Swiss Nanoconvention 2014

BOOK of ABSTRACTS

http://www.swissnanoconvention.ch/2014

Compiled by:

Jens Gobrecht, Paul Scherrer Institute and University of Applied Sciences and Arts, Northwestern Switzerland

Contents:

Note:

- Not all SNC speakers have submitted an abstract of their talk.
- Speakers of the CTI event were not asked to submit abstracts.
- Submission of abstracts for the poster presenters was voluntary, i.e. no abstracts are included in this book for many of the posters.

swiss nano convention

Program at a glance

Swiss Nanoconvention 2014 Technical Program Wednesday, May 21, 2014

8:00 – 9:15 Registration, Coffee

9:15 Opening session. Campussaal, Chair: R. Buser, NTB, Buchs and President, Swiss MNT Network
Welcome Addresses: **R. Schnaidt**, School of Engineering, FHNW, Windisch; **J. Gobrecht**, Paul Scherrer Inst., Villigen

9:30 Plenary Lecture I. Campussaal, Chair: R. Buser
G. Aeppli, Paul Scherrer Inst., Villigen, Switzerland and London Centre of Nanotechnology, London, UK, *The next life of silicon*

10:15 Panel discussion, Campussaal, *"Three years of ETHZ-IBM Binnig-Rohrer Nanotechnology Center"*. Moderation: A. Hirstein, Neue Zürcher Zeitung
Panelists: R. Eichler (President, ETHZ), W. Riess (IBM Zurich Research Center), G.-L. Bona (President, EMPA), G. Aeppli (Dept. Head Photon Science) PSI, Christofer Hierold (ETHZ)

10:45 Coffee break, Exhibition, Posters

11:15 Three years Binnig-Rohrer Nanotechnology Center , Part I. Campussaal, Chair: C. Hierold, ETHZ
11:15 A. Knoll, IBM Research – Zurich, *Thermal Probe Nanolithography: What You See is What You Get*
11:35 D. Poulikakos, ETHZ, Zürich, *Direct Open-Atmosphere Functional Printing at the Nanoscale: Toward a new Frontier*
11:55 H. Riel, IBM Research – Zurich, *Semiconducting Nanowires - From Materials to Devices*
12:15 A. Bachthold, ICFO, Barcelona, Spain, *Mechanical Resonators based on Nanotubes and Graphene*

11:15 Nanotechnology in Energy Research Foyerraum A, Chair: J. Brugger, EPFL
11:15 A. Fontcuberta i Morral, EPFL, Lausanne, *Semiconductor Nanowires for next Generation Photovoltaic Energy Conversion*
11:45 D. Opris, EMPA, Dübendorf, *Conductive Nanoparticle Fillers in Elastomers for Actuators*
12:15 V. Brüser, INP, Greifswald, Germany, *Plasma-Enhanced Synthesis of Visible Light-Active Photocatalyst Nanostructures for Water Splitting and Other Solar Applications*

11:15 Applications of nanotechnology in the life sciences, Part I. Foyerraum B, Chair: P. Seitz, EPFL
11:15 A. Fink, Adolphe Merkle Inst., Friboug, *When "Nanomaterials meet Cells*
11:35 D. Müller, D-BSSE, ETHZ, Basel, *Looking inside Cellular Machines using AFM-based Technologies*
11:55 G. Fantner, EPFL, Lausanne, *Life and Death at the Nanoscale: the Growth and Demise of Bacteria observed with Time Resolved AFM*
12:15 E. DiFabrizio, King Abdullah Univ., Thuwal, Saudi Arabia, *Sensing few Molecules at Nanoscale through Raman Spectroscopy*

12:45 – 14:00 Buffet Lunch, Exhibition, Posters

14:00 Three years Binnig-Rohrer Nanotechnology Center , Part II. Campussaal, Chair: W. Riess, IBM
14:00 C. Degen, ETHZ, Zürich, *Adventures in Ultrasensitive Force Detection*
14:20 W. Hänsch, IBM Research-New York, *Will we see Carbon Nanotubes for VLSI in 2020?*
14:40 V. Wood, ETHZ, Zürich, *Understanding and Optimizing Nanostructured Solids for Energy Applications*
15:00 L. Gross, IBM Research - Zurich, *Molecular Structure Determination by AFM*

14:00 Molecular- and quantum structures. Foyerraum A, Chair: L. Heyderman, PSI and ETHZ
14:00 A. Gölzhäuser, Univ. Bielefeld, Germany, *Carbon Nanomembranes Engineered from Molecular Monolayers*
14:30 J. Osterwalder, Univ. Zürich, *CVD Growth and Transfer of Single-Crystalline Hexagonal Boron Nitride Monolayers and Graphene*
15:00 Th. Jung, Paul Scherrer Inst., Villigen, *Organic Electronics and Spintronics at the Ultimate Limit: Engineering with Molecules at Interfaces*

14:00 Applications of nanotechnology in the life sciences, Part II. Foyerraum B, Chair: K. Knop, I4U
14:00 W. Stark, ETHZ, Zürich, *Industrial Applications of Nanoparticles: Safety, Production and Commercialization*
14:30 B. Beck-Schimmer, Univ. Zürich, *Magnetic Nanoparticles: one Step closer to the Bedside?*
15:00 E. Delamarche, IBM Research-Zürich, *Chemistry with Sub-Nanoliter Volumes in the Open Space: from Surface Patterning to Pathology*

15:30 Coffee break, Exhibition, Posters

16:00 Hans-Joachim Güntherodt Lecture on Nanoscience (plenary lecture II). Campussaal, Chair: C. Schönenberger, Univ. of Basel
F. Giessibl, Univ. of Regensburg, Germany, *A Passion for Precision: Atomic Force Microscopy with Subatomic Resolution*

16:45 Plenary Lecture III. Campussaal, Chair: P. Seidler, IBM Research–Zurich
M. Aspelmeyer, Univ. of Vienna, Austria, *Quantum-Optomechanics*

Swiss Nanoconvention 2014 Technical Program Thursday, May 22, 2014

8:00 – 9:15 Registration, Coffee

9:15 Plenary Session IV. Campusssaal, Chair: J. Gobrecht, PSI
9:15 A. Hürzeler, Head of Departement of Education, Culture and Sports, Canton of Aargau, Aarau, Switzerland, *Hightech-Strategie des Kantons Aargau*
9:35 M. Bopp, Hightechzentrum Aargau, Brugg, Switzerland, *Nano in the Hightechzentrum Aargau*

10:00 Plenary Session V, Campussaal, Chair: A. Bismarck
K. Schulte, TU Hamburg, Germany, *Fibre Reinforced Composites with a Nanostructured Polymer Matrix – Outline from Properties to Application*

10:45 Coffee break, Exhibition, Posters

11:15 Technology Transfer. Campussaal, Chair: M. Krack, FITT
11:15 R. Dümpelmann, i-net nano, Basel, *i-net: Nano, Support of 4 Cantons and a Cross-functional Landscape*
11:35 J. Güttinger, NTN innovative surfaces, St. Gallen, *Introduction and Current Activities NTN Innovative Surfaces*
11:55 W. Meier, Univ. of Basel, *NCCR Molecular Systems Engineering*
12:15 C. Dransfeld, FHNW, Windisch, *Industrial Break-through of High-Performance Fibre-reinforced Composite Materials for the whole Value Chain in Switzerland*

11:15 CTI Micro- and Nano-Event 2014, Part I. Foyerraum B, Chair: R. Zehringer, CTI
11:15 R. Zehringer, CTI, Bern, Switzerland
Welcome
11:25 K. Sekanina, CTI, Bern, Switzerland
Latest News from CTI
11:45 Poster Presentations

11:15 Industrial Applications of Scanning Probe Microscopy. Foyerraum A, Chair: E. Meyer, Univ. Basel
11:15 Th. Glatzel, Univ. of Basel, *Advanced Scanning Probe Force Microscopy for Nanoscale Analysis*
11:35 G. Dietler, EPFL, Lausanne, *Fast Detection of Bacterial Resistance to Antibiotics by Nanomechanical Sensors*
11:55 R. Sum, Nanosurf AG, Liestal, *AFM for Automated Inspection and Diagnostics*
12:15 F. Menges, IBM Research-Zurich, *Scanning Probe Thermometry - A Thermometer for the Nanoscale*

12:35 – 13:45 Buffet Lunch, Exhibition, Posters

13:45 Nanoelectronics. Campussaal, Chair: J. Gobrecht, PSI
13:45 U. Grossner, ABB Ltd., Baden, *Nanotechnology in Power Applications: a Feasibility Consideration*
14:15 D. Zumbühl, Univ. of Basel, *Controlling Spins in Semiconductor Nanostructures*
14:45 A. Pasquarello, *EPFL, Lausanne, Accurate Modelling of Defect Levels*

13:30 CTI Micro- and Nano-Event 2014, Part II, Foyerraum B
13:30 O. Porret, Bobst SA, Mex, *An Ultra High Speed in-Line Braille Control System*
14:00 A. Kounga, Straumann AG, Basel, *Laser-Based Fabrication of Biomimetic Dental Restorations*
14:30 F. Holzner, Swisslitho AG, Zürich, *The Nano Frazor - Rapid Prototyping of High-Quality Nanostructures*

13:45 Nanoengineered Structural Materials. Foyerraum A Chair: C. Dransfeld, FHNW
13:45 Th. Graule, EMPA, Dübendorf, *Ceramic Based Nanocomposites – a Processing Challenge*
14:15 A. Bismarck, Imperial College, London, UK, *Hierarchical or Nanomaterial Enhanced Composites*
14:45 A. Battisti, Carbo-Link AG, Fehraltdorf, *Interface Characterization of EPD Deposited CNT Nanocomposites via Single Fiber Pushout*

15:15 Coffee break, Exhibition, Posters

15:45. Nanofabrication. Campussaal, Chair: M. Bopp, Hightechzentrum
15:45 Ch. Rytka, Inst. of Polymer Nanotechnology, FHNW, Windisch; *Mass Replication of Nanopatterns in Polymers*
16:10 Y. Ekinci, Paul Scherrer Inst., Villigen, *Single-digit Nanolithography by EUV-Interference Lithography*
16:35 Ch. Dais, Eulitha AG, Würenlingen, *PHABLER 100: An Innovative Tool for Low-Cost nano-Patterning of Large Areas*

15:30 CTI Micro- and Nano-Event 2014, Part III, Foyerraum B
15:30 T. Lamprecht, vario-optics AG, Heiden, *InnoWave: Innovative Waveguide Technology*
16:00 M. Gonin, Tofwerk AG, Thun, *Timing Matters - Mass Spectrometry in the Nano Scale*
16:30 M. Willemin, EM Microelectronic-Marin SA, Marin, ***Keynote:** EM Microelectronic-Marin SA and CTI*

15:45 Nanoengineered Functional Materials. Foyerraum A, Chair: M. Kristiansen, FHNW
15:45 S. Vogel, FHNW, Windisch, *Protective Effect of Alumina Layer on CF during CVD Processing for Hierarchical Composites*
16:10 C. Daraio, ETHZ, Zürich, *Nano-structured Materials with Enhanced Mechanical Properties*
16:35 A. Stuck, ETHZ, Zürich, *Mass Manufacturing of Nano-Structured Surfaces*

17:05 Plenary Session VI, Campussaal, Chair: P. Gröning, EMPA
R. Landsiedel, BASF, Ludwigshafen, Germany, *Safety Assessment and Grouping of Nanomaterials*

