Biomaterial Interfaces
Room: 202 - Session BI+SS+NC-MoA

Honorary Session for Bengt Kasemo
Moderator: M. Textor, ETH Zürich, Switzerland

2:00pm **BI+SS+NC-MoA1 Self–Assembly of Organic Molecules on Surfaces Studied by STM: Dynamics, Chirality and Self-Organization**, ***F. Besenbacher***, University of Aarhus, Denmark **INVITED**

Adsorption and organization of organic molecules on solid surfaces is central to self-assembly and bottom-up fabrication within nanoscience and technology. The Scanning Tunneling Microscope allows exploration of atomic-scale phenomena occurring on surfaces: Dynamic processes can be followed by fast-scanning STM, and from data acquired at a range of temperatures; detailed information on kinetic parameters can be extracted. In the talk, a number of studies investigating dynamics and organization of organic molecules on metal surfaces will be described, addressing surface diffusion, chiral recognition chiral switching and also the interaction of molecules with chiral sites on a metal surface[1-5]. Finally, the self-assembly of Nucleic Acid (NA) base molecules on solid surfaces has been investigated. I will discuss the fact that Guanine molecules form the so-called G-quartet structure on Au(111) that is stabilized by cooperative hydrogen bonds[6]. Interestingly, cytosine molecules only form disordered structures by quenching the sample to low temperatures, which can be described as the formation of a 2D organic glass on Au(111)[7]. Molecular recognition between complementary nucleic acid (NA) bases is vital for the replication and transcription of genetic information, both in the modern cell as well as under prebiotic conditions, when a dedicated molecular machinery of evolved living organisms had not yet been developed. By means of variable-temperature Scanning Tunneling Microscopy (VT-STM) we show that on a flat metal surface, formation of complementary NA bases pairs is favoured. The C+G mixture resilience to heating is due to the formation of G-C Watson-Crick base pairs. The observation that not the oligonucleotide backbone, but a flat metal surface may be instrumental for specific WC base pairing has interesting implications for the proposed scenarios of the emergence of life.

[1] M. Schunack et al., Phys. Rev. Lett. 88, No. 156102 (2002)
[2] R. Otero et al., Nature Materials 4 779 (2004)
[3] A. Kühnle et al., Nature 415, 891 (2002)
[4] S. Weigelt et al., Nature Materials, 5 11 (2006)
[5] S. Weigelt et al., Angew. Chem. 119, 9387 (2007)
[6] R. Otero et al., Angew. Chem. Int. Ed. 44, 2270-2275 (2005)
[7] R. Otero et al., Science 319 (2008) 312-315 .

2:40pm **BI+SS+NC-MoA3 Interaction of AH Amphipathic Peptide with Lipid Bilayers and Application to the Understanding of Hepatitis C Viral Infection via QCM-D Measurements**, ***C.W. Frank***, *N.J. Cho*, Stanford University, *K.H. Cheong*, Samsung Advanced Institute of Technology, Korea, *J.S. Glenn*, Stanford University **INVITED**

Membrane association of the hepatitis C virus NS5A protein is required for viral replication. This association is dependent on an N-terminal amphipathic helix (AH) within NS5A and is restricted to a subset of host cell intramolecular membranes. The mechanism underlying this specificity is unknown, but it may suggest a novel strategy for developing specific antiviral therapy. Here we probe the mechanistic details of NS5A amphipathic helix-mediated binding to both cellular-derived and model membranes using biochemical membrane flotation and quartz crystal microbalance with dissipation. In both assays, we observed AH-mediated binding to model lipid bilayers. When cellular-derived membranes were coated on the quartz nano-sensor, however, significantly more binding was detected. Biochemical flotation assays performed with trypsin-treated cellular-derived membranes exhibited reduced amphipathic helix-mediated membrane binding, while membrane binding of control Cytochrome b5 remained unaffected. Similarly, trypsin treatment of the nano-sensor coated with cellular membranes eliminated amphipathic helix binding to the cellular membranes while that of a control lipid-binding protein remained intact. These results, therefore, suggest the effect of a protein in mediating and stabilizing the binding of NS5A's amphipathic helix to its target membrane. These results also demonstrate the successful development of a new nano-sensor technology ideal for both studying the interaction between a protein and its target membrane, and for developing inhibitors of that interaction.

3:20pm **BI+SS+NC-MoA5 Tethered Biomolecular Lipid Membranes - a Membrane Mimetic Sensor Platform**, ***W. Knoll***, *I. Köper, R. Naumann, E.-K. Sinner*, Max-Planck-Institute for Polymer Research, Germany

This contribution summarizes some of our efforts in designing, synthesizing, assembling, and characterizing functional tethered lipid bilayer membranes (tBLMs) as a novel platform for biophysical studies of and with artificial membranes or for sensor development, employing, e.g., membrane integral receptor proteins. Chemical coupling schemes based on thiol groups for Au substrates or silanes used in the case of oxide surfaces allow for the covalent and, hence, chemically and mechanically robust attachment of anchor lipids to the solid support, stabilizing the proximallayer of a tethered membrane on the transducer surface. Surface plasmon optics, the quartz crystal microbalance, fluorescence- and IR spectroscopies, and electrochemical techniques are used to characterize these complex supramolecular interfacial architectures with respect to their assembly, their structure and function. We demonstrate, in particular, that these bilayers show the fluid character of a liquid-crystalline membrane with a specific electrical resistance of better than 10 MΩcm2. Then a totally novel approach for the functional incorporation of membrane proteins, i.e., by their cell-free expression and in vitro reconstitution in the presence of tBLMs is demonstrated. We focus on the yeast expression system for the synthesis of the olfactory receptor species OR5 from Rattus norvegicus. By the combination of the corresponding coding DNA with the protein synthesis machinery of a cell-extract (in vitro transcription and translation) we observe spontaneous and vectorial insertion of an interesting example for a membrane protein into a tethered bimolecular lipid membrane: the OR5 receptor as a family member of the G-protein coupled receptors.

