Nanotech Northern Europe 2007

Largest nanotechnology event in Northern Europe!

Program

Nanotech
Northern Europe
2007
www.nanotech.net

Abstracts

NTNE2007
Congress & Exhibition
27-29 March 2007
Helsinki, Finland

Information

Event Partners

NOKIA Connecting People · Tekes · Veeco · norden Nordic Innovation Centre · Millennium Prize Foundation

We would like to thank the following people and organizations for making this event possible

Nanotech Northern Europe 2007 Executive Committee:

Yrjö Neuvo *(Chair)*
Professor and Technology Advisor, formerly Executive Board Member, CTO of Nokia Corporation

Markus Pessa
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Heli Jantunen
Professor, University of Oulu

Arto Urtti
Professor, University of Helsinki

Jouko Korppi-Tommola
Professor, University of Jyväskylä

Event Partners:

NOKIA Connecting People · Tekes · Veeco · norden Nordic Innovation Centre · MILLENNIUM PRIZE FOUNDATION

Media Partners:

nanotoday · SMALLTIMES · mst news · Springer the language of science · nanotechweb.org The world service for nanotechnology · wtc

Organising Partners:

Nano Øresund · ENTA The European Nanotechnology Trade Alliance

Lead Organiser:

SPINVERSE Capital & Consulting

Spinverse Consulting
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NTNE 2007 is a China-EU Science & Technology Year event

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Foreword

Welcome to Nanotech Northern Europe 2007!

In three years, Nanotech Northern Europe has grown to be one of the major nanotechnology events in Europe. The 2007 congress brings together over 500 high-level experts, leading companies, policymakers and investors, as well as over 70 innovative companies in the exhibition.

With well over 20 sessions and 100 speakers, Nanotech Northern Europe covers the full range of nanotechnology-related topics, from the latest scientific breakthroughs to the challenges and opportunities of commercialisation, as well as health and safety as an important part of responsible development.

Commercial development is moving fast with lots of new nanotechnology-enabled products now appearing on the market and global industry leaders showing increasing interest. For example, Nokia has increased the scale and scope of its nanotechnology activities.

In Finland, the number of companies actively involved with nanotechnology has more than doubled in just two years. Over 40 companies have commercial products on the market. Much of the success can be ascribed to Finland's National Nanotechnology Programme (FinNano), funded by Tekes, the Finnish Funding Agency for Technology and Innovation.

The key objective of Nanotech Northern Europe is to create partnerships that cross the borders between scientific disciplines, industries and countries. This is what we mean by "Making Nanotechnology Happen".

We have participants from 22 of the 27 EU member states which creates excellent opportunities to find those missing partners for EU Framework Programme 7 projects. Nanotech Northern Europe is also an official China-EU Science & Technology Year Event, and we hope that you take this opportunity to establish new links with your Chinese or European colleagues.

We wish you the most invigorating, thought-provoking and enjoyable three days in Helsinki!

Pekka Koponen
Event Director
Spinverse

***Spinverse** accelerates the commercialisation of nanotechnology. Spinverse combines scientific and industrial expertise to produce information about the development and market potential of nanotechnology, evaluates the most promising applications, and showcases the achievements of the leaders in the field. Spinverse is the lead organizer of Nanotech Northern Europe and the coordinator of Tekes FinNano Technology Programme.*

Nanotech Northern Europe 2007 – Spinverse Organising Team

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Poster Awards

During the conference the poster awards committee will review all posters and will award the most distinguished.

The Poster Award Committee

Heli Jantunen
Professor, University of Oulu

Arto Urtti
Professor, University of Helsinki

Jouko Korppi-Tommola
Professor, University of Jyväskylä

Poster Categories

- Nanobiotechnology and diagnostics
- Nanoelectronics and nanophotonics solutions
- Nanomaterials and particles
- Nanotechnology instruments and tools

The poster awards will be presented to the winners on Wednesday at the Helsinki City reception.

General Information

Registration and information desk

Situated at the main entrance (Southern Entrance) to Helsinki Fair Centre.
Opening hours:

Tue	27.3.	*8:00 - 17:00*
Wed	28.3.	*8:00 - 17:00*
Thurs	29.3.	*8:00 - 17:00*

Badges

Congress delegates are required to wear badges at all times. With the badge, delegates have access to all congress sessions, Nanotech and ChemBio Finland 07 exhibitions, congress meeting area, congress lunch and coffee area (separate lunch and coffee vouchers are included in the delegate bags) and social programs. Badges and other congress material should be picked up from the congress registration.

Lunch and coffee

Lunch and coffee are served in the Coffee & Lunch area in the Exhibition Hall for registered congress delegates and participants of the FinNano Annual Seminar (27th March 2007). Congress delegates have been issued lunch and coffee vouchers in their delegate bags. Please remember to bring a voucher with you for coffee/lunch.

Evening networking events

All congress delegates are invited to join the following networking events:

Networking Reception, Tue 27th March, 17:00
Winter Garden, Helsinki Fair Centre

Helsinki City Reception - Announcement of poster winners, Wed 29 March, 19:00
Helsinki Town Hall (Pohjoisesplanadi 11-13, in the City Centre by the central market square)
Please bring your invitation card (included in the congress bag).

CONTACT DETAILS

NTNE2007 Organizer

Spinverse Consulting

Congress Info and Registration Desk

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Exhibitor List

Acreo AB	6h27
Anton Paar Benelux BVBA	6e26
ASTRaL Lappeenranta University of Technology	6c26b
BFI OPTILAS AB	6d27
BTK/Turku Centre for Biotechnology	6c41
CeNano, Linköping University	6k20
Chalmers University of Technology	6h25
Cheos Oy	6f22
Commonwealth of Pennsylvania	6k18
CSEM SA	6d25a
Danmarks Tekniske Universitetet	6e22
Dekati Ltd	6e27
DelsiTech Ltd	6c41
Ekonia Oy	6e23
FEI Company	6d28
Feinmess Dresden GmbH	6b26
FMV	6k22
FUJIFILM Dimatix Inc.	6d25
GenoSyst Ltd	6c41
HelsinkiNano	6e27
HY Kiihdytinlaboratorio	6e27
IMAPS Europe	6e25
Innomedica Ltd	6c41
Institute of Chemical Physics, Univeristy of Latvia	6k25
Kelvin Nanotechnology Ltd	6d24
Oy Keskuslaboratorio - Centrallaboratorium Ab	6e27
KTH Elektrum Laboratory	6k21
Laborexin Oy	6f26
Labtronic Oy	6b29
Laser 2000 AB	6c26
L.O.T. -Oriel GmbH & Co KG	6c27
Micronova - Centre for Micro and Nanotechnology	6e27
MIKES Mittaustekniikan keskus	6e27
Nano Öresund	6d21
Nano-Science Center at the University of Copenhagen	6e20
Nanoclay and Technologies Inc	6c25
Nanogap Sub-Nm-Powder S.A.	6k26
Nanometer Structure Consortium, Lund	6d23
NanoScience Center at University of Jyväskylä	6h23
NanoSight Ltd	6c31
National Nano Cluster	6b25b
Nature Publishing Group	6b24
NIL Technology ApS	6k19
Phadia AB	6c29
Picosun Oy	6d29
Planar Systems Oy	6e27
Raith GmbH	6c24
Riso National Laboratory	6k23
SINTEF Materials and Chemistry	6h19
Spectral Solutions AB	6a21
Spinverse Consulting	6f24

Springer	6d26
ST Instruments	6b27
Tampere University of Technology	6k24
Tecan Ltd	6c28
Tekes - FinNano, Symbio	6a27
TKK Uusien Materiaalien keskus UMK	6e27
University of Oulu	6h21
Veeco Instruments	6a25
VTT	6e24
Åbo Academi University	6k27

Exhibitors by product group

Instruments and tools (incl. modeling software)
Academy of Finland - Suomen Akatemia 6c51
Agilent Technologies Finland Oy 6f62
Anton Paar Benelux BVBA 6e26
Cheos Oy 6f22
Dekati Ltd 6e27
Ekonia Oy 6e23
FEI Company 6d28
Feinmess Dresden GmbH 6b26
Gammadata Instrument AB 6e34
HAMILTON Robotics GmbH 6g31
Hosmed Oy 6e33
HY Kiihdytinlaboratorio 6e27
KSV Instruments Ltd 6d53
Laborexin Oy 6f26
Labtronic Oy 6b29
Laser 2000 AB 6c26
Micronova - Centre for Micro and Nanotechnology 6e27
MIKES Mittaustekniikan keskus 6e27
NanoSight Ltd 6c31
Oleinitec Oy Ab 6h42
PAMAS GmbH
Picosun Oy 6d29
Raith GmbH 6c24
Sigma-Aldrich Finland Oy 6e32
Sintrol Oy 6d31
Spectral Solutions AB 6a21
ST Instruments 6b27
Suomen toimisto 6b51
Sympatec GmbH 6g52
Veeco Instruments 6a25

Chemicals and materials
Academy of Finland - Suomen Akatemia 6c51
HY Kiihdytinlaboratorio 6e27
KTH Electrum Laboratory 6k21
Lab-dig Oy / Validcom Ky 6f36
Laborexin Oy 6f26
Micronova - Centre for Micro and Nanotechnology 6e27
Nanoclay and Technologies Inc 6c25
Nanogap
Sub-Nm-Powder S.A. 6k26
NanoSight Ltd 6c31
PerkinElmer Finland Oy 6f38
Sigma-Aldrich Finland Oy 6e32
Suomen Teknohaus Oy 6h38
TKK Uusien Materiaalien keskus UMK 6e27
VTT Technical Research Centre of Finland 6e42

Electronics
Academy of Finland - Suomen Akatemia 6c51
Gammadata Instrument AB 6e34
HY Kiihdytinlaboratorio 6e27
IMAPS Europe 6e25
Kelvin Nanotechnology Ltd 6d24
KTH Electrum Laboratory 6k21
Micronova - Centre for Micro and Nanotechnology 6e27
MIKES Mittaustekniikan keskus 6e27
Suomen Teknohaus Oy 6h38
TKK Uusien Materiaalien keskus UMK 6e27
VTT 6e24
VTT Technical Research Centre of Finland 6e42

Nanobiotechnology, life sciences, energy
Academy of Finland - Suomen Akatemia 6c51
BFI OPTILAS AB 6d27
Biofellows Oy 6c43
DelsiTech Ltd 6c41
Gammadata Instrument AB 6e34

HY Kiihdytinlaboratorio 6e27
Kelvin Nanotechnology Ltd 6d24
L.O.T. -Oriel GmbH & Co KG 6c27
Micronova - Centre for
Micro and Nanotechnology 6e27
Phadia AB 6c29
QIAGEN Finland, filial
av QIAGEN AB Sverige 6b49
Sigma-Aldrich Finland Oy 6e32
Spinverse Consulting 6f24
ST Instruments 6b27
Tekes - FinNano, Symbio 6a27
TKK Uusien Materiaalien
keskus UMK 6e27
VTT 6e24
VTT Technical Research
Centre of Finland 6e42

Research and professional services
Academy of Finland -
Suomen Akatemia 6c51
Acreo AB 6h27
CeNano 6k20
Chalmers University
of Technology 6h25
Commonwealth of
Pennsylvania 6k18
Danmarks Tekniske
Universitetet 6e22
FMV 6k22
Gammadata Instrument AB 6e34
GTK Kemian Laboratorio 6e35
HelsinkiNano 6e27
HY Kiihdytinlaboratorio 6e27
IMAPS Europe 6e25
Institute of Chemical Physics 6k25
Invenire Market
Intelligence Oy 6c41
Kelvin Nanotechnology Ltd 6d24
Oy Keskuslaboratorio -
Centrallaboratorium Ab 6e27
Kolster Oy Ab 6d49
KTH Electrum Laboratory 6k21
Micronova - Centre for Micro and
Nanotechnology 6e27
MIKES Mittaustekniikan
keskus 6e27
Nanometer Structure
Consortium 6d23
NanoScience Center
at University of Jyväskylä 6h23
National Nano Cluster 6b25b
PerkinElmer Finland Oy 6f38
Riso National Laboratory 6k23
SINTEF Materials and Chemistry 6h19
Spinverse Consulting 6f24
Springer 6d26
Tampere University of
Technology 6k24
TKK Uusien Materiaalien
keskus UMK 6e27
University of Oulu 6h21
VTT 6e24
VTT Technical Research
Centre of Finland 6e42
Åbo Academi University 6k27

Other
Asianajotoimisto
Jukka Kallio Oy 6d50
Commonwealth of
Pennsylvania 6k18
Dekati Ltd 6e27
Feinmess Dresden GmbH 6b26
FUJIFILM Dimatix Inc. 6d25
Gammadata Instrument AB 6e34
Innomedica Ltd 6c41
Kolster Oy Ab 6d49
Laborexin Oy 6f26
Oleinitec Oy Ab 6h42
OPAM Instruments 6g43
Pineco Trading Oy 6g33
Tecan Ltd 6c28
Tekes - FinNano, Symbio 6a27
VTT 6e24

Map of Exhibition Area

Program: Tuesday 27th March

	Pre-Congress Workshop: FinNano Annual Seminar (Ballroom)	
	Chair: **Markku Lämsä**, Programme Manager, Tekes	
9:00	*Opening:* **Petri Peltonen**, Director, Technology Department, Ministry of Trade and Industry	
9:20	*FinNano Programme Status:* **Markku Lämsä**, Programme Manager, Tekes	
9:35	*National Strategy for Nanotechnology in Finland:* **Pekka Koponen**, Managing Director, Spinverse	
9.50	*FinNano Research Project:* **Päivi Törmä**, Professor, University of Jyväskylä	
10:10	*FinNano Company Project:* **Antti Valtakari**, Managing Director, Montreal Sports	
10:30	**Coffee** (Coffee & Lunch area, Exhibition Hall)	
11:00	*"Nanolife" - Nanobiotechnology Vision for Finland:* **Juhani Luotola**, Orion Diagnostica	
11:25	*Nanotechnology in the EU Framework Programme 7:* **Nicholas Deliyanakis**, European Commission	
11:55	*Introduction to partnering program:* **Laura Juvonen**, Programme Coordinator, Spinverse	
12:00	**Lunch and Exhibition** (Coffee & Lunch area, Exhibition Hall)	
12:30	**FinNano poster session**	
13:30	**FinNano** (Ballroom 1)	**FinNano** (Ballroom 2)
	Nanotechnology Materials and Processes	*Nanotechnology Solutions for Electronics*
	Chair: **Anneli Ojapalo**, Director, New Concept Development & IPR, Perlos Corporation	*Chair:* **Veli-Pekka Leppänen**, CEO, Nanocomp Oy
	Nanopatterned, porous inorganic films - synthesis and applications (15mins). **Mika Linden**, Åbo Akademi	*Organic solar cell based on layered molecular (15mins).* **Helge Lemmetyinen**, Tampere University of Technology
	Isotropic Liquid Crystalline Nanocomposite as an Advanced Packaging Material for Future MEMS and NEMS Systems (15mins). **Markku Lyyra**, VTI Technologies Oy	*Molecular Scale Memory Elements (15mins).* **Andreas Johansson**, University of Jyväskylä
	Production of cobalt and nickel nanoparticles by hydrogen reduction (15mins). **Johanna Forsman**, VTT, Fine Particles	*Nanofabrication Development at Micronova - TKK (15mins).* **Veli-Matti Airaksinen**, Helsinki University of Technology
	Advanced catalytic products by utilization of nanotechnology (15mins). **Toni Kinnunen**, Ecocat	*Optical magnetic metamaterials (15mins).* **Sergei Tretyakov**, Helsinki University of Technology
	Versatile Atomic Layer Deposition System - A Flexible Research Platform and a Reliable Production Unit (15mins). **Sami Sneck**, Beneq	*Institute for Semiconductor Technology & Nanoelectronics (15mins).* **Udo Schwalke**, Darmstadt University of Technology
	Nanotechnology for a Mass Production Industry (15mins). **Thad Maloney**, KCL	
15:00	**Closing coffee**	
15:30	**Grand Opening** (101)	
	Visions 2007 is the joint opening for Nanotech Northern Europe and ChemBio Finland 2007 *Panelists:* President & CEO **Jukka Viinanen**, Orion Corporation Professor **Erkki Ruoslahti**, Burnham Institute for Medical Research and the University of California Managing Director **Mark Sutton**, 3M Finland and Baltic Countries Director General **Jukka Pekkarinen**, Ministry of Finance Senior Vice President, R&D **Tiina Mattila-Sandholm**, Valio Ltd *Challengers:* Senior Adviser **Nina Etelä**, Nordic Innovation Centre Professor **Markus Mäkelä**, University of Turku The panel is hosted by Journalist **Leena Brandt**.	
17.00	**Networking reception** (Winter Garden)	

Program: Tuesday 27th March

13:30	**FinNano** (201)
	Nanotechnology Networks and Cooperation
	Chair: **Laura Juvonen**, Spinverse
	Nano Science and Technology Research in Shanghai (15mins). **Hongchen Gu**, Jiaotong University
	NaNet – The Danish Nanotechnology Network (15mins). **Morten Bøgedal**, NaNet, Danmarks Tekniske Universitet
	Nanoforum – Europe's Nanotechnology Gateway (15mins). **Tom Crawley**, Spinverse
	Nanonet Styria – Austrian Nanotechnology Network (15mins). **Brigitte Kriszt**, Montanuniversität Leoben, Austria
	Nano and Microsystems and Future Materials Cluster in Finnish Centre of Expertise Programme 2007-2013 (15mins). **Esko Peltonen**, Jyväskylä Innovation Ltd

Program: Wednesday 28th March

8:45	**Keynote session** (101cd)	
	Chair: Professor **Yrjö Neuvo**, Technology Advisor, formerly CTO of Nokia Corporation	
	Welcome: NTNE 2007 Event Director **Pekka Koponen**, Managing Director, Spinverse	
	Recent Performance of Nonpolar/Semipolar/Polar GaN-based Blue LEDs and LDs (30mins). Professor **Shuji Nakamura**, University of California, Santa Barbara, USA	
	Mastering the interface to physical world (30mins). **Tapani Ryhänen**, Head of Nano Sciences Laboratory, Nokia Research Center	
10:00	**Coffee** (Coffee & Lunch area, Exhibition Hall)	
10:30	**Photonics 1: *Nanophotonics for ICT*** (101cd)	**Nanomaterials 1: *Nanostructured materials*** (Ballroom 1)
	Chair: **Harri Lipsanen**, Professor of Nanotechnology, Helsinki University of Technology	*Chair:* **Tapani Ryhänen**, Head of Nano Sciences Laboratory, Nokia Research Center
	Electromagnetic Coherence in Nanophotonics (25mins). **Ari Friberg**, Royal Institute of Technology, Sweden	*Nanomaterials and nanosciences (25mins).* **Marc Drillon**, Institute of Physics and Chemistry of Materials, Strasbourg
	Display Applications of Carbon Nanotube Composite (20mins). **In Taek Han**, Samsung	*(20mins).* **Elmar Keßenich**, BASF
	Performance of Quantum Dots-in-a-Well Infrared Photodetectors – Status and Prospects (15mins). **Linda Höglund**, Acreo, Sweden	*Zinc oxide and titania nanostructured layers by wet chemical methods (15mins).* **Malle Krunks**, Tallinn University of Technology, Estonia
	Single Polymer Nanowire Nanolasers (15mins). **Gareth Redmond**, Tyndall National Institute, Ireland	*Colloidal synthesis and growth mechanism of asymmetric nanocrystal heterostructures (15mins).* **Raffaella Buonsanti**, CNR-INFM, Lecce, Italy
12:00	**Lunch and Exhibition** (Coffee & Lunch area, Exhibition Hall)	
13:00	**Poster session and Partnering program** (Coffee & Lunch area, Exhibition Hall)	
14:00	**Electronics 1: *Nanowires*** (101cd)	**Nanomaterials 2: *Nanoparticles - applications*** (Ballroom 1)
	Chair: **Heli Jantunen**, University of Oulu, Finland	*Chair:* **Ari Ivaska**, Åbo Akademi
	Nanotech and Portable Electronics (20mins). **Tim Harper,** Cientifica Ltd	*(25mins).* **Mamoun Muhammed**, KTH, Sweden
	Piezoelectric nano-wires (25mins). **Nava Setter**, Ecole Polytechnic Federal Lausanne, Switzerland	*A Nordic project on enhanced functionality of self-cleaning and antibacterial surface coatings (FUNCOAT) (15mins).* **Jyrki Mäkelä**, Tampere University of Technology
	The superconducting single-electron transistor as a tool for quantum measurements (15mins). **Sorin Paraoanu**, University of Jyväskylä	*Theoretical investigation of the motion of magnetic nanoparticles in a magnetic field gradient (15mins).* **Vincent Schaller**, Chalmers University of Technology, Sweden
		Liquid Flame Spray made Titania and Titania-Silver Nanoparticle deposits Functionality as Photocatalyst for Organic- and Biofilm Removal (15mins). **Mikko Aromaa**, Tampere University of Technology, Finland
15:30	**Coffee** (Coffee & Lunch area, Exhibition Hall)	
16:00	**Instruments 1: *Atomic imaging and characterisation*** (101cd)	
	Chair: **Risto Nieminen**, Helsinki University of Technology, Finland	
	Transmission Electron Microscopy without Aberrations (25mins). **Crispin Hetherington**, University of Oxford	
	Ultra-high resolution nano-characterisation and analysis using advanced S/TEM (15mins). **Dominique Hubert**, FEI	
	Time-of-Flight SIMS Applications: From Semiconductor to Biology (15mins). **Sven Kayser**, ION-TOF	
	DHM technology for 3D non-contact dynamical measurements (15mins). **Frédéric Montfort**, ST Instruments	
- **17:30**	*ionLiNE a New Tool Concept for Nanofabrication in Surface Science and Thin Film Engineering (15mins).* **Andreas Rampe**, Raith	
19:00	**Helsinki City Reception**	

Program: Wednesday 28th March

10:30		**Workshop: *Nanotechnology and Safety*** (201)
		Chair: **Jorma Jokiniemi**, VTT, Finland
		Detecting nanoparticles (15mins). **Arto Kekki**, Dekati
		(15mins). **Jyrki Heino**, University of Turku
		Industrial H&S aspects on nanomaterials (15mins). **Katriina Heikkilä**, Kemira Pigments
		(15mins). **Maila Puolamaa**, EU Commission
		Outline of nanostandardization and nanosafety research in China (20mins). **Qian Liu**, NCNST, China
14:00	**Photonics 2: *Controlling light by nanostructured materials*** (Ballroom 2)	**Workshop: *Nanotechnology and environment, health & safety*** (201)
	Chair: **Markus Pessa**, ORC, Tampere University of Technology, Finland	*Chair:* **Del Stark**, CEO, European Nanotechnology Trade Alliance
	Enhancement of the Luminescence from Single InAs/GaAs Quantum Dots by Application of an Electric Field (25mins). **Per-Olof Holtz**, Linköping University	*(20mins).* **Markus Pridoehl**, Degussa GmbH
	Surface plasmon enhanced emissive devices (15mins). **Janne Simonen**, Technical University of Tampere, Finland	*(20mins).* **Stephan Schaller**, triple innova
	Resonance effects in nanostructured magneto-optic gratings (15mins). **Jari Turunen**, University of Joensuu, Finland	*Understanding the potential toxicology of nanomaterials and its importance for nanomanufacturing (20mins).* **Terry Wilkins**, Leeds University
	MONA - Merging Optics and Nanotechnologies: The Nanophotonics Technology (15mins). **Suvi Haukka**, presenting on behalf of the MONA consortium	*CENARIOS - The first certifiable nanosafety label for industry and retail companies (20mins).* **Christoph Meili**, Die Innovationsgesellschaft
16:00	**Nanomaterials 3: *Nanoparticles - manufacturing*** (Ballroom 1)	
	Chair: **Mamoun Muhammed**, KTH, Sweden	
	Synthesis of nanoparticles with a plasma torch (15mins). **Frederik Cambier**, CRIF, Belgium	
	RF Thermal Plasma Synthesis of Nanocrystalline Zirconia (15mins). **János Szépvölgyi**, IMEC CRC HAS, Hungary	
	Improved catalyst annealing process for the rapid growth of carbon nanotubes by microwave plasma-enhanced chemical vapor deposition (15mins). **Alexander Malesevic**, VITO, Belgium	
- 17:30		

Program: Thursday 29th March

8:45	**Keynote session** (101cd)	
	Chair: Professor **Yrjö Neuvo**, Technology Advisor, formerly CTO of Nokia Corporation	
	Multifunctional Nanoparticles: Vascular Zip Codes in Targeted Delivery of Nanodevices (30 mins). Professor **Erkki Ruoslahti**, Burnham Institute, CA, USA	
	An Integrated Science Perspective on Driving Innovation with Materials at the Nanoscale (30 mins). **E. James Prendergast**, Vice President, Chief Technology Officer, DuPont Electronic & Communication Technologies	
10:00	**Coffee** (Coffee & Lunch area, Exhibition Hall)	
10:30	**Nanobio 1: *Drug and gene delivery*** (101cd)	**Photonics 3: *Waveguides*** (Ballroom 1)
	Chair: **Erkki Ruoslahti**, Burnham Institute, CA, USA	*Chair:* **Ari Friberg**, KTH, Sweden
	Polymer Therapeutics as Nanomedicines for Cancer Therapy (25mins). **Ruth Duncan**, Welsh School of Pharmacy, Cardiff University, UK	*Nanophotonics (25mins).* **Lars Thylén**, KTH, Sweden
	Industrial Speaker to be confirmed	*Fabrication and replication of 2D photonic crystal waveguides (15mins).* **Jurriaan Huskens**, University of Twente
	Magnetic Nanoparticles: functional tools for bio and clinical applications (15mins). **Hongchen Gu**, Research Institute of Micro/Nano Science and Technology, Shanghai Jiaotong University, China	*Silicon nanophotonics: Light emission, wavelength-selective waveguiding and laser-induced thermal effects (15mins).* **Leonid Khriachtchev**, University of Helsinki
	Effects of Survivin siRNA conjugated Carbon nanotube on Human MCF-7 Cells (15mins). **Bifeng Pan**, Shanghai Jiao Tong University, China	*Nanostructured ridge waveguide lasers fabricated by nano-imprint lithography (15mins).* **Tapio Niemi**, Tampere University of Technology
12:00	**Lunch and Exhibition** (Coffee & Lunch area, Exhibition Hall)	
	Poster session and Partnering program (Coffee & Lunch area, Exhibition Hall)	
14:00	**Nanobio 2: *Nano-bio-materials*** (101 cd)	**Nanomaterials 4: *Wires and tubes*** (Ballroom 1)
	Chair: **Arto Urtti**, University of Helsinki	*Chair:* **Risto Nieminen**, Helsinki University of Technology, Finland
	Fabrication of nanomaterials using peptide motifs (25mins). **Shuguang Zhang**, MIT, United States	*Electronic transport in nanowires at different length scales (25mins).* **Antti-Pekka Jauho**, Technical University of Denmark
	Designing nano-bio materials from the bottom-up: an interdisciplinary modeling approach (20mins). **Gerhard Goldbeck-Wood**, Accelrys	*Novel Static and Dynamic Mechanical Response of Transitional Metallic Nanorods (15mins).* **Adrian Koh**, National University of Singapore
	Lipid Membrane Nanotechnology (15mins). **Nikos Hatzakis**, Nano-Science Center, University of Copenhagen	*Chip-cooling with carbon nanotubes (15mins).* **Krisztian Kordas**, University of Oulu
	Molecular Profiling using NanoPatterning of Extra-Cellular Matrix Components (15mins). **Frederic Zenhausern**, Center for Applied NanoBioscience, ASU, United States	
15:30	**Coffee** (Coffee & Lunch area, Exhibition Hall)	
16:00	**Nanobio 3: *Nanosensors and diagnostics*** (101cd)	**Nanomaterials 5: *Polymers*** (Ballroom 1)
	Chair: **Juhani Luotola**, Technology Manager R&D, Orion Diagnostica Oy	*Chair:* **Antti-Pekka Jauho**, Technical University of Denmark
	State-of-the-art Nanotechnology for Diagnostics (15mins). **Hesaam Esfandyarpour**, Stanford University, United States	*Derivated polythiophenes for gas sensing and ion sensing in solution (15mins).* **John Mortensen**, Roskilde University Center, Denmark
	The use of nanoparticles in Allergy Diagnostic in vitro test systems (15mins). **Mats Nystrand**, Phadia	*Shaping of polypyrrole nanoparticle (15mins).* **Burkhard Shultz**, Institute of Thin Film and Microsensor Technology, Germany
	Nanocrystals for biosensors applications (15mins). **Arben Merkoçi**, Institut Català de Nanotecnologia, Spain	*Self-organization of light-harvesting molecules in monomolecular layers (15mins).* **Hans Bettermann**, University of Dusseldorf, Germany
-17.30	*"Soft" nanolithographic patterning of surfaces for design of functional assemblies and nanoarrays of proteins (15mins).* **Ramunas Valiokas**, Institute of Physics, Lithuania	*Compliant elastomer electrodes for polymer actuators (EAP) (15mins),* **Mika Paajanen**, VTT, Finland

Program: Thursday 29th March

10:30	**Instruments 2: *Characterization*** (Ballroom 2)	**Nanoforum Workshop: *Nanotechnology Business Development*** (201)
	Chair: **Veli-Matti Airaksinen**, Micronova	*Chair:* To be announced
	Relevant characterization techniques for thin films and coatings at liquid and solid interfaces (15mins). **Tapani Viitala**, KSV Instruments	*Success Factors for Building a Nanotech Business (20mins).* **J. Malcolm Wilkinson**, Technology For Industry
	Direct visualization and analysis of nanoparticles using a new laser-based, single particle tracking system (15mins). **Bob Carr**, NanoSight Ltd	*Immaterial Rights in Fledgling SMEs (20mins).* **Markku Simmelvuo** & **Jukka Korhonen**, Papula-Nevinpat
	Characterization of Materials and Multilayer Structures of OLED by Spectroscopic Ellipsometry (15mins). **Vincent Couraudon**, SOPRA	*Global Trends in Venture Capital(20mins).* **Markku Maula**, Helsinki University of Technology
	BioImageXD – New Software for Visualizing and Analyzing Nanoparticles in Living Cells (15mins). **Pasi Kankaanpää**, BioImage XD	*March forward to the industrialization of Nanotechnology (20mins).* **Shicheng Mu**
14:00	**Electronics 3: *Nanosensor systems*** (Ballroom 2)	**Nanoforum Workshop: *Nanotechnology Commercialisation*** (201)
	Chair: **Jouko Korppi-Tommola**, University of Jyväskylä	*Chair:* **Pekka Koponen**, Spinverse Consulting
	Study on Spin-Valve GMR Sensor and Its Applications (25mins). **Tian-Ling Ren**, Tsinghua University, China	*Academic Entrepreneuship (20mins).* **Russell Cowburn**, Imperial College
	(25mins). **Philippe Andreucci**, Leti / MINATEC	*Nanotechnology and venture capital (20mins).* **Aymeric Sallin**, NanoDimension
	Printed devices based on inorganic nanoparticles (15mins). **Mark Allen**, VTT, Finland	*Case Study - NIL Technology (20mins).* **Brian Bilenberg**, NIL Technology
	Nano- and biosensing systems at CSEM (15mins). **Erika Györvary**, CSEM	**Cathal Mahon**, CAT Science Park
16:00	**Electronics 2: *New FETs?*** (Ballroom 2)	**15.45 Nanoforum Workshop: *Industrial perspectives*** (201)
	Chair: **Jouko Korppi-Tommola**, University of Jyväskylä, Finland	*Chair:* **Pekka Koponen**, Spinverse Consulting
	Top-down Nanotechnology Breakthrough (20mins). **Paula Goldschmidt**, Intel Corporation	*Bayer's Experiences of Commercialising Nanotechnology (20mins).* **Péter Krüger**, Bayer MaterialScience AG
	Fabrication-Process for CNTFETs Based on Sacrificial Catalyst: Device Characterization and Conductive-AFM Measurements (15mins). **Lorraine Rispal**, Darmstadt University of Technology, Germany	*Industrial Panel Discussion, featuring:* **Nicolas Deliyanakis,** European Commission **Lars Gädda**, Senior Vice President, R&D, M-real **Matti Kleimola**, Professor, Senior Advisor, formerly CTO of Wärtsilä
	Deposition Defined Nanometer Scale Dots (15mins). **Karsten Wolff**, University of Paderborn, Germany	
- 17.30	*Novel Flash Memory Cell with LaAlO3 as Tunneling Dielectrics for beyond Sub-50 nm Technology (15mins).* **Yaohui Zhang**, China	**17:00 - 17:45 Nanoforum Workshop Reception** **18:00 Venue Closes**

Nanoforum Workshop - Nanotechnology Commercialisation

On Thursday 29th March, Nanotech Northern Europe 2007 will be featuring a full-day session stream looking at the challenges and opportunities of commercialising nanotechnology. This workshop is being operated on behalf of the EU-funded Nanoforum project, and is intended to provide a valuable input to the discussion about how Europe can ensure that nanoscience research translates to economic growth.

