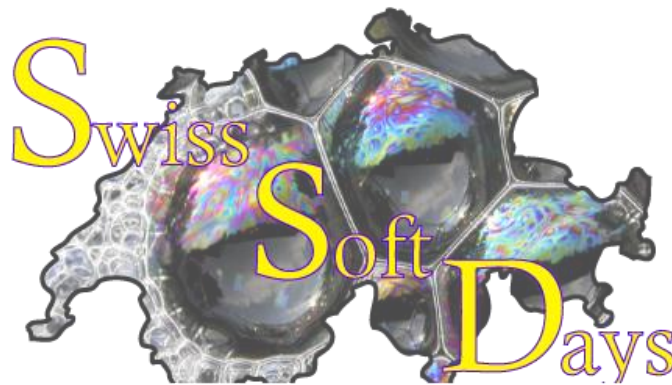


SWISS SOFT DAYS 7TH

EPFL, LAUSANNE

13/2/2012



LOCAL ORGANIZERS:

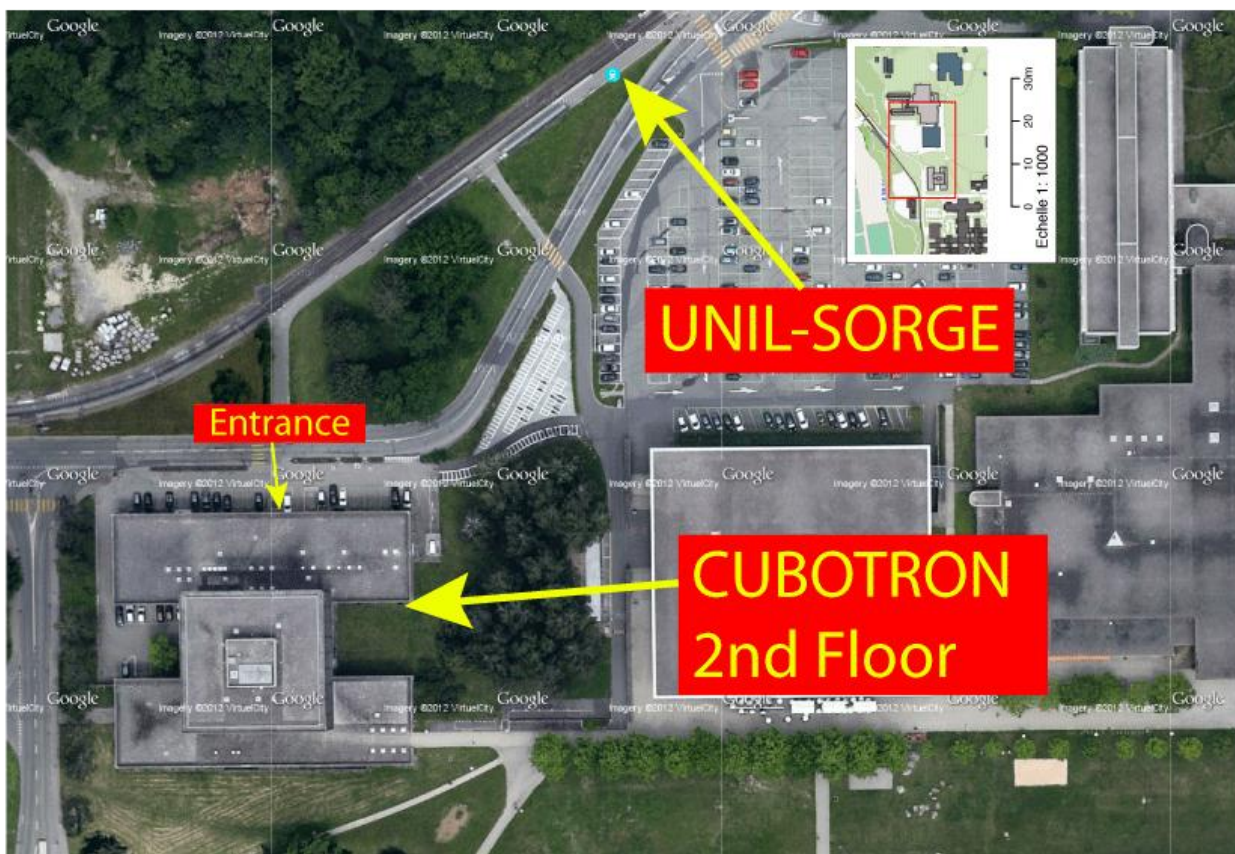
Giuseppe Foffi
Sylvia Jeney
Suliana Manley



ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

DIRECTIONS FOR SSD7 FROM LAUSANNE STATION

- Take the metro M2 (in front of the main entrance of the station) in the direction *Croisettes* (going up)
- Get off at Lausanne-Flon (one stop)
- Take the metro M1 (it is upstairs with respect to M2) . This is the terminus and you can go in only one direction (Renens-Gare)
- Get off at UNIL-Sorge
- In front of the Metro stop you will find the Cupotron (see map)
- SSD7 will take place at the 2nd Floor in the room BSP 231. We will set up signs.



10.00-10.05	Welcome	
Theme 1: Materials & Assemblies		
10.05-10.45	Langevin (U d'Orsay)	Physical Chemistry of Foams
10.45-11.00	I.Ziemecka (U Delft)	All-aqueous single and double emulsions by microfluidics
11.00-11.15	Gour (U Geneva)	Self-Assembling Peptide-Nucleotide Hybrids
11.15-11.30	Vallooran (ETHZ)	Macroscopic Alignment of Lyotropic Liquid Crystals Using Magnetic Nanoparticles
Theme 2: Methods		
11.30-11.45	Isa (ETHZ)	Unravelling adsorption and alignment of amyloid fibrils at interfaces by probe particle tracking
11.45-12.00	Croccolo (U Fribourg)	CUDA/C++ implementation of the Differential Dynamic algorithm
12.00-13.30	Lunch/Posters/Discussion	
Theme 2: Colloids & Polymers		
13.30-14.00	Felderhof (RWTH Aachen)	Brownian motion and hydrodynamics near a wall
14.00-14.15	Farage (U Fribourg)	Three-dimensional flow of colloidal glasses
14.15-14.30	Zahn (ETHZ)	Redox-active polyelectrolyte multilayers: all about ion-exchange and entropy of water
14.30-14.45	Nigro (EPFL)	Tunneling conductivity in composites of attractive colloids
14.45-15.00	Kowal (U Basel)	Solid-supported planar polymer membranes
15.00-15.15	Griffete (U Fribourg)	Synthesis of polymer-coated magnetic nanoparticles using the diazonium salt chemistry
15.15-16.00	Coffee/Posters/Discussion	
Theme 3: Biophysics		
16.00-16.15	Assenza (EPFL)	A simple model for amyloid fibrils twisting structure
16.15-16.30	Benke (EPFL)	Direct live-cell super-resolution imaging of cellular DNA
16.30-16.45	Ambühl (EPFL)	Exploring the cell lamellipodium dynamics using image segmentation
16.45-17.00	Langowska (U Basel)	<i>In situ</i> synthesis of antibiotics inside nanoreactors
17.00-17.15	Cremmel (ETHZ)	Orthogonal particle-height and density gradient for biomedical applications