17:50 Closing of Conference, announcement of Swiss Nanoconvention 2015

Part A, Oral presentations

Wednesday, May 21, 2014

Plenary Lecture 1:

- **G. Aeppli,** London Center of Nanotechnology, London UK (until April 2014), Paul Scherrer Inst., Villigen, Switzerland (since April 2014)**,** *The next Life of Silicon*

Panel Discussion ETHZ – IBM Research – Zurich

Session "Three years Binnig-Rohrer Nanotechnology Center"

- **A. Knoll**, IBM Research – Zurich, *Thermal Probe Nanolithography: What You See is What You Get*
- **D. Poulikakos**, ETHZ, Zürich, *Direct Open-Atmosphere Functional Printing at the Nanoscale: Toward a new Frontier*
- **H. Riel**, IBM Research – Zurich, *Semiconducting Nanowires - From Materials to Devices*
- **A. Bachthold**, ICFO, Barcelona, Spain, *Mechanical Resonators based on Nanotubes and Graphene*
- **C. Degen**, ETHZ, Zürich, *Adventures in Ultrasensitive Force Detection*
- **W. Hänsch**, IBM Research-New York, *Will we see Carbon Nanotubes for VLSI in 2020?*
- **V. Wood,** ETHZ, Zürich, *Understanding and Optimizing Nanostructured Solids for Energy Applications*
- **L. Gross**, IBM Research - Zurich, *Molecular Structure Determination by AFM*

Plenary Lecture 2, **Hans Güntherodt Lecture on Nanoscience**:

- **F. Giessibl**, Univ. of Regensburg, Germany, *A Passion for Precision: Atomic Force Microscopy with Subatomic Resolution*

Plenary Lecture 3

- **M. Aspelmeyer**, Univ. of Vienna, Austria, *Quantum-Optomechanics*

Thermal Probe Nanolithography: What You See is What You Get

Armin W. Knoll[a)], M. Zientek[a),d)], C. Rawlings[a)], P. Paul[b),d)], F. Holzner[b),d)], D. J. Coady[c)], J. L. Hedrick[c)], U. Duerig[a)]

a) IBM Research – Zurich, b) SwissLitho AG, c) IBM Research – Almaden, d) ETH Zurich

http://www.zurich.ibm.com/st/nanofabrication/probe.html

Abstract

Thermal Scanning Probe Lithography (tSPL) is a novel nano-patterning technique based on Scanning Probe Microscopy. A heated tip with an apex-radius of merely 5 nanometers is used to locally evaporate organic resists and thereby create arbitrary patterns. Recently, the technology has demonstrated several key achievements towards technical readiness and has become commercially available via the startup company SwissLitho.

A particular strength of scanning probe lithography methods is their potential to nondestructively image a surface with up to atomic resolution. We exploit this feature to implement a closed-loop control scheme which enables an autonomous and precise operation of the tool. Nanometer scale accurate reproduction of absolute depth values is demonstrated for 3D grayscale images. In addition, the scheme allows for a nanometer precise and marker-less overlay process of the next patterning level relative to existing nanostructures. These novel capabilities provide an intuitive and visually accessible platform for researchers to perform future challenges in nanofabrication.

Direct Open-Atmosphere Functional Printing at the Nanoscale: Toward a new Frontier

Prof. D. Poulikakos

Lab of Thermodynamics in Emerging Technologies

Mechanical and Process Engineering Department

ETH Zurich

www.ltnt.ethz.ch

Abstract

The controlled fabrication of functional nanostructures enables the utilization of unique properties of such structures for a broad range of applications. Ink-based direct writing techniques are evolving as a flexible alternative to common photo- or e-beam lithography but have not been able to consistently provide three-dimensional entities smaller than several hundred nanometers. By exploiting the combined physics of electrohydrodynamics, wetting and vaporization, we present a remarkably simple method for the rapid, free-form generation of multidimensional nanostructures well below 100nm in diameter, going down to individual nanoparticle printing, from zeptoliter ink droplets printed at frequencies exceeding 100 kHz with "nanometer" accuracy not attainable by other direct printing techniques. We further demonstrate the potential of so printed structures in challenging fields ranging from plasmonics to solar cells and to biology and chemistry.

Mechanical resonators based on nanotubes and graphene

Adrian Bachtold

ICFO – The Institute of Photonic Sciences, Castelldefels (Barcelona), Spain

http://bachtoldgroup.icfo.eu/

Abstract

Carbon nanotubes and graphene offer unique scientific and technological opportunities as nanoelectromechanical systems (NEMS). Namely, they have allowed the fabrication of mechanical resonators that can be operable at ultra-high frequencies and that can feature high quality factors. In addition, nanotubes and graphene have exceptional electron transport properties, including ballistic conduction over long distances. Coupling the mechanical motion to electron transport in these remarkable materials is thus highly appealing. Here, I will review some of recent results on nanotube and graphene resonators, including mass sensing at the proton mass level [1], and force sensing with ~10 $zN/Hz^{1/2}$ noise [2].

[1] J. Chaste, A. Eichler, J. Moser, G. Ceballos, R. Rurali, A. Bachtold, Nature Nanotechnology 7, 301 (2012).

[2] J. Moser, J. Güttinger, A. Eichler, M. J. Esplandiu, D. E. Liu, M. I. Dykman, A. Bachtold, Nature Nanotechnology 8, 493 (2013).

swiss nano convention

Adventures in ultrasensitive force detection

Christian Degen

Laboratory for Solid State Physics, Department of Physics, ETH Zurich

www.spin.ethz.ch

Abstract

Micro- and nanomechanical elements are in widespread use in nanoscale science and technology. Some prominent examples include cantilevers used in ultra-sensitive force microscopes, membranes for pressure measurements, or bottom-up nanowires for mass spectroscopy. With the advent of modern cleanrooms and lithographic technology, hundreds to thousands of nanomechanical sensor elements can now be integrated in a single chip, with dimensions approaching near atomic dimensions.

In this talk, I will give an overview on our group's effort in ultrasensitive force detection and imaging. I will show how nanomechanical silicon cantilevers are fabricated, how they can be used to measure forces as small as ~10^{-18} Newton, and how their properties can be improved by tuning their surface chemistry. I will also show that other materials, such as single-crystal diamond, could offer superior performance in the future. The talk will conclude by some applications pursued in our laboratory that are enabled by these nanomechanical sensors.

Will we see Carbon Nanotubes for VLSI in 2020?

Wilfried Haensch

IBM TJ Watson Research Center
Yorktown Heights NY

Abstract

When the first carbon nanotube FETs were presented more than a decade ago they were considered a candidate for the ultimate scaled transistor. Very quickly it became clear however that the intrinsic material problems associated with the carbon nanotubes presented a formidable challenge and interest waned. With performance scaling slowing down, driven by serious power constraint on the system level and manifest in a constant clock frequency for more than the last half decade, academia and industry intensified the search for the "next switch". Many candidates emerged over the recent years. The dream is, of course, to find a new switching element that can replace the conventional transistor. Preferably with out any change of the existing infra structure – new materials and fabrication methods would be tolerated. The goal is to find a switch that can give high performance at low supply voltage and high integration density that is consistent with the power constraint of the system. Due to its superb scaling behavior and electrical transport properties carbon nanotubes are a natural successor of the current available technology solutions for the digital application space if the material problems could be solved. Carbon nanotube devices can be build that resemble very closely the exiting device structures and would therefore fit into the exiting CMOS technology ecosystem with out major interruptions. To move carbon nanotubes into a main stream technology many challenges lie ahead. The foremost are: (1) to obtain an extremely high purity population of semiconducting carbon nanotubes and (2) to place these carbon nanotubes at precise positions to build the circuits. Although device scaling beyond a 10nm gate length has been shown there are a number of questions unanswered related to the integration of carbon nanotubes into high density digital technology. My presentation will address the fundamental material questions and the still open integration issues that need to be addressed to make carbon nanotubes a main stream technology by 2020.

Colloidal Nanocrystal-based Optoelectronic Devices

Deniz Bozyigit, Oleysa Yarema, Wedye Lin, Sebastian Volk, Vanessa Wood

Department of Information Technology and Electrical Engineering, ETH Zurich

www.lne.ee.ethz.ch

Abstract

Materials with nanoscale dimensions often exhibit novel optical and electronic properties that could improve the performance of optoelectronic and electrochemical systems; however, transport in solids made of these materials remains poorly understood, leaving significant room for improvement in the way these materials are integrated into devices. This talk will introduce our research activities at the Laboratory for Nanoelectronics (lne.ee.ethz.ch), which focus on the development of analytical techniques to study the electronic and ionic transport in solution-processed structures composed of materials with nanoscale dimensions. The understanding gained from these studies is then applied to developing new materials and device architectures for optoelectronic and electrochemical energy storage applications.

The talk will present two examples of our work pertaining to colloidal nancrystal (NC) solids for LEDs and solar cells. First, I will introduce the concept of capacitive-based structures to experimentally investigate the origins of luminescence quenching in NCs and explain how we used these structures demonstrate a fundamental tradeoff facing bandstructure engineering of NCs for LED applications.[1] Second, I will explain how we perform the first quantitative measurements on electronic trap states in NC solids and use our findings to explain the current-voltage characteristics of NC-based solar cells and the fundamental limiting processes in these systems.[2]

[1] D. Bozyigit, O. Yarema, and V. Wood. *Advanced Functional Materials* **23** (2013).
[2] D. Bozyigit, S. Volk, O. Yarema, and V. Wood. *Nano Letters* **13** (2013).

Molecular structure determination by AFM

Leo Gross

IBM Research - Zurich

http://www.zurich.ibm.com/st/atomic_manipulation/

Abstract

Single organic molecules were investigated using noncontact atomic force microscopy (NC-AFM) and Kelvin probe force microscopy (KPFM). The resolution was increased due to tip functionalization by atomic manipulation. Using NC-AFM with CO functionalized tips, atomic resolution on molecules and molecular structure identification was demonstrated and the bond orders of individual carbon-carbon bonds were distinguished. Moreover, the molecular adsorption height and tilt was determined. With KPFM information about the intramolecular charge distribution was gained.

Nanotechnology for Energy Research

- **A. Fontcuberta i Morral**, EPFL, Lausanne, *Semiconductor nanowires for next generation photovoltaic energy conversion*
- **D. Opris**, EMPA, Dübendorf, *Dielectric elastomer actuators put to work*
- **V. Brüser**, INP, Greifswald, Germany, *Plasma-Enhanced Synthesis of Visible Light-Active Photocatalyst Nanostructures for WaterSplitting and Other Solar Applications*

Conductive nanoparticles fillers in elastomers for actuators

Dorina M. Opris

Swiss Federal Laboratories for Materials Science and Technology

Dorina.opris@empa.ch

Abstract

Dielectric elastomers actuators (DEA) are electromechanical actuators based on the ability of elastomers to change dimensions when an electric field is applied. They are made from a thin elastic film sandwiched between two compliant electrodes. When an electric voltage is applied, an electrostatic pressure is acting on the film compressing it in thickness while elongating it in plane. Despite of the large application potential, a disadvantage of DEA is the large activation voltage required to induce their mechanical deformation. One way to overcome this problem is to increase the permittivity of the elastomer. This presentation will show how this can be overcome by blending the elastomer with functionalized conductive nanoparticles. Additionally, it will be shown how the actuator performance and its lifetime can be improved by using graphene composite electrodes that are able to self-repair after a breakdown.