How to Participate

These sessions are open to all congress participants, space permitting. Shortly after the workshop, a report will be published which distills the key findings and proposes actions. This report will be avaiable on the Nanoforum website, and you will be able to discuss the findings on the Nanoforum discussion board at www.nanoforum.org. For more information about the Nanoforum project in general, please contact Tom Crawley, tom.crawley@spinverse.com.

10.30 Global Overview of Nanotechnology Commercialisation (201)

Session one will address the broad themes affecting nanotechnology commercialisation. **Malcolm Wilkinson**, founder of Technology for Industry, will outline the success factors for building a nanotechnology business. Professor **Markku Maula** will discuss global venture capital trends, particularly with regard to emerging technologies. **Markku Simmelvuo** and **Jukka Korhonen** of Papula-Nevinpat will provide an overview of nanotechnology patenting, and address the protection of immaterial rights as a key success factor for nanotechnology businesses. Finally, **Shicheng Mu** will discuss nanotechnology commercialisation activities in the People's Republic of China.

14.00 Entrepreneurship and Venture Capital (201)

This session will feature leading VCs and Entrepreneurs drawing on their experiences to discuss the challenges of nanotechnology commercialisation from a ground-level perspective. Professor **Russell Cowburn** of Imperial College is an academic and entrepreneur, and recently won Degussa's Science to Business award. **Aymeric Sallin** is one of Europe's leading nanotechnology investors. **Brian Bilenberg** is the CTO of NIL Technology, a Danish nano-imprint lithography start-up which has experience rapid growth. **Cathal Mahon** is an investment manager at CAT Science, a Danish venture capital and incubator organisation, and an investor in NIL Technology.

15.30 Coffee (201 lobby)

15.45 Industrial Perspectives and Panel Discussion (201)

Session three will look at the question of how nanotechnology can support industrial renewal in Europe. **Peter Kruger** of BASF will provide a stimulating initial presentation, introducing topics such as the . He will be joined for discussion by other industrial representatives, including **Lars Gädda** of M-real, **Matti Kleimola**, and **Nicolas Deliyanakis** of the European Commission.

17.00—17.45 Drinks and Networking (201 lobby)

The session stream will conclude with an opportunity for discussion and networking with other participants over drinks.

18.00 Venue Closes

Speaker abstracts by session

FinNano Annual Seminar Tuesday 28th March

13.30 -15.00 Nanotechnology Materials and Processes (Ballroom 1)

Nanopatterned, porous inorganic films - synthesis and applications
Mika Linden, Åbo Akademi

Some recent advances related to the field of inorganic mesoporous materials will be discussed, with bias towards recent work in the Abo group. The synthesis of mesoporous materials with controlled morphologies will be covered in some detail, including powders, films, and monolithic materials. Furthermore, difference means of surface functionalization of said materials will be described, and critically discussed. Finally, some recent results related to the application of the materials will be high-lighted, with special focus on bio-related applications, but also electronic applications will be discussed briefly.

Isotropic Liquid Crystalline Nanocomposite as an Advanced Packaging Material for Future MEMS and NEMS Systems
Markku Lyyra, VTI Technologies Oy

Authors:
Jouni Enqvist, VTT, Technical Research Center of Finland, Advanced Materials
Markku Lyyra, VTI Technologies Oy
Maarit Enqvist, Tampere University of Technology, Institute of Materials Science

Isotropic liquid crystalline nanocomposites are predicted to be excellent packaging materials for electronics devices that will be used in various harsh environments like for packaging of silicon sensors to be used in automotive engine compartments and process industry. It is obvious that these nanostructured organic-inorganic hybrid materials could significantly increase operation temperatures and environmental and chemical stability and damage resistance of devices that are to be installed at even drastic conditions (operated at temperatures of up to 300C under oil, gasoline and other chemical stress as well as under mechanical wear due to dust and hard particles).

This new material is manufactured from certain aromatic co polyesters and magnesium silicates using high energy solid state synthesis processes to produce nanoscale bonding between organic and inorganic species. When the produced nanopowder is mixed with a high temperature resistant liquid crystalline polymer the obtained material is nearly isotropic whereas the original polymer is highly anisotropic.

Anisotropic liquid crystalline polymers and composites are excellent materials for rod-like and other uniaxial products but because different material parameters differ greatly in orientation directions of injection molded products some critical problems appear in testing or end use of molded electronics packages. Strength and coefficient of thermal expansion are significantly different for injection molded orientation direction and direction vertical to this. Gluing stability of silicon components at the package surface depends of orientation of material in a sensor package. If a liquid crystalline material can be made macroscopically isotropic preserving its otherwise excellent material properties it would dramatically increase it competitiveness as an advanced sensor packaging material.

This paper describes some preliminary results obtained for manufacturing of test specimens and sensor package prototypes.

Today commercial plastics do have clear limitations when requirements are for hermetic structure or high temperature applications. As well, the lack of mechanical stiffness of available materials today leads often to compromises. This new material technology seems to have potential to improve those properties.

Production of cobalt and nickel nanoparticles by hydrogen reduction

Johanna Forsman, VTT, Fine Particles

Johanna Forsman, Ari Auvinen, Unto Tapper, VTT Technical Research Centre of Finland
Jorma Jokiniemi VTT & University of Kuopio, Department of Environmental Science, Fine Particle and Aerosol Technology Laboratory,

Cobalt and nickel nanoparticles have applications for example as catalysts, in conducting inks and polymers, magnetorheological devices and multilayer capacitors. Currently in many of these applications, particle size is around 0.3 – 5 mm. Replacing these with smaller particles could reduce costs and improve performance. The lack of suitable commercial nanoparticles restrains the transition. Wet methods exist, but they require multiple steps and many chemical substances. In this work chemical vapour synthesis (CVS) is used to produce cobalt and nickel nanoparticles. Cobalt and nickel chlorides reduce in presence of hydrogen at high temperature (around 900°C) to pure metal and hydrogen chloride as:

$$CoCl_2(g) + H_2(g) \rightarrow Co(s) + 2 \cdot HCl(g) \quad (1)$$

Production of cobalt and nickel nanoparticles by hydrogen reduction method has been reported by Jang et al (2004). In this project, we developed the method further to reduce costs and increase particle yields considerably.

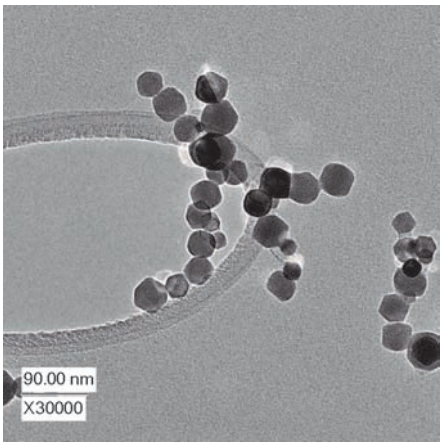

Figure 1. Nickel particles produced at reaction temperature 900°C. Evaporation temperature of $NiCl_2$ was 650°C.

The particles were studied with a transmission electron microscope equipped with EDS analyser and SAED. Fourier-transform infrared spectroscopy (FTIR) was used to determine the hydrogen chloride content of the gas flow. Mass concentration of particles was measured with filter samples.
High mass concentrations, up to 40 g/m^3, of high-purity cobalt and nickel nanoparticles with primary particle diameter below 100 nm were produced with aerosol method. Production rates up to 10 g/h with 99% yield were achieved even with a laboratory scale setup. An example of the produced nickel particles is illustrated in Figure 1. The size distribution of the primary particles was narrow. The particles were mostly well faceted single or twin crystals with fcc structure. The oxidation of the chain-like particle agglomerates was slow.
The aim is now to investigate possible applications, for example corrosion sticks, conducting polymers, Fischer-Tropps catalysts, RF antennas and biosensors. Different applications might require tailoring the particles.

Acknowledgements
Funding from OMG Kokkola Chemicals Oy and TEKES is acknowledged.

Advanced catalytic products by utilization of nanotechnology
Toni Kinnunen, Ecocat

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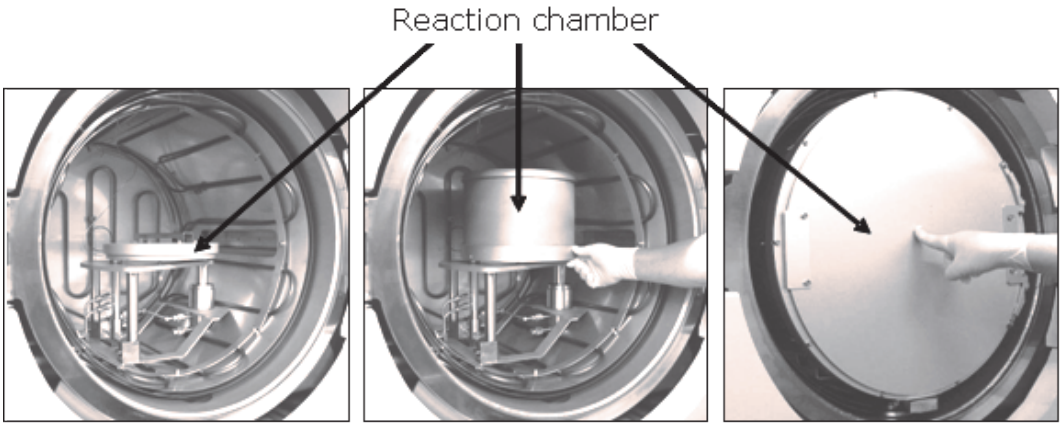
Kallinen K.,

New advanced catalysts for emission control of mobile and stationary applications have been developed for ensuring the competitiveness also in future with tightening emission limits. Because of very high price of platinum group metals (“PGM”, i.e., Pt, Rh, Pd), only a very minute amount can be used in a modern competitive catalyst. Nevertheless, the activity of the catalyst has to remain at high level throughout the lifetime of the vehicle.
Within FinNano technology program of Tekes, Ecocat Oy has been successful in developing new generation products for future needs. A dramatic increase in thermal stability and simultaneously, a substantial decrease in PGM amount can be obtained using these new catalysts. Key factors are controlled, molecular-scale interactions of Pd and Pt with their support materials. The tailored interaction has clearly been observed to be the major factor for significantly better performance in real conditions.
Comprehensive laboratory and real vehicle testing have shown the superiority of the novel catalysts compared to previous generation products. Novel catalysts are able to achieve lower emissions than previous generation products. These outputs from the project increase competitiveness of Ecocat Oy and enhance the effectiveness in common target for environmental care.

Versatile Atomic Layer Deposition System - A Flexible Research Platform and a Reliable Production Unit
Sami Sneck, Beneq

A highly flexible Atomic Layer Deposition (ALD) system TFS 500 was developed with modularity and flexibility as the basic principles. The flexible equipment platform with small footprint is ideal for constantly changing needs of today’s leading edge research work. The same platform is also capable of providing high capacity needed in production. ALD is finding new applications outside the semiconductor industry. As an example of these emerging ALD applications Beneq has introduced nSILVER® technology, which is now used in silver industry. This technology uses ALD to provide an anti-corrosion coating on three-dimensional silver products (jewelry, coins etc.) to prevent silver from tarnishing. In addition to anti-corrosion and passivation functions, emerging ALD applications use thin films as diffusion barriers, adhesion layers, wear resistant and optical coatings. Today TFS 500 is a proven platform both in research and production environment.



Modularity of TFS 500 enables utilization of various reaction chambers needed in different applications ranging from research to mass production.

Nanotechnology for a Mass Production Industry
Thad Maloney, KCL

The recent explosion of nanotechnology activity is based on the recognition that our ability to engineer materials on the small length scale has improved dramatically and that this is opening up a broad range of product development opportunities. In paper engineering we have long recognized that the assembly of a composite structure (paper) involves manipulation of structural hierarchies from the molecular to the macro scale. Thus for the paper industry, the advances in nanomaterials should be considered evolutionary rather than revolutionary.

There are two distinct paths for the application of nanotechnology in the forest products industry. The first is to develop advanced new products for non-existing markets which are produced with new technologies. Such products are likely to have high returns, low volumes, require a tremendous R&D expenditure and be far in the future. A second path is to leverage advances in nanotechnology (or more appropriately material science) to improve current products and processes. This latter route attempts to either 1) significantly improve the cost structure of current grades of paper and board or 2) to develop products with improved functionality that can, generally speaking, be sold to existing markets and be produced in high volumes on existing infrastructure. While the first avenue is important, it is imperative that nanotechnology research deliver successes in the short term to the current paper industry. This presentation will address the issue of introducing new technologies to a mass production industry and some of the opportunities that nanotechnology presents for the paper industry in the next 5 years.

13.30—15.00 Nanotechnology Solutions for Electronics Cluster (Ballroom 2)

Organic solar cell based on layered molecular
Prof. Helge Lemmetyinen, Tampere University of Technology

Efficient molecular donor-acceptor systems converting the photon energy to electrostatic energy in a form of electron-hole pairs are well known for a few decades already. Potentially such molecular systems, e.g. donor-acceptor compounds, can be used to build up solar cells. However the practical problem in development of organic solar cells arises from the necessity to construct (assemble) molecular systems with predefined ordering of the functional donor-acceptor compounds in a nanometer scale in order to achieve a unidirectional cooperative photocurrent generation in macroscopic scale. This project is aimed to solve this problem by selecting, designing, synthesizing and utilizing special donor-acceptor dyads, secondary donors and acceptors, electron and hole conducting materials and other functional compounds. In addition to photo- and electro-functionality these compounds are aimed to be suitable for layer-by-layer deposition of thin molecular films with desired order of the functional groups across the molecular film.

At present a range of self-assembling techniques, such as Langmuir-Blodgett and Langmuir-Scheffer, vacuum evaporation and spin coating, has been tested with a variety of newly synthesized and commercially available compounds to build molecular films for solar cell application. The key compounds for these structures are porphyrin-fullerene and phthalocyanine-fullerene dyads, which serve as the primary centers converting photon energy to electrostatic energy by photoinduced charge separation. The group synthesized these compounds during the past decade. The secondary electron donating layers are formed by thiophene derivatives, in particular polythiophene thin layers can be assembled using LB or spin coating techniques. The secondary electron accepting/hole blocking layers were assembled using commercially available PDI and vioalanthrone derivatives.

The films are grown on ITO semitransparent electrodes and consist from 2 to more than 10 functional layers. Although indirect measurements have indicated a high efficiency of the light conversion, the actual efficiency of the complete solar cell prototypes is limit by the top electrode at present. To address the problem the research is split in two directions: deposition of a solid electrodes and using liquid electrolytes for photocurrent collection. As of now, the best results were obtained for liquid cells, indicating the quantum efficiency close 20% and total power conversion approaching 1% . However the ion conductivity and diffusion controlled redox reactions at film/electrolyte interface seems to be the efficiency limiting steps. Therefore more efforts will be put to fabricate solid organic top electrodes to overcome the limitations.

The research group is open for a wide cooperation with other research groups and industrial partners

interested in solar cell applications. Of particular benefits could be atomic scale characterization of functional films, deposition of conducting molecular layers and advanced packaging of the device prototypes.

Molecular Scale Memory Elements
Andreas Johansson , University of Jyväskylä

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We investigate potential solutions for the fabrication of future molecular scale memory elements based on single walled carbon nanotube field-effect transistors (CNT-FETs). CNT-FETs are known to frequently display undesirable hysteresis in their transfer characteristics. For a memory element, this is on the contrary a favorable feature that can be utilized.

The studied devices are CNT-FETs based on semiconducting single-walled carbon nanotubes having a diameter close to 2 nm. Part of the CNTs were synthesized by a novel aerosol technique that yield particularly clean, unbundled nanotubes. The gate insulator film has a crucial influence on the operation of proposed memory elements. For a strong capacitive coupling and enabling gate voltages, a thin and dielectrically strong film is required. On the other hand, in order to achieve the desired hysteretic behavior for non-volatile memory, the gate-nanotube coupling has to include mobile charges within the gate-insulator or at some interface in the system. Measurements of CNT-FETs exhibiting memory effect in various conditions and our conclusions thereof will be presented, as well as an outlook to possible future directions of this study.

Nanofabrication Development at Micronova - TKK
Prof. Veli-Matti Airaksinen, Helsinki University of Technology

MICRONOVA is a leading research centre combining the expertise of nearly 300 researchers of the Technical Research Centre of Finland (VTT) and Helsinki University of Technology (TKK) for micro- and nanotechnology R&D. This presentation describes the research on nanofabrication techniques at Micronova-TKK and the new possibilities these technologies offer for practical and commercial applications and systems.

Optical magnetic metamaterials
Prof. Sergei Tretyakov, Helsinki University of Technology

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One of the most exciting new opportunities resulting from recent research of artificial electromagnetic materials (metamaterials) is a possibility to realize artificial media showing magnetic properties in the visible range. There are no such materials in nature, however, it appears possible to make them artificially using lattices of complex-shaped nano-sized metal particles (e.g. in form of a split ring or as pairs of closely positioned nano-bars). Magnetic response of such composites can be either dia-

or paramagnetic, so that even negative values of permeability can be possible. In particular, this will possibly open a way to design optical devices utilizing materials with negative refractive index. In such materials very interesting phenomena take place, for example, negative refraction and enhancement of evanescent fields.
In this review presentation we will discuss the present state of the art of research towards artificial magnetic optical materials, with the emphasis on the results obtained in our group, and outline several prospective new research ideas for possible future cooperative research. Special attention will be given to challenges in reducing dimensions of complex-shaped inclusions with the goal to achieve resonant magnetic response in the visible. We will discuss the optimal particle shapes and fundamental limitations on the achievable magnetic properties. Novel approaches including the use of quantum dots in combination with metal nano-particles will be introduced. An overview of potential applications of novel artificial magnetic metamaterials will conclude the talk

Institute for Semiconductor Technology & Nanoelectronics
Prof. Dr. Udo Schwalke, Darmstadt University of Technology

The Institute for Semiconductor Technology and Nano-Electronics owns a complete Nano-CMOS clean room facility. The CMOS fabrication line is equipped with e.g. ion implantation, optical lithography and e-beam litho (65nm at present), chemical-mechanical-polishing (CMP), RIE and CVD equipment (also to grow CNTs), advanced wet-chemistry and more. In addition we have advanced characterization tools like AFM, conductive AFM, SEM and elec-trical characterization (parameter analyzer, CV, charge pumping, dielectric reliability testing...). For details please see www.iht.tu-darmstadt.de.
The institute's research work focuses on "Nanoelectronics for Integrated Information Technologies" including the fabrication and evaluation of nano-devices, nano-sensors and circuits. These can be either silicon-based (like Si-nanowire devices and high-k damascene metal gate MOSFETs) or non-silicon e.g. carbon nanotube field effect transistors (CNTFETs). Reliability studies on failure and degradation mechanisms of integrated devices and materials complement the institute's work in respect of the above-mentioned core research areas.
We are interested in research collaborations in the nano-electronics area and are looking for partners complementing (theoretically / experimentally) our research fields for participation in related FinNano research projects.

Nanotechnology Networks and Co-operation (room 201)

Nano and Microsystems and Future Materials Cluster in Finnish Centre of Expertise Programme 2007-2013
Esko Peltonen, Jyväskylä Innovation Ltd, Jyväskylä, Finland

In Finland we count on understanding that success in competitiveness and economic growth is based on world class expertise. Hence, the third generation of national Centre of Expertise Programme has been launched for the time period of 2007-2013. The programme is constructed on Clusters of Competence that are appointed based on strong and developing research, education and business activities with fluent collaboration between top centres. One of the clusters is called Nano and Microsystems and Future Materials. The cluster has its own role in the Finnish innovation system.

Nano and Microsystems and Future Materials cluster is a network consisting of seven Centers of Expertise which operate at regions with strong competence in research and companies utilizing nano or microtechnology, viz. Helsinki metropolitan region, Tampere, Mikkeli, Oulu, Kokkola, Joensuu and Jyväskylä. The cluster brings together best companies, best universities and best research organizations in the country. The cluster covers more than 90% of the players in the whole Finland.

The vision of the cluster is that Finland will be one of the most important places in EU for applied research and business in nano and microsystems and future materials. To achieve this goal the cluster accelerates and strengthens the use of nano and microtechnologies and future materials in Finnish companies, both in big companies with mass products and in new innovative technology companies. Being a nationwide network, the cluster combines and binds regional expertises into national strength.

The Finnish cluster Nano and Microsystems and Future Materials is seeking for cooperation with for-

eign research organisations and companies, both small and big firms, in order to accelerate the breakthrough of nano and microtehnology for the benefit of the society. We offer world class expertise in our universities, research institutes and technology companies. We offer business networks including global players, growth companies and start-ups. In addition, we offer to companies business premises via Science parks.

The cluster is coordinated by Jyväskylä Innovation Ltd, the coordinator being Dr. Esko Peltonen. The coordinator is appointed by the ministry of trade and industry.

The Danish Nanotechnology Network, NaNet, Nanotechnology activities in Denmark

Morten Bøgedal, NaNet, Danmarks Tekniske Universitet

The talk will focus on the work carried out in the Danish National Network, NaNet. Furthermore will the picture of the nanotechnology scene in Denmark be drawn. An interesting scene with a lot of strong developments.

The vision of the member based network NaNet is to advance the Danish high technological expertise within the nanotechnology field. NaNet's intention is to establish a platform from which we can create the necessary focus and facilitate the utilization of this technology on all levels of society, from research and education to industrial application and development. Thus, we wish to help optimize the benefits this new technology can offer the Danish society and industry.

NaNet tries to meet the needs and wishes of its members in order to encourage bilateral matchmaking. Consequently, NaNet has analyzed the qualifications and activities of the network participants so that we can assist when it comes to creating new R&D projects or developing a great idea into a finished product. NaNet can also help concretize the possibilities for using nanotechnology with a specific industry.

Important links for you to seek more info in nanotechnology in Denmark:

www.nanet.nu	(National Nanotechnology Network)
www.hoejteknologifonden.dk	(Nanotechnology funding body)
www.fist.dk	(Nanotechnology funding body)
www.inano.dk	(Nanotechnology research)
www.nano.dtu.dk	(Nanotechnology research)
www.nano.ku.dk	(Nanotechnology research)

Nanoforum: Europe's Nanotechnology Gateway

Tom Crawley, Spinverse

Nanoforum is a pan-European nanotechnology network funded by the European Union under the Fifth Framework Programme (FP5) to provide information on European nanotechnology efforts and support to the European nanotechnology community. On the Nanoforum website (www.nanoforum.org), all users (whether they are members of the public, industry, R&D, government or business communities) can freely access and search a comprehensive database of European nanoscience and nanotechnology (N&N) organisations, and find out the latest on news, events and other relevant information (including education tools, further training, jobs, and other EU projects). In addition, Nanoforum publishes its own specially commissioned reports on nanotechnology and key market sectors, the economical and societal impacts of nanotechnology, as well as organising events throughout the EU to inform, network and support European expertise.

NTNE 2007 Wednesday 28th March

8.45-10.00 Keynote session (room 101cd)

Recent Performance of Nonpolar/Semipolar/Polar GaN-based Blue LEDs and LDs
Professor Shuji Nakamura, University of California, Santa Barbara, USA

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Farrell, R.M.
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Tyagi, A.
Zhong, H.
Masui, H.
Fellows, N.N.
Iza, M.

Charge separation due to spontaneous and piezoelectric polarization inherent to the wurtzite structure has deleterious effects on the performance of most c-axis oriented devices.1) To overcome this problem, Nonpolar GaN, such as a-plain and m-plain GaN or Semipolar GaN substrates have been grown. We reported the fabrication of violet InGaN/GaN Light Emitting Diodes (LEDs) on semipolar $(10\bar{1}\bar{1})$ GaN bulk substrates. The output power and External Quantum Efficiency (EQE) at a driving current of 20 mA were 20.58 mW and 33.91% respectively, with peak electroluminescence (EL) emission wavelength at 411 nm. The LEDs showed minimal shift in peak EL wavelength with increasing drive current indicating an absence of polarization induced electric fields.2) Also, high power and high efficiency nonpolar *m*-plane nitride LEDs were fabricated on low extended defect bulk *m*-plane GaN substrates.3) The first nonpolar *m*-plane $(10\bar{1}\bar{1})$ nitride laser diodes (LDs) were realized on low extended defect bulk *m*-plane GaN substrates. Broad area lasers were fabricated and tested under pulsed conditions. Lasing was observed at duty cycles as high as 10%. These laser diodes had threshold current densities (J_{th}) as low as 7.5 kA/cm^2. Stimulated emission was observed at 405.5 nm, with a spectral line-width of 1nm.4) The recent performance of Nonpolar, Semipolar and Polar (c-plain) GaN-based devices are described.

