BP 42: Biotechnology and bioengineering

Time: Friday 9:30–12:00 Location: HÜL 386

BP 42.1 Fri 9:30 HÜL 386

Massively parallel computation with self-propelled biological agents in nanofabricated networks — •Till Korten[1], Dan V. Nicolau Jr.[2], Mercy Lard[3], Falco van Delft[4], Malin Persson[5], Elina Bengtsson[5], Alf Månsson[5], Stefan Diez[1], Heiner Linke[2], and Dan V. Nicolau[6] — [1]B CUBE - Center for Molecular Bioengineering, TU Dresden, Dresden, Germany — [2]University of California, Berkeley, USA — [3]Lund University, Lund, Sweden — [4]Philips Research, Eindhoven, The Netherlands — [5]Linnaeus University, Kalmar, Sweden — [6]McGill University, Montreal, Canada

Combinatorial optimization problems are important for network routing, protein folding, and decrypting encoded messages. Solving such a problem often requires computation of all possible combinations of the elements in a problem set. However, the number of combinations - and thus the number of calculation operations - grows exponentially with the number of elements. Because they work sequentially, conventional computers are quickly overwhelmed with solving even relatively small problem sets of this type. We demonstrate a new parallel and scalable computation approach by encoding the NP-complete subset-sum problem in a physical network of lithographically defined nanochannels. The network, and thereby solution space, is explored in a massively parallel fashion by a large population of cytoskeletal filaments powered by molecular motors. All possible subset sums are recovered from the final positions of the filaments. The method is scalable, energy efficient, and may be used to augment conventional computing devices for solving combinatorial optimization problems.

BP 42.2 Fri 9:45 HÜL 386

A droplet based microfluidic device for single paramecia cell trapping and viability measurements — •Rico Illing[1], Daniel Pfitzner[2], Corinna Burkart[2], Dirk Jungmann[2], Larysa Baraban[1], and Gianaurelio Cuniberti[1,3] — [1]Institute for Materials Science, Max Bergmann Center of Biomaterials Center for Advancing Electronics Dresden, Technische Universität Dresden, 01062 Dresden, (Germany) — [2]Technische Universitaet Dresden Faculty of Environmental Sciences Institute of Hydrobiology — [3]Center for Advancing Electronics Dresden, 01062 Dresden, (Germany)

Digital microfluidics, enabling entrapping of living cells inside of the emulsion droplets, is an attractive platform for rapid single-cell analysis. Here we present a simple way for encapsulating and observing the viability and growth kinetics of single paramecia cells in droplets (approx. 200 nL). The aim of the work is to measure the viability of single cells within hundreds of microreactors, exposed to different silver nitrate concentrations. Hundreds of droplets were created which were containing paramecia cells, culture media, viability indicator resazurin and silver nitrate. Detection of the cells activity was done by measuring the fluorescence intensity of the viability indicator, added to each droplet. To be flexible with different viability indicators, the spectrum of every single droplet was measured in less than one minute. With the help of the spectra counting and labelling of the droplet was also achieved. Finally, our detection platform enabled precise determination of a number of encapsulated cells per droplet relying only on metabolic activity of the paramecia cell.

BP 42.3 Fri 10:00 HÜL 386

Aerographite for biomedical applications — •Constanze Lamprecht[1], Carsten Grabosch[1], Arnim Schuchardt[1], Ingo Paulowicz[1], Matthias Mecklenburg[2], Karl Schulte[2], Rainer Adelung[1], and Christine Selhuber-Unkel[1] — [1]Institute for Materials Science, University of Kiel, Kiel, Germany — [2]Istitute of Polymers and Composites, Hamburg University of Technology, Hamburg, Germany

Aerographite is a novel carbon based material that exists as a seamless 3D network of interconnected nano- and microtubes. The material exhibits outstanding physical properties such as ultra-lightweight, excellent electrical conductivity, and mechanical robustness, which are shared by the related material of carbon nanotubes (CNTs). CNTs have found a multitude of possible applications in a variety of disciplines including biomedical and tissue engineering. Notably CNT substrates have been shown to promote cell attachment, growth, and differentiation. However, the natural scaffold of tissues, the extracellular matrix, is a 3D structure with nano- and microscale features such as interconnecting pores, ridges, and fibers. While these requirements pose a difficult challenge for CNT composites, Aerographite (AG) might present new bioengineering possibilities, as it naturally provides a stable porous 3D scaffold that offers accessibility and penetrability of surfaces. AG can be synthesized as a macroscopic self supportive 3D scaffold in a variety of micro- and nano-architectures tailored by the growth conditions. This structural flexibility may prove as competitive advantage of AG for biomedical applications.