Plasma-Enhanced Synthesis of Visible Light-Active Photocatalyst Nanostructures for Water Splitting and Other Solar Applications

A. Kruth [1], S. Müller[1], S. Peglow[1], S. Hansen[2], T. Beweries[2], N. Rockstroh[2], H. Junge[2], M. Karnahl[2], V. Brüser[1], K-D. Weltmann[1]

[1] Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany

[2] Leibniz Institute for Catalysis (LIKAT), Rostock, Germany

http://www.inp-greifswald.de

Abstract

Hydrogen is considered to be the main future energy carrier. Its carbon-free production is one of the main challenges for the breakthrough in sustainable energy conversion technologies. Semiconductor photocatalysis for solar hydrogen generation from water has attracted an enormous amount of research interest. In nano material synthesis, plasma-enhanced surface modification and layer deposition methods are based on the presence of non-equilibrium states of reactive species in a plasma environment. They are therefore able to overcome limitations of traditional catalyst synthesis methods, giving rise to new reaction pathways and resulting in unique properties of nano materials.

In this work, our current approaches to improve nano materials properties through plasma-enhanced PVD and PECVD methods are demonstrated.

Molecular and Quantum Structures

- **A. Gölzhäuser**, Univ. Bielefeld, Germany, *Carbon Nanomembranes Engineered from Molecular Monolayers*
- **J. Osterwalder**, Univ. Zürich, *CVD Growth and Transfer of Single-Crystalline Hexagonal Boron Nitride Monolayers and Graphene*
- **Th. Jung**, Paul Scherrer Inst., Villigen, *Organic Electronics and Spintronics at the Ultimate Limit: Engineering with Molecules at Interfaces*

Carbon Nanomembranes Engineered from Molecular Monolayers

Armin Gölzhäuser
Physics of Supramolecular Systems and Surfaces
Bielefeld University, 33615 Bielefeld, Germany.
E-Mail: ag@uni-bielefeld.de

A scheme for the fabrication of extremely thin (~1nm) carbon nanomembranes is presented [1,2]. The first step is the formation of a self-assembled monolayer (SAM) of amphiphilic molecules. Then the SAM is exposed to electron or UV-irradiation that leads to a dehydrogenation, followed by a cross-linking between neighboring molecules. The cross-linked SAM can be released from the surface, forming a self-supporting carbon nanomembrane (CNM) with properties that are determined by the constituting molecular monolayer [2,3]. CNMs can be further processed, for example perforated or surfaces functionalized. Pyrolysis transforms CNMs into graphene [4,5]. It will be shown that CNMs can be engineered with a controlled thickness, conductivity, permeability and elasticity. Advanced microscopic (helium ion microscopy) and spectroscopic methods as well as functional tests are applied to investigate the CNMs [6].

[1] A. Turchanin, A. Gölzhäuser*: Carbon Nanomembranes from Self-Assembled Monolayers: Functional surfaces without bulk*, Progress in Surface Science, **87**, 108 (2012).

[2] P. Angelova, H. Vieker, N. Weber, D. Matei, O. Reimer, I. Meier, S. Kurasch, J. Biskupek, D. Lorbach, K. Wunderlich, L. Chen, A. Terfort, M. Klapper, K. Müllen, U. Kaiser, A. Gölzhäuser, A. Turchanin: *A Universal Scheme to Convert Aromatic Molecular Monolayers into Functional Carbon Nanomembranes*, ACS Nano **7**, 6489 (2013).

[3] D. Rhinow, J. Vonck, M. Schranz, A. Beyer, A. Gölzhäuser, N. Hampp: *Ultrathin conductive carbon nanomembranes as support films for structural analysis of biological specimens*, Phys. Chem. Chem. Phys. **12**, 4345 (2010); X. Zhang, A. Beyer and A. Gölzhäuser: *Mechanical characterization of carbon nanomembranes from self-assembled monolayers*, Beilstein J. Nanotechnol. **2**, 826 (2011).

[4] A. Turchanin, D. Weber, M. Büenfeld, C. Kisielowski, M. Fistul, K. Efetov, T. Weimann, R. Stosch, J. Mayer and A. Gölzhäuser: *Conversion of Self-Assembled Monolayers into Nanocrystalline Graphene: Structure and Electric Transport*, ACS Nano, **5**, 3896 (2011)

[5] A. Gölzhäuser: *Graphene from Molecules*, Ang. Chem. Intl. Ed. **51**, 10936 (2012).

[6] Ch. Nottbohm, A. Turchanin, A. Beyer, R. Stosch, A. Gölzhäuser: *Mechanically stacked ultrathin layered materials with tunable optical, chemical and electrical properties*, Small **7**, 874 (2011).

CVD growth and transfer of single-crystalline hexagonal boron nitride monolayers and graphene

J. Osterwalder, Silvan Roth, Huanyao Cun, Adrian Hemmi, Carlo Bernard, Thomas Kälin, Thomas Greber

Physik-Institut, Universität Zürich, Winterthurerstr. 190, CH-8057 Zürich

http://www.physik.uzh.ch/groups/osterwalder/

Abstract

Chemical vapor deposition (CVD) performed under ultra-high vacuum conditions on single-crystal metal surfaces enables the growth of large-area and high-quality graphene and hexagonal boron nitride (h-BN) single layers. Aiming towards a platform technology for graphene-based electronic devices, our group follows two different approaches. On the one hand, we explore the CVD parameter space of precursor pressure and temperature in order to go beyond the self-saturating single-layer growth, or to grow heterostacks of the two materials. The second approach is based entirely on single-layer growth that leads to much lower defect densities, and subsequent transfer of the layers onto a different substrate. These efforts are strengthened by the setup of a growth chamber for these films on the four-inch wafer scale.

Switching Molecules: Imagine There Is a Device only 1nm in Size

N. Ballav[1], Chr. Waeckerlin, M. Stoehr[2], J. Lobo Checa[2], P. Oppeneer, L. Gade, S. Decurtins, F. Diederich,

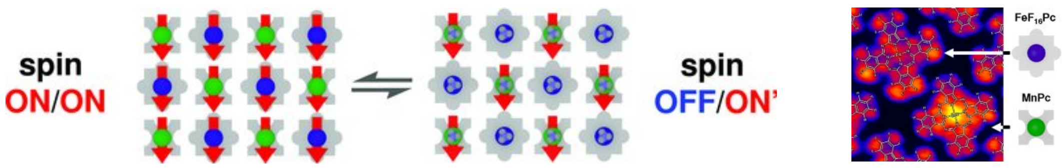
T. A. Jung[1]

Laboratory for Micro- and Nanotechnology, Paul Scherrer Institute and Swiss Nanoscience Institute, University of Basel

psi.ch/lmn/molecular-nanoscience
nanolab.unibas.ch

Well defined electronic and spintronic interfaces can be architectured by combining self-assembly and surface science. The atomically clean metal surface in the ultra-high vacuum provides a very specific environment affecting the behaviour of the ad-molecules as well as the adsorbent-adsorbate interaction. Depending on the bonding at the interface, complex electronic and magnetic interaction can occur which can be explored using spectro-microscopy correlation, in this case photoemission and photoabsorption spectroscopy (PES, PAS) and Scanning Tunnelling Microscopy (STM).

Common to these molecular interfaces is their production from atomically clean substrates and molecular building blocks. The physics and chemistry of these unprecedented systems, which are addressable by scanning probes, provides insight into novel materials in their assembly, their electronic and spintronic properties which emerge from the interaction of their components down to the scale of single atoms, molecules and bonds.



Scheme. 1. Controlling the spin state of a supra-molecular array of Fe-Phthalocyanines and Mn-Phthalocyanines by NH3.

swiss nano convention

Applications of Nanotechnology in the Life Sciences

- **A. Fink**, Adolphe Merkle Inst., Friboug, *When "Nanomaterials meet Cells*
- **D. Müller**, D-BSSE, ETHZ, Basel, *Looking inside Cellular Machines using AFM-based Technologies*
- **G. Fantner**, EPFL, Lausanne, *Life and Death at the Nanoscale: the Growth and Demise of Bacteria* ***observed with Time Resolved AFM***
- **E. DiFabrizio, King Abdullah Univ., Thuwal, Saudi Arabia, *Sensing few Molecules at Nanoscale through Raman Spectroscopy***
- **W. Stark**, ETHZ, Zürich, *Industrial Applications of Nanoparticles: Safety, Production and Commercialization*
- **B. Beck-Schimmer**, Univ. Zürich, *Magnetic Nanoparticles: one Step closer to the Bedside*?
- **E. Delamarche**, IBM Research-Zürich, *Chemistry with Sub-Nanoliter Volumes in the Open Space: from Surface Patterning to Pathology*

When "Nanomaterials meet Cells"

Alke FINK

Adolphe Merkle Institute & Chemistry Department, University of Fribourg, Switzerland

www.am-institute.ch, alke.fink@unifr.ch

Abstract

Engineered nanoparticles meet the biological world at the nano-bio interface. This encounter holds many promises e.g. for application in medicine, raises concerns for the safe use of nanomaterials and has led to novel science investigating the cellular interaction of nanoparticles. There is a commonly held view that the nanoparticle-cell interaction is a complex problem, where a multitude of physicochemical properties of the nanoparticles rule. Examples of these would be size, shape, charge, hydrophilicity, and chemical reactivity. One parameter, which is often neglected, refers to the aggregation behaviour of nanoparticles in the biological environment. This presentation will give an overview of field, point out challenges, and answer some of the current state-of-the art questions.

Sensing few Molecules At Nanoscale through Raman Spectroscopy

KAUST (King Abdullah University of Science and Technology), Physical, Biological and Engineering Divisions, Thuwal-Jeddah, Saudi Arabia
And
BIONEM lab, University Magna Graecia, Catanzaro, Italy

e-mail: enzo.difabrizio@kaust.edu.sa
www.kaust.edu.sa and www.bionem.unicz.it

Abstract

In the last few years, there has been a burst in the study and conceiving of new devices for the generation and manipulation of electromagnetic field at the nanoscale, where radiation-matter interaction is strongly enhanced. Several fabrication methods are now available for material preparation and nano-structuring, but only few of them can ensure the stringent design control needed for the effective and reproducible device behavior.
We report, herein, novel processes of micro and nanofabrication techniques for several applications in different research fields.
During the lecture it will be presented selected topics from our research activity. In particular it will be highlighted the results on single molecule detection[1], Plasmon Polariton conversion to Hot electrons [2] and direct imaging of DNA [3].

[1] Nanoscale chemical mapping using three-dimensional adiabatic compression of surface plasmon polaritons
F. De Angelis, et al. *Nature nanotechnology* 5 (1), 67-72, 2009
[2] Hot-electron nanoscopy using adiabatic compression of surface plasmons
A Giugni, et al, *Nature nanotechnology* 8 (11), 845-852,2013

[3] Direct imaging of DNA fibers: the visage of double helix
F Gentile et al, *Nano letters* 12 (12), 6453-6458, 2012

Magnetic nanoparticles: one step closer to the bedside?