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Tyagi, H. Zhong, N. N. Fellows, M. Iza, J. S. Speck, S. P. DenBaars, and S.i Nakamura, Jpn. J. Appl. Phys. 46 (2007) L129;
M. C. Schmidt, K-C Kim, H. Sato, N. Fellows, H. Masui, S. Nakamura, S. P. DenBaars, and J. S. Speck, Jpn. J. Appl. Phys. 46 (2007) L126
M. C. Schmidt, K-C Kim, R. M. Farrell, D. F. Feezell, D.I A. Cohen, M. Saito, K. Fujito, J. S. Speck, S. P. DenBaars, and S. Nakamura, Jpn. J. Appl. Phys. L190-L191, Vol 46 (2007)

Mastering the interface to the physical world
Tapani Ryhänen, Head of Nano Sciences Laboratory, Nokia Research Center

Two years ago in the NTNE conference Nokia's CTO Tero Ojanperä presented Nokia's deep interest in radical materials, novel manufacturing solutions, energy sources and increased memory capacity to be used to enhance the capabilities of mobile devices. A year ago in the same conference, Bob Iannucci, Head of Nokia Research Center, discussed the role of nanotechnologies in embedding intelligence into human environments and to enhance human sensory capabilities. Building on these highly relevant messages the role of nanotechnologies in creating new paradigms for sensing, computing and communication will be discussed. Nanotechnologies and related manufacturing

solutions will have deep impact in the electronics industry, and they will enable new applications that are not feasible today. Tailoring of electronics and products for various markets of different scale will be enabled by novel manafacturing solutions based on nanotechnologies. Responsible introduction of nanotechnologies into applications related to human everyday life will require attention by all the different players. Nanotechnologies can lead towards more environmentally sustainable products but potential risks in introducing the new materials must be serious taken into account. The business landscape of nanotechnologies will be discussed based on intellectual property created by various players and on the maturity of the technologies. Finally, Nokia's approach to nanoscience research in close collaboration with top universities is presented.

10.30-12.00 Photonics 1: "Nanophotonics for ICT" (room 101cd)

Electromagnetic Coherence in Nanophotonics
Ari Friberg, Royal Institute of Technology, Sweden

Only now, some 50 years after the basic polarization and optical coherence theories were first developed, the notions of coherence and polarization in electromagnetic fields are attracting closer attention. Electromagnetic optics is a comprehensive field of (classical) optical physics that includes the rapidly progressing areas such as near-field optics, micro-optics, nano-photonics, and plasmonics. Correlations of the electromagnetic field, which are fundamental dynamic quantities, are modified in radiation, propagation, and material interactions, and consequently the field's coherence properties, polarization state, spectrum, and entropy are changed as well. Some general effects and results in this area are discussed and examples related to boundary waves are reviewed. In arbitrary random electromagnetic fields all three electric vector components must be taken in account. This has lead to new definitions for the degree of polarization, which previously existed only for planar or beam-like wave fields. The degree of coherence, in scalar theory normally introduced via Young-type two-pinhole experiments, likewise has encountered electromagnetic extensions, both for beams and general (three-dimensional) fields. Some of these recent developments are discussed and the relationship between coherence and polarization is assessed.
Further, consequences of the new definitions, for instance, as regards so-called coherent modes, laser resonators,high-numerical-aperture focusing, and intensity interferometry of electromagnetic fields, are briefly analyzed.

Display Applications of Carbon Nanotube Composite
In Taek Han, Advanced Materials Lab. SAIT

Authors: In Taek Han
Jong Min Kim
Advanced Materials Lab, Samsung Advanced Institute of Technology
Display Device & Processing Lab, Samsung Advanced Institute of Technology

The use of carbon nanotube (CNT) to the field emission display (FED) is now on the edge of commercialization. However, some issues are not confirmed yet for the launching of the CNT-FED TV business. The market positioning of CNT-FED is one of the most difficult dilemmas between PDP and LCD TV. Another application of carbon nanotube field emitter in flat panel display is a backlight unit (BLU) in liquid crystal display (LCD). The world wide market size of LCD BLU will be 13 billion dollars in 2009. The LCD becomes the main stream of FPD, and the size of LCD grows bigger and bigger every year. Moreover, the image quality of LCD is critically depends on the performance of the BLU. The CNT BLU uses similar architecture with CNT-FED. It has emitters, anode screen, and vacuum gap between them. The difference of CNT BLU with FED is that it has to have the brightness more than 10,000 cd/m2 at low power. The anode bias, vacuum distance, emission current density, and phosphor design were changed to acquire that brightness. Uniform distribution of light was made by designing the emitter array design and cathodoluminescence scattering structure. We got a 6-inch diagonal backlight unit with a cathode of printed carbon nanotubes.
The material properties of carbon nanotube is outstanding, however, it can be greatly enhanced by mixing it with other nano materials. For example, the mixing of carbon nanotubes with MgO particles showed 10,000 times higher 2nadary electron emission properties than the conventional ones. This can be used in plasma lighting system. And the mixing it with inorganic electroluminescent materials also showed the possibility of the EL properties enhancement.

I will present the LCD BLU and inorganic EL composite technologies using carbon nanotube and show some preliminary results.

Performance of Quantum Dots-in-a-Well Infrared Photodetectors – Status and Prospects
Linda Höglund, Acreo, Sweden

Authors: Asplund, Carl
Wang, Qin
Almqvist, Susanne
Petrini, Erik
Borglind, Jan
Smuk, Sergiy
Pettersson, Håkan
Holtz, Per Olof
Höglund, Linda
Andersson, Jan Yngve

In recent years a novel kind of detector has been suggested for detection of infrared radiation, namely the quantum dot infrared photodetector (QDIP). The QDIP utilises intersubband transitions between different energy states of the charge carriers in the quantum dot (QD), to detect radiation in the infrared wavelength region. In this study, vertical InAs/In0.15Ga0.85As/GaAs dots-in-a-well (DWELL) QDIPs have been developed to detect infrared radiation in the long wavelength infrared (LWIR, 8 12μm) region. In DWELL structures inter sub band transitions occur with in the conduction band between the quantum dot (QD) and the quantum well (5μm) to the LWIR region by small changes in the applied bias. These properties could be useful for modulators and for two− colour infra red detection, respectively. The performance of the DWELLQDIPs has been evaluated with respect to responsivity and dark current for temperatures between 15K and 77K.5) A/cm2. In a comparison between DWELLQDIPs and state−of−the−art quantum well infra red photo detectors (QWIPs) it was found that the dark current in QDIPs is lower than in QWIPs.

ingle Polymer Nanowire Nanolasers
Gareth Redmond, Tyndall National Institute, Ireland

We have developed methods to create conjugated polymer nanowires that demonstrate optical functions such as waveguiding, microcavity effects and optically pumped lasing. We used templated assembly to form highyields of nanowires with controlled dimensions from an emissive liquid crystalline conjugated polymer material, poly(9,9-dioctylfluorenyl-2,7-diyl), PFO. By selective template removal, wires could be freed and dispersed yielding ˜ 10e9 discrete nano-optical elements of uniform cylindrical morphology, 250 350 nm diameter and 3 30μm length. When optically excited by UV light, the wires exhibited blue photoluminescence. Emission spectra exhibited vibronic peaks at 434, crystallinePFO. Epi−fluorescence microscopic inspection indicated that ˜50% of the wires behaved as active wave guides as luminescence was guided along nanowires and scattered at wire ends.

10.30-12.00 Nanomaterials 1: "Nanostructured materials" (Ballroom 1)

Nanomaterials and nanosciences
Marc Drillon, Institute of Physics and Chemistry of Materials, Strasbourg

One of the technological challenges of the next twenty years deals with the control of the properties of materials at the scale of a few nanometers, in order to be able to build up components or devices bringing into play a few hundreds or even a few tens of atoms.
Whereas the fast development in the field of data processing and biotechnology does not astonish anybody any more, recent progress in "nanosciences" announces a true technological revolution. At the scale of nanometer, the materials adopt against-intuitive behaviors and are often more powerful than conventional materials. This reduction of size induces profound modifications of the properties of matter. Thus, the fullerene C60, made of 60 atoms of carbon organized in the shape of soccer ball, has a hardness larger than that of diamond. In the same way, when they are divided into grains of about fifteen nanometers, metals and semiconductors change colour.
For a few years, the chemists who developed a true engineering for the construction of nanoscaled

objects are at the heart of the development of nanotechnologies. The realization of electronic circuits, whose components may be functionalized molecules, aims at proposing an alternative to current micro-electronics.
Lastly, many potential outlets of nanomatériaux concern the medical applications. Major openings are expected in the field of biological sensors and the vectorization of molecules for therapeutic applications. I will present some breakthroughs in the field of nanomaterials and nanosciences.

Zinc oxide and titania nanostructured layers by wet chemical methods
Malle Krunks, Tallinn University of Technology, Estonia

Aurthors: Oja Acik, Ilona
Dedova, Tatjana
Mere, Arvo
Krunks, Malle

An overview of recent attainments in development of TiO2 and ZnO nanostructured coatings at Tallinn University of Technology will be presented. Wet chemical methods of spray pyrolysis and and sol-gel deposition were applied to prepare nanostructured films and layers. These methods are simple, fast and can be easily scaled up to produce coatings with large area at low cost. Nanocrystalline TiO2 films were deposited from titanium-tetra-isopropoxide based sol using spin coating and spray techniques. Anatase films with crystallite size from 5 to 30 nm, refractive index of 2.1-2.4 and surface roughness < 1 nm were grown. Porous layers with thickness of 2.5 microns were prepared from the sol containing a pore creator additive. The crystallite size of 5-9 nm and pore size of 2-40 nm is controlled by the additive concentration, deposition and annealing temperatures. Highly structured ZnO layers comprising well-developed hexagonal rods with diameter of 50-200 nm and length up to some microns were prepared by spray pyrolysis technique using zinc chloride containing solutions at temperatures around 500 C. The size, aspect ratio and orientation of rods is controlled by precursor concentration, growth temperature and substrate properties. Photoluminescence and Raman spectroscopy studies revealed high optical and crystalline quality of sprayed ZnO rods.

Colloidal synthesis and growth mechanism of asymmetric nanocrystal heterostructures made of a semiconductor titania rod-like section and a magnetic iron oxide spherical domain
Raffaella Buonsanti, CNR-INFM, Lecce, Italy

In the last years, advances in colloidal chemistry approaches have opened up access to a variety of size- and shape-tailored inorganic nanocrystals (NCs), enabling verification of dimensionality-dependent chemical-physical laws of nanoscale matter[1-2]. Owing to their robustness and processability, NCs are being currently integrated with existing devices and exploited in the bottom-up fabrication of innovative materials. Although refinement in the dimensional and morphological regimes of nanoparticles is still desirable, a further step toward structural complexity and increased functionality has been recently devised with the synthesis of hybrid NCs with a topologically controlled composition, i.e., consisting of two or more chemically different material sections grouped together through an inorganic junction[3-8]. As a result of the combination of the properties that distinguish each crystalline domain, such composite particles hold promise as first prototypes of “smart” NCs, i.e. nanosized objects potentially able to perform multiple tasks, such as in biomedical engineering, diagnostics, sensing, and catalysis[8].
Herein, we report a straightforward colloidal approach to fabricate a new type of highly asymmetric binary nanocrystal (BNC), made of one spherical γ-Fe2O3 particle epitaxially grown on a lateral facet of a rod-like anatase TiO2 domain [9]. The BNCs were obtained by selective heterogeneous nucleation of iron oxide onto c-axis-elongated TiO2 nanorods in a suitable surfactant mixture at high temperature. The chemical and structural identity of each heterostructure domain was ascertained by a combination of powder X-ray Diffraction, Raman and Mössbauer spectroscopy, high angle annular dark field (HAADF) imaging, and high-resolution transmission electron microscopy (HRTEM) analyses. The BNCs exhibit the characteristic size-dependent magnetic behaviour of maghemite, as indicated by ac susceptibility measurements. A striking structural feature of the BNCs is that the nanorod section is slightly bowed in proximity of the γ-Fe2O3 sphere, and follows its curvature at the junction region. Detailed lattice fringe mapping actually revealed that the coherent attachment between γ-Fe2O3 and TiO2 lattices proceeds similarly to one of the known mechanisms leading to the low defect density growth of quantum dot islands onto highly mismatched substrates by epitaxial growth techniques (as by Molecular Beam Epitaxy): i.e., the two domains share a rather restricted

interface that is locally bended to decrease the interfacial strain (mostly due to the large misfit between the two lattices), thus retarding the formation of dislocations.
To the best of our knowledge, it is the first time that such a mechanism of heteroepitaxial growth is observed for colloidal hybrid nanostructures. Finally, we will also briefly outline the technological potential of such combined semiconductor-magnetic nanocrystals in several fields of nanoscience, such as in photocatalysis, in malignant cell treatments, and in nanocrystal assembly.
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(5) S. Kudera, L. Carbone, M. F. Casula, R. Cingolani, A. Falqui, E. Snoeck, W. J. Parak, L. Manna, Nano Lett. 2005, 5, 445.
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10.30-12.00 Workshop: Nanotechnology and Safety (Room 201)

Detecting nanoparticles
Arto Kekki, Dekati Oy

Nanoparticles are vital components of modern materials, from enhancing their characteristics to being key components in many modern articles. In everyday household products they can be found from shampoos and hair conditioners to skin care products. Car waxes are advertised by their superior characteristics achieved with nanoparticles. Some products are strengthened with nanomaterials, like ice hockey sticks and tennis rackets. Fabrics can be embedded with nanoparticles to make stain-repellent clothes. By coating glass with nanoparticles, the color or the characteristics of the surface can be adjusted. One example already in use is self cleaning windows. Nanoparticles are also present in ambient air, due to the emissions form combustion processes and from natural sources.
In making these enhanced materials, the nanoparticles need to be handled in a controlled way in manufacturing processes in. To adjust the manufacturing process the feed of nanomaterials needs to be monitored. The possible emission to working environment needs also to be detected, to protect people in their working environment. Real time monitoring of nanoparticles could also be used to detect rapid concentration changes, e.g. like in the case of forest fire.
The harmfulness on nanoparticles is well proven in different research studies. Even though it's still studied, what is the base mechanism to toxicity, some indication is available that just the small size itself can cause harm, especially if nanoparticles are inhaled to lungs.
Dekati Ltd. has developed a cheap, real time, easy to use and robust detector DIH (Dekati Industrial Hygiene). It is designed to give an indication of the presence of nanoparticles in air. The main use of this type of sensor is planned to be in industrial hygiene. Other applications are related to monitoring particle emissions in combustion processes, detecting the small particles in ambient air and monitoring nanoparticles in a process as a part of the process control.

Industrial H&S aspects on nanomaterials
Katriina Heikkilä, Kemira

Environmental, health and safety related issues are considered as essential frame conditions for modern business operations. Proper management of these elements are operated according to Product Stewardship where the whole product life cycle is taken under consideration. Product Stewardship goes beyond the verifying the regulatory compliance to the awareness of potential risks and impacts of products and processes and further to the commitment to the research and development of safer and environmentally preferred products and processes. The basic tool utilized

for risk management risk assessments. These are used daily basis - from sophisticated techniques to very basic ones. Risk management always starts with the examining the possibilities of eliminating the risk and just then reducing the risk to the minimum. Adequate protection measures are applied if eliminating or reducing is not possible, or when the remaining calculated risk is somehow unknown, protection measures are still put in place due to precautionary principles. Communication and information is essential throughout the procedure.
Risk management is an ongoing process and risk assessments are iterated whenever a new piece of information is available. With nanomaterials, the practical tools for risk assessments have been until now the same as applied to the conventional products and processes. Thus precautionary principle has been merely exercised and the iteration cycle has been frequent. Conducting of well detailed exposure assessments have been impracticable due to lack of portable (personal) measurement techniques and thus other indirect means are been used to form the understanding of the risk related to working and handling of nanomaterials.

Outline of nanostandardization and nanosafety research in China
Qian Liu, National Center for Nanoscience and Technology (NCNST), China

In this presentation, we will give a brief introduce on an outline of nanostandardization and nanosafety in China, from research background, research progress and program in the near future.

14.00-15.30 Photonics 2: "Controlling light by nanostructured materials" (Room 101cd)

Enhancement of the Luminescence from Single InAs/GaAs Quantum Dots by Application of an Electric Field
Per-Olof Holtz, Linköping University

Authors: Holtz, P.O.
Moskalenko, E.
Larsson, M.
Karlsson, K.F.
Schoenfeld, W.V.
Petroff, P.M.

A spectroscopy study of single InAs/GaAs quantum dots (QDs) has been performed by means of micro-photoluminescence (micro-PL). Well-defined narrow excitonic features from these self-organized quantum dots, fabricated by the Stransky-Krastanov (SK) growth mode, have been monitored in the micro-PL spectra. From the well-defined excitonic spectra, the charge state of the quantum dot can easily be revealed from the micro-PL spectra. However, by tuning the TiSp laser excitation energy, it is demonstrated that the charge state of the dot can be altered, and consequently be controlled. In fact, the charge state of the exciton, neutral or negatively charged, is demonstrated to be extremely sensitive on the laser energy:
A slight alteration of the laser energy above or below a well defined threshold energy, Eth, will entirely change the charge state of the dot. In a subsequent step, with an additional infrared (IR) laser employed, striking changes were induced in the quantum dot charge state as well as for micro-PL intensity levels. The results achieved demonstrate that the complementary IR laser will give rise to either a decrease or an increase of the integrated dot micro-PL intensity, dependent on whether the principle laser is below or above the threshold energy, Eth. For excitation above the critical Eth energy of the main laser, the additional IR laser will induce a considerable increase, by up to a factor 5, of the QD emission intensity. On the other hand, for laser excitation below the Eth energy, the QD emission intensity will decrease or almost get quenched, while the PL intensity from the wetting layer instead increased.
The behavior is explained in terms of a varied carrier capture efficiency into the dot as determined by the internal electric field driven carrier transport into the dots. The internal field could be screened by the complementary IR laser. The model proposed is supported by electric field dependent micro-PL measurements, in which the QDs were subjected to an external electric field. The purpose was to gain further insight into the transport and carrier capture process into the dots. This external field is formed by application of a lateral field between two top contacts. An increasing external field is demonstrated to increase the carrier transport, and consequently the capture efficiency and subsequent dot exciton recombination intensity. It is established that the QD PL signal intensity could be increased several times (>5 times) by optimizing the magnitude of this external field. In fact, in

most optical experiments with QDs, electrically injected or photoexcited carriers are primarily created somewhere in the sample outside the QDs, e.g. in the barriers or in the wetting layer. Consequently, excited carriers undergo a transport in the wetting layer and/or barriers prior to the capture into the QDs. This circumstance highlights the crucial role of the carrier transport and capture processes into the dot for the performance and operation of the dot based devices such as QD lasers, QD IR detectors and QD memory devices.

Surface plasmon enhanced emissive devices
Janne Simonen, Technical University of Tampere, Finland

The presence of a metal film close to a light-emitting material has been shown to greatly enhance the emission due to the generation of surface plasmons. We used this phenomenon to demonstrate novel optical devices based on fluorescent dyes and semiconductor quantum wells. Both thoretical and experimental results will be presented.

Resonance effects in nanostructured magneto-optic gratings
Jari Turunen, University of Joensuu, Finland

Authors:Bai, Benfeng
Tervo, Jani
Turunen, Jari

Dramatic polarization conversion effects (Kerr rotation and ellipticity) are predicted in zero-order reflection of light from a resonance-domain magneto-optic (MO) Bi:YIG grating with nanoscale features, embedded in a dielectric material. It is shown by rigorous electromagnetic calculations that field localization in the MO medium gives rise to the excitation of leaky guided waves, which propagate in (and around) the high-index Bi:YIG layer along the grating surface. The resonant interaction between the incident, reflected, and transmitted fields results in narrow-band reflection spectra with highly dispersive Kerr rotation and ellipticity within the reflection peak. Some application aspects of the predicted phenomena, including magneto-optically switchable quarter-wave plates, are illustrated.

MONA - Merging Optics and Nanotechnologies: The Nanophotonics Technology Roadmap
Suvi Haukka on behalf of the MONA consortium

Authors: Fulbert, Laurent
MONA - Merging Optics and Nanotechnologies: The Nanophotonics Technology Roadmap Laurent Fulbert, CEALETI France Roel Baets, - IMEC, Belgium Andr´e Scavennec, Alcatel-Thales 3-5 Lab, France Ulrich Fotheringham, Schott, Germany Rainer Beccard, Aixtron, Germany Krassimir Krastev, Optics Valley, France Dirk Holtsmanspötter, VDI-TZ, Germany Eric Mounier, YOLE D´eveloppement, France Bertrand Noharet, Acreo, Sweden Thomas Pearsall, EPIC France Ivo Raaijmakers & Suvi Haukka, ASM, Netherlands

The MONA project has three principal objectives: Create a common site for the exchange of information concerning research, networks of excellence, and integrated projects in photonics and nanotechnologies. Promote the timely exchange of scientific results, market development, and technology needs through MONA-developed workshops. Develop a European roadmap for photonics and nanotechnologies. MONA, both through its expected outcomes and the collective process implemented, will help the future European research be more competitive through the development of the Nanophotonics Technology Roadmap. In this presentation we will present the structure and preliminary results from the Nanophotonics Technology Roadmap.
The identification of key technical hurdles indicating what kind of research projects should be conducted in order to overcome them, and how to focus the resources accordingly; The benchmarking of the European research community with international competition will allow to allocate resources where the potential of Europe to become leader is the highest; Identification of ”time-shot windows” for financial investment, in particular for start-ups, and a better assessment of risks for venture capitalists. The MONA Roadmap will provide an essential decision-supporting instrument for the Community at a broad and international level. The results will directly feed into the European Technology Platform Photonics21.
14.00-15.30 Electronics 1: "Nanowires" (Ballroom2)

Nanotech and Portable Electronics
Tim Harper, Cientifica

From cameras to displays, and from printed circuit boards to power sources, nanotechnologies are already having an impact on portable electronics, something that is expected to dramatically increase over the next five years. We take a rational look at the technologies, the applications and the markets.

Piezoelectric nano-wires
Nava Setter, Ecole Polytechnic Federal Lausanne, Switzerland

Aurthors: J. Wang,
Vasco, E.
Suyal, G.
Setter, N.
Colla, E.
Piezoelectric materials are being used and further investigated for a wide range of applications, from medical, environmental, and industrial process monitoring, to robotics, energy harvesting, and high frequency communication systems. Due to their important sensing and actuating capabilities, they are of interest also for eventual nano-electro-mechanical systems. Ferroelectric perovskites constitute the most useful group of piezoelectric ceramics due to their large piezoelectric coefficients and electromechanical coupling coefficients. The synthesis of ferroelectric nanowires and nanotubes has been reported for some 6 years. Those included several perovskites such as $BaTiO_3$, $SrTiO_3$, $KNbO_3$, $PbTiO_3$, and $Pb(Zr,Ti)O_3$ [PZT]. Synthesis methods include infiltration, molten salt technique, electrophoresis, solvo-thermal, and others.

After reviewing the general state-of-art in this area, the focus will be on results from the authors' laboratory: processing by solvo-thermal route and mechanism of formation of monocrystalline nano-wires of potassium niobate, $KNbO_3$, and lead-zriconate-titanate, PZT, will be discussed, the latter is the technologically most important piezoelectric material and the former is an emerging important piezo-electric which is lead-free, thus a cleaner material. Ferroelectric domain formation is shown by high transmission electron microscopy, ferroelectric switching and piezoelectric activity is evidenced using piezo force microscopy, and ferroelectric to paraelectric phase transition is further evidenced. Expectations on the applicability of piezoelectric nano-wires will be included in the conclusion.

Mo6S9-xIx nanowire recognitive molecular-scale connectors
Dragan Mihailovic, Jozef Stefan Institute, Slovenia

We demonstrate recognitive self-assembly of molecular-scale circuits using conducting 8°A diameter Mo6S9-xIx (MoSIx) molecular nanowires. We show that connection between gold surfaces, such as gold nanoparticles (GNPs) and the molecular wires can be efficiently achieved with single step processing in solution. We also demonstrate 2- and 3-terminal branched circuits with GNPs, opening a self-assembly route to multiscale complex molecular-scale architectures at the single-molecule level. Furthermore, due to their sulfur-terminated structure, naked nanowires are shown to bind efficiently to proteins such as green fluorescent protein or thyroglobulin via S-S bonds directly, thus providing a universal electrically conducting connector construct to which proteins or other biological entities can be attached.

The superconducting single-electron transistor as a tool for quantum measurements
Sorin Paranaou, University of Jyväskylä

The single-electron transistor (SET) has been already for a number of years an invaluable tool for ultrasensitive electrometry; more recently, it has been used in superconducting circuits that aim at implementing elementary operations (quantum gates) for future quantum computers. I will describe some of our experimental results on electronic transport in Al- and Nb- based superconducting SETs, and I will present a proposal for interaction-free measurements using an electrical circuit consisting of a superconducting SET shunted by a Josephson junction.
References: G. S. Paraoanu, Interaction-free measurements with superconducting qubits, Phys. Rev. Lett. 97 180406 (2006); G. S. Paraoanu and A. M. Halvari, Suspended single-electron

transistors: fabrication and measurement, Appl. Phys. Lett. 86, 093101 (2005).

14.00-15.30 Nanomaterials 2: "Nanoparticles - applications" supported by Nordic Innovation Center (Ballroom 1)

A Nordic project on enhanced functionality of self-cleaning and antibacterial surface coatings (FUNCOAT)
Jyrki Mäkelä, Tampere University of Technology, Finland

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Piispanen, Minna
Deppert, Knut
Persson, Stellan
Lang, Maria
Gunnarsson, Gudmundur
Pimenoff, Joe
Kronberg, Thomas
Mäkelä, Jyrki
Pore, Viljami
Ritala, Mikko
Leskelä, Markku
Raulio, Mari
Salkinoja-Salonen, Mirja
Airaksinen, Veli-Matti
In the FUNCOAT project (2006-2007), the goal is to develop an industrial coating process for glass and glossy surfaces. It is known from a recent study (Keskinen et al., 2006), that when using a flame based method with titania and silver liquid precursors, we can generate a surface coating with both photocatalytic and antibacterial properties.
Here, float glass and glaze-coated ceramic substrates have been coated with TiO2-Ag nanoparticles using an industrial process LFS/nHALO (Liquid Flame Spray/Hot Aerosol Layering Operation). A wide measurement matrix of coating parameters was generated for experimental study. The amount, composition and morphology of the
nanoparticle coating have been studied using Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and Energy Dispersive Spectrometry (EDS). Also the most promising functionality of the samples have been verified by water contact angle measurements, bio- and organic film reduction by photocatalysis. Funded by Nordisk Innovations Centre (NICe) References
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Theoretical investigation of the motion of magnetic nanoparticles in a magnetic field gradient
Vincent Schaller, Chalmers University of Technology, Sweden

Authors: Rusu, Cristina
Enoksson, Peter
Wahnström, Göran
Johansson, Christer
Schaller, Vincent
Magnetic particles with sizes in the nanometer range are very promising for use in biomedical applications, due to, for instance, higher surface-to-volume ratio and lower sedimentation rates. When decreasing the size of the particles below about 500 nm the Brownian motion of the particles needs to be considered. The purpose of our work is to
evaluate the influence of this stochastic motion on the trajectory of the magnetic nanoparticles in a magnetic field gradient. We developed a simulation model for the magnetic separation of particles with size ranging from 500 nm down to 50 nm, which takes into account the Brownian random motion of the nanoparticle. The simulation also gives the capture rate as a function of the properties of the magnetic separation system, like magnetic core material properties, and allows optimizing these

properties based on separation time requirements. The results of the simulations showed a significant increase of the effective separation time of the magnetic nanoparticles compared to a simplified model where the Brownian motion is not taken into account. This demonstrates that the Brownian motion cannot be neglected when studying magnetic separation of nanometer sized particles. Furthermore, an experimental set-up is currently investigated in order to compare experimental separation measurements with the simulations and to evaluate the validity of the theoretical model. The full investigation will be presented at the conference.