BP 42.4 Fri 10:15 HÜL 386

Two-photon composition and modification of a PEG-based hydrogel — •Christiane Jungnickel[1], Mikhail Tsurkan[2], Carsten Werner[2], and Michael Schlierf[1] — [1]B CUBE - Center for Molecular Bioengineering, Dresden, Germany — [2]IPF - Leibniz-Institut für Polymerforschung Dresden e.V, Dresden, Germany

Hydrogels are used on an everyday basis in a lot of different fields like contact lenses [1], biomimetic scaffolding [2] and drug delivery [3]. Hydrogels are becoming increasingly popular in biological and medical sciences because of their broad application possibilities for tissue engineering.

Here, we present a novel approach to build up a hydrogel with nanometer precision in 3D around a living cell via two-photon reaction [4]. In comparison to previous approaches, the polymer based hydrogel does not require photoinitiators for its reaction. The two-photon process allows a high spatial and temporal control and enables furthmore a precise surface or volume structuring with a broad selection of functionalized biomolecules. Therefore it is now possible to trap cells in a hydrogel cage, manipulate and release them afterwards.

[1] O. Wichterle et al., Nature 185, 117 (1960)
[2] P.B. Welzel et al., Polymers 3, 602 (2011)
[3] T. Nermonden et al., Chem. Rev. 112, 2853 (2012)
[4] M.Pawlicki et al., Angew. Chem. Int. Ed. 48, 3244 (2009)

BP 42.5 Fri 10:30 HÜL 386

A versatile 3D tubular platform for single cell analysis and study — •Wang Xi[1,2], Samuel Sanchez[1,2], Christine K. Schmidt[3], David H. Gracias[4], Richard Butler[3], Rafael E. Carazo-Salas[3], Stephen P. Jackson[3,5], and Oliver G. Schmidt[1,6,7] — [1]Institute for Integrative Nanosciences, IFW Dresden, Dresden, Germany — [2]Max Planck Institute for Intelligent Systems, Stuttgart, Germany — [3]The Gurdon Institute, Cambridge, UK — [4]Johns Hopkins University, Baltimore, US — [5]The Wellcome Trust Sanger Institute, Cambridge, UK — [6]Material Systems for Nanoelectronics, Chemnitz University of Technology, Chemnitz, Germany — [7]Center for Advancing Electronics Dresden, Dresden University of Technology, Dresden, Germany

We use micropatterning and strain engineering to encapsulate single live mammalian cells into 3D rolled-up transparent nanomembrane architectures suitable for the scrutiny of cellular dynamics within confined 3D-microenvironments with high- and super-resolution microscopy. We show that during cell division in non-transformed RPE1 cells and transformed HeLa cancer cells the extent of spatial confinement correlates strikingly with chromosome missegregation, delayed mitotic progression, cortex bipolarisation and membrane blebbing, highlighting both conserved and novel phenomena compared to the effects previously reported in 2D cultured mammalian cells. Collectively, this novel approach represents a multifunctional device which enables the detection and scrutinization of single cell inside the 3D space of cavity of microtubes which would capture more of the complexity present in tissue scaffold.

15 min. break

BP 42.6 Fri 11:00 HÜL 386

Heart-on-a-chip - Design, Fabrication, and Characterization of a Microphysiological Platform for Drug Screening in Cardiac Tissue — •Peter Loskill[1], Anurag Mathur[1], Zhen Ma[1], Micaela Finnegan[1], Natalie C. Marks[1], SoonGweon Hong[1], Bruce R. Conklin[2], Luke P. Lee[1], and Kevin E. Healy[1] — [1]Department of Bioengineering, UC Berkeley, Berkeley, United States — [2]Gladstone Institute of Cardiovascular Disease, San Francisco, United States

Drug discovery and development to date has relied on animal models, which are useful, but fail to resemble human physiology. The discov-

ery of human induced pluripotent stem (iPS) cells has led to the emergence of a new paradigm of drug screening using human disease-specific organ-like cultures in a dish. One promising approach to produce these organ-like structures is the use of microfluidic devices, which can simulate 3D tissue structure and function with microphysiological features. Using microfabrication techniques we have developed a 3D microphysiological platform that mimics human cardiac tissue and is amenable to drug screening. The microfluidic 3D culture platform consists of three functional components: endothelial like barriers that are 2 μm wide; 30 μm wide capillary like media channels; and 100-200 μm wide cell culture channels. The platform is able to create a functional cardiac microtissue with physiological beat rates (60-80 beats/min) and with viability for multiple weeks. Assessing the physiological response to various cardiac drugs validated function of the cardiac microtissue. The microphysiological platform is extremely versatile and can be used for drug toxicity screening and therapeutic applications.