Beatrice Beck Schimmer

Institute of Anaesthesiology, University Hospital Zurich

Institute of Physiology and Zurich Center for Integrative Human Physiology, University of Zurich

http://www.physiol.uzh.ch/research/Anaesthesiology.html
http://www.anaesthesie.usz.ch/UeberUns/Mitarbeiter/Leitende.Aerzte/Seiten/BeckSchimmer.Beatrice.aspx
http://www.anaesthesie.usz.ch/LehreUndForschung/Forschung/Nanomedizin/Seiten/default.aspx
http://www.nfp64.ch/E/projects/biomedical_applications/carbon_coated_nanomagnets/Pages/default.aspx

Abstract

Metallic nanoparticles such as carbon-coated nanomagnets have recently been shown to be of particular interest for specific removal of pathogens and disease causing factors in intoxication, severe inflammatory response syndrome or sepsis, but also for drug delivery. Before bringing an application close to a clincial scenario detailed assessment of interactions of particles with the according environment – in this case the vascular compartment - is mandatory to evaluate potential health risks. This presentation will focus on possible chances of magnetic nanoparticles showing promising results with regard to the use of a blood purification system. At the same time tests involving risk analysis will be presented elucidating clinically relevant possible harms.

Chemistry with sub-nanoliter volumes in the open space: from surface patterning to pathology

Emmanuel Delamarche

IBM Research - Zurich

http://www.research.ibm.com/labs/zurich/st/bioscience/

Abstract

In contrast to standard microfluidics, which are typically closed, we developed a scanning, non-contact microfluidic technology that can shape liquids in the "open space" over surfaces. This technology utilizes a microfluidic probe (MFP) having microfabricated injection and aspiration apertures for localizing a liquid of interest on a surface using hydrodynamic flow confinement. The MFP permits patterning surfaces with proteins in an additive and subtractive manner, forming gradients of protein on surfaces, and interacting with cells on surfaces. With flow confinement operating at volumes smaller than 1 nanoliter, a few cells can be targeted in a tissue section for the specific staining of disease markers. Flow confinement and efficient use of chemicals can be further optimized using a new concept called "hierarchical" hydrodynamic flow confinement. I will show how the MFP and new concepts may contribute to the analysis of critical samples in the context of pathology.

Thursday, May 22, 2014

Plenary Session 4

- **Alex Hürzeler**, Canton of Aargau, Aarau, *Hightech-Strategie des Kantons Aargau*
- **M. Bopp,** Hightechzentrum Aargau, Brugg, *Nano in the Hightechzentrum Aargau*

Plenary Session 5

- **K. Schulte**, Technical University Hamburg-Harburg, Germany, *Fiber reinforced Composites with a Nanostructured Polymer Matrix – Outline from Properties to Application*

Plenary Session 6

- **R. Landsiedel**, BASF, Ludwigshafen, Germany, *Safety Assessment and Grouping of Nanomaterials*

Nanotechnology in the Hightech Zentrum Aargau

Martin A. Bopp

Hightech Zentgrum Aargau AG, Badenerstrasse 13, 5200 Brugg

www.hightechzentrum.ch

Abstract

The goal of the Hightech Zentrum Aargau AG is to support SME in questions on technology and innovation. The Hightech Zentrum Aargau is part of the cantonal program "Hightech Aargau" and is operational since March 2013. As nanotechnology is one of the key technologies of this century, it is also one of our focal points. We mainly support SME in the canton of Aargau. For the selection of the partners for these SME however we are not limited to the canton of Aargau. One of our key partners are all Swiss universities and research institutions. We will show how we foster knowledge and technology transfer between universities and SME in all its aspects and how we financially support feasibility studies with universities.

Fibre Reinforced Composites with a Nanostructured Polymer Matrix – Outline from Properties to Application

Karl Schulte

S. Chandrasekaran, E. Mannov, Chr. Viets, B. Fiedler

Institute of Polymers and Composites, Hamburg University of Technology

21073 Hamburg, Germany

www.tu-harburg.de/kvweb

Abstract

Fibre reinforced composites have superior properties compared to conventional structural materials. They already gain a very high standard, resulting in application in the aerospace and other important industry, however, there is still room for further improvement. These developments go towards cost reduction during material production, manufacturing, and also application and material properties.

Nanocomposites (polymers filled with nanoparticles as carbon nanotubes, graphene, etc.) have been under investigation in the last decade, and they resulted in tremendous improvements in mechanical properties, as fracture toughness, but also electrical conductivity. Nanocomposites themselves are a new class of material. Nanocomposites used as matrix for fibre reinforced composites have the potential to improve overall mechanical properties as interlaminar shearstress, first ply failure, impact and compression after impact etc. At the same time the polymer matrix, being an isolator by nature can be turned into an electrically conductive material. This additional function can be used not only for electric charge ablation but also for sensing deformation and/or damage. Especially their potential for strain sensing applications with electrical conductivity methods can be used to investigate the electromechanical response of nanocomposite deformation when subjected to mechanical load.

Within this presentation we will give an overview on the development of nanocomposites, its integration into fibre reinforced polymeric structures and the gain achieved in overall properties, so that composite materials can even better compete with conventional structural materials, respectively are an even more attractive alternative.

Safety Assessment and Grouping of Nanomaterials

Robert Landsiedel

BASF SE, Experimental Toxicology and Ecology,
67056 Ludwigshafen am Rhein, Germany

www.nanotechnology.basf.com

Abstract

On the one hand, possible risks of nanomaterials are related to the specific uses of specific materials. On the other hand, it will not be possible to test all nanomaterials in all uses and life-cycle stages. Hence, safety assessment will address concerns arising from material properties, use, release, uptake and biopersistence as well as early biological (cellular) and toxic effects. These data will help to identify concerns in order to choose the right toxicological studies and to aid grouping of nanomaterials. Examples of the preliminary use of this concept include concrete (use), paint (release), sunscreen (uptake) and pristine nanomaterials (inhalation toxicity). Inhalation studies with more than 30 nanomaterials are available and provide data on biodistribution, hazard and potency. For the evaluation of potential long-term effects (including carcinogenicity) a chronic inhalation study is currently performed with special focus on mechanisms by which nanomaterials may cause long-term effects.

Technology Transfer Session

- **R. Dümpelmann**, i-net nano, Basel, *i-net: Nano, Support of 4 Cantons and a Cross-functional Landscape*
- **J. Güttinger**, NTN innovative surfaces, St. Gallen, *Introduction and Current Activities NTN Innovative Surfaces*
- **W. Meier**, Univ. of Basel, *NCCR Molecular Systems Engineering*
- **C. Dransfeld**, FHNW, Windisch, *Industrial Break-through of High-Performance Fibre-reinforced Composite Materials for the whole Value Chain in Switzerland*

i-net: Nano, Support of 4 Cantons and a cross-functional Landscape

Dr. Ralf Dümpelmann

i-net innovation networks switzerland

http://www.i-net.ch/

Abstract

i-net innovation networks switzerland is a joint organization of the cantons of Northwestern Switzerland aimed at promoting innovation. As a public private partnership of the cantons Aargau, Baselland, Basel-Stadt and Jura, as well as leading companies from the region, i-net supports companies in the promising technology fields of ICT, Life Sciences, Medtech, Cleantech and Nanotechnologies.

i-net offers companies and innovators individual advice and far-reaching opportunities for the sharing of experiences and transfer of knowledge at no cost. With around 50 events a year, i-net appeals to a network of more than 5500 individuals and companies – from start-ups to global companies.

The technology field «Nano» is managed – since February 2014 - by Dr. R. Dümpelmann and guided by Prof. H. Güntherodt as technology field leader. One important objective is to explore the full potential of nanotechnology as an interdisciplinary field reaching from life sciences over medtech to material science and analytical techniques. Innovation will take place just there! And i-net is bringing the experts together and supports them.

Examples are the Technology Circle «NanoMedicine» which took place at the ETH-department BioSystems Science and Engineering in Basel (D-BSSE), the connection of «Nano»-knowhow with 3D-printing of medtech structures, the expert support of a start-up in the canton Jura to optimize material properties, or the Technology Circle NanoPolymers & Structures supported by CSEM and FHNW Windisch. The region has excellent companies and universities and thereby a great fundament to explore exciting innovation fields.

swiss nano convention

Introduction and current activities NTN Innovative Surfaces

innovative surfaces

Dr. Jörg Güttinger, Managing Director

Association NTN Innovative Surfaces, Lerchenfeldstrasse 5, CH-9014 St.Gallen

www.innovativesurfaces.ch

Abstract

The **N**ational **T**hematic knowledge and technology transfer **N**etwork ("**NTN"**) **Innovative Surfaces** fosters the collaboration between technology companies and knowledge institutions to leverage the promises of advanced surface technologies.

Surface properties are often decisive for the business value of a specific product. Surface engineering thus is critical to enable technology innovation in virtually every industry sector. To optimally commercialize this innovation potential by surface engineering, the close cooperation between developers and technology oriented producing companies is crucial and was never more important than today.

The presentation will show, how exactly a value chain-oriented cross industry approach for technology transfer initiatives between knowledge institutions and industrial companies may successfully enlarge their innovation perspectives and product success in today's global market, in particular also for SMEs.

In cooperation with the CTI

KTT-Support
National thematic networks

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Commission for Technology and Innovation CTI

Molecular Systems Engineering

Wolfgang Meier

Department of Chemistry, University of Basel

http://www.chemie.unibas.ch/~meier/index.html

Abstract

The aim of the new NCCR MOLECULAR SYSTEMS ENGINEERING is to foster and coordinate interdisciplinary approaches to establish the fundamental principles of engineering functional molecular modules into complex synthetic or cellular systems. The focus of this NCCR is thus to integrate molecular modules with defined functions to engineer synthetic systems that harness the resulting emerging properties and functional modules towards controlling existing systems, such as a living cell.

swiss nano convention

Industrial breakthrough of high-performance fibre-reinforced composite materials for the whole value chain in Switzerland

Clemens Dransfeld[a,b,] *, Stève Mérillat [a]

[a] Carbon Composites Schweiz, Windisch, Switzerland
[b] Institute of Polymer Engineering, University of Applied Sciences and Arts Northwestern Switzerland FHNW, Windisch, Switzerland
* clemens.dransfeld@fhnw.ch

www.cc-schweiz.ch

Abstract

High performance composites, mostly composed of carbon fibres and polymeric matrix systems, have reached the maturity to replace load bearing metal structures in weight critical applications at a large scale. This represents a big opportunity for the industrial sector in Switzerland resulting in several attractive business opportunities, but also requiring technological innovations and the creation of novel occupational profiles.

Carbon Composites Schweiz is an industry driven network dedicated to the industrial breakthrough of high-performance fibre-reinforced composite materials for the whole value chain in Switzerland. It has been awarded the status of a national thematic network by the CTI. Its aim is to bring together the competences in industry and academia to foster technological innovation, improved access to key markets and proliferation of professional education in the industry sector of high performance composites. The members represent various sectors along the value chain, including SME's, international corporations, as well as academic institutions.

Industrial Applications of Scanning Probe Microscopy

- **Th. Glatzel**, Univ. of Basel, *Advanced Scanning Probe Force Microscopy for Nanoscale Analysis*
- **G. Dietler**, EPFL, Lausanne, *Fast Detection of Bacterial Resistance to Antibiotics by Nanomechanical Sensors*
- **R. Sum**, Nanosurf AG, Liestal, *AFM for Automated Inspection and Diagnostics*
- **F. Menges**, IBM Research-Zurich, *Scanning Probe Thermometry - A Thermometer for the Nanoscale*

Advanced Scanning Probe Force Microscopy for Nanoscale Analysis

Th. Glatzel, Rèmy Pawlak, Shigeki Kawai, Antoine Hinaut, Res Jöhr, Sweetlana Fremy, Alexis Baratoff, and Ernst Meyer

University of Basel, Department of Physics, Klingelbergstr. 82, 4056 Basel, Switzerland

nanolino.unibas.ch

Abstract

Scanning Probe Force Microscopy (SPM) has demonstrated true atomic resolution on metals, semiconductors and insulators even under liquid conditions. The application of SPM to single molecules is a challenge because of relatively weak bonding to the substrate, which often leads to high diffusion rates of the molecules. The imaging of molecules, which were designed to interact with specific sites on insulating surfaces, wires of porphyrin molecules on ionic crystal surfaces observed by noncontact Atomic Force Microscopy (nc-AFM) and Kelvin Probe Force Microscopy (KPFM) as well as the acquisition of full 3D force fields of single molecular structures will be discussed. Recently, intramolecular resolution is studied on a variety of molecules. A further challenge is the manipulation of molecules on surfaces, including the controlled rotation, which means that the direction of rotation of the molecule can be chosen by the experimentalist.