Abstracts Talks

Theme 1: Materials & Assembly 10.05 – 11.30

Physical chemistry of Foams

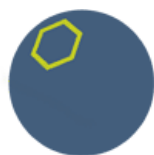
Dominique Langevin

Laboratoire de Physique des Solides, Université d'Orsay

Foams are dispersions of bubbles in liquids (or solids). We will discuss the case of aqueous foams, usually stabilized by surfactants. Among applications, let us mention : detergency, food industry, petroleum industry (injection of foams for oil recovery). Foams are also used to obtain insulation materials (glass and polymer foams), and for car industry (metallic foams).

Despite the large amount of work devoted to the understanding of foaming and foam stability, many questions still remain unclear. Improving this knowledge is very important for the understanding and improvement of different technological processes. We will describe the different destabilisation mechanisms : gravity drainage, coarsening (gas diffusion from small to large bubbles) and coalescence. We will discuss the relevance of the surface viscoelasticity concept in the case of foams stabilised by surfactants and proteins. We will also discuss the case of particles (micro and nano) which can be also used as stabilisers and are extremely efficient (as in Pickering emulsions).

This key-note lecture has been sponsored by the NCCR on Chemical Biology



SWISS NATIONAL CENTRE OF COMPETENCE IN RESEARCH
CHEMICAL BIOLOGY
VISUALISATION AND CONTROL
OF BIOLOGICAL PROCESSES USING CHEMISTRY

All-aqueous single and double emulsions by microfluidics

I.Ziemecka¹, V.van Steijn¹, G.J.M..Koper¹, M.T. Kreutzer¹, J.van Esch¹

¹ Delft University of Technology, Department of Chemical Engineering, Delft, The Netherlands

INTRODUCTION: Aqueous two-phase systems (ATPS) are a biocompatible soft-matter in which all constituent phases share water as the common solvent but differ in their dissolved components. Because of the very low interfacial tension, these systems are attractive for partitioning and separation of biomolecules as ATPS provide the mild conditions that do not denature or destabilize these biomaterials. This low interfacial tension, however, prevents the facile formation of droplets. To overcome this problem, we developed a method to form monodisperse microspheres in a surfactant-free, organic-solvent free, all-aqueous environment. We show how to use it to form hydrogel microspheres as well as to produce droplets with internal structure (core-shell).

METHODS: Microfluidic devices such as the one shown in Fig. 1 were used to produce single and double emulsions. We used the well-known ATPS composed of dextran and polyethylene glycol (PEG). Streams

were injected into the device through separate inlets. Key to the method is the forcing we apply to one of the streams. Without this forcing, the immiscible streams flow in parallel without the formation of drops. Actuation of a piezo electric bending disc embedded in our devices (Fig. 1) induces perturbations, which leads to the periodic formation of monodisperse water-in-water droplets. After formation, these droplets were polymerized to yield microspheres. We also present an extension of this method to produce droplets with an internal structure.

RESULTS: We were able to form monodisperse hydrogel microspheres from water-in-water droplets. Drop formation was forced by destabilizing the interface between dextran and PEG using low frequency mechanical oscillations

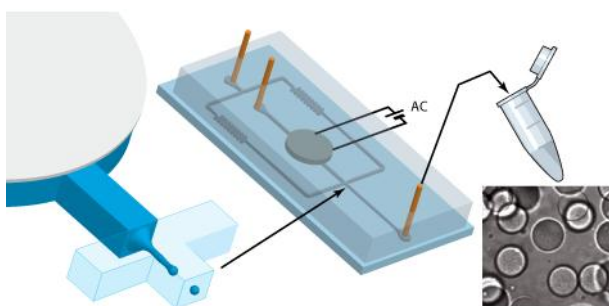


Fig. 1: Monodisperse hydrogel microspheres produced by forced jet breakup in ATPS.

(20-50Hz) induced by the piezo electric bending disc. The diameter of the droplets could be easily controlled in the range between 30 to 60 μ m using the flow rates as well as the frequency of the AC voltage used to actuate the piezo disc. Subsequent on-chip polymerization of the droplets yielded stable hydrogel particles. [1]

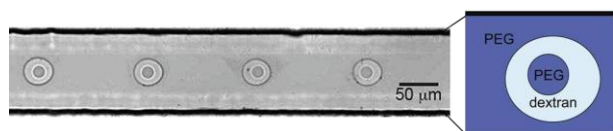


Fig. 2: All-aqueous core-shell emulsion droplets flowing through a microfluidic channel

We used a similar approach to also create droplets-inside-droplets (double emulsions). This is achieved by encapsulating a mixture of PEG and dextran inside droplets that are carried in a solution of PEG. Phase separation inside the droplets readily occurs and yields core-shell droplets as shown in Fig. 2. Also here, the frequency together with the flow rates can be used to tune the diameter of the core and the thickness of the shell. [2]

DISCUSSION & CONCLUSIONS: We have demonstrated the continuous generation of single and double emulsion microdroplets using aqueous polymer solutions. Our methods allow the efficient encapsulation of biomaterial in a biofriendly environment, free of organic solvents. This work forms an excellent and versatile starting point for the fabrication of stable all-aqueous microstructured systems, for instance by on-line crosslinking of the shell of the double emulsion droplets. Without a physical barrier in the form of a lipid bilayer, we foresee that the core-shell structures offer the potential to impact on synthetic cell studies, as biomaterial can readily transfer from the core to the surroundings in these all-aqueous structured fluids. We expect the approach we presented to be useful in various fields such as in food engineering, tissue engineering and drug delivery, where microspheres with and without internal structure often need to be biocompatible and monodisperse.