Liquid Flame Spray made Titania and Titania-Silver Nanoparticle deposits Functionality as Photocatalyst for Organic- and Biofilm Removal
Mikko Aromaa, Tampere University of Technology, Finland

Authors: Keskinen, Helmi
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Leskelä, Markku
Raulio, Mari
Salkinoja-Salonen, Mirja
Levänen, Erkki
Mäntylä, Tapio

Flame methods have been used in particle production for several decades and most of the present studies in this area concentrate on composite nanoparticles. Titania is noted for its photocatalytic properties, but composite titania-silver nanoparticles have been proved to have even better activity as photocatalyst. Titania and titaniasilver nanoparticle deposits were made by Liquid Flame Spray technique (LFS). In LFS the liquid precursor is injected into a high temperature flame, where it will evaporate and nucleate to nanosized particles. The precursors were titanium(IV)ethoxide (TEOT) and silver nitrate (AgNO3) in ethanol solution. One-step and two-step methods were used for preparation of titania-silver deposits. The silver amount was 1 wt%. The deposits were collected in the flame zone on steel and glass surfaces and were analyzed by TEM, EDS, XPS and SAXS. The titania deposits consisted of porous nanosized titania agglomerates of primary particles (˜10 nm). With silver addition, small spherical silver metal particles (˜ 2 nm) were detected on the agglomerates. An increase in the photocatalytic activity was verified by stearic acid decomposition and biofilm removal using Deinococcus geothermalis as the model organism. The titania-silver deposit produced by one-step method has the highest potential as photocatalyst.
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14.00-15.30 Nanotechnology and environment, health & safety (Room 201)

Understanding the potential toxicology of nanomaterials and its importance for nanomanufacturing
Terry Wilkins, University of Leeds, UK

Manufacturing and sale of products based on nanomaterials is now a growing reality. Some $50billion products were sold in 2006 worldwide. As we move to creating into materials with architectures at the lower end of the nano length scales properties become more interesting scientifically and commercially. However, our understanding of the impact on mammals and the environment requires much more study to evaluate the risks and ethical issues. Such research is and will be fundamental for any organisation studying and developing commercial products. This paper presentation provides an overview of the challenges and demonstrates some of the research tools

that could play a part in beginning to understand the ways in which these new materials interact with the biosphere.

CENARIOS - The first certifiable nanosafety label for industry and retail companies
Christoph Meili, The Innovation Society Ltd, Switzerland

The future nanotechnology risk landscape
As the ETC-Group called for a worldwide moratorium on synthetic nanoparticles in 2003, a broad debate on the potential risks of nanomaterials has been launched. The debate was heated up by the "Magic-Nano" recall in 2006. Regulators started to discuss suitable regulatory frameworks and actionplans on national and international level. Expert groups were set up and many research programs were launched in order to identify and handle potentially hazardous nanomaterials proactively. Today more than a hundred risk-research projects and programs are going on and many more are about to come. However, there is still a substantial lack of risk knowledge. Furthermore there is a growing gap between nanorisk related know-how and the growing number of nanoconsumer products. The lack of a clear, nanospecific regulatory framework and the high volatility of the debate lead to uncertainty and pose high market- and liability risks to all stakeholders. Traditional risk management approaches are based on technical risk analysis parameters such as "Probability of Loss" and "Damage", which, in the case of many nanomaterials, are not suitable or sufficient. In contrast, more information from other areas is needed to assess the risk- and liability potential of nanoproducts
CENARIOS® - A new approach towards uncertainty and complexity
CENARIOS (Certifiable Nanospecific Riskmanagement and Monitoring System) is the world`s first certifiable, nanospecific risk managementsystem It was developed by the Innovation Society and TÜV-SÜD Industry Services GmbH (www.tuev-sued.de) in order to assess HSE and occupational safety risks of nanomaterials and to provide foresight information. CENARIOS was established in 2006 for Bühler PARTEC www.buhlergroup.com, a Swiss manufacturer of nanoparticles. CENARIOS includes the Octagon Certificate and will be audited annually. The Octagon Certificate testifies a company's high-level safety engagement and serves as a communication tool of high credibility towards customers, authorities and insurance companies. The system constists of two basic elements: A product-specific risk assessment and evaluation tool and a 360 degree risk-monitoring tool.
Product-specific Risk Assessment
The product-specific risk assessment tool is based on a specific methodology and a database. The database is updated every 1-2 months according to the latest "state of the art" knowledge. The portfolio serves as a tool to substantiate e.g. productportfolio decisions.
360 Degree Risk-Monitoring Tool
The monitoring system is designed to anticipate strategically relevant developments. Several areas are monitored: Science (e.g. latest scientific studies), Society (regulatory trends, public perception, etc.), Technology and Market Trends. The aggregated results are integrated into a comprehensive risk management-system which is improved continuously.

16.00-17.30 Instruments 1: "Atomic imaging and characterisation" (Room 101cd)

Transmission Electron Microscopy without Aberrations
Crispin Hetherington, Oxford

Author: Angus Kirkland, Oxford
The modern Transmission Electron Microscope (TEM), operating at voltages between 200 and 400kV provides sufficient resolution to directly determine the positions of atoms in many solids in projection. In addition a variety of additional signals can be acquired using bright nanometre sized electron probes that provide complementary chemical and electronic structure information. Finally it is now possible to acquire multi-image datasets that can be reconstructed to give a full three dimensional representation of materials, albeit not currently at atomic resolution.
Thus, one of the key challenges in electron microscopy is to further extend resolution, and analytical sensitivity. However, the resolution of electron microscope is inherently limited by the aberrations of the objective lens. Hence, unlike their light optical counterparts which achieve resolutions close to the limit imposed by the wavelength electron microscopes are resolution limited to typically 0.1nm; some two orders of magnitude poorer than the diffraction limit.
In recent years a variety of complex electron optical aberration correctors have been designed and

constructed to overcome these traditional limitation and electron microscopy is now entering a new era with the promise of substantially higher spatial resolution and single atom chemical and spectroscopic sensitivity. These corrected instrument also enable novel optical geometries to be exploited some of which provide depth information at close to the 1nm level.
This presentation will firstly review these instrumental advances with particular reference the world's only instrument fitted with two aberration correctors installed in Oxford. Data acquired from this machine demonstrating its potential use in catalyst characterisation and semiconductor device analysis will be presented together with initial results arising from the exploitation of novel optical geometries.

Ultra-high resolution nano-characterisation and analysis using advanced S/TEM
Dominique Hubert, FEI

Authors: Freitag, Bert
Stokes, Debbie
Hubert, Dominique

As the limits of nanotechnology are expanded ever further, so too must we push back the frontiers of imaging and analysis. The need for tools that can deliver new, ultra-high resolution information is driving the development of electron microscopy and spectroscopy to the extremes of performance. For example, aberration-corrected S/TEM gives us the ability to work at sub-angstrom length-scales. This, combined with sharply-defined energy resolution, gives us the capability to acquire information at the single atomic level and gain knowledge of inter-atomic bonding, to enable characterisation of chemical composition, electronic structure and mechanical properties. In addition, there is scope for capturing time-resolved structural transformations with sub-nanometer detail, enabling us to directly observe and understand the dynamics of a range of chemical processes in situ. The capability of directly interpretable images at atomic resolution promises to revolutionise materials science. It crosses an important threshold in allowing researchers to investigate material properties in terms of individual atomic and molecular
mechanisms rather than as the bulk properties of an aggregate population. In a practical sense, ease of operation and interpretation provides access to new information and new results, allowing scientists to spend their time and effort applying results rather than obtaining them and seeing things that have never been seen before. We demonstrate the potential of this state-of-the-art technology for a range of nanotechnology applications, from complex oxides and interfaces to carbon nanotubes.

Time-of-Flight SIMS Applications: From Semiconductor to Biology
Sven Kayser, ION-TOF

TOF-SIMS is a very sensitive surface analytical technique, covering a wide range of organic and inorganic applications. It provides detailed elemental and molecular information about surfaces, thin layers, interfaces, and full three-dimensional analysis of the sample.
Today, TOF-SIMS has become a standard requirement for a surface analysis laboratory. A major reason for its success is its unique flexibility which allows a wide range of applications, from material to life science.
In this contribution we will give an introduction into the technique and show results from a broad selection of modern research areas.

DHM technology for 3D non-contact dynamical measurements
Frédéric Montfort, ST Instruments

DHM technology for 3D non-contact dynamical quality control Actual technology developments require both static and dynamical characterization with interferometric resolution. This can be achieved for static measurement with a rather large range of instruments and by white light interferometer operating in stroboscopic mode when considering periodic movements. For dynamic measurements, the palette of instruments reduces drastically. Digital Holographic Microscopy (DHM) is an ideal technology for both static and dynamic measurements. Light interaction with a sample modifies both intensity and phase of the illuminating wave. Any available supports for image recording are sensitive only to intensity. Denis Gabor [1] invented in 1948 a way to encode the phase as an intensity variations: the "hologram". Digital Holographic Microscopy (DHM) implements digitally

this powerful hologram.
With the present power of computers and the developments of digital cameras, holograms can be numerically interpreted within a tenth of second to provide simultaneously: (1) the phase information, which reveals object surface with vertical resolution at the nanometer scale along the optical axis, and (2) intensity images, as obtained by conventional optical microscope. Both images are defined with a diffraction limited resolution in the transverse (0xy) plane and are ”reconstructed” from the hologram in real time (more than 10 frames per second). The strength of DHM lies in particular on the use of the so-called off-axis configuration [2], which enables to capture the whole information by a single image acquisition within a few microseconds. This important feature makes out of DHM a unique tool for dynamic sample characterization: Such extremely short acquisition time makes DHM systems insensitive to vibrations. These instruments can operate without vibration insulation means, making them a cost effective solution for an implementation on production lines. Acquisition rates are about fifteen frames per second using standard camera and can be as high as 10’000 frames per second using fast cameras. In such case, reconstruction of intensity and phase images are performed in a second step. Stroboscopic mode can be performed very easily, only triggering properly the camera. There is no need to use pulsed light source. The presentation illustrates both static and dynamics application metrology and characterization ofMEMS andMOEMS by DHM.
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[2] Etienne Cuche, Pierre Marquet , and Christian Depeursinge ”Simultaneous amplitude-contrast and quantitative phase-contrast microscopy by numerical reconstruction of Fresnel off-axis holograms”, APPLIED OPTICS, Vol. 38, No. 34 ,December 1st 1999, p. 69947001.

ionLiNE a New Tool Concept for Nanofabrication in Surface Science and Thin Film Engineering
Andreas Rampe, Raith

Authors: Bruchhaus, Lars
Bauerdick, Sven
Rampe, Andreas
Remscheid, Andreas

The ionLiNE workstation is a novel focused ion beam instrument for low dose patterning in surface science, thin film engineering, and applied physics research. The unique components are the patented NanoFIB column and a Laser interferometer stage with 1-nm positioning, all integrated into one system and combined with software enabling advanced ion beam patterning. The ion beam column provides overnight beam current stability as required for advanced and automated patterning down to a sub ten nanometer level. Low beam tails offer high lateral selectivity. For applications covering larger areas, a Laser interferometer controlled stage is an integrated part of the ionLiNE workstation. It offers a unique positioning of 1 nm, under digital and manual control, and specifications like overlay and stitching, well known for high-end patterning tools. The software used for advanced ion beam patterning includes the generation or import of complex patterns in the widely accepted GDSII data format. Exposures are made in vector scan mode using the high speed 16 bit pattern generator. The pattern generator technology enables nanosecond ion dose control and moreover straightforward 3D grey level patterning capabilities. Job automation for overnight patterning requires no intermediate user interaction, secured by automated focus control using height sensing schemes and an automated dose correction control. A continuous - zero stitching - writing mode for seamless exposure of extended structures - FBMS mode - complements the advanced patterning of ionLiNE.

16.00-17.30 Nanomaterials 3: "Nanoparticles - manufacturing" (Ballroom1)

Synthesis of nanoparticles with a plasma torch
Frederik Cambier, CRIF, Belgium

Production of nano-powders by plasma at CRIF-Liège A new production line for the manufacturing of nanopowders has been installed at CRIF in Seraing.. The principle of this method is the following: a powder or liquid precursor is fed with a carrier gas into a plasma torch, where an in-flight particle melting and vaporization is carried out. The vapor cloud arrives in the quenching zone where the nano-powder is formed. This very powerful method leads to a safe and competitive production of nano-powders, with the following main advantages: high production volume, no limitation on material vaporization temperature and chemistry (production of carbides, nitrides, oxides and pure metals).

The installation is also able to transform micro-powders into nano-powders.
The two production units are able to process chemically aggressive or less aggressive species. The produced nanopowders are used at CRIF for feasibility studies where those powders are incorporated in matrices of different materials (plastics, ceramics, metals) to enhanced pre-defined properties of those materials. The quality of the nano-powders, as well as the incorporation rate and methods, are tested and the final products are characterized in our laboratories. The economical aspects as well as the health and safety issues are also considered in the assessment of the process in order to validate the future industrialisation of the production. CRIF participates in European projects (Nanoker) but also in private studies for the set-up of high added-values applications. In a first stage, the production will be concentrated on carbide and nitride powders.

RF Thermal Plasma Synthesis of Nanocrystalline Zirconia
János Szepvölgyi, IMEC CRC HAS, Hungary

Authors: Ilona, Mohai
Zoltán, Károly
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Szepvölgyi, János
Effect of synthesis conditions on the properties of nanosized ZrO2 and ZrO2/SiO2 particles was studied in a radiofrequency (RF) thermal plasma reactor. Colloidal ZrO2, zirconium propoxide and ethyl silicate, respectively were used as precursors. In this work, effects of the following synthesis conditions were investigated: (i) plate power of the RF generator, (ii) composition and flow rate of central and sheath gases, (iii) composition, concentration and feed rate of the feedstock and (iv) injection spot of precursors. Due to special synthesis conditions (very high temperature and high-rate cooling of the gas phase below the plasma flame region), nanosized powders were formed in all cases. The products were characterized for morphology (SEM, TEM), for particle size distribution (LD-PSA), for specific surface area (BET), for phase conditions (XRD) and for surface chemistry (XPS). It was found that using aqueous sol resulted bigger particles (D50=300-500 nm) as compared to organic precursor (D50=60-70 nm).
Effects of synthesis conditions as above on the properties of products will be discussed in details in the paper.

Improved catalyst annealing process for the rapid growth of carbon nanotubes by microwave plasma-enhanced chemical vapor deposition
Alexander Malesevic, VITO, Belgium

Authors: Van Haesendonck, Chris
Vanhulsel, Annick
Malesevic, Alexander
A two-step catalyst annealing process is developed in order to control the diameter of nickel (Ni) catalyst particles for the growth of carbon nanotubes (CNTs) by microwave plasma-enhanced chemical vapor deposition (PECVD). A continuous Ni film is deposited by molecular beam epitaxy (MBE) and thermally annealed in hydrogen (H2) environment. A subsequent H2 plasma treatment reduces the catalyst diameter by a factor 2 and increases the particle density by a factor 5. An x-ray photoelectron spectroscopy (XPS) study of the catalyst evolution during annealing is presented. The Ni catalyst particles are used for the rapid growth of a high density CNT coating by microwave PECVD. The produced CNTs are analyzed with electron microscopy and Raman spectroscopy. It is found that the graphitization of the CNTs degrades with increasing synthesis time. An optimal result is obtained after a synthesis time of 10 s. The growth rate is determined by cross-section scanning electron microscopy (SEM) to be 50 nm/s.

8.45-10.00 Keynote session (room 101cd)

Multifunctional Nanoparticles: Vascular Zip Codes in Targeted Delivery of Nanodevices
Professor Erkki Ruoslahti, Burnham Institute, CA, USA

This laboratory screens phage libraries in live mice to identify peptides that direct phage homing to a specific target in the body. When the libraries are injected into the circulation, tissue-specific or tumor-specific differences in endothelial cells are primarily targeted. We have identified tumor-homing peptides that recognize angiogenesis-associated or tumor-type specific markers in tumor blood vessels, or distinguish the vessels of pre-malignant lesions from those of the corresponding normal tissues and of fully malignant tumors. Homing peptides have also revealed a zip code system of molecular changes in tumor lymphatics. We have used synthetic homing peptides identified by phage display to target nanoparticles to tumors. The vasculature is an excellent target because blood supply is important for tumor growth and because tumor vessels are readily available for circulating particles. The homing peptides deliver nanoparticles into tumors in a highly selective manner, and we have recently developed a system in which the nanoparticles amplify their own homing to tumors. We are currently constructing targeted nanoparticles with additional functions, such as tissue penetration and drug delivery.

An Integrated Science Perspective on Driving Innovation with Materials at the Nanoscale
Dr E. James Prendergast, DuPont

DuPont is a science-based products and services company with a long-standing commitment to materials-based innovation. Nanostructure can dramatically influence the fundamental properties of materials including thermal, mechanical, electrical, optical, and chemical. The availability of modern tools for synthesis, measurement, characterization and modeling now permits the deliberate design of novel nano-structured materials. Such materials can deliver enhanced performance in existing applications, and can enable new applications and new business opportunities. DuPont is exploring how nano-scale science and engineering can add value in a number of applications, such as coatings, polishing, polymer nanocomposites, printable electronics, displays, sensors, membranes and functional surfaces. In these explorations, DuPont is guided by the belief that nanoscale science and engineering is not an end in itself, but enriches the options available to materials scientists to meet current and future market needs. DuPont is also committed to ensuring that any new nanomaterials are brought to market in conformance with its rigorous safety, health and environmental principles.

10.30-12.00 Nanobio 1: "Drug and gene delivery" (room 101cd)

Polymer Therapeutics as Nanomedicines for Cancer Therapy
Ruth Duncan, Welsh School of Pharmacy, Cardiff University, UK

Nanomedicines or nanopharmaceuticals have been defined as nanometre size scale complex systems consisting of at least two components one of which is biologically active, and it is agreed that nanopharmaceuticals can be developed either as drug delivery systems or biologically active drug products (European Science Foundation's Forward Look on Nanomedicine (2005) www.esf.org). This definition includes polymer therapeutics (e.g. polymerprotein and polymer-drug conjugates) (Duncan, R. (2003) Nature Rev Drug Disc. 2(5), 347-360), and they share many features with other macromolecular pro-drugs such as antibody conjugates of drugs and radiotherapy. Over the last decade several polymer-protein conjugates have been transferred to market (including PEG-asparaginase, PEG-GCSF, PEG-interferon-alpha), and > 11 polymer-anticancer drug conjugates have progressed into clinical development. Clinically the most successful polymer-anticancer drug conjugates have been rationally designed in respect of their molecular weight, drug content and most importantly the polymer drug linker (Duncan, R. (2006) Nature Rev Cancer, 6, 688-701). Antitumour activity has been seen in chemotherapy refractory patients with hints (preclinical and clinical) that polymer conjugation may bypass MDR. Drug conjugation radically changes its pharmacokinetics and having prolonged circulation times, conjugates target tumours by the enhanced permeability and retention (EPR) effect. Once in the tumour interstitium the polymer-drug enters cells by the endocytic route leading to lysosomotropic drug delivery. Several conjugates have peptidyl polymer-drug linkers that are cleaved by lysosomal thiol-dependent proteases. As clinical trials progress it is increasingly apparent that lysosomotropic delivery is not only an opportunity for delivery, but malfunction can be a

mechanism of resistance. The rationale for design of preclinical lead compounds will be summarised, and the challenges for effective preclinical and clinical development of these complex macromolecular prodrugs discussed.

Magnetic Nanoparticles: functional tools for bio and clinical applications
Hongchen Gu, Research Institute of Micro/Nano Science and Technology,
Shanghai Jiaotong

Authors: Ma, Yongjie
Wang, Xiaoliang
Gu, Hongchen

The emerging fields of nano science and technology--the ability to work on molecular scale, to create new functions and properties atom by atom—has greatly stimulated scientist to explore the new world from the basic building blocks.
Based on the progress of fundamental chemistry, biotechnology and materials science over the past three decades, the research dimension in these disciplines advanced almost with the same path into nanoscale. DNA, RNA, proteins has became the basic molecular standpoints for understanding bio phenomenon and process. Materials science has make it possible to synthesize bio compatible particles with varieties of functions. The novel and highly interdisplinary field of chemistry has closely associated with both the physical and chemical properties of organic and inorganic nanoparticles.
The integration of the above progress recently make the nanoparticles as the most potential powerful tools for biotechnology. Superparamagnetic particles, quantum dots, dendrimers and nano contrast imaging have brought exiting findings wave by wave.
This talk summarizes the work in our group on the biofunctioned magnetic nano particles and demonstrated the successes on design, synthesize and applications of MNP in typical bio and clinical examples. The main content includes (1)preparation of monosized superparamahnetic nanoparticles, (2)surface functionization and bioconjugation of these particles, (3)endocytosis of magnetite nanoparticles by different kind of cells, and (4) hyperthermia, MRI, and DNA transfection applications of nanomagnetic particles.

Effects of Survivin siRNA conjugated Carbon nanotube on Human MCF-7 Cells
Bifeng Pan, Shanghai Jiao Tong University, China

Authors: Cui, Daxiang
Xu, Ping
Pan, Bifeng
Gene targeting using short interfering RNA (siRNA) has become a common strategy to explore gene function because of its prominent efficacy and specificity. For the application of siRNA technology to gene therapy, however, still more efficient transduction of siRNA into target cells is needed. In this study, we developed an carbon nanotube vector harboring a tandem-type siRNA expression unit, in which sense and antisense strands composing the siRNA duplex were separately transcribed by two human U6 promoters. Targeting survivin, an antiapoptotic molecule widely overexpressed in malignancies but not detected in terminally differentiated adult tissues, this type of carbon nanotube vector successfully exerted a gene knockdown effect and induced apoptosis in MCF-7 cells. These cancer cells, once infected with carbon nanotube/survivin siRNA, displayed remarkably attenuated growth potential in vitro. This novel modality may be a promising tool for cancer therapy.

10.30-12.00 Photonics 3: "Waveguides" (Ballroom 1)

Nanophotonics
Lars Thylen, KTH, Sweden

Nanophotonics seems to be a contradiction since nanotechnology is generally defined as a technology involving feature sizes in the nanometer range, whereas conventional photonics devices and technology exhibit characteristic sizes at least on the order of the wavelength, around 1 mm, but in many cases orders of magnitude larger than the wavelength. An example of the former is the transverse dimension of an optical waveguide, of the latter the length of a semiconductor modulator. However, in view of the different roles the nanodimensions can play, an appropriate definition of nanophotonics is the “technologies for engineering the flow of optical frequency electromagnetic ra-

diation in dimensions, or with function enabling feature sizes, smaller than the vacuum wavelength". In this case, subwavelength resonators would be one of many examples of the first case and photonic crystals an example of the latter case, since the tolerances encountered in many photonic crystals structures are on a nanometer scale.
Focusing on physical dimensions, somewhat in line with the development of microelectronics, there has been a very rapid progress in photonics integration density (L. Thylén et.al, "The Moore's Law for photonic integrated circuits", J. Zhejiang Univ. SCIENCE 2006 7(12) p.1961-1964) However, to continue this, break throughs in materials science and technology are required. As an example, a material with a negative e but very low loss (at room temperature) could be one of the enablers of a vast range of structures and devices, drastically expanding the application envelope of photonics. Metals such as gold and silver meet the first requirement but not the second.

The talk will treat the status and prospects of nanophotonics, focusing on materials and technology requirements to achieve true nanoscale or nanoenabled integrated photonics.

Fabrication and replication of 2D photonic crystal waveguides
Jurriaan Huskens, University of Twente, the Netherlands

During the last decades, ongoing research has shown the potential of photonic crystal structures in terms of controlling the light propagation in a range of devices. Most studies are focussing on the fabrication and characterisation of these devices using several state-of-the-art lithographic techniques. In this contribution, we demonstrate the low-cost replication of these master structures on silicon-on-insulator (SOI) substrates by nanoimprint lithography (NIL) in combination with local oxidation of silicon (LOCOS) into SiO2 masks for cryogenic reactive ion etching (RIE). First, the master waveguides are fabricated by a two-stage fabrication procedure combining large area patterning of the ridge waveguides by conventional photolithography with local introduction of the photonic elements by FIB. After transfer of these waveguide structures in high-molecular weight PMMA by NIL and subsequent conversion into silicon nitride (Si3N4), using tetraethyl-orthosilicate (TEOS) as a sacrificial layer, LOCOS is done to invert the structure into SiO2 using Si3N4 as an oxidation mask during dry oxidation. Finally, the photonic devices are fabricated into SOI with excellent profile control by cryogenic reactive ion etching (RIE) using SiO2 as etch masks. Examination of the structures by high-resolution SEM indicates that the replication into SiO2 masks is very accurate (< 4 nm). This accuracy and the excellent feature definition of the resulting SiO2 mask demonstrate the potential our fabrication technique for the replication of photonic waveguide devices. Initial optical characterization indicates the formation of a band gap structure, and the photonic crystal waveguide structures show quite low losses in the photonic crystal waveguide area. This confirms the accurate feature definition of the photonic element, and the faithful replication of it during all pattern replication and transfer steps.

Silicon nanophotonics: Light emission, wavelength-selective waveguiding and laser-induced thermal effects
Leonid Khriachtchev, University of Helsinki

Authors: Khriachtchev, Leonid
Räsäanen, Markku
Novikov, Sergei

Silicon nanocrystals (Si-nc) constitute a promising photonic material with a large variety of applications.1 In this contribution, we present a series of experimental studies on Si-nc embedded in silica. We describe preparation and optical characterization of Si-nc/SiO2 materials as substrate-supported and free-standing films with emphasis on thermally annealed Si-rich silica films and Si/SiO2 superlattices. The red-NIR photoluminescence (PL) of these materials and its mechanism is studied and systematic correlations of PL with optical and structural properties are analyzed. The obtained results support a surface light-emission mechanism involving Si=O bonds.2 Wavelengthselective optical waveguiding of silica layers containing Si-nc has been observed and studied.3 The found filtering effect (FWHM < 10 meV) allows tunable optical waveguiding to be obtained.4 Laser-induced thermal effects on structural and optical properties of free-standing silica films containing Si-nc have been found.5,6 In particular, we demonstrate a very efficient Si/SiO2 phase separation by CW laser radiation. Laser-controlled stress of Si-nc in silica (up to 3 GPa) has been found.7 The latter effect offers an approach to Si-nc optical memory with an extremely long

retention time and high data density, which can be written, read, and erased by optical means.8 The work was supported by the Academy of Finland.

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Nanostructured ridge waveguide lasers fabricated by nano-imprint lithography

Tapio Niemi, Tampere University of Technology

Authors: Dumitrescu, Mihail
Rytkönen, Tuomo
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Pessa, Markus
Niemi, Tapio

Distributed feedback (DFB) and distributed Bragg reflector (DBR) laser are favoured in applications where narrow line width, single-longitudinal mode emission and stable wavelength are required. Typical applications include dense wavelength division multi-plexed optical communications, optically-pumped atomic clocks and optical spectroscopy. The conventional fabrication of DFB and DBR edge-emitting lasers includes epi-taxial overgrowth after grating fabrication. The overgrowth induces increased crystal-line defects into the semiconductor and complicates the device fabrication, reduces the fabrication yield and increases the fabrication costs. Our investigations indicate that nanostructured ridge-waveguides could produce wave-length-selective feedback strong enough for fabricating DFB and DBR lasers. The sur-face-nanostructure-based device operation limits the interaction between the carriers and the defect-prone processed interfaces, reduces device fabrication complexity and increases fabrication flexibility.
Reduced costs are achieved by using low-cost wafer-level UV-based nanoimprint lithography (UV-NIL) to define the surface features. Our latest results in the development of nano-structured ridge waveguide lasers' fabrica-tion will be presented. The performances in defining nanoscale surface features by UV-NIL and in achieving high aspect ratio etching as a part of the DFB laser fabrication will be particularly discussed.

10.30-12.00 Instruments 2: "Characterization" (Ballroom 2)

Relevant characterization techniques for thin films and coatings at liquid and solid interfaces

Tapani Viitala, KSV Instruments

The interest towards the characterization and knowledge how to manipulate interfacial properties at a molecular level has gained a lot of interest during the past decades. The main reason for this is that the most interesting and important phenomena occur at interfaces i.e. heterogeneous Catalysis, electron transport and scattering at semiconductor-metal or semiconductor-dielectric interfaces, molecular binding and transport at cell membranes, nanoscale dynamics at polymer interfaces etc. Often these processes are governed by the interfacial properties of the phases involved. Hence, there is an ongoing need for development of novel characterization techniques for various types of interfaces. The objective of this presentation is to give an overview of the utilization of the Dissipative Quartz Crystal Microbalance (D-QCM) based on true impedance analysis, Interfacial Stress Rheometer (ISR), Polarisation Modulated - Infrared Reflection Absorption Spectroscopy (PM-IRRAS), Contact Angle (CA) and Surface/Interfacial tension (SFT/IFT) measurement technique based on axisymmetric drop shape analysis.
Shortly, the above techniques can be utilized for following purposes:
· QCM: Adsorption, interaction and reactions studies at solid interfaces. Mass sensing tool for determining adsorption of nanogram quantities of material to solid interfaces.
· ISR: A novel technique to determine the rheological properties and interactions of a few nanometer thick floating monomolecular monolayers at the air-liquid or liquid-liquid interfaces.

· PM-IRRAS: Quantitative studies of properties and interactions of floating monomolecular monolayers at the air-water interfaces, and monolayers on solid substrates
· CA & SFT/IFT: Interactions of liquids with solid surfaces, wetting, surface free energy. Optical technique determines the properties of the outermost layer of interfaces i.e. the first 1-2 nm of the interface.