Fast detection of bacterial resistance to antibiotics by nanomechanical sensors

Giovanni Dietler

Laboratoire de Physique de la Matière Vivante, EPFL, 1015 Lausanne

LPMV.epfl.ch

Abstract

We present how the fluctuations of highly sensitive atomic force microscope cantilevers can be used to detect low concentrations of bacteria, characterize their metabolism and quantitatively screen (within minutes) their response to antibiotics. We applied this methodology to Escherichia coli and Staphylococcus aureus, showing that living bacteria produced larger cantilever fluctuations than bacteria exposed to antibiotics. Our experiments suggest that the fluctuations are associated with bacterial metabolism. Other applications on living organisms will be also presented. Moreover the importance of this new detector for slow growing bacteria like tuberculosis will be discussed.

Longo et al., Nature Nanotechnology, **8** (2013) 522.

swiss nano convention

AFM for automated inspection and diagnostics

Robert Sum

Nanosurf AG, Gräubernstrasse 12-14, 4410 Liestal, Switzerland

www.nanosurf.com/nanite

Abstract

To measure large areas on a specimen is a challenge for most atomic force microscopes (AFM) due to their limited scan range — typically around 100 µm. In addition, randomly positioned measurements are required to obtain reasonable statistics for the surface roughness of a specimen. Nanosurf has manufactured numerous specialized systems that allow the automated positioning of an AFM on top of a specimen to perform measurements that produce mm-sized images of the sample surface or statically distributed roughness information over a large workpiece. Examples of such applications will be discussed.

For nanomechanical tissue diagnostics, like on breast cancer biopsies and skin dermatitis samples, a comprehensive system (ARTIDIS) was developed with the Biozentrum Basel, which performs automatic measurements to diagnose the disease state of these tissues.

swiss nano convention

Scanning probe thermometry – A thermometer for the nanoscale

Fabian Menges1,2, Heike Riel1, Andreas Stemmer2, Bernd Gotsmann1

1) IBM Research – Zurich, 8803 Rueschlikon, Switzerland

2) Nanotechnology Group – ETH Zurich, 8803 Rueschlikon, Switzerland

www.zurich.ibm.com/st/nanoscale/thermaltransport.html

Abstract

Numerous technical processes, such as the speed of today's computing devices, are strongly influenced by temperature. Both, the performance and reliability of transistors depend on the formation of local hot spots and reduced thermal conductance on the nanoscale. As the demand to characterize and control this nanoscopic temperature fields is not matched by the spatial resolution of established thermometry techniques, new methods are needed to probe temperature down to the single nanometer regime.

To address this challenge, we developed a vacuum-operated scanning thermal microscope. We apply the new instrument to gain fundamental understanding of thermal processes in nanoscale materials and devices. In particular, we present our study of self-heating in nanowire electronic devices to visualize the formation of hot spots near semiconductor doping junctions and nanowire-metal contacts. Our scanning probe thermometry method is expected to find wide applications in the characterization of thermal processes and properties of nanosystems.

Nanoelectronics

- **U. Grossner**, ABB Ltd., Baden, *Nanotechnology in Power Applications: a Feasibility Consideration*
- **D. Zumbühl**, Univ. of Basel, *Controlling Spins in Semiconductor Nanostructures*
- **A. Pasquarello**, *EPFL, Lausanne, Accurate Modelling of Defect Levels*

Nanotechnology in power applications: a feasibility consideration

U. Grossner

ABB Corporate Research Center, Segelhofstrasse 1K, CH- 5405 Baden-Dättwil

Abstract

Nanotechnology has emerged as one of the most important trends in recent years, offering new device functionality as well as manufacturing benefits. For efficient power applications, large areas need to be homogeneously fabricated, maintaining the properties of the nano-sized functional units. In power electronics, the nano-scale properties need to be stable enough for high voltage and high current operation. The talk focuses on industry requirements for power applications and extracts the corresponding specifications needed for the successful application of nanotechnology.

Accurate Modelling of Defect Levels

Alfredo Pasquarello

Chaire de Simulation à l'Echelle Atomique (CSEA)
Ecole Polytechnique Fédérale de Lausanne (EPFL)
CH-1015 Lausanne

Abstract

Defects generally play an important role in all functional materials: Either they are undesired and need to be controlled or passivated, or they are introduced on purpose to achieve specific functionalities. In any event, given the experimental difficulties in unveiling the nature of the observed defects, theoretical approaches are often called upon to provide insight. It is thus important to achieve theoretical tools with predictive power. With this in mind, we here focus on the determination of defect energy levels in the form of charge transition levels. The talk focuses on two aspects.
First, we address to what extent various electronic-structure methods, as different as semi-local density functional, hybrid density functional, and many-body perturbation theory provide a consistent description of the position of defect levels in the band gap. Next, we describe how to overcome finite-size effects which affect the defect levels calculated with super-cell techniques. The comparison with experimental data is illustrated and discussed.

Nanoengineered Structural Materials

- **Th. Graule**, EMPA, Dübendorf, *Ceramic Based Nanocomposites – a Processing Challenge*
- **A. Bismarck**, Imperial College, London, UK, *Hierarchical or Nanomaterial Enhanced Composites*
- **A. Battisti**, Carbo-Link AG, Fehraltdorf, *Interface Characterization of EPD Deposited CNT Nanocomposites via Single Fiber Pushout*

swiss nano convention

Ceramic based nanocomposites – a processing challenge

Thomas Graule

Empa, Swiss Laboratories for Materials Science and Technology, Laboratory for High Performance Ceramics, Überlandstrasse 129, CH-8600 Dübendorf

thomas.graule@empa.ch

www.empa.ch

Abstract

Ceramic based nanocomposites will open new applications in structural applications in machine industry and for medical implants, for sensor development, in energy related technologies (fuel cells; hydrogen and synthetic fuel generation) as well as in environmental applications e.g. in nanofiltration and in photocatalysis based degradation of air and water pollutants.

To achieve a good performance of these nanocomposites, the efficient stabilisation of the ceramic based nanopowders is a prerequisite for the preparation of these highly reliable ceramic nanocomposites or as translucent or even transparent nanoparticle containing composites. Agglomeration or re-agglomeration due to Van der Waals forces can be avoided using different concepts to increase the separation barrier by electrostatic or steric means. Extensive studies using silica, alumina and zirconia submicron and nanoparticles were therefore performed in order to develop a basic understanding of the mechanism of dispersing small particles in polar and nonpolar medium. The effectiveness of the dispersants was evaluated on the basis of adsorption, zeta potential measurements, transparency and rheology measurements.

Some results for the application of such surface modified nanopowders in nanoceramics and nanocomposite development are shown.

Interface Characterization of EPD deposited CNT Nanocomposites via Single Fiber Pushout

Dr. Andrea Battisti

R&D Specialist

Carbo-Link AG

Undermülistrasse 25

CH-8320 Fehraltorf

www.carbo-link.com

Abstract

Electrophoretic deposition (EPD) of carbon nanotubes (CNTs) on carbon fibers has been implemented as a continuous process on laboratory-scale. The interfacial adhesion and fracture toughness of the carbon fibers in an epoxy composite is assessed by a modified single-fiber push-out test. A detailed energy analysis yields the different energy contributions in the push-out process. A comparison between CNT-deposited, as received and oxidized carbon fibers (passing through the EPD process without CNT) indicates that interfacial adhesion and fracture toughness are not affected by the different fiber treatments. Interfacial friction after fiber debonding, however, is significantly changed. This is confirmed by finite element simulation which has to include friction for reproducing the essential features of the load–displacement plots from fiber push-out. Scanning electron micrographs indicate little interaction between CNT and carbon fibers, but point to changes in surface roughness of CNT-deposited and oxidized fibers after push-out. Therefore, the cyclic loading–unloading fiber push-out test seems well suited to investigate the micromechanical behavior of carbon fiber composites and to discriminate and quantify the different energy contributions to the total load–displacement curves.

Nanofabrication

- **Ch. Rytka**, Inst. of Polymer Nanotechnology, FHNW, Windisch; *Mass Replication of Nanopatterns in Polymers*
- **Y. Ekinci**, Paul Scherrer Inst., Villigen, *Single-digit Nanolithography by EUV-Interference Lithography*
- **Ch. Dais**, Eulitha AG, Würenlingen, *PHABLER 100: An Innovative Tool for Low- Cost nano-Patterning of Large Areas*

swiss nano convention

Mass replication of nanopatterns in polymer

Christian Rytka[1], Per Magnus Kristiansen[1], Andreas Neyer[2]

[1] University of Applied Sciences and Arts Northwestern Switzerland (FHNW), Institute of Polymer Nanotechnology, 5210 Windisch, Switzerland;

[2] Technische Universität Dortmund, Fakultät für Elektrotechnik und Informationstechnik, Arbeitsgebiet Mikrostrukturtechnik (AG MST), 44227 Dortmund, Germany.

www.fhnw.ch/technik/inka

Abstract

Integration of functional nanopatterns on polymeric surfaces offers a wide range of potential applications for different markets, e.g. in optical and medical industry.

Realization of these applications in polymers requires fast and efficient mass production methods. With increasing complexity of the functional topography, perfect replication becomes more difficult by standard injection molding, especially with highly viscous polymers. For this reason four different injection molding processes (iso- and vario-thermal with and without compression) have been compared to each other and to hot and roll embossing with respect to replication quality applying polymers of different rheology.

Several fabrication routes for the master structures are being explored. A mask based displacement Talbot UV photolithography generating an optical image with a large depth of focus is one method to generate large area structures, conventional laser writing another one.

polyamide replica with nanopatterns

Alternatively, a maskless thermal scanning probe lithography method was used that is capable of fabricating 3D nanostructures below 50 nm resolution with a hot cantilever writing in a polyphthaladehyde thermal resist layer. The fabricated structures can then be transferred into a nickel shim by means of electroplating. The characterization of the injected molded nanostructures in comparison to the master structures provides new insights into replication processes of difficult functional structures with regards to replication accuracy, defect density, reproducibility and mold durability.

Single digit nanopatterning using EUV interference lithography

Yasin Ekinci

Laboratory for Micro and Nanotechnology, Paul Scherrer Institute, Switzerland

www.psi.ch/sls/xil

Abstract

Extreme ultraviolet (EUV) lithography at 13.5 nm wavelength is considered as the leading technology option for future nodes of high-volume manufacturing of semiconductor devices. EUV interference lithography (EUV-IL) combines the simplicity of IL and short wavelength advantage of EUV light, and therefore is an effective method of making high-resolution periodic and quasi-periodic nanostructures over large areas. EUV-IL tool at PSI is the world-leading tool with a resolution of down to 7 nm half-pitch, marking the record in photolithography. It is used for both academic and industrial research owing to its high resolution and well-defined aerial image, high throughput, and large area capabilities. Its industrial applications mainly involve development of EUV resists. It helps academic researchers by proving nanostructures for various applications such as directed self-assembly, nanomagnetism, nanophotonics, and nanoimprint templates.