REFERENCES: ¹ I.Ziemecka *et al.*; **2011**; *Lab on a Chip*; 4: 620-624. ² I.Ziemecka *et al.*; **2011**; *Soft Matter*; 21: 9878-9880.

Self-Assembling Peptide-Nucleotide Hybrids

Nidhi Gour, Dawid Kedracki, Ilyès Safir, Kien Xuan Ngo, and Corinne Vebert-Nardin

Department of inorganic, analytical and applied chemistry, University of Geneva-Sciences II; 30,quai Ernest-Ansermet, CH-1211 Geneva 4, Switzerland.

Aside from being the universal carrier of the genetic information, DNA and short nucleotide sequences thereof are involved in a plethora of vital biological mechanisms like gene silencing for instance. However, the main obstacles of using nucleotide sequences as such is their limited plasma half-life as well as cellular penetrability and uptake. To overcome these issues, their conjugation with biocompatible ligands has thus increasingly become a topic of intense research. One may also envisage to design nucleic acid decorated structures or supramolecular assemblies which may serve as delivery cargo molecules. Peptides due to their inherent property of self-assembling in solution may be used as one of such ligand. We demonstrate in here for the very first time that conjugation of peptide ligand with a nucleotide sequence results in a peptide-nucleotide hybrid which self-assembles to give rise to vesicular structures which was assessed by various techniques i.e., imaging of the vesicles using fluorescence microscopy, atomic force microscopy (AFM). scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Vesicular structures efficiently encapsulate a hydrophilic dye and pH triggered release reveals their potential for application as carriers for drug delivery for instance. The design of this fully biocompatible self-assembling material paves the way to many possible future uses e.g., as targeted drug delivery vehicle for sustained drug release and/ gene therapy just to cite few examples.

Macroscopic Alignment of Lyotropic Liquid Crystals Using Magnetic Nanoparticles

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Laboratory of Food and Soft Materials, ETH Zürich, Switzerland.

INTRODUCTION: Liquid crystalline (LC) mesophases such as the columnar hexagonal phase and lamellar phase can be manipulated to acquire desirable long-range orientational order typical of anisotropic species. However, bulk LC samples are usually not uniformly aligned and possess a polydomain structure, which smears out the long-range anisotropic order. Controlled alignment of nanostructured domains in these self-assembled soft materials presents a significant challenge, especially in bulk. By doping lyotropic liquid crystal systems with magnetic nanoparticles, macroscopic alignment of the mesophase can in principle be achieved in low magnetic field [1], although this remains a challenging task due to the constraint in the choice of nanoparticle size, which shall remain smaller than lamellar periodicity, and the pronounced tendency of the nanoparticles to aggregation.

METHODS: Spherical magnetite nanoparticles were synthesized by co-precipitation method. The system was studied with small angle x-rays and neutron scattering (SAXS, SANS), and optical microscopy.

RESULTS: In the presence of a magnetic field, when the sample is cooled from the isotropic micellar phase to the lamellar phase it is observed that the dark structures were aligned along the field (Figure 1). This is interpreted as the result of the alignment of magnetite nanoparticles in presence of the applied field.

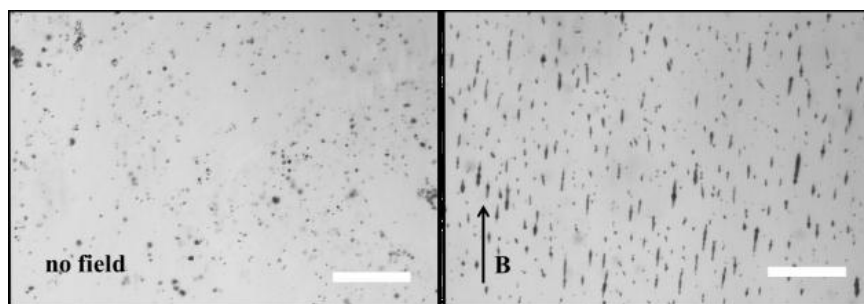


Fig. 1: Bright field optical micrographs of magnetic nanoparticles-doped lamellar phase: in the absence of magnetic field (left) in the presence of 1.1T magnetic field as indicated (right).

In the absence of magnetic field, the two dimensional neutron scattering pattern of doped lamellar phase was azimuthally symmetric, showing isotropic alignment of the lamellar grains (Figure 2). However, in presence of an applied magnetic field of 1.1 T, upon cooling from the isotropic micellar state to the lamellar phase, a strong anisotropic scattering pattern was observed. This indicates that not only the nanoparticles within the grain boundaries, but also lamellar domains do align parallel to the magnetic field vector. The re-alignment in the opposite direction indicates both the reversibility of the process and that there is no loss of efficiency in the orientational order [2].

Theme 2: Methods 11.30-12.00

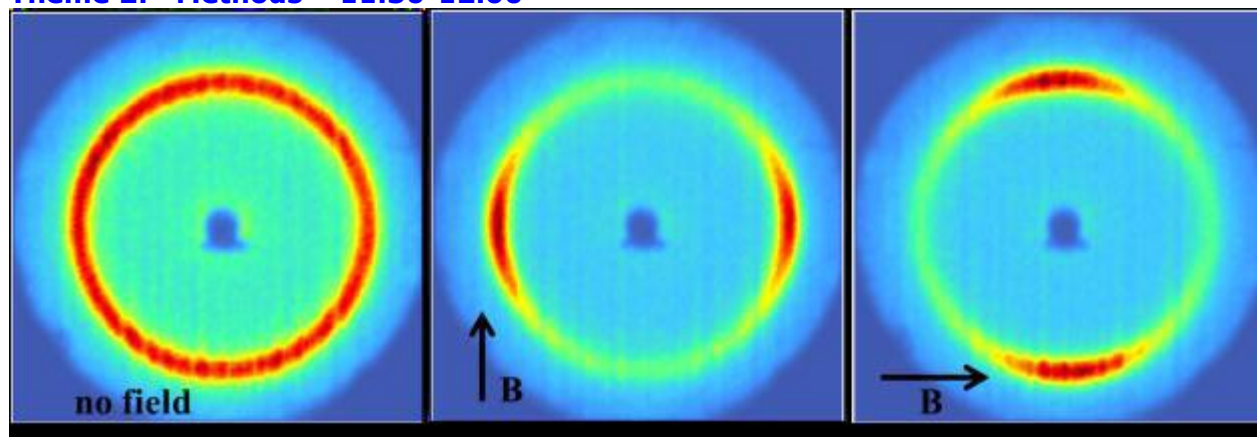


Fig. 2: SANS 2D pattern of magnetic nanoparticles-doped lamellar phase: 0T (left) and 1.1T magnetic field as indicated (middle and right).