4:00pm **BI+SS+NC-MoA7 Tethered Biomolecular Lipid Membranes - a Membrane Mimetic Sensor Pattern II**, ***E.-K. Sinner***, Max-Planck-Institute for Polymer Research, Germany

4:20pm **BI+SS+NC-MoA8 2D Self-Assembly of Annexin-A5 on Lipid Surfaces: Biological Function, Mechanism of Assembly and Biotechnological Applications**, ***A.R. Brisson***, *N. Arraud, R. Bérat, A. Bouter, B. Garnier, C. Gounou, J. Lai-Kee-Him, S. Tan*, CNRS-University of Bordeaux, France **INVITED**

The self-assembly of proteins in 2D arrays at membrane surfaces is a generic strategy used by the cell for the construction of functional supramolecular edifices, e.g. bacterial S-layers, inter-membrane cadherin junctions, etc.. Annexin-A5 (Anx5) is the prototype member of the annexins, a superfamily proteins which share the properties of binding to negatively charged phospholipids in the presence of Ca2+ ions and forming various types of 2D ordered arrays at membrane surfaces. A detailed model of the structure and mechanism of formation of Anx5 2D arrays has been elaborated from EM, AFM and physico-chemical studies on various types of model membranes – liposomes in solution, lipid monolayers at the air-water interface, supported lipid bilayers.[1-4] The long-debated question of the functional role of Anx5 and annexins starts to be elucidated. The unique properties of binding and 2D self-assembly of Anx5 were exploited to develop various types of molecular tools for nanobiotechnological applications in proteomics, diagnosis or drug delivery. Chimerical proteins made of Anx5 fused to an antibody-binding moiety or linked to cell-adhesion peptides allow the construction of 2D platforms for anchoring antibodies, proteins or cells in a controlled orientation and density.[5] Gold particles functionalized with oriented Anx5 or Anx5-fusion proteins are used for labelling membrane fragments exposing phosphatidylserine molecules, such as apoptotic membranes or plasmatic microparticles, opening novel strategies for the separation and the analysis of circulating cell membrane fragments.

[1]F. Oling, W. Bergsma-Schutter and A. Brisson J. Struct. Biol. 2000, 133, 55-63.
[2]Reviakine, I., Bergsma-Schutter, W. and Brisson, A. J. Struct. Biol. 1998, 121, 356-61.
[3]Richter, R.P.; Lai-Kee-Him, J.; Tessier, C.; Brisson, A. R. Biophys. J.2005, 89, 3372-3385.
[4]Richter, R.P.; Bérat, R; Brisson, A. R. Langmuir 2006, 22, 3497-3505.
[6]Bérat, R.; Rémy-Zolghadry, M.; Gounou, C.; Manigand, C.; Tan, S.; Saltó, C.; Arenas, E.; Bordenave, L; Brisson, A. R. Biointerphases, 2007, 2, 165-172.

5:00pm **BI+SS+NC-MoA10 From Surface Science to Biointerfaces to Nanoscience**, ***B. Kasemo***, Chalmers University of Technology, Sweden **INVITED**

The development of surface science can, depending on ones background and focus, be regarded as a bottom up outgrowth of, e.g., solid state physics towards surfaces (structure, electron structure,..) or molecular physics towards interfaces (collision dynamics, adsorption,…), or one can alternatively see it as the result of a top down process, where technologically important areas, such as semiconductor technology, materials science, catalysis and biointerfaces [1], stimulated development of

more knowledge about and better tools to study interface properties and processes. The strength of surface science originates to a large extent from the strong feed back loop between the top down and bottom up processes, connecting a manifold of interesting fundamental questions with a large diversity of applications. Historically the focus of surface science has moved from simple model systems of small molecules on metal surfaces in UHV, to more complex systems in UHV or at higher gas pressures (e.g. in catalysis), to the liquid phase (e.g. electrochemistry), and further to very complex systems (biointerfaces, tribology,…), involving also more complex materials like oxides and polymers. The evolution sketched above is here exemplified by a personal and subjective choice of examples, like surface scattering and charge transfer processes, catalysis, and biomimetic membranes. The "newest" addition on the arena is nanoscience and nanotechnology, which has connected to almost all fields of traditional surface science. Although one can claim in catalysis, and several other fields, that there has always been a "nano-" element, the control of the latter through fabrication and characterization, is what has changed dramatically over the past decade or so. Specific examples chosen here to illustrate this latter development is taken from nanotechnology for sustainable energy [2], namely (i) so called LSPR applications for solar cells and sensing, (ii) metal hydrides, and (iii) exhaust cleaning catalysis and (iv) fuel cells.

[1]Kasemo, B., Biological Surface Science. Surface Science, Vol. 500 (2002) 656.
[2]Zaech M., Haegglund C., Chakarov D., Kasemo B., Current Opinion in Solid State and Materials Science Vol. 10 (2006) 132.

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