PhableR 100: An innovative tool for low-cost nano-patterning of large areas

Christian Dais, Francis Clube, Li Wang, Harun Solak

EULITHA AG, 5303 Würenlingen, Switzerland

www.eulitha.com

Abstract

High-resolution periodic patterns such as linear gratings or two-dimensional arrays of structures are required in many new applications. This is especially true in photonics, where light management through nanostructures leads to higher performance and more efficient devices such as LEDs, photovoltaic panels and LCD screens. In order to address this emerging market, we have recently introduced a unique photolithography tool called PhableR 100 that enables low cost patterning of large areas with periodic structures. The new exposure tool is based on the Displacement Talbot Lithography technique developed by Eulitha. The tool is similar to a conventional mask aligner in terms of simplicity of operation and maintenance but has more than 10 times higher resolution, enabling printing of structures with a resolution of about 100nm. Full field exposures can be performed for seamless patterning of substrates up to 4” in diameter. The capabilities of this new tool and technique will be presented with examples of potential applications.

swiss **nano** convention

Nanoengineered Functional Materials

- **S. Vogel,** FHNW, Windisch, *Protective Effect of Alumina Layer on CF during CVD Processing for Hierarchical Composites*
- **C. Daraio**, ETHZ, Zürich, *Nano-structured Materials with Enhanced Mechanical Properties*
- **A. Stuck**, ETHZ, Zürich, *Mass Manufacturing of Nano-Structured Surfaces*

PROTECTIVE EFFECT OF THIN ALUMINA LAYER ON CARBON FIBRE TO PRESERVE TENSILE STRENGTH DURING CNT GROWTH BY CVD PROCESSING

Samuel Vogel

University of Applied Sciences and Arts Northwestern Switzerland,

Institute of Polymer Technology

http://www.fhnw.ch/ikt

samuel.vogel@fhnw.ch

Abstract

As received AS4 carbon fibres were covered with a thin alumina layer by atomic layer deposition prior to the growth of radially aligned carbon nano tubes onto the fibre surface. The deposition of alumina was found to preserve the initial fibre tensile strength in the harsh conditions during carbon nanotube growth by chemical vapour deposition. The fibre tensile strength was measured by single fibre tensile test for fibres treated with different processing parameters. The interphase properties between carbon fibre, alumina layer and matrix material were characterized by carrying out single fibre fragmentation tests. The length of the ongrown carbon nano tubes can exceed 7 µm, i.e. the carbon fibre diameter. Experiments prove that the deposited alumina layer with a thickness of as little as 12.8 nm preserves the fibres initial tensile strength.

Nanostructured materials with enhanced mechanical properties

Chiara Daraio

Chair of Mechanics and Materials, Department of Mechanical and Process Engineering (D-MAVT), ETH Zürich

http://www.mechmat.ethz.ch

Abstract

Engineered materials with unprecedented mechanical properties enable the design of new technology and are critical for many applications, ranging from novel protective foams for impacts and vibrations absorption, to scaffolds and surfaces for biomedical devices. We use computational models to design materials with tailored functional properties, by controlling their micro- and nano-structure geometry. We fabricate experimentally bulk samples of these materials and test their mechanical response in quasistatic and dynamic conditions. This talk will focus on examples of nanostructured materials designed for impact absorption, thermal sensing and vibration mitigation.

swiss nano convention

Part B, Posters

- **List of Posters displayed at the Swiss Nanoconvention 2014**
- **List of Posters displayed within the CTI Micro- and Nano Event 2014**
- **Abstracts of the SNC 2014 posters, as far as available**

swiss nano convention

SNC Posters

Arnold	Stefan	University of Basel	Single-Cell Lysis of Adherent Eukaryotic Cells
Barfuss	Arne	University of Basel	Spin-Optomechanics on Diamond Nanoresonators
Beni	Alessandra	Empa	Hard X Ray Photoelectron Spectroscopy study of nm- thick passive films
Bircher	Benjamin	C-CINA, Biozentrum, University of Basel	Poster: "High-speed viscometry using nanomechanical resonators"
Boudoire	Florent	Empa	Poster: "Light management in nanostructured water splitting photoanodes"
Bracher	David	University of Basel	The local electric behavior of insulating polymer surfaces
Burn	Andreas	Berner Fachhochschule - ALPS	"All Laser Scribing of CIGS Photovoltaic Panels on Rigid Substrates"
Cadeddu	Davide	University of Basel - Department of Physics	Nonlinear motion and mechanical mixing in as-grown GaAs nanowires
Dübner	Matthias	Paul-Scherrer-Institut / ETH Zürich	Nanostructured Light-Responsive Polymer Brushes
El idrissi	Mohamed	FHNW	Synthesis of iron oxide-doped CDP for the recovery of valuable phenolics...
Fan	Daniel	PSI	Ultra-dense 14 nm half-pitch silicon nanowires unsing extreme UV interference lithography
Ganzhorn	Marc	University Basel	Quantum sensing using single spins in diamond nanostructures
Gerspach	Michael	Swiss Nanoscience Institute/Paul Scherrer Institute	Poster: Towards trapping of biomolecules using nanofluidic devices
Giss	Dominic	C-CINA, Biozentrum, University Basel	Microfluidic isolation of protein complexes for electron microscopy
Herzog	Benedikt	Departement Physik, Uni Basel	Thermal and Statistical Polarisation in Nanometre-Scale Samples
Hestericova	Martina	Universität **Basel**	Imine Reductases based on Streptavidin-Biotin Technology in *E. Coli* Cell Free Extracts and Cell Lysates
Karim	Waiz	ETH Zurich/ Paul Scherrer Institute	High-resolution/large-area nanoparticle array for model system in catalysis
Kuentz	Martin	University of Applied Sciences Northwestern Switzerland	Pharmaceutical emulsion manufacturing: introducing DWS as a process analytical tool

Meier	Tobias	University of Basel	Aging of thin polymer films investigated by AFM
Menzel	Michael	Federal Institute for Materials Research and Testing (BAM)	Poster 1 : The new nano silver reference material BAM-N001 / Poster 2 : Advantages of dual wavelength detection for size determination of nanoparticles with analytical centrifugation
Tarik	Mohamed	PSI (Paul Schrrer Institut)	Online determination of size distribution and elemental composition of nanoparticle aerolols by a scanning mobility particle sizer coupled to an inductively coupled plasma mass spectometry (SMPS-ICPMS)
Moridi	Negar	fhnw	Reversible supramolecular modification of surfaces
Muoth	Matthias	ETH Zurich, Micro and Nanosystems	Mechanical strain in ultraclean carbon nanotube transistors
Nowakowska	Sylwia	Department of Physics, University of Basel	Exploration of on-surface click-chemistry
Pigozzi	Giancarlo	EMPA Swiss Federal Laboratories for Materials Science and Technology	Core-shell Nanoparticles via Electrochemical Selective Phase Dissolution
Pilger	Frank	Paul Scherrer Institut (PSI) / École Polytechnique Fédérale de Lausanne	Advanced CeO2-Nanopowders Synthesis in the Segmented Flow Tubular Reactor
Riedel	Daniel	University of Basel	Poster title: Efficient photon detection from single emitters in diamond
Rullaud	Vanessa	University of Applied Sciences and Arts Northwestern Switzerland	Calixarene-based solid lipid nanoparticles: DNA binding, a sequence-dependent interaction
Sauter	Nora	Swiss Nanoscience Institute, University of Basel	Probing the initial steps of bacterial biofilm formation
Stoop	Ralph	Universität Basel	The Essential Requirements of ISFET Sensors for Biochemical Detection
Tulli	Ludovico	FHNW	Nanostructured surfaces for the control of polymorphism of APIs
Voirin	Guy	CSEM	BIOSENSIT: Real-time signal processing of label-free biosensor signals for
Wipf	Mathias	Universität Basel	Poster: A Biochemical Sensor Based on an ISFET Platform
Bandera	Davide	Empa	Production and Applications of Nanocellulose

Tschupp	Simon	PSI	From light to Catalysis: Well-defined Structures for Electrochemistry
Signorello	Giorgio	IBM Research	Inducing a direct-to-pseudodirect bandcap transition in WZ GaAs nanowires
Plodinec	Marija	Uni Basel	Resolving the Mechanobiology of the Epithelium on Native Basement Membranes
Lütolf	Fabian	CSEM	Custom Nanostructures: From Design to Application
Rossmann	Harald	PSI	Device simulation and fabrication of novel 4H-SiC nano trench MOSFET devices
Zweifel	Ludovit	SNI, Basel	Glass Nanopores that exert biomimetic control over single molecule transport
Schwarz	Florian	IBM Research Zurich	Molecular Building Blocks for Nanoscale Electronics

Posters at CTI-Event 2014

Title	Authors	Institution
SpaceTracker	GRENET Eric	CSEM
MINImizing the DIE Size Using LASER Dicing (MiniDIE)	NEELS Antonia	CSEM
Assemblage de micro pièces silicium	PANNATIER Christophe	Sigatec SA
Entwicklung und Herstellung thermoelektrischer Generatoren für die Energieversorgung intelligenter Heizungsventile und weiterer Energy Harvesting Anwendungen	HELBLING Thomas	ETHZ
PICOFAB	KAUFMANN Julian	CSEM
SMARTFILL	SPINOLA Guido	CSEM
TRIGGER High-Efficiency Thin-Film Silicon Triple Junction Solar Cells	SCHUETTAUF Jan-Willem	EPFL
Capacitive Micro-machined Ultrasonic Transducers (CMUT)	KEPPNER Herbert	HE Arc
Novel reflective layer allowing a control of the quality of the microcrystalline solar cell in thin film Micromorph devices	KEPPNER Herbert	HE Arc
Lithography-free processing of interdigitated back-contacted silicon heterojunction solar cells with efficiency over 21 %	PAVIET-SALOMON Bertrand	EPFL
Wireless Aircraft Tire Pressure Sensing (WAITIPS)	PICHON Bertrand	Meggitt
CITSens Bio, a wireless disposable sensor array for disposable bioreactors	GLASER Nicolas	FHNW / CSEM
Woven substrates for organic light emitting diodes (WowLED)	FERNÁNDEZ Oscar	CSEM
SWiss Precision Electronic GRAvure PrintEr (SWIPEGRAPE)	SCHLEUNIGER Jürg	CSEM
All Laser Scribing of CIGS Photovoltaic Panels on Rigid Substrates	BURN Andreas	BFH Burgdorf
Pharmaceutical emulsion manufacturing: introducing DWS as a process analytical tool	MACHADO Alexandra	FHNW / CSEM
Magical Watch Dial	KALLWEIT David	CSEM
SWARM - Early warning point for toxins in water resources	WENGER Bernard	CSEM
Reinforcing the use of reconfigurable instructions in an ultra-low-power DSP	MORGAN Marc-Nicolas	CSEM
DVSense	CORBAZ Alexandre	CSEM
FASEM Fast Angular position Sensor for brushless Electric Motors	KEJIK Pavel	EPFL
QuanTime	KEIJK Pavel	EPFL
BIOSENSIT: Real-time signal processing of label-free biosensor signals for robustness and speed of measurement improvement	VOIRIN Guy	CSEM
Microstructured Glasssy Carbon for Glass Molding of Diffractive Optical Elements	PRATER Karin	EPFL
Printed flexible RFID label with CMOS temperature and humidity sensors	BRIAND Danick	EPFL

Development of a Novel Nanobiocatalyst

M.R. Correro,[1,‡] A. Cumbo,[3] H. Schützinger,[1] P. F.-X. Corvini[2] and P. Shahgaldian[1]

[1]Institute of Chemistry and Bioanalytics and [2]Institute for Ecopreneurship, School of Life Sciences, University of Applied Sciences and Arts Northwestern Switzerland, Muttenz, Switzerland; [3] INOFEA GmbH, Basel, Switzerland

www.fhnw.ch; www.inofea.com

Abstract

Biotechnological processes are based on the ability of enzymes to efficiently catalyze reactions. Enzymes, compared to chemical catalysts possess remarkable levels of chemo-, stereo-, and regio-selectivity. Nevertheless, their application is limited by their lack of stability in hostile physico-chemical environment. In order to overcome this limitation several methods of enzyme immobilization and protection have been established.[1,2]

Lately we developed a strategy to produce silica-based nanomaterial for virus recognition.[3] The synthetic strategy is based on the possibility to self-assemble silane building-blocks around a protein template, prior to their incorporation in a covalent and stable organosilica shell. Exploiting this chemical strategy, we have developed a novel type of nanobiocatalyst that, without manipulation of the protein sequence by genetic engineering or structural manipulation of the enzyme, allows the protection of the natural biocatalyst against chaotropic stresses.