BP 42.7 Fri 11:15 HÜL 386

Biocompatibility of $Fe_{70}Pd_{30}$ ferromagnetic shape memory films for cell sensing — •Mareike Zink[1], Uta Allenstein[1], Yanhong Ma[2], Florian Szillat[2], and Stefan G. Mayr[2,3] — [1]Division of Soft Matter Physics, Institute for Experimental Physics I, Universität Leipzig, Germany — [2]Leibniz-Institut für Oberflächenmodifizierung (IOM) e.V., Leipzig — [3]Translationszentrum für Regenerative Medizin and Fakultät für Physik und Geowissenschaften, Universität Leipzig, Germany

Ferromagnetic shape memory alloys (FSMAs) have received great attention recently as an exciting class of smart functional materials. In comparison to conventional shape memory alloys, FSMA bear the significant potential for miniaturized devices for single cell actuation which is capable of yielding magnetically controllable shear strains and/or volume dilations of several percent. However, biocompatibility of this material remains to be confirmed. Our in vitro assessments show that various cell types adhere and proliferate well on Fe-Pd. Since adhesion and spreading is mediated by the interaction of the amino acid sequence RGD which binds to integrin receptors on the cell surface, we further compared the interaction of RGD molecules with Fe-Pd by ab initio simulation, delamination and cell tests. We could demonstrate that the adhesion force of RGD with Fe-Pd is larger compared to the binding strength of RGD with integrin receptors - a prerequisite for good bioactivity of the surface.

BP 42.8 Fri 11:30 HÜL 386

Label free biomolecular interaction studies with imaging ellipsometry * an Overview. — •Peter H. Thiesen — Accurion GmbH, Göttingen, Germany

Interactions between biomolecules play a central roles in every life process. Surface plasmon resonance (SPR) in Kretschmann configuration is state of the art in bio molecular interaction analysis, but a number of papers in literature show that the high lateral resolution, the capability of mapping and ellipsometric contrast micrographs performed by Imaging SPR in the ellipsometric mode or imaging surface plasmon resonance enhanced ellipsometry (i-SPREE) is promising for the development of new options in detection and screening of biomolecular interaction. Valiokas et al. [1] characterized differential protein assemblies on micro patterned surfaces with nitriletriacetic acid based surface functionalization. Klenkar et al. [2] used the technique to follow the addressable adsorption of lipid vesicles and subsequent protein interaction studies and to detect Narcotics trace detection [3]. Schuy et al. report a mimetic approach to the active drug target for fusion inhibitors of HIV (human immunodeficiency virus) and SIV (simian immunodeficiency virus) [4]. Beside reviewing, new applications in the field of protein adsorption, protein/protein and single strain DNA interaction, the capability of imaging ellipsometry in QC of arrays and also basic surface coating will be addressed. [1] Valiokas et al., ChemBioChem 7, 1325 (2006) [2] Klenkar et al., Biointerphases 3, 29(2008) [3] Klenkar et al., Anal Bioanal Chem 391, 1679(2008) [4] Schuy et al., Journal of Structural Biology 168, 125 (2009)

BP 42.9 Fri 11:45 HÜL 386

Tiny nanodiamonds as potential DNA detectors — •Ganesh Sivaraman and Maria Fyta — Institute for Computational Physics. University of Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

Diamondoids are tiny hydrogen-terminated diamond clusters with a variety of doping and functionalization possibilities. These nanostructures can show strong quantum confinement effects and are potential candidates as nanoscale biosensors. Along these lines, we investigate the possibility of chemically modified diamondoids to detect biomolecules, such as DNA. Quantum mechanical calculations are performed to study the specific interactions of diamondoids with DNA units and reveal the bonding characteristics and distinguishable electronic properties of diamondoid-DNA complexes. At a second step, we perform electronic transport measurements along a DNA placed between two diamondoid-functionalized surfaces in order to reveal whether the diamondoid can enhance the electronic signal differences arising from different DNA units. In the end, we discuss the relevance of our results in view of biosensing applications and specifically nanopore sequencing of DNA.