CONCLUSIONS: A simple, versatile method is demonstrated to produce highly aligned lamellar and hexagonal domains of magnetic nanoparticles-doped lyotropic liquid crystals. Orientation can be written, erased and re-written fully reversibly and without efficiency loss by tuning both the temperature and the direction of the applied magnetic field.

REFERENCES: [1] P. Fabre, C. Casagrande, M. Veyssie, V. Cabuil, R. Massart; **1990**; *Phys. Rev. Lett.*; 64:539-542. [2] J.J. Vallooran, S. Bolisetty, R. Mezzenga; **2011**; *Adv. Mater.* 23:3932-3937.

ACKNOWLEDGEMENTS: We gratefully acknowledge Dr. Urs Gasser (SANS II, PSI, Villigen) for assistance during the neutron scattering experiments.

Unravelling adsorption and alignment of amyloid fibrils at interfaces by probe particle tracking

Lucio Isa,¹ Jin-Mi Jung² and Raffaele Mezzenga³

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[3] ETH Zurich, Food and Soft Materials Science, E-mail: raffaele.mezzenga@agrl.ethz.ch

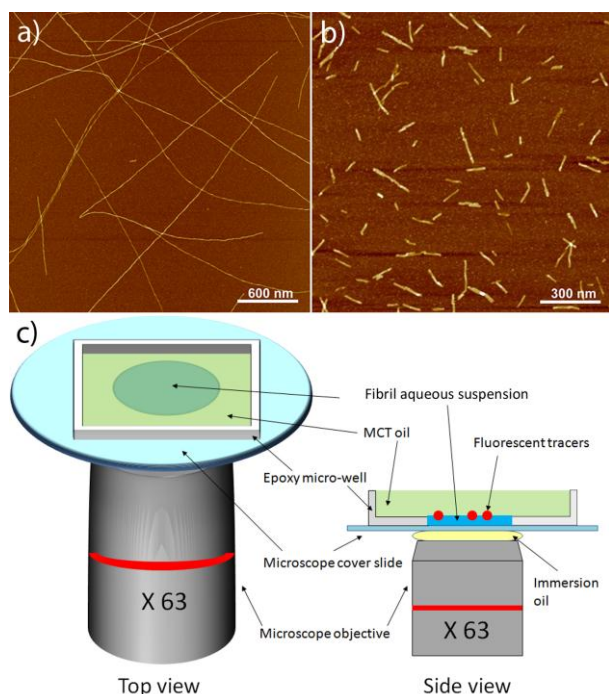


Fig. 1 AFM images of long (a) and short (b) β -lactoglobulin fibrils. (c) Schematics of the microscopy cell set-up used for interfacial particle tracking.

We report the first direct, non-invasive experimental evidence of a 2D isotropic–nematic transition for highly anisotropic nanoparticles at liquid–liquid interfaces by using passive fluorescent particle tracking. In order to illustrate the potential of this approach on systems of high real practical and biological relevance, we select as a model anisotropic nanoparticles, β -lactoglobulin amyloid fibrils of varying aspect ratios. Upon nanoparticle adsorption at the interface, we follow, in real time and as a function of fibril length and bulk concentration, the development of a 2D nematic phase by studying the anisotropy in probe particle traces. We furthermore demonstrate the long-range nature of the nematic phase by calculating order parameters for the traces as high as 0.8 over 102 to 103 mm² areas. The presented route is independent of the system investigated, and thus these findings open a new, general strategy for the experimental assessment of 2D structural changes at anisotropic fluid–fluid interfaces¹.

REFERENCES:

[1] L. Isa, J-M Jung and R Mezzenga “Unravelling adsorption and alignment of amyloid fibrils at interfaces by probe particle tracking”, 2011, *Soft Matter* 7, pp. 8127 – 8134.

CUDA/C++ implementation of the Differential Dynamic algorithm

G. Cerchiari, F. Croccolo, F. Cardinaux and F. Scheffold

Department of Physics / University of Fribourg

The Differential Dynamic Algorithm (DDA) is a powerful tool to extract the correlation function from a signal fluctuating in time. While it was first proposed to evaluate the temporal correlation function out of a pressure detector [1], it has been successfully applied to a variety of optical techniques of the Near Field Scattering family, like Shadowgraph [2,3], Schlieren [4], Near Field Scattering [5], Differential Dynamic

Microscopy [6], and X-ray near Field Scattering [7]. In all these cases the aim is that of obtaining the temporal correlation function for distinct spatial frequencies which requires the execution of Fast Fourier Transforms (FFTs) of the acquired images. This turns out to be rather demanding from the computational point of view, so that, for example, the analysis of a typical set of 2,000 images of 2kx2k pixels requires about 50 hours of calculus. Fortunately the algorithm is perfectly suited for strong parallelization and therefore is worth the effort to implement it in the CUDA/C++ language which takes advantage of the large number of parallel processors of a modern graphic card. Here we show how the code has been implemented in connection with a dedicated strategy for the optimization of the dataflow between the PC Rapid Access Memory (RAM) and the graphic device memory (GRAM) resulting in an increase of the program speed up to 30-fold. An accurate analysis of the timings needed for single operations provides useful hints for further developments of the existing hardware.

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- (2) F. Croccolo et al., Ann. N. Y. Acad. Sci. **1077**, 365-379 (2006)
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- (7) R. Cerbino et al., Nat. Phys. **4**, 238-243 (2008)

Theme 3: Colloids & Polymers 13.30-15.30

Brownian motion and hydrodynamics near a wall*B. Ubbo Felderhof*

RWTH Aachen

Brownian motion of a particle immersed in a viscous fluid may be used as a tool for the analysis of the properties of the fluid and the environment. In experiment it is convenient to keep the particle near a specific position by means of an optical trap. Analysis of the velocity autocorrelation function of a particle in bulk fluid may allow determination of the viscoelasticity of the fluid. Alternatively one may use the position correlation function. If the particle is located near a planar wall, the hydrodynamic environment is modified, and this must be taken into account. One may determine the properties of the wall, for example its elasticity or its slip coefficient, from the correlation function. The theoretical prediction of the correlation function is calculated from linear hydrodynamics.

