common form of breast cancer. Epithelial cells are co-cultured with fibroblasts within the microfluidic interface and become invasive after several days of culture. This allows the group to study cell signaling during the transition process in a system that mimics the *in vivo* environment.

In later sessions, Severine Le Gac (University of Twente, The Netherlands) presented work on the use of microfabrication techniques in tissue engineering. A range of micrometer-sized tissue building blocks are fabricated by seeding cells in microwell chip arrays and are then assembled into larger structures of various shapes. The formation of capillaries was studied by the co-culture of endothelial and mesenchymal stem cells. Building blocks of a triangular geometry demonstrated the best tissue compaction, with capillary formation and stress fiber density greatest in the corners of the structures, highlighting the importance of the latter during vasculogenesis. Stefan Hell (Max Planck Institute, Germany) discussed recent improvements in optical microscopy or 'nanoscopy'. Physical laws that limit the resolution of far-field optical microscopy to approximately 200 nm can effectively be

broken by the use of stimulated emission depletion. An excitation beam is superimposed by another doughnut-shaped beam of a longer wavelength that de-excites molecules at the periphery of the focal spot, thus increasing its resolution. With intensities in the order of 2 GW cm^{-2} , resolutions of several angstroms can be achieved. At lower intensities, resolution can still be increased by quenching the excited molecule via appropriate transitions into a nonfluorescent triplet state.

The speakers were followed by a presentation from BioAlps by Life Science representatives for Western Switzerland, elaborating on their mission to promote further excellence in biotech developments on a regional and international level. BioAlps offers members from academic, industrial, financial and political backgrounds the opportunity to interact with one another and share in these goals, for example by providing sponsorship for the NanoBioTech conference (see website [101] for details of other sponsors).

On the final day, Jochen Guck (University of Cambridge, UK) gave a keynote lecture on his work with the 'optical stretcher', a dual-beam laser tool that can trap and deform cells within a microfluidic environment. Guck showed how the deformability of a cell is linked to the complexity of the cytoskeleton, which in turn depends on pathophysiological changes within the cell. For example, cancerous cells having less cytoskeleton are more easily deformed by the optical stretcher, providing a possible method for diagnosing cancers for which no external markers are currently available, such as oral cancers. Taxol is a chemotherapy drug that affects the stability of microtubules in the cytoskeleton and hence interferes with cancer cell division. The group observed that cells treated with taxol were less able to deform, therefore making it harder for them to migrate into the bloodstream and metastasize into other tissues. In another study, differences in the mechanical properties of embryonic cells were linked to their ability to differentiate, thus presenting a technique for sorting stem cells from heterogeneous populations.

Bruno Teste (PECSA Paris, France) discussed the use of magnetic core shell nanoparticles (MCSNP) for immunoassays.

Current techniques for antibody detection require long processing times and do not model *in vivo* interactions well. By contrast, the MCSNP system involves the diffusion of both antibody and antigen partners within a microfluidic device, allowing a 200-fold increase in capture rate over methods such as ELISA. The nanoparticles contain a maghemite core encapsulated in a silica shell, to which the antigen is grafted. Chaotic mixing with the liquid phase sample inside the device ensures binding of any antibodies present. The MCSNP are then trapped inside a magnetic chamber and their antibody content quantified by fluorescence techniques. The aim is to apply the system to the fast and low-cost diagnosis of milk allergy.

Poster prizes were awarded to three young scientists for their outstanding contributions to the poster sessions. H Menne (ISAS Dortmund, Germany) received the Biocartis award for her poster entitled 'A micropatterning approach for the massively parallel production of uniform tumor spheroids'. The BioAlps award was presented to Songyue Chen (MESA+, The Netherlands) for his poster on 'Top-down fabricated single crystal silicon nanowires for biosensing'. S Schrittwieser (AIT Vienna, Austria) was given the Royal Society of Chemistry, Lab on Chip Award for his work on 'Development of a biosensor based on optical relaxation measurements of hybrid nanoparticles'.

The conference drew to a close with a final keynote lecture from Professor Andreas Manz (University of Freiburg, Germany). His presentation reviewed

how microfluidic chips have excelled in the field of analytical chemistry, scaling laws dictating an increased efficiency for smaller volumes, allowing laboratory processes that previously took hours to be completed in minutes or seconds. Manz also posed some interesting theories about how knowledge gained by human civilization to date might be propagated into the future by the use of silicon microchips. He hypothesized that information about our daily lives, cultural beliefs and even our DNA sequencing could be etched deep into the chip and remain there for millions of years for future generations to find! In closing, he invited delegates to remain focused on what the foreseeable future might hold in terms of new micro- and nano-technologies and their application to the biosciences, which will surely increase the quality of our lives in years to come.

Financial & competing interests disclosure

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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