Direct visualization and analysis of nanoparticles using a new laser-based, single particle tracking system
Bob Carr, NanoSight Ltd

A single nanoparticle tracking analysis system is described which allows nanoscale particles to be individually visualised (but not imaged) in liquids and from which higher resolution particle size distribution profiles can be obtained compared to other light scattering techniques. Sample pre-treatment is minimal requiring only dilution with a suitable solvent to an acceptable concentration range (between 105 and1010 perml depending on sampletype).Accurate and reproducible analyses can be obtained from video of only a few seconds duration and the results allow particle number concentration to be time nature of the technique, particle−particle interactions are accessible as is information about sample aggregation and dissemination. 15nm for high refractive index materials such as colloidal silver. The technique is robust and low cost representing an attractive alternative or complement to higher cost and more complex methods of nanoparticle analysis.

Characterization of Materials and Multilayer Structures of OLED by Spectroscopic Ellipsometry
Vincent Couraudon, SOPRA

Authors: Defranoux, Christophe
Piel, Jean Philippe

Spectroscopic Ellipsometry (S.E) is a well adapted optical technique widely used for the characterisation of all types of thin films for thickness and optical indices on glass or plastic substrates. Flat Panel display (standard AMLCD or Low Temperature Polysilicon) manufacturers are routinely using this method to monitor and control the production line by taking advantage of the high throughput, high accuracy, and the limited measurement probe size of this technique. S.E. is also applied to the characterization of materials and multi-layer structures of organic light-emitting diodes (OLEDs); where all parameters of each layer are given in one single measurement. The main parameters of interest are the thickness and dopant values that are relatively small (lower than 50 nm and a few %). Complex organic materials can be analyzed accurately from their absorption bands in the visible and UV range; therefore, dopant concentrations can be measured, monitored and controlled in these films. It has already been demonstrated that a sensitivity of better than 0.1% for AlQ3 and a Hole Transport Layer can be achieved. S.E allows dopant concentration determination on the whole surface of the coated sample that Quartz balance can not afford. The determinations of the refractive indices by S.E. offer the possibility to optimize the micro cavities effect of the structure. Reflections, transmission inside the OLED multilayers stack are dependant from each layer n and k values. S.E. and appropriate software allows to simulate and optimize for each type of pixel the thickness of any layers to obtain the best efficiency. As the OLED materials are sensitive to moisture and pollution, it is required to measure the materials optical properties and thickness values through an encapsulated layer. Only S.E. is able to measure these parameters through this encapsulated structure. We will demonstrate how we can measure single layer and multi-layers through encapsulated samples from the front side or from the back side of the substrate. This technique can be applied to monitor and control an OLED process in a production line. As demonstrated by our results, ”Backside” and ”through the cap” measurements can also be applied for the determination of the ITO resistance, without contact, by using Near Infra Red ellipsometry. Additionally, we will study the effect of the change of refractive index versus the resistance of the ITO. Correlation measurements with 4 Point Probe will also be presented.

BioImageXD – New Software for Visualizing and Analyzing Nanoparticles in Living Cells

Pasi Kankaanpää, University of Turku, Finland

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Modern bioimaging techniques such as confocal and atomic force microscopy have become essential and popular in following the movement and behavior of various types of nanoparticles in living cells. What has largely been missing, however, is suitable computer software to visualize and analyze the data produced by these methods. We have created new software, BioImageXD, as a solution to this problem. BioImageXD is free and open source, and it is developed as an extensive multidisciplinary collaboration between computer scientists, cell biologists and molecular modeling experts mainly from the universities of Turku and Jyväskylä in Finland. It is tailored to the needs of fluorescent nanoparticle imaging. BioImageXD contains sophisticated 3D rendering, animation and other visualization tools that are among the best available. It also offers a constantly increasing number of tools for quantitative and statistical analyses, such as one of the most versatile colocalization analysis tools available, segmentation based analyses and particle tracking features. The first beta version of the software was released in early 2006, and it has received significant attention around the world and has been downloaded thousands of times (http://www.bioimagexd.org). We apply and develop BioImageXD to study different types of nanoparticles in living cells. Of particular interest is the integrin family of cell surface receptors that are often internalized upon ligand binding and the virus EV1, which utilizes this mechanism to get inside cells. We image the internalization and movement of these particles with confocal microscopy and use BioImageXD to quantitatively analyze their size, distribution, rate of internalization, speed of movement etc. Our major goal is to use this information to develop drug delivering nanoparticles. BioImageXD also enables us to develop the necessary algorithms to evaluate for instance the internalization efficiency of such particles.

14.00-15.30 Nanobio 2: "Nano-bio-materials" (room 101 cd)

Fabrication of nanomaterials using peptide motifs
Shuguang Zhang, MIT, United States

Two complementary fabrication technologies are employed in the production of materials and tools. In the topdown' approach, materials and tools are manufactured by stripping down an entity into its parts, e.g. carve a boat from a tree trunk. This contrasts sharply with the bottom-up' approach, in which materials and tools are assembled bits by bits to produce supra-structures and architectures, e.g. build a ship using wood strips. The bottom-up approach is likely to become an integral part of materials manufacture in the coming decades. This approach requires a deep understanding of individual molecular building blocks, their structures, assembling properties and dynamic behaviors. Two key elements in molecular material manufacture are chemical complementarity and structural compatibility, both of which confer the weak and noncovalent interactions that bind building blocks together during self-assembly. Following nature's leads, significant advances have been made at the interface of materials chemistry and biology, including the design of helical ribbons, peptide nanofiber scaffolds for three-dimensional cell cultures and tissue engineering, peptide surfactants, peptide detergents for solubilizing, stabilizing and crystallizing diverse types membrane proteins and their complexes.

Designing nano-bio materials from the bottom-up: an interdisciplinary modeling approach
Gerhard Goldbeck-Wood, Accelrys

Many aspects of Nanobiology are at an intersection between materials science and life science. Methods and materials brought to bear on drug discovery and delivery utilise an ever wider range of materials, build on a wide range of physico-chemical properties from magnetic heating to self-assembly, and exploit new phenomena arising at scales from the atomistic to the so-called mesoscale.
This scenario poses many challenges but also opportunities for computational modelling tools.

Software has traditionally been developed specifically for either life science applications such as small molecule or protein modelling, or for materials applications such as catalysis or polymer simulations. On the other hand, there has been substantial method development in recent years addressing in particular multi-scale phenomena and multi-material systems.
The presentation will review recent modelling developments pertinent to the field, provide some case examples, and give an overview of the Accelrys NanoBiology Initiative, a framework for companies to direct the development of multiscale modeling software and components with applications such as drug delivery platforms and diagnostics systems.

Lipid Membrane Nanotechnology
Nikos Hatzakis, Nano-Science Center, University of Copenhagen, Denmark

Authors: Stamou, Dimitrios
Lipid membranes constitute the boundaries of cells and play an active role in regulating countless biological processes. They can also be seen as supramolecular architectures with extremely well defined properties that can be used as scaffolds for the construction of biofunctional devices. With the emphasis on nanometer scale phenomena, I will discuss certain aspects of the physiological role of lipid membranes as well as some of their technological applications. Selected examples will include: i) the newly established critical role that membrane curvature plays in biorecognition ii) SNARE mediated single vesicle-vesicle fusion resolved at the ms range iii) activity of single enzymes confined in attoliter volumes iv) triggered release of reactants in systems with a total volume of a few femtoliters.

Molecular Profiling using NanoPatterning of Extra-Cellular Matrix Components
Frederic Zenhausern, Center for Applied NanoBioscience, ASU, United States

”Controlled engineering” of the cells’ nano-environment will lead to advances in understanding the molecular actions of biomarkers and cellular mechanotransduction with oncogenic signaling. Microtopography has been shown to provide cues to cells that elicit a large range of cell responses, including control of adhesion, morphology, apoptosis and gene regulations. Cells have many structures at the nanoscale such as filipodia and cytoskeletal and membrane proteins that interact with the environment surrounding them. By using techniques that can control the nanoenvironment presented to a cell, and in particular by patterning and printing the stroma region of a tumor, one can begin to mimic the 3D confined environment with nano-scale features presented to cells by extracellular matrix proteins such as collagen and other ECM components. Our interdisciplinary team is initiating studies that will characterize tumor-stromal interactions as they relate to malignant gliomas. By using nano-imprinting lithography techniques one can create large area surface patterns and 3D arrangements suitable for microphenotyping the glioma cells in brain tumors. Preliminary results will be presented that may lead to identification of new classes of molecular targets for future cancer therapy.

14.00-15.30 Nanomaterials 4: "Wires and tubes" (Ballroom 1)

Electronic transport in nanowires at different length scales
Antti-Pekka Jauho, Technical University of Denmark

Nanowires, i.e., systems with a diameter of the order of 1 – 10 nanometers, and length up to microns, form a subclass of modern nanoscale systems, which hold a great promise for future technologies. For example, they could be used as interconnects in future's nanoelectronics, or they could form the basis of extremely sensitive sensors. In addition to their possible practical applications, nanowires exhibit a wide range of physical properties, which are of their own intrinsic interest. The theoretical scientist attempting to model charge transport in these systems faces many challenges. The number of atoms or active charge carriers requiring a microscopic treatment may vary from a few to several millions. The transport may be coherent, or dominated by interaction effects. No single formalism can capture all the different facets, and in this talk a review of a few selected modern techniques, operative at different length scales, is given. Specifically, we shall be considering three different physical systems: (i) Semiconducting nanowires; (2) Gold atomic wires; and (3) Molecular electronics.

Novel Static and Dynamic Mechanical Response of Transitional Metallic Nanorods

Adrian Koh, National University of Singapore

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Koh, Adrian

The fcc transitional group of metals were found to display excellent ballistic conductance, great sensitivity to high-frequency oscillations and good biocompatibility at nanoscale. Intensive research was conducted on their electrical, thermal and magnetic properties at nanoscale, with limited studies on its optical and mechanical aspects. The exceptional electrical and dynamic properties of transitional metallic nanomaterials would inevitably lead to its deployment in extreme physical, thermal and chemical environments. As such, the relatively lesser-studied mechanical properties must be investigated in order to gain a more complete understanding of metallic nanomaterials. In this study, the mechanical responses of two metallic nanorods belonging to the transitional group of metals were studied namely Platinum (Pt) and Gold (Au), using large-scale, parallel computational simulations. Pt nanorods display high strength and excellent ductility at nanoscale, it has high sensitivity towards frequency fluctuations and exhibited exceptional nano-biocompatibility. On the other hand, Au nanorods have a near-perfect quantum conductance at nanoscale. This made Pt nanorods an ideal candidate for drug delivery and Au nanorods for a nanosuperconductor.
This study revealed the novel characteristic of ”momentum-induced melting” of the nanorods, which occurred at strain rates at order of magnitude of 109/s and above. The mechanism behind ”momentum − induced melting” was due to the reduced enthalpy of fusion at nanoscale, whereby a relatively smaller strain energy would result in the breaking of metallic bonds and lead to the overall disintegration of the fcc crystal strstrain response and the classical one−dimensional wave−propagation equation, which would enable the prediction and control of the necking location. Dependent wave propagation speed was observed in metallic nanorods, where enhanced primary wave(p − wave) speeds of up to 50% larger than that predicted from the classical wave equation was discovered in very small nanorods with characteristic sizes of less than 4.0nm. waveguides for electrical and mechanical transmission.

Chip-cooling with carbon nanotubes

Krisztian Kordas, University of Oulu, Finland

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The increasing integration and component density in processor components along with the associated higher power consumption necessitate an enhancement of heat dissipation from the high power devices to avoid overheating and failure. Several solutions for component thermal management have been suggested, but there is a continuous need for developing novel cooling methods and utilize new materials - to be able to dissipate heat in a more efficient manner. Because of their high thermal conductivity, carbon nanotubes have great potential in thermal management of future devices. In our work, we demonstrate cooling of hot chips with micro-finned films of nanotube coolers either integrated or directly grown on the components. To complement and validate our experimental results, also computational fluid dynamics and thermal-electric simulations on various chip/cooler assemblies are presented. To date, our nanotube coolers enable 20 to 100% more efficient heat dissipation from the components by the integrated and on-grown nanotube architectures, respectively.

14.00-15.30 Electronics 3: "Nanosensor systems" (Ballroom 2)

Study on Spin-Valve GMR Sensor and Its Applications
Tiang-Lin Ren, Tsinghua University, China

During the past several years, magnetic field sensors based on spin-valve giant magnetoresistance materials had been paid much attention in the field of magnetoelectronics and sensing techniques. Now, the spin-valve GMR sensors have not only been used in read head in hard disk conventionally, but also emerged as a new promising platform technology for some linear detection system and biochip development. Some magnitoresistance characteristic and performance optimizing methods of spin-valve material have been studied in our lab, and we have developed some detection sensor chips for displacement detection, angle detection, and bio-applications.

Characteristic and performance optimizing methods of spin-valve materials have been studied. Utilizing special structure such as NiFeCr accessorial buffer layer, spin-valve materials with partial outstanding performance, Magnetoresistance Ratio (MR) 14.09% have been obtained in the structure Ta/NiFeCr/CoFe/Cu/CoFe/IrMn/Ta. And after a novel transverse annealing process, the coercivity of the spin-valve material with structure Ta/NiFe/CoFe/Cu/CoFe/IrMn/Ta is reduced to 0.04Oe, and maintains a relatively high MR 7.65%, which can fit the needs of the practical applications well.

Two kinds of detection sensor chip systems including low magnetic field linear detection system, magnetic grating vernier displacement detection system have been realized. These GMR sensors are fabricated using semiconductor process by three photolightprocesses method or five photolightprocesses method. The test results show that GMR single strip sensor and GMR magnetic grating vernier sensor have good performances, and the linear range, sensitivity and linearity of the GMR linear bridge sensor are 30.25Oe, 1.61(mV/Oe)/V and 99.952%, respectively.
The bio-applications of the spin-valve GMR sensors have also been studied. The technology are based on the detection of the magnetic fringe field of a biomolecule labeled by some magnetic microspheres or nanoshperes with diameters from 2um~50nm, interacting with a complementary biomlecule bound to a magnetic field sensor. A biologic immune magnetic bead detection system has been developed, including the biosensor chip system with two sensor elements (one for signal, one for reference, and comprised half of a Wheatstone bridge to obtain an optimal signal-to-noise ratio), magnetizing-field generator (to generate a magnetic field in the surface plane of the sensor), and the lock-in amplifier (LIA) (to detect the subtle AC signal). The initial experimental results indicate that the sensitivity of the biosensors can be used for immune detection system.

Printed devices based on inorganic nanoparticles
Mark Allen, VTT, Finland

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We will review our recent work on printed nanoparticle structures. As a specific case, results on printed RFID antennas based on silver nanoink will be presented. The antennas are ink-jet printed onto a polyimide substrate using the Dimatix Materials Printer. The thickness of the printed silver was increased by printing several layers on top of each other to reduce resistive losses. A resistivity of only four times higher than the bulk resistivity of pure silver was obtained for both multiple and single printed layers. RFID antennas for operating frequencies of 13.56 MHz and 869 MHz were printed. High Q-values of 9.4 and 5.3 were obtained for the 13.46 MHz antennas with three and two printed layers, respectively. For 869 MHz, a spiral shaped half-wave dipole antenna was designed for direct impedance matching with the PALOMAR encapsulated RFID microchip. The maximum reading distance of the RFID chip connected to the antenna was 3 meters with a 0.5 W transmitted power for continuous reading and up to 5 meters was measured at best in laboratory conditions (8 meters with 2 W transmitted power). The measured reading distances using corresponding copper antennas have been of the order of 5 meters.

Nano- and biosensing systems at CSEM

Erika Györvary, CSEM, Switzerland
CSEM SA, the Swiss Center for Electronics and Microtechnology, is an innovation center collaborating with universities and seeking to provide solutions to industry. CSEM is active in the fields of nano/microtechnology, microelectronics, systems engineering, information and communication technologies. It supplies customized microsystems, microelectronic designs and system solutions, as well as services for high-tech coatings and new materials.
In this presentation, CSEM's activities in nanotechnology & nan/biosensing will be discussed . More closely optical biosensor platform & latest developments in miniaturization of lab devices for nanotechnology applications will be presented.

16.00-17.30 Nanobio 3: "Nanosensors and diagnostics" (Room 101cd)

State-of-the-art Nanotechnology for Diagnostics
Hesaam Esfandyarpour, Stanford University, United States

The creation of faster, more accurate infectious disease detection devices is imperative and we are increasingly looking to the nano-world for such technology. In this paper we chart recent advances in the state-of-the-art methods which are being used to fill this need in biotechnology and then talk about the future and possibilities in the road. One such method uses the detection of emissions from quantum dots manipulated to bind to certain targets. A certain emission resulting when these quantum dots are introduced into a specimen corresponds to the presence of a specific target. The second utilizes nanowires with certain antibodies attached to them. A change in the conductance of the wire indicates the presence of the corresponding antigen. The third method discussed uses carbon nanotubes with a similar idea. If the nanotube is attached between a source and a drain, there will be a measurable change in conductance when the target particle binds to the receptor sites on the tube.

The use of nanoparticles in Allergy Diagnostic in vitro test systems
Mats Nystrand, Phadia AB, Sweden

Allergen-specific IgE is an established marker used in the diagnosis of allergy. To address an increasing need of screening large numbers of different allergens in both research and clinical applications, an experimental protein microarray assay for detection of specific IgE antibodies has been developed. The major challenge in the design of such an array is to achieve an antigen binding surface sufficiently large to reach adequate analytical sensitivity in the test assay. In comparison to many other analytes, the detection of specific IgE antibodies poses exceptional difficulties with respect to assay design and performance. First, in relation to total serum protein, specific IgE antibodies are only present at ppb-ppm levels and often comprise only a limited fraction of total IgE. Secondly, antibodies with the same allergen specificity but a different isotype (such as IgG) will bind to the assay reagent and may interfere with the IgE detection. Third, natural allergen extracts commonly used for diagnosis contain a complex mixture of allergenic and non-allergenic proteins of which the latter may not be the dominant constituent.
The assay described here is based on a capillary flow membrane with an inherent 3-dimensional structure on which nanoparticles carrying allergen reagent are arrayed. A 3-dimensional structure has two major benefits. First, it has an enlarged surface area, which favours efficient detection of low-concentration analytes. Secondly, the structure enables a liquid flow driven by capillary force to take place, from the site of sample and reagent application through the reaction zone, which allows a simple and robust instrument solution to be devised. To further enlarge the surface at the reaction zone, nanospheres are used. The enlarged inner surface area contributed by the nanosphreres is necessary to ensure the detection IgE antibodies to low-abundance components in the allergen extract. As antibodycapturing reagents in this assay, natural allergen extract or purified allergenic proteins may be used, which are covalently immobilized to the nanospheres. Also the detection system of this assay is based on nanospheres, which carry a binding function on the outer surface and the signal-generating substance inside. Using the nanoparticle technique, two different assays for determination of specific IgE have been developed. One is a qualitative point of-care test to be used mainly in primary care with visual reading while the other is a quantitative microarray test system intended for hospital laboratories.

Nanocrystals for biosensors applications

Arben Merkoçi, Institut Català de Nanotecnologia, Spain

The use of nanocrystals for biosensing has generated great interest with the increasingly understanding of the structure and function of gene, especially for Human Genome Project. By the other side, sequence specific DNA detection has been a topic of significant interest, for its application in diagnosis of pathogenic and genetic diseases between other fields. The design and electrochemical as well as optical characterisation of water soluble and electroactive nanocrystals (such as heavy metal sulphide quantum dots) for use in the DNA and immunosensing systems will be presented. Their modification with DNA strands or antibodies will be shown in connection to novel electroanalytical formats employed to follow the hybridisation / immunoreaction event with interest for various bioanalytical applications. The direct electrochemical detection modes are based on either composite electrodes or paramagnetic particles as DNA immobilisation platforms. The high sensitivity of electrochemical transducers employed coupled with the low cost and low power requirements will be discussed. The proposed detection bioassay strategies are based on magnetically induced electrochemical stripping detections as well as other methods. Several examples based on the use of gold as well as other quantum dot nanocrystals will be presented. The developed nanoparticles and electroanalytical strategies hold a great promise for developing novel low cost genosensors and immunosensors with interest in genomics and proteomics. Results related to the optimization of the developed genosensors and immunosensor will be shown. These will include optimization of the amount of nanocrystals, paramagnetic beads, the time of hybridization / immunoreaction along with electrochemical stripping detection variables of the DNA/ Antibody nanocrystal networks magnetically trigged using magneto DNA/immuno probes.

“Soft” nanolithographic patterning of surfaces for design of functional assemblies and nanoarrays of proteins

Ramunas Valiokas, Institute of Physics, Lithuania

Alternative, scanning probe based lithographic methods, such as nanografting and dip-pen nanolithography (DPN), have proved to be a powerful experimental platform for the construction of organic and inorganic nanostructures on solid surfaces. Further on, these nanostructures can be used as templates for interfacing with biological materials, organelles and cells. For example, we have shown that DPN can be employed to generate positively charged molecular domains on gold surfaces for selective recruitment of photosynthetic core complexes (1), a promising material in bioelectronics. Moreover, nanolithographic manipulation of surfaces opens new possibilities to create well-defined molecular assemblies with terminal affinity tags for precise positioning of proteins. In particular, selfassembled monolayers (SAMs) with terminal multivalent chelators (MCHs) are interesting chemical tools and we already have demonstrated arraying and multiplexing of recombinant proteins on MCH SAM microdomains (2). However, fabrication of MCH nanoarrays is a nontrivial task because of the increased complexity of the molecular entities involved in the self-assembly process. Thus, this contribution will focus on technological aspects of the nanolithographic formation of the MCH domains using a closed loop atomic force microscope with a commercial DPN package. Some functional properties of the designed protein assemblies and their potential applications in proteomics will be also discussed.

References:

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(2) Valiokas R., Klenkar G., Liedberg B., Tinazli A., Tampé R., Piehler J.; Differential Protein Assembly on Micropatterned Surfaces with Tailored Molecular and Surface Multivalency, ChemBiochem; 7, 1325 - 1329, 2006.

16.00-17.30 Nanomaterials 5: "Polymers" (Ballroom 1)

Derivated polythiophenes for gas sensing and ion sensing in solution
John Mortensen, Roskilde University Center, Denmark

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John Mortensen

Thiophene very easily forms conducting polymers. This can be done during electro polymerisation from a radical cation stabilising solvent such as acetonitrile with lithium perchlorate as conducting salt. Also derivated thiophenes easily undergo electro co-polymerisation. In our group we use this for producing sensitive membranes both for gas sensing and for ion sensing in solution. Amino-5-crown-15-bensene is an ionophore with good sensing properties for potassium ions in aqueous solutions. This ionophore is reacted with 3-thiophene aldehyde forming a C=N binding between the thiophene and the ionophore. This compound is polymerized alone or co-polymerised with thiophene during electro polymerisation on either platinum or gold substrate. The polymers show a Nernstian behaviour for the sensing of potassium ions in aqueous solution from
5x10-5 M to 0.01 M with a slope of 47 mV/s. Structural investigations on the polymerisation process using STM (on Au (111)) in combination with electrochemistry showed the formation of low molecular polymer units in quaternary polymer and units with eight monomers. Derivated thiophene polymers of different types for gas sensing were formed through electro co-polymerisation of monomer thiophene and thiophene derivates on gold plated quarts crystal micro balances (QCM). The derivated thiophenes were formed through the amine aldehyde process mentioned above or from commercial available thiophenes derivated in the 3-position. Various membranes of differently derivated polymers show different sensitivities towards different types of gasses. Surface structures of sensitive coating polymers on QCM disks have been characterized by AFM. A measuring system consisting of eight QCM's with different derivated polymers of thiophene were available from FORCE-Technology. The QCM's showed different sensitivity towards different types of gases. Principle component analysis and partial least squares yielded good quantification of ethanol and toluene in gas mixtures.

Shaping of polypyrrole nanoparticle
Burkhard Shultz, Institute of Thin Film and Microsensor Technology, Germany
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Tauer, Klaus-Dieter

Polypyrrole (PPy) was in the centre of great interest during the development of the science and technology of polyconjugated materials. Because of its stability in the oxidized state the technological application of doped PPy have spanned a wide range of possible application and in some cases have reached the commercial level. But, in many applications the control of the polymer morphology like needles, tubes or other shapes is necessary. Here, it is shown for the first time, that the formation of PPy tubes in the chemical synthesis proceeds via a complex formation between NSA and pyrrole. The isolated crystals of the complex were found to posses completely different properties from that of the reactants and the final polymer. Further investigations reveal that the crystal is formed from a salt in which one NSA molecule interacts not with three single pyrrole molecules but with a 2,5-di (pyrrol-2-yl) pyrrolidine molecule.
The influence of additional applied tensides which at the same time act as dopants for PPY was also investigated. Here, it could be shown that there is a specific complexation between the NSA and fluorinated surfactants. By the use of ammonium perfluorooctanoate (APFO) the square-like complex acts also as in-situ template and PPy with tubular or quadrangular morphology is formed. Contrary, the application of other fluorinated compounds results in much more complex structures like rings, disks or hexagons. Whereas the experimental results are reproducible the explanation is very difficult and only a first, very rough model is given.

Self-organization of light-harvesting molecules in monomolecular layers
Hans Bettermann, University of Dusseldorf, Germany

One of the fundamental processes in nature is the conversion of light into energy. These processes are carried out by specifically organized chlorophyll or bacteriochorophyll assemblies. The high efficiency of the biologic process has induced scientific efforts to copy the energy conversion by artificial light harvesting complexes. These complexes are preferentially composed of porphyrin molecules, which are the framework molecules of chlorophylls. This contribution is concerned with studies on monomolecular films of tetraphenylporphyrins. The layers were prepared by a Langmuir technique and characterized by fluorescence microscopy with picosecond laser excitation. Further characterizations of ultrathin layers occured by resonance Raman microscopy. The fluorescence spectra from monolayers exhibit dual fluorescence from the first two excited electronic singlet states. Restricting the layer area per molecule from 4.4 to 1.4 nm2, the self-organization of molecules to assemblies could be monitored by sequentially recorded spectra. The analysis of spectra with regard to former fluorescence measurements of sub-attomolar concentrated porphyrin solutions show that the tetraphenylporphyrin molecules are pyramidally assembled provided by T-shaped intermolecular bondings between the phenyl substituents of adjacent porphyrins. The supramolecular structure of porphyrin aggregates within the monolayer is mainly formed by the intermolecular interaction of subtituents. This encourages us for the nearest future to exchange substituents in order to vary assembly structures for managing energy and electron transfer reaction.

Compliant elastomer electrodes for polymer actuators (EAP)
Mika Paajanen, VTT, Finland

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Pelto, Jani
A key feature of electroactive polymer (EAP) actuator technology is the use of compliant electrodes. The mechanical as well as electrical behaviour of the required compliant electrodes is critical, because of the performance of the actuator must be well-matched with the polymer behaviour. Many types of compliant electrodes have been reported, e.g. graphite contained silicone rubber and grease electrodes and polypyrrole electrodes. Typically, the adhesion of electrodes to EAP was poor. A new electrically conductive
elastomer compound has been investigated as compliant electrodes for dielectric elastomer actuators. The surface resistance of the electrodes was 1000 kohm/sq. when the thickness of the elastomer layer was appr. 3-4 µm. High adhesion to acrylic based dielectric elastomer was observed. The mechanical and electrical behaviour of elastomer electrodes were tested using the soft frame method.

16.00-17.30 Electronics 2: "New FETs? (Ballroom 2)

Top-down Nanotechnology Breakthrough
Paula Goldschmidt, Intel

In 50 years of history transistors had gone through many structural changes. Following Moore's Law the number of transistors in a chip is being doubled every 2-3 years by the traditional scaling of the transistors structural component or by equivalent scaling through the change or addition of new materials to achieve improved performance. After 40 years of evolution Intel is making the biggest set of changes in transistor technology on its 45nm logic technology by changing the gate insulator and gate electrode composition to High-K and Metal Gate materials extending Moore's law beyond the end of this decade. In this presentation we will go over the transistors technology evolution and ideas for the future.