Three-dimensional flow of colloidal glasses*T.F.F. Farage¹, J.M. Brader¹*

University of Fribourg, Fribourg, Switzerland

Recent experiments performed on a variety of soft glassy materials have demonstrated that any imposed shear flow serves to simultaneously fluidize these systems in all spatial directions [Ovarlez et al. (2010)]. When probed with a second shear flow, the viscous response of the experimental system is determined by the rate of the primary, fluidizing flow. Motivated by these findings, we employ a recently developed schematic mode-coupling theory [Brader et al. (2009)] to investigate the three dimensional flow of a colloidal glass, subject to a combination of simple shear and uniaxial compression. Despite differences in the specific choice of superposed flow, the flow curves obtained show good qualitative agreement with the experimental findings and recover the observed power law describing the decay of the scaled viscosity as a function of the dominant rate. We then proceed to perform a more formal analysis of our constitutive equation for different kind of 'mixed' flows consisting of a dominant primary flow subject to a weaker perturbing flow. Our study provides further evidence that the theory of Brader et al. (2009) reliably describes the dynamic arrest and mechanical fluidization of dense particulate suspensions.

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G. Ovarlez, Q. Barral, and P. Coussot, *Nature Materials*, 9, 115-119 (2010) J.M. Brader, T. Voigtmann, M. Fuchs, R.G. Larson, and M.E. Cates, *Proceedings of the National Academy of Science*, 106, 15186-15191 (2009)

Redox-active polyelectrolyte multilayers: All about ion-exchange and entropy of water*R. Zahn¹, K. Bickel², R. Schuster², F. Boulmedais³, J. Vörös¹, P. Schaaf³ and T. Zambelli¹*

¹Laboratory of Biosensors and Bioelectronics, Institute for Biomedical Engineering, ETHZ ² Institute of Physical Chemistry, Condensed Matter Division, Karlsruhe Institute of Technology (KIT), Germany. ³ Institut Charles Sadron, CNRS, Strasbourg, France.

INTRODUCTION: Polyelectrolyte Multilayers (PEMs) are formed by alternating layer-by-layer (LBL) deposition of polyanions and polycations, and have been widely studied during the last decade. The properties of these layers can be tuned by varying the PEM composition and current research is aimed at applications of LBL films in areas like drug delivery, ion filtration and anti-flammable coatings. However, the internal properties of PEMs are still not very well understood. This makes it hard to understand and predict the characteristics of custom-designed films. In particular, the ion and the water content of PEMs are known to have a crucial effect on the properties of LBL films.

Here we present a PEM consisting of alternating layers of Poly-L-Glutamic Acid (PGA) and Poly-(Allylamine Hydrochloride) (PAH) containing Ferrocyanide (FC) ions as the electrochemically active species. We found that oxidation of the incorporated FC ions caused an expansion of the PEM films. This behavior was attributed to charge compensation by counter ions. Upon oxidation of the FC, anions diffuse into the PEM and replace the missing negative charge. These ions, and their accompanying hydration shell, cause an increase in the osmotic pressure within the layer, which leads to the observed swelling behavior.

RESULTS & DISCUSSION: Using electrochemical quartz crystal microbalance with dissipation monitoring (EC-QCM-D) it is possible to determine the number of ion and water molecules exchanged during the electrochemical swelling. Measurements involving different counter ions showed a strong dependency on the anion species, charge, and molarity.

We performed electrochemical microcalorimetry experiments to obtain additional thermodynamical information about the exchange processes during electrochemical swelling, and found that the entropy of the water molecules taken up by the film is lower than the entropy of bulk water. This indicates a reduced mobility of the molecules in the PEMs. A series of microcalorimetry experiments with different counter anions at several concentrations enabled us to determine the entropy change of 1 mole of H₂O molecules that is taken up by the multilayer to be 0.9 ± 0.2 J/mol·K

Tunneling conductivity in composites of attractive colloids

Biagio Nigro

Ecole Polytechnique Federale de Lausanne

In conductor-insulator nanocomposites in which conducting fillers are dispersed in an insulating matrix the electrical connectedness is established by interparticle tunneling or hopping processes.

These systems are intrinsically non-percolative and a coherent description of the functional dependence of the conductivity σ on the filler properties, and in particular of the conductor-insulator transition, requires to go beyond the usual continuum percolation approach by relaxing the constraint of a fixed connectivity distance.

In our work we consider dispersions of conducting spherical particles which are connected to all others by tunneling conductances and which are subjected to an effective attractive square well potential. We show that the conductor-insulator transition at low contents ϕ of the conducting fillers does not determine the behavior of σ at larger concentrations, in striking contrast to what is predicted by percolation theory. In particular, we find that at low ϕ the conductivity is governed almost entirely by the stickiness of the attraction, while at larger ϕ values σ depends mainly on the depth of the potential well. As a consequence, by varying the range and depth of the potential by keeping the stickiness fixed, composites with similar conductor-insulator transitions may display conductivity variations of several orders of magnitude at intermediate and large ϕ values. By using a recently developed effective medium theory and the critical path approximation we explain this behavior in terms of dominant tunneling processes which involve interparticle distances spanning different regions of the square-well fluid structure as ϕ is varied. Our results could be tested in experiments by changing the potential profile with different depletants in polymer nanocomposites.

Solid-supported planar polymer membranes

J. Kowal¹ and W. Meier¹

¹Department of Chemistry, University of Basel, Switzerland

Solid-supported polymer membranes are of great interest because they can act as synthetic models in investigations of processes taking place within cell membranes. In contrast to natural phospholipid membranes, polymer membranes are characterized by higher mechanical stability, greater thickness and rigidity, while remaining fluid enough to incorporate proteins. Such systems may find application, for example, in sensor development. We present the preparation and characterization of planar polymer bilayers composed of poly(dimethylsiloxane)-*block*-poly(2-methyloxazoline) amphiphilic diblock copolymers covalently attached to an amino-silane modified silicon surface. We produced well organized membranes through Langmuir-Blodgett and Langmuir-Schaefer transfers from a water-air interface. We showed, by means of surface analysis techniques (AFM, ellipsometry), that the obtained structures were homogenous, with thickness of approximately 14 nm.