The novel biocatalytic nanomaterial consists of enzymes immobilized on a solid carrier, namely silica nanoparticles (SNPs) and protected by an organosilica shell. Because of their chemical structure, the inner surface of the shell interacts with the outer surface of the immobilized enzyme, causing the stabilization of the three-dimensional structure of the protein. Thus, the protective shell establishes a resistant, porous nano-environment around the immobilized enzyme. As model system we immobilized β-galactosidase on SNPs and protected it with a silica shell. Compared to the native enzyme, the so produced biocatalytic-

---

‡rita.correro@fhnw.ch

[1] Wenshan, L.; • Liang, W.; • Rongrong, *J. Top. Catal*. **2012**, 55, 1146

[2] Rodrigues, R.C.; Ortiz, C.; Berenguer-Murcia, A.; Torresd, R. ; Fernandez-Lafuente, R. *Chem. Soc. Rev*. **2013**, 7, 6290

[3] Cumbo, A. ; Lorber, B. ; Corvini, P. F.-X. ; Meier, W.; Shahgaldian, P. *Nat. Commun*. **2013**, 4, 1503

nanomaterial showed resistance to temperature stress and to pH variation. In more detail, while the native enzyme kept only 10 % of its activity after incubation at 42 °C for 60 minutes, the protected enzyme preserved 90 % of its original activity. Similarly, while the native enzyme maintained only 20 % of its activity after incubation at pH 4.8 for 15 minutes, the protected enzyme preserved as much as 85 % of its activity.

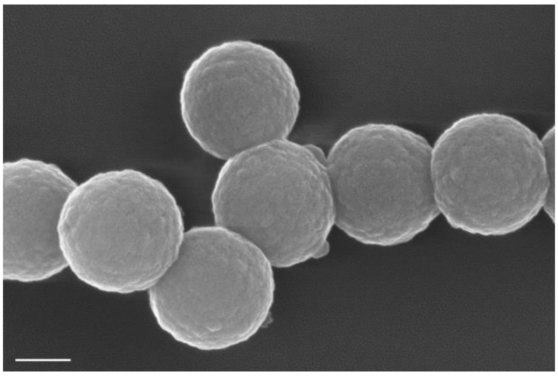


Figure 1. Scanning electron micrograph of the SNPs covered by the organosilica shell (scale bar 200 nm)

Custom Nanostructures: from Design to Applications

Fabian Luetolf, Luc Duempelmann, Benjamin Gallinet, David Kallweit, Guillaume Basset, Oscar Fernández, Ton Offermans, Martin Stalder, Angélique Luu-Dinh, Igor Zhurminsky, Nicolas Glaser, Christian Schneider, Rolando Ferrini, Marc Schnieper

Thin Film Optics, CSEM Muttenz

www.csem.ch

Abstract

Our main competences include the fabrication of periodic nanostructures which we apply in various fields such as light management, sensing and security. Examples of applications of our optical nanostructures are solid-state lighting devices, photovoltaic devices, light management foils, resonant sensors, identity cards and banknotes.

The fabrication methods therefore were refined over years and impose different challenges in up-scalability, rapid prototyping and low cost replication methods. This includes the application-tailored design, the simulation of the nanostructure and the wafer-scale origination with holography and/or lithography. Further we show the in-house tooling for diverse replication processes ranging from soft imprinting over steel structuring. Up-scalability of the moulds is achieved with step-and-repeat. The fabricated tools can be integrated into industrial injection moulding and roll-to-roll embossing processes. The optical properties of the nanostructures can be tuned by thin film deposition of various materials. This enables us to fabricate customized nanostructures for diverse applications.

Synthesis of iron oxide-doped cyclodextrin-based polymers for the specific recovery of valuable phenols from industrial streams.

M. El Idrissi,[‡] P. F-X. Corvini and P. Shahgaldian

Institute of Chemistry and Bioanalytics, School of Life Sciences, University of Applied Sciences and Arts Northwestern Switzerland, Muttenz, Switzerland

www.fhnw.ch

Abstract

Molecular recognition is of great interest for environmental applications and mostly when it comes to the removal of organic compounds from industrial streams. Several methods have been developed for the removal of organic compounds from water (activated carbon, resins) to prevent environmental damages. Nonetheless these methods do not or very few exploit or valorize the removal of these organic compounds from wastewaters. The olive oil industry is known to produce a large amount, up to 30Mm^3, of olive mill wastewater (OMW)[1] each year with a high level of organic compounds, including polyphenols. Polyphenols are natural anti-oxidants which properties can be exploited in numerous fields (food, pharmaceutical and agriculture to name but a few),[2] therefore there removal from wastewater could be valorized in multiple ways.

Supramolecules (curcubit, calixarene) are attractive for the capture of organic compounds because of the complexes they form with guest molecules. Among these supramolecules, we selected cyclodextrin for the host-guest complexes that it could form with phenols. And we decided to use cyclodextrin within polymer. Cyclodextrin-based polymers appeared to be great candidates for removal of such compounds from waters. We had previously designed cyclodextrin-based polyurethanes with molecular recognition properties for active pharmaceutical ingredients (APIs).[3]

In this poster, we report the successful synthesis of cyclodextrin-based polyurethanes doped with iron oxide (Fe_3O_4) nanoparticles and its efficient capture of phenols from OMW. The presence of Fe_3O_4 nanoparticles within the polymer allows the recovery of CDPs by magnetic separation. Different cyclodextrin-based polymers have been synthesized and each cyclodextrin-based polyurethane complexes a different set of phenols.

---

‡ mohamed.elidrissi@fhnw.ch

1 Tsagaraki, E.; Lazarides ,H. N.; Petrotos, K. B.; *Olive mill wastewater treatment* in *Utilisation of by-products and treatment of waste in the food industry*, V.Oreopoulou & W. Russ Eds., Springer, **2007**,Vol 3, 133-157.

2 Bertin, L.; Ferri, F.; Scoma, A.; Marchetti, L.; Fava, F. *Chem. Eng. J.* **2011**, *171*, 1287.

3 Xiao, P.; Dudal, Y.; Corvini, P. F. X.; Pieles, U.; Shahgaldian, P. *Polym. Chem.* **2011**, *2*, 1264.

Reversible supramolecular modification of surfaces

Negar Moridi, Philippe F.-X. Corvini, Patrick Shahgaldian*

University of Applied Sciences Northwestern Switzerland, Gründenstrasse 40, 4132 Muttenz, Switzerland

www.fhnw.ch

Abstract

Enzymes are widely used in a number of industrial biotech processes as they offer clear advantages over alternative chemical catalysts, such as high specificity, selectivity and turnover ratios. Nevertheless, the use of biocatalysts is restricted by their intrinsic fragility and high water solubility. Indeed, in order to recover enzymes in biotech processes, they have to be immobilized on solid supports.[1] In this poster, the development of a new supramolecular strategy, to functionalize polymeric filtration membranes with enzymes is presented.[2] This approach allows regenerating and changing the enzymatic functionalities of filtration membranes "in-place" during their industrial use (Figure 1).

The developed supramolecular surface modification approach is based on a supramolecular complex formation between an enzyme-functionalized soluble guest and a host covalently immobilized on a surface. β-cyclodextrin as "host" molecules were covalently immobilized at surfaces of filtration membranes. The chemical modification of the polymeric membrane was based on a coupling reaction between activated carboxylic acids, introduced at surface of membranes and amine functions of β-cyclodextrin.

Multivalent polymeric "guest" molecules possessing adamantyl functions as guest moieties and laccase as a biocatalyst were synthesized. This system is shown to form supramolecular complexes and immobilize the biocatalyst, in a reversible fashion, on filtration membrane surfaces.

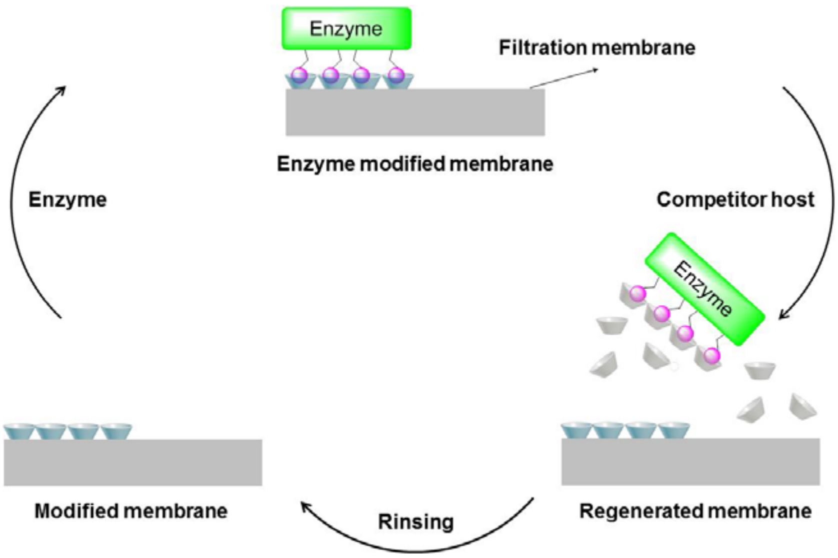


Figure 1. Schematic representation of the strategy for the reversible surfaces functionalization of polymeric filtration membranes

References

1) Illanes, A. *Enzyme Biocatalysis: Principles and Applications*; Springer: 2008.

2) Ludden, M. J. W.; Reinhoudt, D. N.; Huskens *J. Chem. Soc. Rev.*, **2006**, 35, 1122-1134.