Fabrication-Process for CNTFETs Based on Sacrificial Catalyst: Device Characterization and

Conductive-AFM Measurements
Lorraine Rispal, Darmstadt University of Technology, Germany

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Schwalke, Udo

Single-Walled Carbon Nanotubes (SWNTs) are one of the most promising candidates for future nanoelectronics because of their unique one-dimensional geometry giving them excellent transport properties. By metallic SWNTs or semiconducting ones in the on-state, it is possible to obtain a ballistic transport over 1 µm at room temperature. Since 1998, it is known that semiconducting SWNTs can act as the channel in field-effect transistors called CNTFETs. Currently CNTFETs are fabricated and investigated by many research groups. Nevertheless, fabrication processes are often complicated, including either separate growth and manipulation of the CNTs or require multi-step lithography with the risk of misalignment. Moreover major issues must be solved: first a selective growth of semiconducting SWNTs is needed to fabricate devices. Also most of the CNTFETs in the literature are ambipolar, which means that they are turned on by big positive and negative gate voltages (Vg). This characteristic is incompatible with an integration in the CMOS-technology. The purpose of this work is the development of a very simple process, where SWNTs are grown homogenously on unstructured wafers. Aluminum/Nickel films act as “sacrificial” catalyst to stimulate SWNT growth and lift-off structured palladium films provide electrical source/drain contacts. The CNTFETs are characterized by conventional “macroscopic” current-voltage (I-V) measurements in combination with conductive-AFM characterization which gives simultaneously topographical and electrical information at the nanoscale. The principle of the C-AFM technique is to apply a bias to the S/D contacts via the AFM chuck and measure the current passing through a conductive AFM probe, e.g. Pt-Cr coated. As result, the transistors are unipolar, PMOS-like, which means that they are turned off at positive values of Vg and turned on at negative values of Vg. The CNTFETs show a strong dependence on oxide thickness analogue to conventional MOSFETs, i.e with decreasing oxide thickness the sub-threshold characteristics of the CNTFETs improves. The on-current of CNTFET with 390 nm SiO2 is 30 nA, leading to an on/off ratio of 30000. For Tox = 30 nm, the on-current improves to 200 nA / 1 CNT, which corresponds to 150 µA / µm at Vd = 0.4 V. The on/off ratio is improving already to 40000. By AFM, diameter measurements and structures overviews could be obtained. These overviews are nevertheless only possible by very smooth underlayer. Increased surface roughness largely degrades the image contrast, so that it becomes impossible to identify SWNTs. This drawback is omitted when using the conductive AFM (C-AFM) method instead. In addition to the previous application, the C-AFM opens new ways to characterize electrically the CNTFETs after fabrication. First, we managed to differentiate structures in which CNTs are linking source and drain or not. We also have made a first attempt to perform resistance measurements on individual SWNTs by the C-AFM technique. In this case, the probe tip stays at a fixed position in contact with the SWNT and a bias ramp is applied, such that the current-voltage (I-V) characteristic is obtained, from which the total resistance between the probe and the chuck can be calculated. As a conclusion, this process may be suitable to realize integrated hybrid CNT-CMOS technologies in the future. Conductive AFM has proven to be very useful tool for CNT-process optimization and nanoscale electrical characterization. It is a non-destructive way of measurements and gives both global and local information of the structures. It opens the possibility to distinguish in-situ metallic from semiconducting SWNTs and could be a very useful help in the search of a selective growth method.

Deposition Defined Nanometer Scale Dots
Karsten Wolff, University of Paderborn, Germany

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Layer deposition and etch back is a well known technique to achieve nanometer scale lines of polysilicon /1/ or other materials common in semiconductor technology /2/. The process applies a sacrificial layer, which is structured by standard optical lithography and anisotropic dry etching. The border of the sacrificial layer defines the position of the nanostructure only. Its size is given by the layer width of a conformal deposition process (LPCVD). After anisotropic dry etching of the conformal layer, a spacer remains at the border of the sacrificial layer. Removing the sacrificial layer leaves a nanoscale spacer standing alone. The whole technique is demonstrated in Fig. 1. To achieve

nanoscale dots the process described above has been applied a second time, perpendicular to the first line. It results in an increased height at the crossing of both nanolines. Now the lines have been etched away very exactly, and only at the cross remains a dot like structure. It is shown by atomic force microscopy (AFM) that diameters in the region of less than 70nm can easily be achieved by this technique (Fig. 2). Thereby, the raising at the crossing point constitutes up to 150nm. /1/ J. T. Horstmann, U. Hilleringmann, K. F. Goser: Matching Analysis of Deposition Defined 50-nm MOSFET's IEEE Transactions on Electron Devices, Vol. 45, 1998, pp. 299 - 306 /2/ U. Hilleringmann, J. T. Horstmann "A Structure Definition Technique for 25 nm Lines of Silicon and Related Materials" Micro and Nanoengineering MNE'99, Microelectronic Engineering 53, 2000, pp. 525-528

Novel Flash Memory Cell with LaAlO3 as Tunneling Dielectrics for beyond Sub-50 nm Technology
Yaohui Zhang, China

As the feature size of flash memory scales down to 50 nm, there are scaling limitations to all flash cell technologies. The intrinsic storage limit and stress induced leakage current (SILC) requests the tunnel oxide above 80 Å. The gate oxide thickness as large as 80 Å results in other two cell scaling limits: gate length (Lg) and gate width (Z). Lg is limited by punchthrough and drain turn-on. Z is limited by the "ON" cell current during the read operation. A new kind of dielectrics needs to be explored to replace SiO2 gate dielectrics for sub-50 nm flash memory technology.
A new flash memory cell Floating-gate (FG) transistor with LaAlO3 (LAO) as a gate tunneling dielectric has been proposed and simulated. Program/erase (W/E) operations based on Fowler-Nordheim tunneling under a voltage of less than 10 V was demonstrated with a time of less than 10 Sec, by making full use of the smaller band offset (ΔEc) between LAO and Si. The retention time of programmed memory cells can be more than 10 years. LAO gate dielectrics reduced the equivalent oxide thickness (EOT) of FG transistors to be less than 15 Å, and this increased "ON" cell current by 10 times in the read operation and eliminated drain turn-on problem, short-channel effects and punch-through of FG transistors. This new memory cell can scale the feature size of flash memory down to sub-50 nm.

Poster abstracts

FinNano Annual Seminar poster abstracts

Novel delignification methods for producing annual plant based products
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Maximova, Natalia
Dahl, Olli

Annual plants, together with forests, are the greatest fibre resources in the world. Agro-fibres have already been utilised industrially for a long time, for instance in the field of energy production and for pulp production for paper manufacturing, particularly in China and India. The benefits of utilising agro-fibres are their fast annual growth and the smaller amount of lignin binding the fibres together. The disadvantage is their high concentration of silica rendering the chemical and energy recovery processes difficult and ineffective, leading to many environmental problems. The widespread utilisation of annual plants in pulping has not, up until now, been technically or economically feasible in western countries.
It is obvious that there is a need to develop a novel, environmentally friendly and simple method to utilise agro-fibres as a source of fibre for traditional paper making or for making novel "green" chemical products, i.e. the agro-fibre biorefinery. We believe that using new thinking and multidisciplinary research ideas the most environmentally friendly and economically feasible process concepts can be developed for the application of both acidic and alkaline processes in approaching the utilisation of annual plants as part of the whole chain of agro-fibre utilisation.
The potential of using "over-treated or over-cooked" fibres for making traditional paper products and other new fibre products (**nanofibrils**) is also to be covered. We are looking for a partner that could test and utilize our product with nanotechnological innovations. This project should be of interest to everyone seeking ways of utilizing annual plants or involved in the development of new nanomate-

rials.

Ink-jet printing of carbon nanotubes and their polymer composites

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Ink-jet printing of any materials offers a cost-effective and scaleable pattern generation on various surfaces. Printing inks that consist of carbon nanotubes and their composites with polymers open new and versatile routes for fabricating micro-patterns for diverse applications. Amongst others, we are discussing the synthesis of stable aqueous and alcohol-based inks, generation of high-resolution patterns, optical and electrical characterization of printouts, and list some potential exploitation of the technique.

Improvements to the adhesion of sputtered films on polymers by a nanometre-scale oxide intermediate layer deposited by ALD

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Ensuring good adhesion of sputtered metal and metal and compound films on polymer substrates has been a long standing problem. The effects on the adhesion of Ti and TiC coatings on polycarbonate (PC) and PMMA films by a duplex process where nanometre-scale adhesion layers deposited by atomic layer deposition (ALD) prior to sputter deposition were investigated. TiO_2 and Al_2O_3 ALD grown films were deposited at temperatures below 65ºC on PMMA and PC substrates. The metal precursors used for TiO_2 and Al_2O_3 were tetrakis-dimethyl-amido titanium (TDMAT) and trimethyl-aluminium (TMA), respectively, and ozone was used as a source of oxygen in both processes. The ALD film thicknesses were 5, 15 or 40 nm. This process was followed by deposition of the metal/metal carbide layer using pulsed DC reactive sputtering. The adhesion of the layers was measured by pull-off testing and it was shown that significant improvements could be achieved by adding the intermediate ALD layer. An account will be given of the effects of ALD film thickness and composition on the overall adhesion. The physical and structural characteristics of the adhesion layer and compound film will also be discussed.

Nano-Friction-Wear (NaKiKu) – Halfway

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NaKiKu- project (2005-2008) concentrates on improvement of physical and mechanical properties of polymers using nanofillers. For many industrial applications friction and wear resistance are very important properties. In tailoring of friction of polymer surfaces it is a challenge to retain the characteristic mechanical properties of polymers.

For the modification of the properties of thermosets and thermoplastics the nanofillers are considered very promising materials. Our research focuses on both thermosets and thermoplastics and covers a broad range of nanomaterials from nanoclays and nano-TiO_2 to multi-wall carbon nanotubes (MWCNT). Dispersion of nanomaterials in polymers is a key factor for improved friction behaviour of the material. Agglomeration of nanomaterials to bigger structures can impair the mechanical and wear properties of polymer nanocomposite.

Antireflective dirt resistant surfaces - structural and chemical modification of optical materials at nanoscale (HELI)

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The aim of the HELI-project is to produce antireflective and dirt repellent durable optical surfaces by using nanostructures.
Nanoporous aluminum oxide coatings were formed electro-che-mi-cal-ly on polycarbonate surfaces. The diameters of the pores were 10-20 nm. The nanostructured surfaces were characterized by SEM, ellipsometry and UV-VIS spectrometry. The non-reflecting pro-perties of polycarbonate samples were improved by the nano-porous aluminum oxide coating. The reflecting properties of the sam-ples can be influenced by retreatment of the specimens. The sur-face modified samples were also found to be highly transparent in the wavelength range of visible light.
Antireflective surfaces were also fabricated lithographically by patterning crossed and differently orientated binary grating lines by electron beam. Period of fabricated elements was 270 nm and in the second type of grating six different orientations were used for the grating lines. These different grating line orientations dissipate the angular dependence of typical grating reflection viewing angle, i.e., the grating surface reflection is nearly uniform over large viewing angle. Both grating types had low reflection, less than 1 % over the visible spectrum.
Antireflective surfaces with optimized color properties can be realized by using binary or continuously varying subwavelength structures. We have shown theoretically that using a surface relief profile consisting of pyramids, i.e., by making the refractive index variation continuous, the reflectance can be further decreased compared to the binary structures.
Current nanocoating research focuses to design of new polyacrylate derived nanostructured coatings with different surface properties. In this work we fabricated on PMMA substrates transparent poly-mer-glass coatings, the surface properties of which can be controlled using a nano-sized structure. The transparent nanocoating is created by using a nanoporous aluminum oxide membrane with a pore diameter of 200 nm as a template. The polyacrylate coatings had a surface with nano-scale (130 nm) roughness produced by UV-curing of acrylate inside the membrane pores. Scanning elec-tron microscopy (SEM) clearly indicated the successful formation of a nanostructured polyacrylate coating.
The spectral band of the femto-second pulse laser system is expanded to cover visual and IR bands from 380 nm up to 11000 nm. The system will be used to spectroscopic studies of the surface chemistry of nanostructures.

Nanophotonics

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The “NANOPHOTONICS” Project investigates nano-structures as well as nano-optical components and biosensors. The project has 5 research partners, 11 industrial partners and a wide international collaboration network. The key research areas are nanoimprint lithography (NIL), optical nanostructures, plasmonics and molecular nanotechnology. NIL will be developed and applied to pattern solid surfaces on the nanoscale. NIL will allow nanopatterns to be replicated in a cost-effective way and will therefore have applications in various fields of nanotechnology and biosensing.
We will review the progress and results of the Project. The development of NIL includes the optimization of stamp and resist materials and imprinting large wafers in a single step. We will present the results of imprinting of sub-30 nm linewidths, fabrication of grating stabilized ridge semiconductor laser and narrow linewidth metal reliefs. We will also develop sensors based on second-harmonic generation (SHG) and molecular nanotechnology to probe biological processes in ultra-thin single molecular layers. The efficiency of SHG will be enhanced by using nanoparticle-based labels and/or nanostructured surfaces. The results to be obtained will benefit Finnish industry and train researchers for tomorrow’s nanotechnology field.

Molecular Scale Memory Elements

Andreas Johansson , University of Jyväskylä

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We investigate potential solutions for the fabrication of future molecular scale memory elements based on single walled carbon nanotube field-effect transistors (CNT-FETs). CNT-FETs are known to frequently display undesirable hysteresis in their transfer characteristics. For a memory element, this is on the contrary a favorable feature that can be utilized.
The studied devices are CNT-FETs based on semiconducting single-walled carbon nanotubes having a diameter close to 2 nm. Part of the CNTs were synthesized by a novel aerosol technique that yield particularly clean, unbundled nanotubes. The gate insulator film has a crucial influence on the operation of proposed memory elements. For a strong capacitive coupling and enabling gate voltages, a thin and dielectrically strong film is required. On the other hand, in order to achieve the desired hysteretic behavior for non-volatile memory, the gate-nanotube coupling has to include mobile charges within the gate-insulator or at some interface in the system. Measurements of CNT-FETs exhibiting memory effect in various conditions and our conclusions thereof will be presented, as well as an outlook to possible future directions of this study.

EIT Measurement Using MEAs

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Traditionally, micro electrode arrays (MEAs) have been applied in monitoring neuronal activity and response to stimulation *in vitro*. In this paper, we employ electromagnetic finite element modeling (FEM) in monitoring cell cultures. The result is a conductivity image reconstructed by an electrical impedance tomography (EIT) technique.

During measurements, electrical currents are applied to the MEA electrodes in a programmed way, and the inter-electrode voltages are measured. Two independent measurements are taken over the same area with homogeneous and inhomogeneous background respectively. The difference between them is used in the EIT reconstruction. The resulted image is compared to the ground truth and a good performance is obtained.

In the future research, we will extend the current 2D model to 3D model, and study the effect of different electrode arrangement and measurement patterns. In addition, there is much potentiality to utilize our method to visualize the inner structure of some materials, e.g., implantable scaffolds, or to detect artifacts within materials.

Targeted modification of bulk proteins for food tailoring and packaging

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Proteins and carbohydrates can as such be used as food ingredients or exploited as structural films in edible food packaging solutions. The work is focused on development of novel enzymatic technologies to modify the properties and behaviour of dairy proteins (caseins and whey proteins) suitable for nanoscale protectors against different labile biological components, such as easily oxidisable oils. The aim is also to create novel barrier structures from these natural raw materials to be exploited in food packaging applications. Enzymatic (tyrosinases, laccases) and chemical methods were used to crosslink and functionalise the caseins and whey proteins more suitable for end use applications. Better performance of casein emulsions under low pHs were searched by decreasing/increasing of the isoelectric point of the protein or by modification of the repulsion layer at protein-water interface. As a consequence of enzymatic cross linking and successive functionalisation with a hydrophobic compound improved barrier properties were obtained for casted casein film.

Semisynthetic Pigments for Novel Optoelectronic Devices

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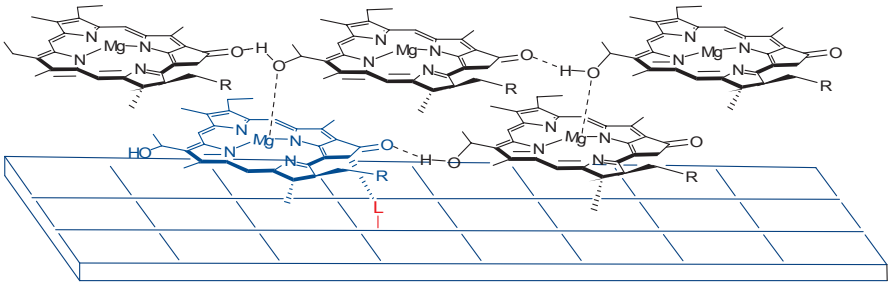
The goal of the conducted research is to create novel, hybrid organic-inorganic nanostructured materials for photonic applications by utilizing self-assembly capability of pigments derived from plants. We are employing the principle of self-assembly inspired by the structure of the chlorosome, the light harvesting complex found in green bacteria. The organism contains self assembled nano sized lamellar protein-free chlorophyll antennae structures, which absorb light and conduct the excitation energy with an extreme efficiency.[1]



Self-assembling bacteriochlorophyll aggregates on a CNT coated semiconductor surface

The project aims to combine the light harvesting sensitivity, efficiency and self-assembling properties of the biological material with the processability, integrability and persistency of inorganic material. We expect that resulted bio-integrated devices will have fast energy transfer and conversion rates, and hence, will offer novel solutions for optoelectronics. Potential applications will be in optoelectronic information processing technology, photovoltaic cells, organic light emitting diodes (OLEDS) and field effect transistors (OFETS).[2]
The principal research place is the Department of Chemistry at the University of Helsinki. The research is conducted in a close collaboration with the groups that have expertises in biochemistry, (pigment self-assembling) and especially optoelectronic laboratories. The latter have the capablity to construct inorganic parts for devices and perform optical measurements essential for the overall development of novel materials. The Finnish collaboration partners having expertise and facilities in laser spectroscopy and inorganic optoelectonic structures are Prof. Harri Lipsanen and Prof. Ilkka Tittonen groups, Micronova, TKK whereas proficiency in biophysics and chlorosome structures is contributed by Doc. Roman Tuma group in the Institute of Biotechnology at the University of Helsinki.
[1] J. Psencik, T. P. Ikonen, P. Laurinmäki, M. C. Merckel, S. J. Butcher, R. E. Serimaa and R. Tuma *Biophysical Journal* 2004, *87*, 1165.
[2] G. D. Scholes, G. Rumbles *Nature Materials* 2006, *5*, 683-912; M. Muccini *Nature Materials* 2006, *5*, 605-613; F. Balzer, V. G. Bordo, A. C. Simonsen and H.-G. Rubahn *Phys. Rev. B* 2003, *67*, 115408.

Electroactive polymer nanocomposites and their actuator applications (ELCOMPO)
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Dielectric elastomers and intrinsically conductive polymers are two examples of materials that are used as electroactive polymers, EAPs. The EAP actuators change their shape or size when actuated by an electric voltage. The EAP research is still new but increasing because of a high demand for materials performing in a controlled manner, to be utilised in various fields ranging from chemical industries to well-fare applications. Nanocompounds potentially offer improved or superior material properties, which has given the motivation to develop stronger actuator materials by nanotechnological means. The ELCOMPO project aims to develop biocompatible PPy actuator materials with nano reinforced structures and nanomodified elastomer materials with high elasticity and strength and simultaneously, with low electromechanical losses. The project comprises the

development of new nanomaterials, and the construction and testing of real actuators.

During the first two years of the project new bending actuator concept has been invented, which enables large out-of-plane movement. Also new compliant polymer electrodes have been successfully tested. New acrylic elastomers modified with either nanoclay or carbon nanotubes, as well as new PPy actuators have been developed for preliminary characterization.

Nano mediated mega value for wood and fibre based products

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Wood and wood-based composites are favourable construction, furnishing and decorating materials for ecological reasons and due to the appealing appearance of wooden surfaces. However, due to its chemical and structural composition wood easily absorbs water and water vapour, which causes dimensional changes in wooden products and even biological problems if the moisture loads are severe and prolonged.

Traditionally, paints and lacquers are used to protect wood against direct contact with water. In this study, sol-gel hybrid coatings have been used to improve the moisture behaviour of coniferious wood (*Pinus sylvestris*, thermally treated *Picea abies*). The performance of the hybrid coatings on wood substrates was evaluated by means of contact angle measurements, water vapour permeability and water floating tests. In addition, the performance of the coatings after short term natural weathering was respectively evaluated.

The study included two sol-gel coatings based on multifunctional alkoxysilanes. The coatings differed from each other in terms of the length of the attached organic aliphatic chain. The analysis (SEM-EDS, FTIR-PAS) results showed that the both sol-gel nano-coatings were able to penetrate in to the wood. In addition, the length of the organic aliphatic chain determined the penetration ability of the coating. The results obtained from the contact angle measurements and water floating tests showed that both nano-coatings improved the water repellence properties of pine sapwood and thermally treated spruce forming quite hydrophobic surface properties and decreased the water uptake of the lateral surfaces of the wood samples. The water uptake properties of the treated wood specimens remained unchanged after three months' outdoor weathering. The nano-treatments had no effect on the water vapour permeability of the samples. This leads to the suggestions that sol-gel hybrid nano-coatings designed for wood material have selective barrier properties with the prevention of penetration of water and permitting the movements of the water vapour.

NANOHEALTH - Engineered Nanoparticles: Synthesis, Characterization, Exposure and Health Hazards

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Nanotechnology, i.e. dealing with matter at or near atomic scale and the production of based on different nano-sized particles will have an increasing impact on the every-day life of people in the industrialized countries. Thus, there are increasing demands by the society for reliable and

understandable information on the possible effects of engineered nanoparticles and the significance of these effects. It is essential that reliable information will be gathered before wide use of nanoparticles to avoid potential health problems of unknown nature. The aim of the NANOHEALTH research project is to synthesize and characterize features of nanoparticles, to delineate levels of nanoparticle exposure in occupational environments, and to explore health effects of nanoparticles. Exposure levels will be evaluated under laboratory conditions and in occupational environments. The nanoparticles will be characterized with respect to their size distribution, morphology, solubility, biological activity related to their surface activity, and potential for agglomerate formation. Health effects to be studied include airway irritation and changes in the respiratory patterns, inflammatory responses of the lungs and pulmonary cells, and genotoxicity. The research will be carried out in four themes as follows: 1) Synthesis, characterization and behavior of nanoparticles 2) Physiological responses of respiratory tract caused by nanoparticles 3) Nanoparticle-induced pulmonary inflammation 4) Genotoxic effects of nanoparticles.

Development of nano-structured powders for coatings and components

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The goal of the project is to modify the mechanical and surface properties of materials and coatings by novel nano-structures. Development of nano-powders for further processing of components and coatings is of main interest. Industrial partners in the project are: Electro Optical Systems Finland Oy, Exote Oy, Genano Oy, Metso Automation Oy, Metso Paper Oy, Millidyne Oy and Luvata Pori Oy. The main financer is TEKES.
In the area of bulk components, mechanical properties (hardness, strength and toughness) have been improved by introducing nano-structures to the components. This is done both by reducing the carbide size and by adding nanoparticles to the microstructure. Also, the use of different types of nano-size TiO_2 raw materials is studied.
In the area of thermal spray, HVOF coating process for commercial nano-structured WC-CoCr powder spraying is optimised. This is done via route of process-mapping concept, which allows spraying parameters to be successively related to in-flight particle state, to the linkage between particle state and microstructure. The coating performance testing has concentrated on coating properties like cavitation erosion, friction and fine particle wear.

Many different production methods, e.g. chemical synthesis, mechanical milling, SHS and microwave-processing used to produce nanosized primary particles for thermal spray powder manufacturing via agglomeration process.
Commercial nanopowders and project made nanomaterials have been characterized in details by SEM, TEM, nanoindentation etc. by TKK. Working practices has been developed for reliable evaluation of nanomaterials. Effect of carbide size and addition of strengthening nanoceramic particles to cermets has been studied. Mechanical properties and the wear resistance of the materials have been evaluated by different methods.
International co-operation has been carried out so far with Osaka University in Japan and KU Leuven in Belgium in the areas of spark plasma sintering and microwave sintering and -processing.

ALDUS - New Industrial Applications of ALD Nanostructures

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The ALDUS project applies the atomic layer deposition (ALD) technique for new industrial applications. This nanofabrication technique is used to develop new coatings for semiconductor lasers, X-ray detectors, MEMS technology and nanoporous materials. A main goal is to find new markets for ALD technology applying the broad Finnish knowledge base in ALD processing and equipment manufacturing.

Piko™ thermal cycler

The scope of this project included the design and manufacture of thermal cycling systems, called Piko™ thermal cycler, with associated consumables based upon the Slidetiter™ format. Piko, inspired by the Italian word “piccolo,” meaning tiny, aptly describes the new PCR system. The three key elements for success in the market place were to make a i) smaller, ii) less expensive, and iii) higher performing instrument than is currently available. These three features were accomplished primarily by basing the design upon the novel Slidetiter PCR plate that is one quarter the size of conventional microplates.

Specific features of Piko thermal cycler:
-Half the size of the smallest thermal cyclers
-Licensed for PCR
-Automatic pressure setting motorized heated lid
-CD drive-like loading of plates and tubes
-Easy to use interface
-Half the price of high performance thermal cyclers
-4x lower power consumption than conventional thermal cyclers
-Can complete PCR protocols in under 10 minutes

Piko™ thermal cycler and Slidetiter™ consumables can be seen at ChemBio Finland 2007 in the High Performance PCR seminar on Tuesday 27.3.2007 in hall 203 at 10-12, and in the exhibition stand 6b43, Finnzymes Oy. More information is also available at http://www.finnzymesinstruments.com/

Nanobiotechnology and diagnostics

EVALUATION OF CELLUSPOT™ PEPTIDE ARRAYS IN SERODIAGNOSIS OF B19 PARVOVIRUS INFECTIONS

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The aim of this project is to develop a normalizing method for synthetic peptides in biochips. The peptide and protein biochips technology supports understanding of disease associations and facilitates design of vaccines or therapies. Peptides as parts of proteins are able to sense other macromolecules thus providing a ground for opportunities to develop dedicated biosensors that are important in biomedical use. Biosensors of infectious disease require study of bio-recognition molecules and hence various peptides, i.e. virus-based materials are employed in this research. We here show that epitope mappings performed with CelluSpot™ microarrays (Ref. 1) correspond to previously identified parvovirus B19 epitope mapping patterns (Ref. 2) generated by Spot method (Ref. 3). To begin with, we made epitope mapping with the highly sensitive Spot array method in order to study antigenic regions of parvovirus B19 VP1 and VP2 capsid proteins. Epitope mapping identified a highly reactive, immunodominant early epitope on parvovirus capsid that centered to KYVTGIN residues of VP1. In the subsequent phases we developed KYVTGIN epitope-based IgG serodiagnostics. A correlation between enhancing IgG avidity to B19 capsid and a transient reactivity with the point-of-care KYVTGIN peptide was clear. Together the two assays enhanced the value of early diagnosis of B19 infections (Ref. 4). We now show CelluSpot peptide arrays to be applicable to diagnosis of parvovirus B19 infections. In addition, CelluSpot array screen provided a new insight in the parvovirus early epitope reactivity and permitted development of dedicated array platforms of epitope type specific diagnosis.

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AN EXCELLENT NANO-BIOLOGY SENSING SYSTEM FOR THE EARLY DIAGNOSTICS OF EVIL

TUMOR

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Generally speaking if cancer cells from the blood or phlegm solution of complex system will be detected early stage for cancer sufferers, after curing 80% people of these sufferers could be in good health. And then It is super important to detect accurately and rapidly the thinly target cell from the solution of complex system such as the blood or phlegm to be treated with a way in clinical diagnostics. Wherefore, this paper reports some basic results that both nanomagnetic immunomicrospheres and biomagnetic induction-piezoelectric sensors array were integrated to form an excellent Nano-Biology Sensing System for the Early Diagnostics of Evil Tumor. This is named as NBSS, which is used in sensing cancer cells in the solution of complex system. Up to date, experiment results have shown that compared with traditional methods such as piezoelectric immunosensor system the NBSS exhibits some excellent advantages as follows: to simplify the analytical process for the solution of complex system; no need for the molecular recognition of antigens by antibodies to form a stable complex on solid-state interfaces of piezoelectric sensors; to sense and capture cancer cells accurately and rapidly from the blood or phlegm solution of complex system in the cancer cells concentration of 10-1-103 number / ml in average content to be approximately 85% in probability; to output electronic signals and to be lower in charge of clinical diagnostics.