Synthesis of polymer-coated magnetic nanoparticles using the diazonium salt chemistry

N. Griffete¹, A. Lamouri¹, H. Dietsch², F. Scheffold² and C. Mangeney¹

¹ ITODYS, Université Paris Diderot (UMR 7086), 15 rue Jean de Baïf, 75013 Paris, France
² University of Fribourg, Switzerland

INTRODUCTION: The grafting of polymer brushes from metal oxide nanoparticles via surface-initiated controlled radical polymerization has been the subject of intense research these last years¹. One of the key steps for obtaining stable hybrid metal oxide cores/polymer shells nanostructures relies on the grafting of an appropriate coupling agent between the nanoparticle surface and the polymer coating. Although many coupling agents have been explored to this end, the anchoring groups of the chelate type often fail on metal oxide surfaces in aqueous or protic media due to the hydrolytic instability of the surface attachment and/or the dynamic nature of the interaction. Therefore, the development of versatile and efficient surface modification strategies for obtaining strong and stable linkages in aqueous media, between the metal oxide NP surface and the polymer coating still remains challenging.

DISCUSSION & RESULTS: In this talk, we address this issue by proposing a novel and facile methodology for the in-situ surface functionalization of Fe₃O₄ nanoparticles, based on the use of diazonium salts chemistry as coupling agents. Such unique chemistry has never been extended to the spontaneous functionalization of metal oxide nanoparticles, probably due to the poor reducing character of this type of material inhibiting the generation of aryl radicals able to bind to the NP surface. We circumvented this difficulty by taking advantage of the transformation of diazonium species to diazoates in basic media which dediazonize spontaneously to give aryl radicals able to bind to the iron oxide surface through highly stable covalent linkages. These aryl grafted groups were then used as macro-initiators for the growing of pH-sensitive poly(methacrylic acid) polymer chains (PMAA) from the NPs surface, by the iniferter method. This strategy provided individually dispersed, highly soluble and pH-sensitive PMAA-coated magnetic nanoparticles. IR spectra after each treatment steps were made: a very intense band is seen at ca. 1715 cm⁻¹ due to the C=O stretching mode. This feature, characteristic of poly(methacrylic acid), indicates

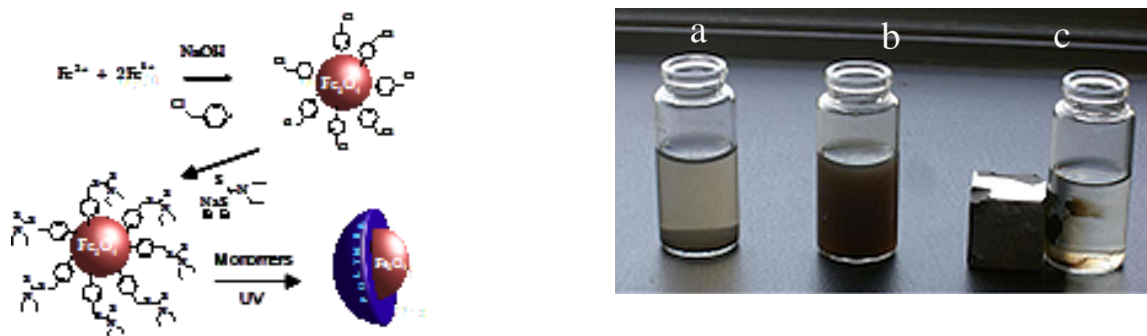


Fig. 1: (LEFT) Surface functionalization strategy of Fe_3O_4 NPs; (RIGHT) Numerical photographs of aqueous dispersions of NP-PMAA particles.

that the polymerization step has been effective. XPS confirmed the efficiency of the grafting procedure as well as the living character of the polymerization process. The magnetic properties of the functionalized Fe_3O_4 nanoparticles were then examined. The saturation magnetization of surface functionalized Fe_3O_4 nanoparticles appeared significantly reduced compared to pure Fe_3O_4 nanoparticles. The stability of the NP-PMAA colloids in water was checked qualitatively. Fig. b reveals that the pH strongly influences the dispersion with flocculated NPs in deionized water (pH 5.5) while they appear highly stable in basic medium (pH 8).

CONCLUSIONS: Our approach offers several advantages over conventional methods: (i) ease and rapidity of the diazonium-based coupling agent grafting at the NP surface; (ii) presence of a covalent bonding between the polymer and the NP surface; (iii) opportunities offered by the living character of the polymerization process. We believe this synthetic approach will not only pave an additional way for the preparation of water-soluble and pH-sensitive PMAA-coated Fe_3O_4 nanocrystals but also provide a new general functionalization strategy for magnetic nanoparticles

REFERENCES: 1R. Barbey and al. 2009; Chem. Rev. 2N. Griffete and al. 2011; J. Am. Chem. Soc.; 133: 1646–1649

A simple model for amyloid fibrils twisting structure

Salvatore Assenza[1], *Paolo De Los Rios* [1] and *Giovanni Dietler* [2]

1Laboratoire de Biophysique Statistique, EPFL, 2 Laboratoire de Physique de la Matière Vivante, EPFL

Under abnormal circumstances, normally soluble proteins may aggregate and form highly stable filamentous structures, known as *amyloid fibrils*. Such structures play a central role in neurodegenerative disorders such as Alzheimer's, Parkinson's and Huntington's diseases, to cite but a few examples. Because of the heterogeneity in sequence of the several proteins able to undergo a disorder-leading fibrillation process, it has been proposed that such ability is a general property of polypeptides, and systematic *in vitro* experiments have shown that even disease-unrelated proteins form fibrils and probed their structure features. Some recent experiments focusing on b-lactoglobuline fibrils showed that they are made of several inter-twisting filaments organized in ribbon-like structures, thus showing a *pitch*, i.e. a period in length, which depends on the width of the ribbon and on the concentration of salt added in the solution. Here, we propose a simple model where the filaments are considered as chains made of springs and charged beads, whose interaction is implemented by means of the Poisson-Boltzmann equation. In spite of its simplicity, the model turns out not only to capture the physics of the system, but also to quantitatively describe the experimental data.