Device simulation and fabrication of novel 4H-SiC nano trench MOSFETs

H.R. Rossmann[1,2], F. Zanella[3], N. Marjanovic[3], R. A. Minamisawa[4], H. Bartolf[4], T.A. Jung[1,2], E. Meyer[2], J. Gobrecht[1] and M. Schnieper[3]

[1] Laboratory for Micro- and Nanotechnology, Paul Scherrer Insititute, CH-5232 Villigen PSI, Switzerland
[2] Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland
[3] CSEM Muttenz, Tramstrasse 99, CH-4132 Muttenz, Switzerland
[4] ABB Switzerland Ltd, Corporate Research, Segelhofstrasse 1K, CH-5405 Dättwil, Switzerland
harald.rossmann@psi.ch

Abstract

The two main figures of merit of power semiconductor devices are (i) a high blocking voltage capability, which minimizes the reverse current in the OFF-state and (ii) a low ON-state resistance when the device is operated under forward conditions. In silicon trench technology the trade-off between these two entities has been improved [1] at the cost of highly demanding manufacturing processes. Nevertheless, in high power silicon technology physical limits have been reached. Superior material properties of 4H-SiC, such as a higher critical electric field and a higher thermal conductivity [2], have led to the development of SiC based planar MOSFETs which demonstrated their potential in terms of low power dissipation [3]. However, low channel mobilities and an increasing junction-FET resistance with the downscaling of these devices limit their performance significantly. In order to combine the better material properties of SiC with the well-established trench technology for device tuning, we present optimized simulations of a 4H-SiC nano trench MOSFET, with 3 µm depth and widths ranging from 500 nm up to 3 µm. The simulated devices out-perform state-of-the-art SiC planar MOSFETs in terms of channel mobilities and additionally the junction-FET resistance is eliminated [4]. The impact of the trench geometry on the mobility and the electrical field distribution is studied systematically.

[1] H. Bartolf *et al*, IEEE Transactions on Semiconductor Manufacturing, 26, 4, 529 (2013)
[2] M. Östling, Proc. 23rd Int. Symp. Power Semicond. Devices ICs, pp. 10-15 (2011)
[3] A. Bolotnikov *et al*, Proc. ISPSD2012, Bruges, Belgium, 389 (2012)
[4] J. Baglia, Fundamentals of Power Semiconductor Devices, Springer, New York, USA (2008)

swiss nano convention

Swiss NanoConvention 2014 Brugg, May 21-22, 2014

Guanidino calixarene, self-assembly and DNA sequence-dependent interaction

V.Rullaud, [a, ‡] A. Cumbo, [b] N. Moridi [a] and P. Shahgaldian [a*]

[a] Institute of Chemistry and Bioanalytics, School of Life Sciences, University of Applied Sciences and Arts Northwestern Switzerland, Muttenz, Switzerland

[b] INOFEA AG, Basel, Switzerland

www.fhnw.ch

Abstract

An effective gene therapy requires the design of a vector able to transfer the genetic information to the target cells. Significant efforts have been dedicated to develop effective synthetic carrier systems able to protect and transport DNA, to deliver the genetic information into the cell nucleus. Molecules that possess self-assembling properties like cationic lipids are promising delivery system, as their cationic charges can interact with the negatively charged DNA and carry the genetic information to its target.[1] Among cationic amphiphiles, calixarenes are attractive molecules, their unique conical structure can be designed to bear several cationic charges and therefor form complex cationic amphiphiles able to interact with DNA molecules.[2] A natural cationic biopolymer like chitosan able to interact with anionic components as nucleic acids can be used to protect DNA and ensure the delivery of DNA into the target cell.[3]

In this poster, we report on a new cationic amphiphilic calixarene functionalized with four guanidino moieties as recognition sites, and four dodecyl chains as hydrophobic part. This cationic calixarene is able to self-assemble as stable monolayer at the air-water interface. We demonstrate that the interaction of the monolayer with DNA at the interface is dependent on the DNA sequence. Furthermore, this calixarene is also able to self-assemble in water as stable solid lipid nanoparticles (SLNs). An ethidium displacement assay revealed the ability of the calixarene-SLNs to interact with double-stranded DNA. The effect of ionic strength on the fluorescence displacement experiment experiments indicated that the binding is not purely electrostatic. Circular dichroism and isothermal titration calorimetry

experiments demonstrated that the binding also occur through a groove binding mechanism. To deliver DNA into the target cell, the nanoparticles were modified using the layer-by-layer technique, several DNA-chitosan layers were added around the calixarene-SLNs. Our results point out the importance of the DNA sequence in the mechanism of interaction between the DNA phospho-diester backbone and the guanidinium head of the calixarene.

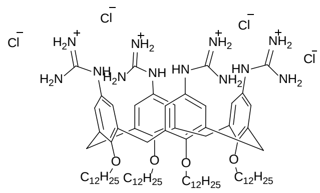


Figure 1. Para-guanidino-calix[4]arene

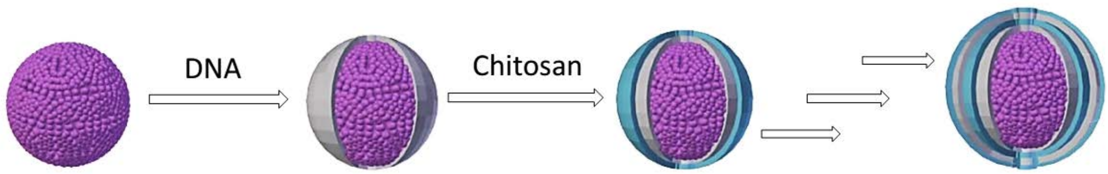


Figure 2. Layer by layer assembly of DNA-chitosan onto calixarene-based SLNs

[‡] vanessa.rullaud@fhnw.ch
[1] Curiel, D. T.; Douglas, J. T. eds., *Vector Targeting for Therapeutic Gene Delivery*, John Wiley & Sons, Inc., Hoboken, NJ, USA. **2002**.
[2] Helttunen, K.; Shahgaldian, P. *New J. Chem.*, **2010**, *34*, 2704.
[3] Nault, L.; Cumbo, A.; Pretot, R. F.; Sciotti, M. A.; Shahgaldian, P. *Chem. Commun*, **2010**, *46*, 5581.

Silica biomineralization applied to the synthesis of virus binding recognition nanomaterial

S. Sykora[a‡], A. Cumbo[b] and P. Shahgaldian[a*]

[a]Institute of Chemistry and Bioanalytics, School of Life Sciences, University of Applied Sciences and Arts Northwestern Switzerland, Muttenz, Switzerland

[b]INOFEA GmbH, Basel, Switzerland

www.fhnw.ch

Abstract

Silica biomineralization is a fascinating process that allows living organism to incorporate inorganic silicon to complex organic–inorganic hybrid materials, which feature high level of hierarchical organization and functionality. Complex biosilica are mainly found in marine organisms, such as diatoms and sponges, and are formed under the influence of proteins, which act as structural templates and mechanistic catalysts for the condensation of tetraethyl orthosilicate into complex structures[1]. Inspired by the building principles and components of protein-templated silica condensation, we established a strategy to design organic-inorganic hybrid nanomaterials that recognizes non-enveloped icosahedral viruses.

The method we developed to produce virus-recognition nanomaterials follows the principles of a surface imprinting approach and comprises the use of silica nanoparticles as a carrier material and organosilanes as biomimetic building blocks[2].

The proof of principle was recently reported by our research group employing plant viruses as templates. These synthesized virus-imprinted nanoparticles (VIP) shown to possess remarkable selectivity and affinity for their target virus[2]. The aim of the present work is to adapt the VIP synthesis on human pathogen viruses. However, performing the synthesis with high amounts of infectious viruses is not possible due to the high risk of health hazard. In order to circumvent this, we decided to use virus-like particles (VLPs), which present self-

assembled protein structures with identical or highly related overall structure to their corresponding native viruses, but lacking pathogenicity.

The outcome of this work proves the possibility of creating recognition layer for binding of infectious pathogens under the use of VLPs as safe replacement. Furthermore, these studies also provide new information about the condensation reaction and its dependence on properties of template protein.

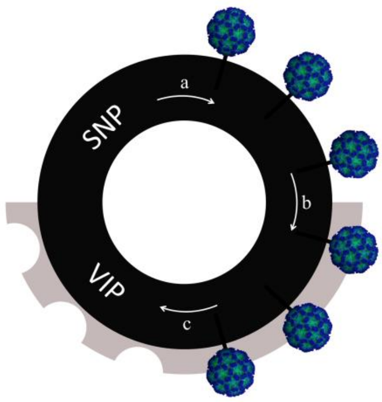


Figure 1. Schematic strategy for the design of virus-imprinted nanoparticles (VIPs)

‡sabine.sykora@fhnw.ch

[1] Kröger, N., Deutzmann R., Sumper A.; *Science*. **1999**, 286, 5442.

[2] Cumbo, A., Lorber, B., Corvini, P. F.-X., Meier, W., Shahgaldian, P.; *Nat. Commun.* **2013**, 4, 1503.

Polymorphism control of gabapentin using calixarene-based Langmuir monolayers

Ludovico Tulli, Negar Moridi and Patrick Shahgaldian*

Institute of Chemistry and Bioanalytics, School of Life Science, University of Applied Sciences Northwestern Switzerland, Gründenstrasse 40, Muttenz CH-4132, Switzerland

www.fhnw.ch

Abstract

Several active pharmaceutical ingredients (APIs) exist as more than one polymorphic form. Each form may exhibit different physicochemical properties, having a dramatic effect on the ability to process and manufacture the drug product. Besides the modulation of the physical and chemical crystallization conditions, heterogeneous nucleation may represent an additional parameter for the control over the polymorphism of APIs.

Langmuir monolayers have been extensively exploited as templates for the crystallization of inorganic molecules (*e.g.* $CaCO_3$) at the air-water interface.[1] Recently, our group demonstrated that the quantity of produced acetaminophen crystals at the air-water interface can be controlled by varying the compression rate of monolayers of a calix[4]arene derivative.[2] In this work, we show for the first time that the polymorphism of gabapentin (GBP), an API used to relieve neuropathic pain, is controlled by modulating the packing density of tetra-dodecyl-*p*-carboxy-calix[4]arene monolayers. Indeed, the monolayer with high packing density templates the nucleation of the polymorph α while the monolayer with a low packing density kicks off the crystallization of the polymorph ɣ. Grazing incidence X-ray diffraction measurements were performed to shed light on the structure of the film. It is demonstrated that, while the fully compressed monolayer possesses 2D crystalline domains, the partially compressed monolayer is amorphous. Therefore, even the film deprived of long-range order can act as template for the nucleation of one polymorphic form of GBP.[3]

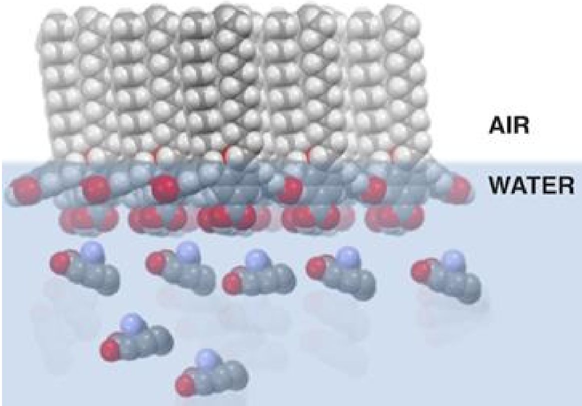


Figure 1: Graphical representation of the interfacial crystallization of GBP.

[1] Mann, S.; Heywood, B. R.; Rajam, S.; Birchall, J. D. *Nature* **1988**, *334*, 692.
[2] Moridi, N.; Elend, D.; Danylyuk, O.; Suwinska, K.; Shahgaldian, P. *Langmuir* **2011**, *27*, 9116.
[3] Tulli, L.; Moridi, N.; Wang, W.; Hettulnen, K.; Neuburger, M.; Vaknin, D.; Meier, W.; Shahgaldian, P. *Chem. Commun.* **2014**, *50*, 3938.