AUTOMATED CHARACTERIZATION AND MANIPULATION OF BIOLOGICAL CELLS BY A NANOHANDLING ROBOT STATION

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Current research work on the development of an AFM probe based desktop station for cell characterization is presented. The setup consists of a nanopositioning piezo sample stage with three degrees of freedom (DoF) for fine positioning and scanning and a three-axes nanomanipulator for coarse positioning. As an endeffector, piezoresistive AFM probes are utilized. Thus, not only mechanical properties can be measured, but also the acting forces allow force feedback for the stations control system. The inverted optical microscope is used as an optical sensor for positioning. The setup is enhanced by a second nanomanipulator bearing a pipette for injection/extraction or even patch clamp purposes or a second piezoresistive AFM tip. First experiments cover measurements of force distance curves, gaining information about elasticity and adhesion of the cells. The force distance curves are conducted on fixated and living cells, to verify the quality and possible resolution of the cantilevers. This mechanical characterisation of a cell can give valuable information about cell mechanics not only concerning cell to cell contact or cell motility, but is also of interest in oncology, as tumor cells tend to have a different elasticity than healthy cells. An automated scanning option allows for recording of elasticity or adhesion maps of the specimen. Additionally, by using functionalized cantilevers, the station can measure intermolecular binding forces in this way. The second endeffector allows for more complex measurements, enabling the station to cover areas as DNA extraction, reactions to drug injection, electrophysiological measurements of stress activated ion channels. To accomplish measurements in an automated manner a complex control system has to be developed. The system has to cover object recognition and tracking tasks by analysis of images gained by the inverted optical microscope. This will facilitate the application of path planning algorithms to avoid collisions while high level tasks are performed. A client/server architecture will be

implemented, allowing most possible flexibility.

DIRECT CONJUGATION OF WATER-SOLUBLE GADOLINIUM-CONTAINING ENDOHEDRAL FULLERIDES TO ANTIBODIES

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Water-soluble gadofullerides have been revealed to have high efficiency and low toxicity as magnetic resonance imaging (MRI) contrast agents. Here we report the conjugation of gadofullerides with antibody in pursuit of the so-called “tumor-targeting” MRI contrast agents. The newly synthesized gadofulleride, [Gd@C82O6(OH)16(NHCH2CH2COOH)8]8, forms ~30 nm well-defined aggregates in pH=7 aqueous solution, and the aggregates were selected to conjugate with the antibody of green fluorescence protein (anti-GFP). The objective-type total internal reflection fluorescence microscopy was applied to characterize the gadofullerene/antibody conjugations by taking the GFP as a probe. The results revealed that each gadofulleride aggregate conjugates averagely five anti-GFPs, and the activity of anti-GFPs is preserved after conjugation.

THE EFFECT OF NANOPARTICLES ON HUMAN DENDRITIC CELLS

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Gold is recognized as one of the most biocompatible and stable materials, and therefore recent biological applications are focusing on using gold nanoparticles for e.g. drug and gene delivery. Another interesting material with several attractive features is mesoporous silica. These are ordered porous structures which allow nanoparticles to host molecules of various shapes, sizes and functionalities. There is however very little information available concerning what influence such particles have on the immune system, e.g. on dendritic cells (DCs).

DCs are the most efficient type of antigen presenting cells having a capacity both to initiate primary and secondary immune responses. DCs decide whether an immune response should be initiated and are able to affect the development of T-cells into Th1- or Th2-cells depending on their cytokines produced and their expression of co-stimulatory molecules. We addressed the question whether gold nanoparticles of 7 nm or silica particles of 10 nm or 2 µm affect DCs, looking at viability, uptake, and expression of cytokines and of co−stimulatory and antigen presenting molecules. This was assessed by using human monocyte derived DCs from healthy blood donors together with gold or silicaparticles, 10, IL−12 and IFN−alpha after incubation with either gold or silica particles. In conclusion, both gold and silica particles seem to have potential to be used as carriers in biomedical applications.

A BIOSENSOR SYSTEM BASED ON THERMALLY BLOCKED MAGNETIC NANOPARTICLES

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An ideal biosensor should detect target molecules directly without use of labeled ligands or washing steps. We have overcome these obstacles by designing a sensor system based on magnetic nanoparticles with a surface modified to bind any specific molecule we want to detect. Upon binding of target molecules (i.e. antibodies) to the particles, the hydrodynamic particle volume increases which can be detected using dynamic magnetic measurements. Nanoparticles in suspension undergo Brownian motion that is a chaotic motion due to collisions with water molecules. The frequency of Brownian motion is dependent on the size of the particles, the motion of smaller particles occurs at higher frequencies than larger particles. For thermally blocked magnetic particles in colloidal suspension, one can monitor Brownian rotational motion by measuring the frequency dependent magnetic susceptibility of the particle system. Since the frequency can be detected in this way, so can also the particle size be determined and most important, a change in particle size can be observed upon binding of target molecules. We have designed an instrument to measure the frequency dependent magnetic susceptibility of nanoparticle systems and find experimentally for protein G particles a good correlation between antibody concentration in a sample and the observed change in hydrodynamic volume of the particles. The technique can be used for a wide variety of analyzes with biological applications. Detection of disease markers in patient samples constitute one area, other areas can be analyses of environmental samples or to follow chemical reactions or synthesis in (bio-) chemical industry.

LIPOSOMES AS SCAFFOLDS FOR MEASURING SINGLE ENZYME KINETICS

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Single enzyme experiments are the only way to measure the exact kinetics as well as the behavior of enzymes. Recent advances in fluorescent microscopy1 made possible the monitoring of the behavior of individual enzyme molecules in addition to probing their conformational changes. Using these techniques, unique aspects of the catalytic activity of individual enzyme molecules were revealed. A clear oscillating behavior2,3 has been observed for a variety of enzymes, which is otherwise masked in ensemble measurements. Various models have been proposed suggesting that the enzymes adopt a variety of interconverting conformations each one of them exhibiting different catalytic activity.4 The majority of these studies has been performed using Confocal Fluorescent Microscopy (CFM) where the enzymes were immobilized directly on a surface, on agarose gel,2 polystyrene beads,3 or even using proteins as foot.5 The main drawback of these studies remains the non-natural environment were the enzyme is performing, where non-specific interaction may affect the reactive conformation and subsequently its catalytic activity. Here we present an alternative method for studying single enzyme kinetics based on liposomes as three-dimensional scaffolds that confine spatially enzymes, while keeping them under physiological conditions. Single enzymes are confined on the outer surface or the interior of immobilized liposomes.6 In this way non-specific interactions of the enzyme with the surface are excluded allowing the enzyme to adopt its most reactive

conformation. Such a platform allows the study enzymatic activity in an environment as close as possible to the natural environment of the enzyme, the cell.

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PHYSISORPTION OF NUCLEOBASES ON GRAPHENE

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We report the results of our first-principles investigation on the interaction of the nucleobases adenine (A), cytosine (C), guanine (G), thymine (T), and uracil (U) with graphene, carried out within the density functional theory framework, with additional calculations utilizing Hartree- Fock plus second order Muller Plesset perturbation theory. The calculated binding energy of the nucleobases shows the following hierarchy: G > T = C = A > U, with the equilibrium configuration being very similar for all five of them. Our results clearly demonstrate that the nucleobases exhibit significantly different interaction strengths when physisorbed on graphene. The stabilizing factor in the interaction between the base molecule and graphene sheet is dominated by the molecular polarizability that allows a weakly attractive dispersion force to be induced between them. The present study represents a significant step towards a first-principles understanding of how the base sequence of DNA can affect its interaction with carbon nanotubes, as observed experimentally.

SCANNING PROBE MICROSCOPY APPLIED TO BIOLOGY AND DIAGNOSTICS

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AFM/SPM (Atomic Force Microscopy/Scanning Probe Microscopy) is widely used to image active protein molecules or living cells in a non-destructive manner. In addition, a variety of molecules can be attached to AFM cantilevers, making them chemically selective sensors for studying individual molecular interactions. Agilent Technologies has developed a variety of different techniques to investigate and manipulate biological matter - from single molecules to live cells. The following topics will be discussed in more detail: 1. High Resolution Imaging of biological species: Several examples of both controlled imaging forces and controlled environment, together with modified cantilevers will be demonstrated. Applications include imaging and probing live cells and viruses, isolated proteins, protein crystals and DNA/RNA. 2. Topography and Recognition (TREC): We will present recent advances in a new AFM technology called TREC, a unique technique that enables measuring real-time, simultaneous topography and specific recognition information. Examples for recognition imaging will be presented on receptor/protein identification on live cells and DNA/protein complexes, as well as applications in medical diagnostics. 3. AFM in combination with inverted optical microscopy: Simultaneous gathering of light, fluorescence, topography and probe data of living cells and/or their components will be introduced. We apply this technique on finding and probing cell membrane proteins where fluorescence microscopy helps us to locate receptors, and AFM imaging

and force spectroscopy enables us to study interactions with biologically relevant ligands.

SACCHARIDE RECOGNITION BASED ON MODIFIED GOLD NANOPARTICLES

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Preliminarily studied saccharide receptors in the water-methanol solution[1,2] (porphyrin-bile acid conjugates) were immobilized on modified gold nanoparticles by two-step modification of bare nanoparticles. Modified nanoparticles were purified and characterized by variety of techniques including electron microscopy and absorption spectroscopy in UV-Vis range. In comparison with behavior of porphyrin-bile acid conjugates in an aqueous solution, different interactions with saccharides were observed after the immobilization of the conjugates on the nanoparticle surface. The selectivity toward saccharides and the effect of immobilization will be discussed. In the next step, modified nanoparticles will be used to selective cancer cell fluorescence detection.
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PLASMAS BIOTECHNOLOGY - THE TOOL OF REGULATION OF DEVELOPMENT OF BIO OBJECTS

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Plasmas nanobiotechnology on bio objects allows to adjust and improve such properties of seeds and plants, as: energy of germination, field germination, stability of plants to fungicide and bacterial diseases, acceleration of rates of growth and development of plants, increase of productivity of plants, increase of the maintenance{contents} in fruits of vitamins, fibers, amino acids, micro-and macro-elements and others.

LIGHT SOURCE WALL TREATMENT AND SURFACE CHANGES

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The history and development of lamps has always been closely connected to materials properties used for them. Our work is concerned with the preparation and investigation of high-frequency light sources excited by means of outer electrodes, so called, electrodeless light sources (HFELS). The HFELS are widely used as bright radiators of narrow and intensive spectral lines covering spectral region from VUV to IR. The HFELS vessels are mostly made of glass or quartz and filled with a working element and rare gas at low pressure. High frequency (HF) electromagnetic field is applied to induce an inductive coupled discharge. Such light sources are very useful for the plasma-wall

interaction studies due to the lack of the electrodes. That means that many problems caused by influence of the electrodes on plasma, like production of pollution elements, are eliminated. Because of lack of electrodes it seems like these light sources are living forever but there is another process restricting source lifetime: interaction of filling element with walls of the glass bulb. This process depends strongly on the light source operating power. To prevent this process, the rare gas as a buffer gas could be added. In [1] gases coming out of walls of source vessel has been measured by means of mass-spectrometry. There the training method was suggested using discharge in the rare gas to clean the light source walls from pollution. Commonly, the training of the glass vessel is performed by means of the same rare gas which is provided for filling. We have investigated spectroscopically the lamp vessel training efficiency using different rare gases. We have compared emission of pollution elements, such as oxygen, carbon, hydrogen, in helium high-frequency electrodeless light sources, prepared applying different training techniques.[2] Atomic force microscopy has showed that during operation of the electrodeless lamp, the plasma interacts with the material of the bulb wall, causing important nanoscale modification of the material. As revealed by AFM image analysis the wall surface after plasma treatment becomes covered with grains of the size (perimeter) m, which protect lamp bulb walls from furthermfrom 0.1 to 1.5 influence.[3] The task of the inventors and manufacturers of the light sources is to minimize this influence by appropriate choice and improvements of materials and technologies to make the bulbs working longer and to avoid the changes of spectral qualities with age. Surface kinetics dependent on diffusion and interactions on the surface, is a complex phenomenon requiring further studies. Acknowledgments: The study was partly supported by the European Social Fund (ESF) and the National Research Program in Material science (Project No. 1).

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BASIC PROBLEMS IN DESIGN OF FLUIDICS MEMS AND NEMS

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The focus of this presentation will be on the basic issues of the designing theoretical and experimental microfluidics MEMS and NEMS. Microfluidics systems are interesting for various industrial application such as lab-on-chip, DNA analysers, cells on chip manipulations, bio-chemical reactors etc. Fast and cheap design, however is still unreachable due to restriction in understandings of basics processes. However, in this presentation we will show some ways, how this can be achieve at current state of the research knowledge.

FLUORESCENT POLYMERIC NANOPARTICLES PREPARED WITH THE MINIEMULSION TECHNIQUE: PREPARATION, CHARACTERIZATION AND BIOMEDICAL APPLICATION

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Polymeric nanoparticles are proposed for several biomedical applications with specific requirements for the polymeric core and the surface of the particles. The miniemulsion technique provides a convenient and powerful tool for the preparation of polymeric nanoparticles from various polymers. Basic surface modification can be achieved during the preparation process, while more elaborate steps can be performed after particle preparation. Three different polymers were chosen, non-biodegradable polystyrene (PS), biodegradable poly(n-butylcyanoacrylate) (PBCA) and the biopolymer polyisoprene (PI). The basic step for the particle preparation is the formation of a stable monomerin-water miniemulsion. The particles are subsequently formed by polymerization of the respective monomer. For later detection of the particles, a hydrophobic fluorescent dye was encapsulated. Polystyrene particles were synthesized in a radical miniemulsion polymerization process. A surface functionalization of the polystyrene particles was obtained by copolymerization with functional hydrophilic monomers as acrylic acid or aminoethyl methacrylate which accumulate at the interface between the aqueous and the monomer phase. After radical polymerization the functional groups can be found on the particles' surface. Polyisoprene and polyisoprene-co-polystyrene particles were also prepared by radical polymerization. Poly(n-butylcyanoacrylate) particles were prepared by anionic polymerization after the addition of a nucleophile to the miniemulsion. The choice of nucleophile determines the functionalization of the particle surface. Since the part of the growing polymer bearing the hydrophilic initiator acts as surfactant it is likely to find the hydrophilic part on the aqueous side of the BCA/water interface. With this technique unfunctionalized, amino acid functionalized and MethoxyPEG (MePEG)-functionalized particles could be prepared. The size of the particles was determined by means of dynamic light scattering. The particle sizes can be adjusted between 60 and 250 nm with a narrow size distribution. Zeta-potential measurements indicate the presence of the desired functionality. Additionally the molar mass of the biodegradable PBCA was determined by GPC. It was also possible to quantify surface groups present on the functionalized polystyrene particles by surface titration with polyelectrolyte. The impact of the particles on biological systems has been assayed in various cellular experiments. Four clinically relevant cell lines have been used, two suspension cell lines, Jurkat and KG1a as well as two adhesive lines, HeLa and mesenchymal stem cells (MSC). The fluorescence intensity in the cells caused by the fluorescent dye incorporated in the particles was determined by FACS (fluorescence activated cell sorter) analysis.
Visualization of the cells with the incorporated particles was performed with a confocal laser scanning microscope (CLSM). Higher magnification images with a localization of the particles were obtained by TEM studies. The amount of cellular uptake of functionalized polystyrene particles is determined by the amount of functionalizing groups present on the particles. Uptake kinetics depends on the cell line and on the particles' functionalization.

Nanoelectronics and nanophotonics solutions

BRUSH TYPE BONDING WITH NANO-NEEDLE STRUCTURE FOR CARRIER WAFER BONDING IN MICROELECTRONICS

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The objective of the presented work was to find a constructive and technological solution for a solder free dry assembling method at room temperature with reduced requirements for axes coincidence

and decreased irregularity of the currents distribution. We had to find a solution for the construction of a mechanical contact allowing non-axiality, bonding system insuring regular distribution of current lines, construction allowing matrix contacting system, and contacts in the submicron area. In this paper we present a new type of dry microcontacts where the connection is realized via a mechanical coupling: brush type bonding. The coupling is realized through a system of counter positioned nanoneedles, which redistribute the current lines. These nanoneedles are manufactured via growing of anodized aluminium in a dielectric material and following photolithography. The technological process and their application are discussed in details in the paper. The results from the technological process related to the growth of nanoneedles in dielectric material are being evaluated. The standard methods for evaluation of nanostructures are mainly based on observation of the structures by the means of electronic or atomic force microscopes. The possibility for evaluation of the nanoelements through measurement of microstructures, which comprise tens and hundreds of elements, is substantiated. The measurement is carried out via differential measurement of the electric potential, which gives information about the character of the nanoelements.

ELECTRICAL CONTACTS TO SILICON NANOPARTICLES FOR FET DEVICES BY METAL NANOGAPS

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A low-cost and simple fabrication technique is proposed to prepare a bottom-gate FET applying nanoparticlesof silicon (nc-Si). Depending on particle diameter metallic nanogaps were fabricated separating electrodes down to 30nm (fig. 1). The metal can be chosen from a wide range, matched to specific process steps and further materials. Silicon nanoparticles of various diameter were available dispersed in ethanol. Application of nc-Si dispersion is proceeded by spin-coating and causes self-alignment of particles within the nanogaps. Semiconducting particles are contacted by metallic gap-walls providing a transverse direction of current flow through parallel connected particles. Thermal annealing reduces contact resistance and fixes the nc-Si subsequently.
Figure 2 shows the schematic cross-section. Built up on an insulating layer of sufficient thickness, electrical characterisation of nc-Si can be obtained. Thus proceeded characteristics of nc-Si were modeled voltage-dependently and conductance mechanisms of Frenkel-Poole (fig. 3a) and direct tunnelling (fig. 3b) were found accordingly to other proposals [1][2]. An advanced approach succeeded while taking advantage of conclusions in contacting nanoparticles by metal nanogaps and reducing the thickness of the dielectric layer underneath the metallization below 10-15nm. Using the silicon substrate as a kind of ”gate electrode”, a field effect can be induced into the nanoparticles, hence the channel conductance varies with applied gate voltage.
Thus the device can be looked on as field effect transistor with a semiconducting nanoparticle representing the channel region. It is shown, that modulation of channel conductance can be attained indeed. Current investigations of device characteristics show reasonable turn-off characteristics and ON/OFF-current-ratios up to 2x102(fig.4). Implementation of the nanogap devices can be done by conventional optical lithography, but due to the fabrication process the positioning is limited to alignment accuracy of the used lithography technique. Transistor engineering [3][4], this approach is virtually independent from both random distribution and synthesis method of nanoparticles. Effective silicon planar technology and application of nc−Siby spin−coating, this approach is advantageous compared to nanoparticle− transistors built up vertically or as thin−film−transistors[5].

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DAMASCENE METAL GATE TECHNOLOGY: A NOVEL APPROACH TOWARDS NANO CMOS

DEVICES WITH CRYSTALLINE HIGH-K GATE DIELECTRICS

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The paper presents the promising results of integrating crystalline high-k gate dielectric Gd2O3 with EOT of 1.9 nm in a damascene metal gate process in order to replace the conventional SiO2 dielectric in future nano CMOS devices. Since the harsh processing is done prior to high-K deposition in this process, process induced oxide damage effects are minimized and the initial material quality of the crystalline high-K gate dielectric is largely preserved.

DNA ELECTRONICS AND MOLECULAR PHOTONICS

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Due to fundamental physical limitations, the scaling down of present designs in microelectronics and optoelectronics is eventually causing a degraded performance. At the same time the fabrication has become increasingly difficult. The use of molecular level components can, in principle, overcome both of these limitations. We have investigated double-stranded DNA as an electrical component or building block to be used in molecular electronics. Extensive studies have been performed about trapping and immobilization of single DNA molecules to the desired locations by using electromagnetic fields, i.e. dielectrophoresis (DEP), and thiol-modifications, respectively. These experiments yielded critical information about the parameters affecting to the efficiency of DEP, and showed that DEP can be utilized to trap even as short as 10 nm long DNA molecules. Further, it was demonstrated that the efficiency of DEP can be enhanced by shrinking the electrodes, by using a carbon nanotube as an electrode. The same method could also be applied to guide more complicated self-assembled entities to embed them into the rest of the circuit. The DEP results also revealed information about the polarizability of DNA, which may be related to its conductivity. In addition, direct conductivity measurements were performed on the trapped molecules. An insulating behavior was measured in dry conditions, while a clear humidity induced enhancement of the conductivity of single DNA molecules was observed. Although photonic components are conceptually superior to the electronic ones in terms of bandwidth, the fundamental limit set by diffraction does not allow their high density integration. A known solution
to overcome this is to use surface plasmon polaritons (SPP), collective electronic excitation modes propagating on metaldielectric interfaces. SPPs are ideally suited for photonic devices where simultaneous realization of strong confinement and low propagation losses is needed. The major challenges include efficient coupling of regular light with such plasmonic circuits. We have studied and developed a coupling and energy transfer mechanisms between light and SPPs excited on the surface of thin nanoscale silver wires, based on single dye molecules or molecular assemblies.

THE EFFECT OF THREADING DISLOCATION OPTIMISATION ON GAN LED EFFICIENCY

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Major developments in III-nitride semiconductors have led to the commercial production of InGaN-based multiquantum-well (MQW) light-emitting diodes (LEDs) and laser diodes [1]. GaN MQW LEDs use InGaN as the material for well layers and GaN as the material for barrier layers. A large number of threading dislocations (TD) originate from the large lattice constant difference of GaN and sapphire. These TDs propagate through the entire LED structure, including the MQW stack. The high TD density limits the efficiency of GaN LED. Recent experimental observations by Hangleiter et. al. give strong arguments that the high radiative efficiency of InGaN/GaN QWs is due to a potential barrier, that forms around threading dislocations (TD) [2]. This causes screening of the dislocations and prevents the carriers from being trapped by the TDs. In this case, the recombination mechanism should be determined by a competition between the radiative recombination in the InGaN wells and tunneling through the potential barriers that screen the dislocations. As both of these depend on the In content, the effect of TD density on the LED efficiency should be different in the case of high or low In content in the QWs. In this work, we have performed an extensive study on the role of TD density on the efficiency of GaN LEDs operating in spectral range from 470 nm to 500 nm. The LED structures were grown on sapphire substrates in a 3x2” Thomas Swan Close Coupled Showerhead MOVPE reactor. The gallium, nitrogen, indium, and aluminum sources were trimethylgallium (TMGa), ammonia (NH3), trimethylindium (TMI), and trimethylaluminum (TMA), respectively. Silane (SiH4) and bis (cyclopentadienyl) magnesium (Cp2Mg) were used for n-, and p-type doping, respectively. Two different processes for GaN buffer growth were used. The standard ”two-step” process resulted in TD density in excess of 6x108 cm-2. Low dislocation density buffer was grown with the application of a multistep nucleation layer technique [3], which enables TD density of 7x107 cm-2 to be achieved. Growth temperature of the InGaN wells was varied to control the emission wavelength.

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INGAN/GAN MULTIPLE QUANTUM WELL LIGHT EMITTING DIODES WITH HIGHLY TRANSPARENT NI/ITO CONTACTS ON P-GAN

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InGaN/GaN multiple quantum well light emitting diodes (LEDs) grown by metalorganic vapor phase deposition (MOVPE) have attracted considerable interest in the recent years [1]. In the case of insulating sapphire substrate, n- and p-type electrodes are formed on the same side of the epitaxial layers and light is extracted trough the p-type layer. However, ohmic contact at metal/p-GaN interface is still a problem that limits the LED performance [2]. Conventional InGaN/GaN LEDs use semitransparent Ni-Au films as a p-type contact. Optical transmittance of these Ni-Au films is only 60%-75% at visible wavelengths. Contact reliability becomes an issue if higher transparency is achieved with too small contact layer thickness. Several methods for improving the optical transparency and current spreading in the p-type contact have been proposed, including altering the thickness of the Au layer in Ni-Au film [3], or using Pt thin film contacts [4], or using indium tin oxide

(ITO) as the contact to p-GaN [5]. Also various reports of ITO contacts with thin metal sub layers between p-GaN and ITO have been published [6-7]. In this work ITO with different metal sub layers as a contact material for p-GaN in blue LEDs has been studied. We demonstrate efficient current spreading and high optical transparency at visible wavelengths in contrast to conventional Ni-Au contacts. Structures were characterized with transmission, transmission line method (TLM) and electroluminescent (EL) measurements.

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URFACE MODIFIED HIGH RECTIFICATION ORGANIC DIODE BASED ON ORDERED NANOSTRUCTURE OF SULPHONATED POLYANINILE

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A new method has been developed to combine surface modification of indium-tin oxide (ITO) and electropolymerization to prepare well ordered nanostructured sulphonated polyaniline (SPAN) films with good surface coverage. The surface modification enhances the growth of the SPAN film resulting in a better rectification signal for SPAN films than when polymerized on unmodified ITO substrates. The films were characterized by FTIR, scanning electron microscopy (SEM) and atomic force microscopy (AFM). The sulphonation degree of SPAN was determined to 29% by X-ray photoelectron spectroscopy (XPS). UV-VIS spectroscopy shows that the pH sensitivity of SPAN is suppressed due to sulphonation of the polymer backbone. It is also shown that the conversion of the SPAN film to the ES form after polymerization is crucial for obtaining a high rectification signal. This is an important practical aspect in the preparation procedure of organic electronic devices. The current-voltage characteristics of the SPAN based diode prepared on with a specially modified ITO substrate was improved by several orders of magnitude compared with an un modified ITO substrate.

FABRICATION TECHNOLOGIES FOR NANOPHOTONICS COMPONENTS

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Different nanoscale fabrication techniques including nanoimprint lithography (NIL), focused ion beam

(FIB) processing, and pulsed laser deposition (PLD) have been utilized and developed for realization of waveguide structures, subwavelength gratings, nanoaperture components, and optical shutters for photonics applications. Nanoimprint
process was studied and developed in order to replicate nanoscale patterns on quartz, glass, and silicon substrates. UV-exposure curing, post-baking heat treatment, and imprinting process parameters for various commercial resists were optimized and lateral resolution below 40 nm was achieved. Performance of NIL technique was demonstrated
in fabrication of subwavelength grating and optical waveguide structures. A ring-resonator test structure of a surface-plasmon enhanced nanoaperture component was modeled and designed. Sputtering, physical vapor deposition, and e-beam deposition techniques were used to deposit aluminum thin films on glass substrates. Properties
of Al films were varied together with FIB etching process parameters in order to optimize the ring resonator structure. Etched structures were analyzed using SPM technique. Metal-insulator-transition (MIT) effect was utilized in fabrication of an electric field controlled optical shutter for IR wavelengths. Vanadium oxide (VO2) thin films with MIT effect were stacked with ITO transparent electrodes to form multilayer capacitor structures on various substrates using PLD method. Optical densities OD > 5 were achieved at the wavelength of 1550 nm in metallic blocking state of the shutter.

LOSSES OF SURFACE PLASMONS IN THIN CORRUGATED SILVER FILMS

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We studied the propagation losses of long and short range surface plasmons in thin corrugated silver films by rigorous electromagnetic simulations. The grating period was chosen to be 600 nm to open up a band gap in the visible range, and the effects of changing the fill factor and the amplitude of the gratings were investigated.
Moreover, we tried several different grating configurations. We found that changing the fill factor has drastic effects both on the propagation losses and the sizes of the band gaps of the plasmon modes, whereas increasing the grating amplitude only opened up the band gaps. The knowledge gained from this study is essential for minimizing the propagation losses in any application of surface plasmons.

COMPREHENSIVE PERFORMANCE CHARACTERIZATION OF NANOSTRUCTURED DYE SOLAR CELLS

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The nanostructured dye solar cell is a promising concept for economic flexible solar cells. The performance and lifetime of these cells is closely related to the properties and function of the molecular TiO2/dye/electrolyte interface, electron transport in the TiO2 nanoparticle photoelectrode films, catalytic activity of the counter electrode, ion diffusion in the electrolyte and current blocking nature of the photoelectrode substrate – electrolyte interface. Systematic development of the cells and interpretation of the evolution of their performance characteristics over their operating life requires application of versatile and complementary experimental techniques. We have set up

extensive experimental facilities and methods for comprehensive steady state and dynamic characterization of the dye solar cells. The steady state methods include IV-curve and energy conversion efficiency in 1 sun (10 x 10 cm2 area) solar simulator, optical reflectance and transmittance spectroscopy of the cell components, limiting current measurements and quantification of the substrate leakage currents. The dynamic techniques include electrical and optical small amplitude modulation methods, namely electrochemical impedance spectroscopy (EIS) and intensity modulated photocurrent and photovoltage spectroscopies (IMPS, IMVS) as a function of light intensity, cell voltage (operating point) and temperature. These are complemented by large transient techniques such as open circuit photovoltage decay. In this contribution we demonstrate the power of these techniques for the comprehensive and systematic study and development of the nanostructured dye solar cells.

NOVEL SYNTHETIC ROUTES TO CONJUGATED POLYMERS AND THEIR USE FOR THE FABRICATION OF OPTOELECTRONIC DEVICES.