Direct live-cell super-resolution imaging of cellular DNA

Alexander Benke and *Suliana Manley*

Laboratory of experimental Biophysics, EPFL

Direct stochastic optical reconstruction microscopy (dSTORM) is an imaging method that relies on the stochastic photoswitching of single fluorophores and enables resolution of structures down to tens of nanometers in biological samples. Recently, several proteins have been visualized with dSTORM in live cells by using genetically encoded tags labeled with chemical dyes, including DNA-associating proteins. However, despite its importance in cellular processes, live-cell super-resolution imaging of DNA structure itself has never been demonstrated.

We present the imaging of DNA with dSTORM based on direct DNA labeling. We optimized buffer conditions to achieve the reversible photoswitching required for dSTORM in living cells and used it to resolve nuclear and mitochondrial DNA structures. Furthermore, due to the excellent preservation of the dyes, we were able to perform time-lapse super-resolution imaging. This illustrates that it is possible to monitor the sub-diffraction limited organization of DNA in individual cells over time.

This protocol in combination with protein super-resolution imaging provides an advantageous tool to study processes related to DNA dynamic structural rearrangements such as those occurring during cell division or in response to cell stress.

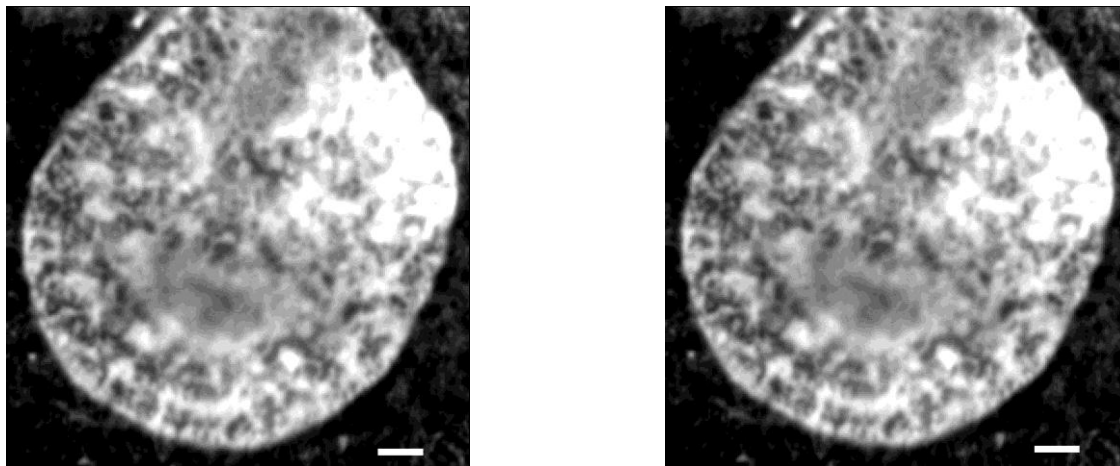


Figure: Wide-field (left) and dSTORM (left) images of cellular nucleus. Scale bar 2.5 μ m

Exploring the cell lamellipodium dynamics using image segmentation

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INTRODUCTION: Accurate extraction of cell outlines from microscopy images is essential for analyzing the dynamics of migrating cells. Phase-contrast microscopy is one of the most common and convenient imaging modalities for observing cell motility since it does not require exogenous labelling and uses only moderate light levels with generally negligible phototoxicity effects. Automatic extraction and tracking of cell outlines from phase-contrast images, however, is difficult due to complex and nonuniform edge intensity. We present a novel image-processing method based on refined level-set segmentation for accurate extraction of cell outlines from phase-contrast images [1].

METHODS: The present segmentation algorithm relies on a two-step procedure to extract accurate and smooth representations of cell outlines from phase-contrast microscopy images. The first step aims at roughly separating the image area containing the cell of interest (i.e. the foreground) from the background, as well as from areas containing other cells possibly present in the same image. This is done by near-optimal thresholding.

The second step then determines the accurate outline shape of the cell of interest to sub-pixel resolution by evolving a geometric active contour [2,3] according to an adapted level-set equation with an energy term suitably chosen for phase-contrast images.

RESULTS: First we benchmarked the accuracy and reliability of the algorithm on artificially generated images with known ground truth corrupted with appropriate noise, leading to a proportion of correctly classified pixels above 98% for a Signal-to-Noise Ratio greater than 6.

It is then applied to time-lapse sequences showing polarizing and migrating keratocyte cells. For each frame, the algorithm returns a function ϕ , the zero-level set of which is the contour segmenting the cell from the background. This contour is represented as a set of (x, y) coordinates, resampled such that the contour contains the same number of points in each frame, evenly spaced along the cell outline. The first point (x₀, y₀) is always placed in the same direction from the cell's centroid. This representation allows us to characterize each point on the cell contour by its curvilinear coordinate s along the outline, which enables

plotting cell-outline properties, such as curvature and edge velocity (see Fig.1), as a function of position, time and distance from the cell centroid.

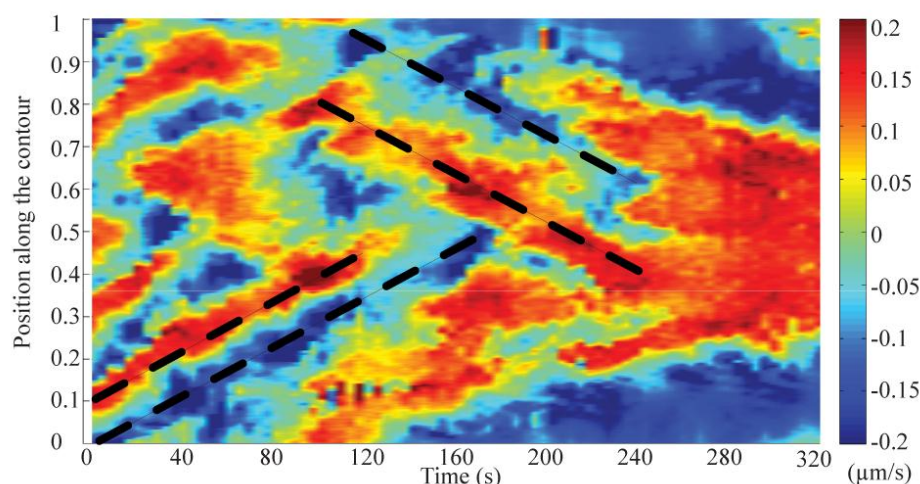


Fig. 1: Evolution of the cell edge velocity along its contour during polarization

DISCUSSION & CONCLUSIONS: The resulting algorithm allows segmenting the cell outlines with more than 98% of accuracy in each frame of a time-lapse movie and tracking them over time, enabling the construction of high resolution protrusion/retraction maps as a valuable tool for studying cell migration and polarization. A MATLAB © toolbox can be downloaded from this page <http://www.mosaic.ethz.ch/Downloads/phasecontrast>

REFERENCES: 1 Ambühl, M. E., 2012; Journal of microscopy; 245: 161–170.

2 Osher, S., & Sethian ; 1988. Journal of computational physics, 79(1), 12–49.

3 Li, C., Xu, C. ; 2005. Pattern Recognition. IEEE Computer Society.

ACKNOWLEDGEMENTS: We thank many of our colleagues from LCB and the MOSAIC group who contributed to this work. M.A. was funded by an NCCBI PhD fellowship. I.F.S. further acknowledges funding from the Swiss SystemsX.ch initiative, grant LipidX-2008/011,

In situ synthesis of antibiotics inside nanoreactors

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Implant-related infections remain a challenge to medicine. Bacterial infections following orthopedic implant surgery are a major problem entailing complications that are difficult to treat, usually curable only by surgical implant removal, and a source of very high medical costs. We present here the potential use of polymeric enzyme-loaded vesicles to synthesize *in situ* a compound with antibacterial activity. We employ nanometer-sized poly(2-methyloxazoline)-*block*-poly(dimethylsiloxane)-*block*-poly(2-methyloxazoline) (PMOXA-PDMS-PMOXA) amphiphilic triblock copolymeric vesicles to encapsulate the enzyme penicillin acylase. The resulting particles are rendered permeable to substrates and products by incorporating the bacterial porin OmpF in their polymeric walls. We show that the obtained ‘nanoreactors’ are enzymatically active and stable under physiological conditions (pH 7.4, 37°C). Penicillin acylase-loaded nanoreactors were tested on an *E.coli* strain. A strong inhibitory effect against these bacteria was demonstrated.

Keywords nanoreactors; bioactive materials, block copolymers, antibiotics

Orthogonal Particle-Height and Density Gradients for Biomedical Applications

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The osseointegration of titanium implants is known to be highly influenced by their surface roughness. This surface property has a significant influence on cell behaviour such as adhesion, proliferation and differentiation. Roughness gradients offer an ideal high-throughput solution in order to investigate the effect of roughness on cell attachment¹.

To study the effect of roughness and feature size on cells, orthogonal particle-height and density gradients were fabricated. The roughness of a flat substrate was modified by slowly immersing TiO₂-coated wafers into a 500 nm diameter polystyrene-particle dispersion. This technique creates a particle-density gradient, generating roughness in the μm range. Subsequently, a gradual shrinking of the particles achieved by a UV-exposure gradient orthogonal to the density gradient allows for the creation of a two-dimensional particle-height and density gradient (see Figure 1).

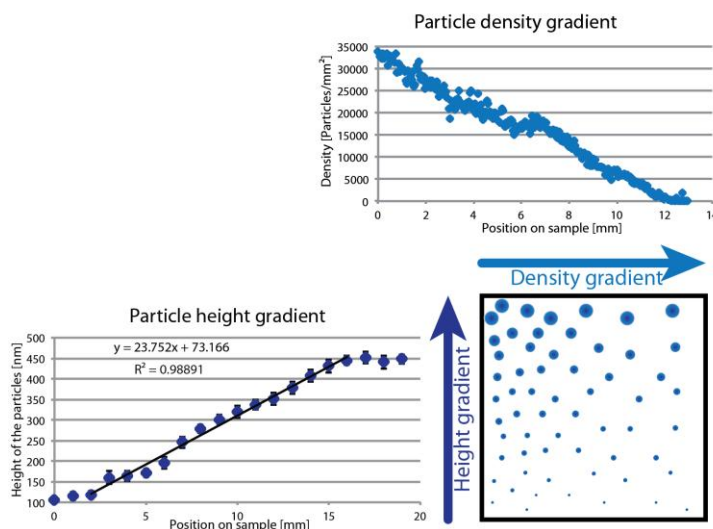


Figure 1: Particle-density gradient versus particle-height gradient. The particle-density gradient was analyzed with light microscopy and the height of the particles was measured with AFM.

In order to further reduce the sample-to-sample error, cell tests have been performed on titanium-coated replicas of the gradients. For this purpose a method for creating replicas had to be employed and osteoblasts were cultivated on the coated replica substrates.

Osteoblasts showed a higher proliferation on the high-particle-density, high-height corner of the gradient. A slow decrease is observed along the particle-height gradient (see Figure 2). This behaviour indicates that the cells have a higher proliferation rate on the rougher corner of the gradient, which is in good agreement with previous results from Kunzler et al 2. Osteoblasts are also showing a decrease in proliferation rate according to the height of the roughness features. This also shows good agreement with the results from Huwiler et al, who reported that cells proliferate faster on the smooth end of a nanoparticle-density gradient 3.

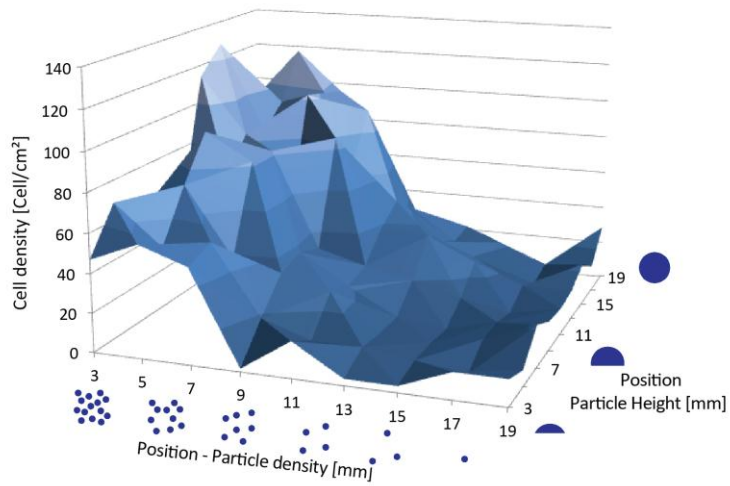


Figure 2: Cell density after a 4 days proliferation assay. The highest density is achieved in the high-density, high-height corner of the gradient. A slow decrease in the proliferation rate is visible along the height gradient, while the particle-density gradient shows a faster decrease.