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Organic and organometallic polymers characterized by extended electronic conjugation along the polymer backbone are currently subject of extensive investigations since their remarkable electrical and optical properties make them excellent candidates for advanced technological applications. The fundamental targets of our current research activities are both the enhancement of the functional properties of new materials as well as the development of synthetic protocols which match the stringent requirements of sustainable chemistry. Within this field, our group has discovered and well exploited a new synthetic protocol named Extended One Pot (EOP), allowing a convenient access to polyethynyl and polymetalloethynyl homo- and co-polymers, with distinct advantages in comparison with current procedures. Using the EOP method we prepared a large variety of highly ethynylated materials of type homo-poly(arylene-ethynylene)s [-Ar-C C-]n, co-poly(arylene-ethynylene)s [-C C-Ar-C C-Ar']n, and poly(arylene-ethynylene-co-metalla-ethynylene)s [-C C-Ar-C C-MLm-]n [2]. The organic and organometallic co-polymers of general formula [-C C-A-C C-B-]n are characterized by the presence of an aromatic group "A"(usually a phenyl carrying lateral substituents) in charge of imparting mechanical strenght, chemical stability and processability to the polymer, while the "B" unit is in charge of imparting the functional properties to the material. This "B" units may be either an aromatic or heteroaromatic unit (Ar'), a simple metal "fragment" MLm (Lm= ancillary ligand), or a macrocycle eventually incorporating metals (e.g. porfirinoids). This strategy has been called "The "A"-"B" modular approach". Moreover, a control on supramolecular assembly is achievable via this approach since the (opto)electronic properties of organic conjugated materials in the solid state strongly depend on thin film morphology and then on relative molecular orientation, by the interplay of the rigid rod-like backbone structure and the presence of appropriate side substituents on the aromatic rings [3]. Currently, in order to form biomimetic materials (bioreceptors), we are incorporating "B" units carrying oligopeptides as side chains in the conjugated polymer backbone, and, as a consequence of the polarity of such lateral groups water soluble polymeric materials have been formed. Being the EOP synthetic protocol based on mild one-pot Palladium catalyzed cascade processes, good tolerance toward many different functional groups is found, thus allowing the introduction of a wide variety of different type of "A" and "B" module into the polymer structure. The photophysical characterization of the PAEs synthesized with the EOP procedure has confirmed that such materials present interesting features for potential applications to optoelectronic devices [4-6].
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NANOMATERIALS IN THE PHYSICS CURRICULUM AT UNIVERSITY OF LATVIA

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The duration of present bachelor and master degree physics programs at University of Latvia (UL) is 4 + 2 years. In order to modernize the programs in accordance with Bologna declaration (3+2 years) and demands of labor market the new master physics program is developed. This program imply modernization of the following optional course modules: - Atom, molecule and optical physics; - Functional materials and nanotechnologies, - Hydrodynamics, thermal physics and magnetic phenomena. In the report a curriculum of optional module ”Functional materials and nanotechnologies” is given. The module consists of following courses:
1. Review on functional materials (4 kr.p.): - Polar dielectrics and applications; - Semiconductor materials and applications; - Photonics materials and applications; - Ionic conductors and sensors; - Interface physics in functional materials; - Organic materials and applications.
2. Nanotechnologies and materials (2 kr.p.)
3. Nanomaterial physics and devices (2 kr. p.)
4. Structure and characterization of nanomaterials (2 kr.p.)
5. ”Soft” nanomaterials (2 kr.p.) The laboratories for all courses are included.

BRUSH TYPE BONDING WITH NANO-NEEDLE STRUCTURE FOR CARRIER WAFER BONDING IN MICROELECTRONICS

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The objective of the presented work was to find a constructive and technological solution for a solder free dry assembling method at room temperature with reduced requirements for axes coincidence and decreased irregularity of the currents distribution. We had to find a solution for the construction of a mechanical contact allowing non-axiality, bonding system insuring regular distribution of current lines, construction allowing matrix contacting system, and contacts in the submicron area. In this paper we present a new type of dry microcontacts where the connection is realized via a mechanical coupling: brush type bonding. The coupling is realized through a system of counter positioned nanoneedles, which redistribute the current lines. These nanoneedles are manufactured via growing of anodized aluminium in a dielectric material and following photolithography. The technological process and their application are discussed in details in the paper. The results from the technological process related to the growth of nanoneedles in dielectric material are being evaluated. The standard methods for evaluation of nanostructures are mainly based on observation of the structures by the means of electronic or atomic force microscopes. The possibility for evaluation of the nanoelements through measurement of microstructures, which comprise tens and hundreds of elements, is substantiated. The measurement is carried out via differential measurement of the electric potential, which gives information about the character of the nanoelements.

DEVELOPING CIRCUIT THEORIES FOR NOVEL NANODEVICES

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With the continuous shrinking of the dimensions, the semiclassical models used till now to describe electronic devices are reaching their limits. This is clearly true for quantities such as, for example, mobility, diffusion and characteristic conductivity of materials which are calculated or measured through the average of a high number of events. Infact, in most nanoelectronic devices a single or few quantum events count and therefore the validity of models obtained through averaging processes is being more and more stressed to the limits. Moreover, the semiclassical models are based on Kirchoff's and Ohm's laws which give a rather limited description of electronic transport in mesoscopic devices compared to the many possibilities and interpretations which rose in the last decades due to theoretical framework provided by Quantum Mechanics. These assessments are strongly proved by the fact that in the last couple of decades the results of many experiments on devices with some nanometric dimensions involved cannot be explained or even treated without recurring to the quantum nature of matter. In this paper we first provide an overview of the main quantum effects in circuits reported in literature, addressing some of them as possible candidates to build novel and revolutionary electronic devices. Furthermore, in order to give an example of some practical applications, we shortly describe some of these novel devices keeping in mind that their ultimate goal is to exploit these uprising quantum effects and to overcome the limits that seem to affect the future of CMOS technology. Then we give a draft of the various theories that have been developed to explain these effects and that can be a starting point in order to build reliable and enough accurate models for benchmarking and simulation of the novel nanodevices. These theories range from quite simple ones to quite complex ones, basically depending on how much they intend to abstract and approximate the rather complex and redundant (from a circuit theory point of view) quantum mechanical equations. A short comparison between these theories will be performed, sheding light on their strong and weak points. Finally we will describe which are, in our opinion, the future directions that will have to be undertaken in order to build a useful circuit theory for the upcoming nanoelectronic era.

LASER SINTERING OF AG NANO PASTE FOR PRINTED ELECTRONICS

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Manufacturing electronic devices by utilizing printing techniques and special inks based on nano - scale metal particles can revolutionize the electronics industry in near future. Due to small particle size, metallic nano particles can be sintered to homogeneous electrically conductive traces at rather feasible temperatures e.g. 220 ˚C.
However, evaporating the solvent and sintering the printed structures well, takes still a long time in convection oven typically from one to two hours. Thus, the exposure to high thermal stresses causes a big reliability risk for the product, especially if the circuit consists of several layers and includes different materials. We have studied laser sintering as an alternative sintering process for inkjet printed silver nano-particles to overcome the above mentioned challenges. Drop-on-demand material printer was used to print conductive patterns with silver nano-particles on a polyimide substrate. Sintering studies were made with a continuous diode laser. Properties of the laser sintered samples were compared to reference samples sintered according to the standard sintering procedure in a hot air oven at 220 oC for 60 minutes. The results show that laser techniques provide a promising alternative for controlled sintering of printed nano metal traces possibly enabling more complicated electronics modules. Also wider range of substrate materials can be used because thermal stresses induced to the materials during the sintering are lower. In the future, research focus will be directed to optimizing of the laser process for several substrates. The aim is to find process parameters for

different material combinations without decomposition of the materials. Also a utilization of an ultra-short pulse-laser will be studied.

SINGLE-ELECTRON CIRCUITS PERFORMING NOISE-TOLERANT PULSEDENSITY MODULATION BASED ON NEUROMORPHIC ARCHITECTURE

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We present a single-electron circuit implementing an inhibitory network model that performs noise-shaping pulsedensity modulation with noisy elements, with the aim of developing a possible ultralow-power pulse-density modulator.
Through circuit simulations we show that the inter-spike intervals of the network was almost uniform compared with that of the uncoupled network as a result of neural inhibition.

NANOMATERIALS AND NANOTECHNOLOGIES IN LATVIA

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In Latvia at least 12 groups of scientists are involved in research and production of different nanomaterials - inorganic, organic and biological. Hence, the strategic goal of the project is to join the research groups and coordinate activities of the researchers. In this presentation the main topics and results of this project will be presented.

QUANTUM CONFINEMENT EFFECT IN NANOHILLS FORMED ON A SURFACE OF SI, GE AND GAAS BY LASER RADIATION

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Nanohills on a surface of Ge, Si and GaAs single crystals were formed by Nd:YAG laser radiation. Photoluminescence from irradiated surfaces was found in visible range of spectrum. PL from Ge, Si and GaAs nanostructures is explained by Quantum Confinement effect on the top of nanohills. A red shift of micro-Raman backscattering spectra is an evidence of this suggestion

HETEROCOMPOSITE BN-TUBE/SIC-WHISKERS ARRAY AS PIEZO-ELECTOACOUSTIC HYPER-SOUND TRANSDUCER IN EXTREMELY HIGH –FREQUENCY 1 1000 GHZ RANGE

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SiC whiskers of submicron 100-800 nm diameters and of ~20 aspect ratio covered by thin (~10-30 nm) BN sheets were fabricated. The SiC whiskers were synthesized at the first stage by both a template method using carbon nanotubes and a carbothermal method. The whiskers were mixed in magnetic mixer with aqueous solution of boron acid and saccharose mixed with ethyl alcohol and surfactant. After drying and graduated heating up to 1100-1300 C during several hours a setting was cooled in nitrogen flow. Samples were characterizated by TEM, IR, EPR, and Raman spectroscopy. TEM images of BN films show the onions, pure BN plates, graphene sheets, bamboo-like and straight nanotubes, as well as other inhomogeneities in their structure. Kaktus-like arrays of SiC whiskers were synthesized by CVD technique. After optimization of processing parameters the BN/SiC heterowhiskers have been obtained. Novel innovative idea of the BN/SiC heteropolar-tube-whiskers arrays as ideal hypersound transducer in extremely high-frequency range was suggested. In contrast to nanorodes and plates in the nanotubes the peculiar gallery of whispering acoustic modes (breathing A1g, squash E2g, et.al.) is possible to propagate due to its cylindrical form. An inherent important feature of these vibrations is their weak attenuation and high frequency that in dependence of diameter fall in the range ac. ~1THz. Hypersound may be excited by microwave using piezoelectric properties of BN heteropolar nanotubes. In complex the BN/SiC nanotubewhiskers give the base for effective generation and detection of acoustic hypersound vibrations from Giga to Tera-Hertz range.

NANOTUBULAR SUPERCONDUCTIVITY

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Systems analysis and short review have been performed of both experimental facts and theoretical models of superconductivity phenomenon in noncarbon heteropolar nanotubes of MgB2 type. Original unique opportunity for triple combined photo-acousto-electronic (P-A-E) super-resonance in nanotubes and nanotubular 2D crystals is predicted theoretically on the sole frequency named as super-resonance frequency. While diminishing a diameter of nanotube a quantum size effect was assumed to arose inevitably leading to a resonance enhancement of electron-phonon interaction that manifest itself in the appearance of superconducting state for which the splitting of optical and acoustical phonons is responsible for, thereby determining a Debay frequancy. The super-resonance frequency is novel characteristic inherent for nanotubes and nanotubular crystals. Such a state is a novel unique structural state of matter in which a high-effective transformation and pump each other of all three kinds of vibration energy (electronic, photonic, phononic) is possible.

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LASER-INDUCED EFFECTS IN NEW NANOSTRUCTURAL ELECTROOPTICAL SYSTEMS: THEIR APPLICATIONS

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The fullerene- and nanotubes doping effect on spectral, nonlinear optical properties, and dynamic parameters of conjugated organic systems has been studied. Optical limiting, hologram recording features, switching and modulation of laser beam have been revealed to apply them in different optoelectronics devices based on nanotubes and fullerene-doped organic compounds.

Nanomaterials and particles

STRUCTURE AND ACTIVITY OF MODIFIED PD BASED CATALYSTS FOR METHANE COMBUSTION

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Structure and Activity of Modified Pd based Catalysts for Methane Combustion Niko Kinnunen(a), Mika Suvanto(a), Tapani. A. Pakkanen(a), M. Andreina Moreno(b) Auli Savim¨aki(b) , Kauko Kallinen(b) and Toni- J.J. Kinnunen(b) (a)University of Joensuu, Department of Chemistry, P.O.Box 111, FI-80101 Joensuu, Finland (b)Ecocat Oy, Typpitie 1, FI-9650, Oulu, Finland The present study deals with modifications on the formulation of Palladium based catalysts for the treatment of exhaust automotive emissions. These modifications intend to study changes on the structure: morphology and surface, the redox behavior of Pd nanoparticles supported in alumina and ceria-zirconia mixed oxides and the reactivity for methane conversion of the above mentioned catalysts. Effects such as particle size growth owe to aging, thermal deactivation; metal support interactions, metal-promoter interactions, effect of preparation method and the use of new raw materials are studied and described in detail.

The techniques employed in the study include: SEM-EDS for surface studies with emphasis on the surface distribution of the palladium nanoparticles and their interaction with key washcoat components such as promoters and supports. XRD is employed to evaluate the stability of the metal nanoparticles and the support phase changes. TPR-TPO is used to study the redox behavior of the palladium in different supports and the effect of preparation method. The catalytic activity for combustion of methane is studied and correlated to the rest of the experimental data. Parallel to this, the activity of the modified catalyst is tested in a system that simulates the exhaust gas composition of a stoichiometric engine. The results of this parallel study are also correlated to the characterization and behavioral data obtained by the above mentioned techniques.

FE-CONTAINING NANOPARTICLES IN POROUS DISORDERED AND REGULAR SILICA

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We report the results of our recent scientific investigations on the technology and characterization of composite structures with Fe containing nanoparticles formed in porous disordered and regular silica. The systems under consideration were
Fe/Fe oxide particles in porous silica layers deposited on Si and hybrid structures of Fe porphyrin intercalated into opal photonic crystal. The effective low-cost sol-gel technique was used for the formation of nanostructures. Fe-doped silica layers were formed on Si substrates by spinning technique. It was shown that controlled formation of Fe/Fe oxide particles could be realized by various technological procedures. Hybrid organic-inorganic precursor TEOS-FeCl3 and organic

alkoxide precursor modified by Fe acetate were used. The porosity of silica layer was varied by adding surfactant. The interaction of silica film with substrate could be enhanced by introducing NH2 groups by adding APTES into precursor composition. The post-growth annealing in various atmospheres was shown to influence significantly on the physical properties of composite structures which have been characterized by structural, optical and magnetic studies. The synthetic opal structures were fabricated by sol-gel technique to produce silica spheres and by sedimentation technique to grow the 3D photonic crystals. The Fe porphyrin was infiltrated into opal structure by immersion technique. It was shown that infiltration of Fe porphyrin influenced significantly on characteristic features of photonic opal crystals. The absorption bands typical of iron porphyrin manifest themselves in the vicinity of stop band. The regularities of optical properties on the acidity and concentration of aqueous solutions of iron porphyrin were determined. The results obtained have shown that opal crystals infiltrated by iron porphyrin can be considered as the element of magnetophotonic crystal.

FABRICATION OF NANOSTRUCTURES VIA SELF-ASSEMBLED BLOCK COPOLYMER/HYBRID MATERIALS

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Over the past ten years research in nanotechnology has been strongly focused on obtaining macroscopic nanostructures, with the potential to be utilized for the next generation of miniaturized devices. However, fabrication of 2D and 3D-nanostructures is still a challenge that needs to be overcome before the routine use of such technology is achieved. Block Copolymers (BCPs) main attractive characteristic is its ability to self-assemble in different morphologies with local polydomains. Combining organic and/or inorganic elements selectively incorporated in one block of the BCP, followed by extending the order of these polydomains, can provide useful directional properties from designed hybrid functional materials. The approach described here, is a simple route to prepare a hybrid organic-inorganic material, based on self-assembled Polystyrene-block-Polyvinylpyridine (PS-b-P4VP) and a metallic precursor selectively incorporated in the P4VP blocks. As a result, periodical metallic nanostructures are developed with alignment in dimensions up to the millimeters scale. Additionally, a narrow distribution of particle size is achieved, with sizes ranging from 2 to 4 nm. The present work might contribute to ease the path to bring down sizes of current devices in electronics, or develop new applications for selective synthesis in catalytic processes.

MANUFACTURING OF BIONANO-COMPOSITE: CNT REINFORCED UHMWPE COMPOSITE

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In recent years, discovery of the advantages of nanotechnology and carbon nanotubes (CNTs) has created enormous attraction due to their unique structure and properties. Carbon nanotubes possess extremely high aspect ratio, low density, high elastic modulus and fierce resistance to failure, so CNT is one of ideal reinforcing materials for polymer
composites. Polymeric based composites which are reinforced with CNTs have already been investigated into the functional application such as, conductive polymer, flame-retardant material, optical emitting devices and etc. The recent understandings of CNTs have initiated investigations in preparation of CNTs reinforced polymeric based
composites. There are many practical challenges to be solved when it comes to preparation and manufacturing methods due to the agglomeration of the CNTs particles during the processing. The reinforcing efficiency of the CNTs in composites depends strongly on the uniform dispersion of CNTs throughout the polymeric matrix without
destroying the integrity of the nanotubes. Nevertheless good interfacial bonding between polymer and CNTs is also required to achieve load transfer across the polymer-CNTs interface to improve the mechanical properties of polymer-CNTs composites. - Ultrahigh molecular weight polyethylene (UHMWPE) is a biocompatible material used to produce different implants such as hip and knee prosthesis. Nowadays wear of UHMWPE is still one of the main cause of implant failure and revision surgery. The aim of this investigation was mainly focused on the manufacturing process of UHMWPE-CNTs nanocomposites in order to present rather a simple and efficient manufacturing method. - Method: Wet-process was the techniques used to manufacture plates and thin films
of composites containing 2 weight% of purified single wall carbon nanotubes. Ultrasound was used to improve dispersion of nanotubes in the matrix, through solvent medium. - Results: Mechanical

properties (tensile strength, Young's modulus, fracture toughness, and Vickers hardness) of manufactured plates (UHMWPE-CNT composite versus pure UHMWPE plates) were analysed. Manufactured plates were investigated with Scanning Electron Microscopy (SEM) and Differential Scanning Calorimetry (DSC). Solution process showed a good dispersion of the reinforcement in the matrix and physical properties were slightly improved for CNTs composite. Tensile tests results revealed no significant differences in Young's modulus and yield strength between composites and pure UHMWPE. Vicker hardness results emphasized the possibility of slightly increases for the UHMWPE-CNTs composite. SEM images suggest that CNTs were successfully dispersed inside the polymer matrix. Thermal analysis results showed that the heat conductivity of the material has been increased due to the presence of nanotubes. Conclusion: The manufacturing of UHMWPE-CNTs composites could successfully carried out for not surface treated CNTs particles by use of mechanical force for dispersing of the particles in HUMPED as matrix resin. There was some improvement of mechanical properties for manufactured composites. - On going studies: The tribological and wear properties of UHMWPE-CNTs versus pure UHMWPE plates.

PRODUCTION OF STABLE COBALT AND NICKEL NANOPARTICLES BY CVS

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INTRODUCTION Cobalt and nickel are ferromagnetic materials and therefore cobalt and nickel nanoparticles possess unique magnetic properties. They may find applications in for example hard metal production, magnetorheological devices, magnetic recording media, magnetic cell separation, conducting inks and multilayer capacitors (Gustafson 2005, Wang 2001, Chaudhuri 2005, Puntes 1998, Kruis 1998, Tseng 2002, Sakabe 1997). Cobalt is also widely used as catalyst and cobalt nanoparticles would be especially suitable for catalytic purposes due to their very high surface to volume ratio and well defined crystal structure. Cobalt and nickel nanoparticles have been prepared by a variety of methods, including laser evaporation, flame synthesis, spray pyrolysis, sonochemical and chemical vapour synthesis (Trzeciak 2004, Che 1999, Koltypin 1996, Syukri 2003, Jang 2003). Commercialising may be excluded if high mass yield is not available with the method or the required technology is expensive. Metallic nanoparticles also tend to oxidise when in contact with air. In this work chemical vapour synthesis (CVS) is used. In CVS there is typically a gaseous precursor, which decomposes either thermally or due to chemical reaction forming a low vapour pressure metal or metal oxide molecules. The molecules then start to form clusters, which grow to larger droplets before crystallisation. Cobalt and nickel chlorides reduce in presence of hydrogen at high temperature (around 900 C) to pure metal and hydrogen chloride as. Production of cobalt and nickel nanoparticles by hydrogen reduction method has been reported by Jang et al (Jang 2003 and 2004, Yong 2005). In this work we describe a method for producing cobalt and nickel nanoparticles based on the same chemical reaction but with significantly better design and online measurements during the experiments.
EXPERIMENTAL Two different setups were used. Both setups were single piece quartz furnaces with two heating zones. In both setups, nitrogen was used as carrier and dilution gas and cobalt or nickel chloride as precursors. The difference between the setups was in the production of metal chloride vapour. The furnace in setup one was L-shaped and the reactor was batch type. In this setup, cobalt chloride was evaporated from one or two alumina crucibles in the horizontal part of the furnace. Setup two was U-shaped, where chloride powder feed is continuous. A powder doser (Lambda) was used to feed chloride powder to the furnace. The powder is fed on a stack of porous aluminium oxide pellets. The combination of powder doser and porous pellets enables continuous feed and saturation of the nitrogen flow with cobalt chloride vapour. The varied parameters were evaporation and reaction temperatures, hydrogen mixing and residence time in the reaction zone. The particles were studied with a transmission electron microscope. One of the samples was also analysed with semi quantitative x-ray fluorescence. Fourier-transform infrared spectroscopy (FTIR) was used to determine the hydrogen chloride content of the gas flow. Mass concentration of particles was measured with tapered element oscillating microbalance (TEOM) and filter samples.

RESULTS AND CONCLUSION High mass concentrations of high-purity cobalt and nickel nanoparticles with primary particles diameter below 100 nm were produced with aerosol method. The size distribution of the primary particles was narrow. The particles were fcc single or twin crystal with little neck formation. The oxidation of the particles was slow, probably because there were few defects in the crystals structure and a thin protective hydrogen chloride layer. Chain-like agglomerates were formed likely because the particles were ferromagnetic. The process is promising for scaling up because it is a one-step process and temperatures are much lower than for cobalt evaporation techniques and no expensive precursor or additives are required.

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POLYMER-ASSISTED SELF-ASSEMBLING PREPARATION OF ZNO NANOWIRES AND THEIR BLUE-ELECTROLUMINESCENCE

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Zinc oxide (ZnO) nanowires were prepared on silicon substrate by a novel process based on polymer grid backbone localization model and their blue-electroluminescence property was experimentally studied. The single crystalline ZnO nanowires were self-assembly grown on n-type (111) plane of the silicon substrate using polymer assisted complexing soft-template process through a simple polymer complexation and low-temperature oxidizing-sintering. The morphologies of the samples were examined using a field scanning electron microscope (FE-SEM) and photoluminescence property was measured at room temperature under the 325 nm UV fluorescent light excitation using a fluorescence spectrophotometer with a Xe lamp. The results indicated that these nanowires have smooth top and fine hexagonal columnar structure with the average length of about 6 μm and the diameter of about 40 nm. It confirmed that the prepared ZnO nanowire film had strong near-band ultraviolet emission at ~383 nm and blue electrically driven emission at ~ 404 nm at room temperature with a relatively low threshold voltage. The peculiar geometrical morphologies of ZnO ordered nanostructures may yield emission are achieved. The current-voltage measurements of the hexagonal-columnar ZnO nanowires film at room temperature showed a typical diode characteristic with the turn-on field about 0.9 V/μm. It may be attributed to a large number of ZnO nanocrystallites as emitter on the surface of the nanowire end. It could be concluded that these columnar structures of ZnO nanowires are particularly well suited to lasing and directed luminescence due to their individual Fabry-Pérot cavities and the combined lateral confinement at an appreciable grain length.

In particular, these structures may possess a good amplified stimulated emission and lasing property due to their high aspect ratio and small tip radius of curvature. These results also exhibit the potential application of ZnO nanowires as electroluminescence flat panel displays in the future.

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ZIRCONIA NANOCRYSTAL LUMINESCENCE DEPENDENCE ON OXYGEN CONTENT

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The luminescence of defects in tetragonal ZrO2 was studied. It was shown the defects luminescence depend on oxygen content in nanocrystals. The ZrO2 nanocrystals were annealed in vacuum as well as in oxygen nitrogen gasses mixtures of different concentrations. The strong change of luminescence intensity was observed after annealing and the dependence of luminescence intensity on oxygen content has been demonstrated. This dependence is different for band to band excitation and direct excitation of defects, however in both cases the oxygen related defects could contribute. The differences observed arise due to different mechanisms of defect excited state creation. The luminescence intensity change caused by annealing is reversible subsequent ZrO2 nanocrystals annealing in the air restore the luminescence intensity to the value measured before annealing in oxygen nitrogen gases mixtures.

THE DEVELOPMENT OF PEDOT:PSS INK FOR GRAVURE PRINTING PROCESS

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PEDOT:PSS, Poly (3,4-ethylenedioxy-2,4-thiophene) doped with poly(styrene sulfonate), was deposited on flexible plastic substrate with gravure printing process by modifying the dispersion with additives. The modification changed the physical and chemical properties of dispersion and improved the printability of PEDOT:PSS. Uniform and pinhole-free films with thickness from 30 to 70 nm were able to produce with the roll-to-roll printing technique. The printed PEDOT:PSS layer operated successfully in the structure of organic light-emitting diode, OLED.

NANO-SCALED METAMATERIALS WITH EXOTIC OPTICAL PROPERTIES: ONTHE WAY TOWARDS OPTICAL MAGNETIC MATERIALS

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One of the most exciting new opportunities resulting from recent research of artificial electromagnetic materials (metamaterials) is a possibility to realize artificial media showing magnetic properties in the visible range. There are no such materials in nature, however, it appears possible to make them

artificially using lattices of complex shaped nano-sized metal particles (e.g. in form of a split ring or as pairs of closely positioned nano-bars). Adding longer nano-wires or using an electrical resonance of the same inclusions small, it is possible to realize negative permittivity response as well. In particular, this will possibly open a way to design optical devices utilizing materials with negative refractive index. In such materials very interesting phenomena take place, for example, negative refraction and enhancement of evanescent fields. Initial studies reported by several international research teams show promising results. In this review presentation we will discuss the present state of the art of research towards artificial magnetic optical materials. Special attention will be given to challenges in reducing dimensions of complex-shaped inclusions with the goal to achieve resonant magnetic response in the visible. What should be the optimal particle shape? What should be the lattice structure? How the particle size and shape affect composite material losses? How to characterize electromagnetic properties of thin composite layers (one-two layers of particles)? What is the meaning of effective permeability of composite materials at optical frequencies? An overview of potential applications of novel artificial magnetic metamaterials will conclude the talk.

NANOPOROUS ALUMINA MEMBRANES: FORMATION AND CHARACTERISTICS

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Anodic oxidation of aluminium is considered as an effective method for producing unique oxide films with different functionality. Nanoporous alumina (NPA) formed by anodization of aluminium in acidic electrolytes has become a key template material for fabrication of nanostructured materials. The broad range of various applications of NPA requires a close control of the nanopore arrangement. The present paper is focused on the anodising parameters influencing the mesoscopic range order in cell/pore arrangement in the NPA formed by different technologies. Xray amorphous oxides formed in different acid solutions were studied. X-ray diffraction (XRD), transmission and scanning electron microscopy (TEM &SEM) were used to analyse the structure of these films. The quantitative data on the size, form and mutual arrangement of the pores and cells were obtained by computer procession of TEM- and SEM-images of the NPA. For this purpose, special software based on the methods of mathematical morphology and statistics was developed. It allows to derive the cell/pore size distribution and to calculate morphological functions of radial distribution (MFRD) of the cells/pores, which are analogues of the functions of radial distribution of atoms.

It has been shown that the construction of MFRD is an effective method to estimate the distance of the ordered arrangement of the cells/pores and gives possibility to choose the optimal conditions of producing membranes on the basis of NPA. The interpretation of MFRD by means of the pair-function technique allows determination of the mesoscopic range order characteristics. In conclusion, the view of the peculiarities of forming mechanism of NPA connected both with the co-operative effect of self-organization of metal/film/electrolyte system (at the stage of initiation of honeycomb pore structure) and with deposition of colloidal oxide material (at the stage of stationary pore growth) was developed.

NANOPOROUS ALUMINA AS A TEMPLATE FOR PRODUCING HIGH-VOLTAGE INSULATION

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Anodic oxidation of aluminium is considered as an effective method for producing unique oxide films

with different functionality. Electrolytic processing of aluminium can produce a through-film porous structure that has both chemical resistance and thermal stability. Nanoporous or mesoporous alumina membranes having regular arrays of pores are widely used as templates for producing nanomaterials such as carbon nanotubes and metal nanowires, because the pores are controllable by the conditions of preparation. So, it seems tempting to use the nanoporous alumina template for producing thick anodic alumina coatings, which would tolerate high electric fields. In this paper the results of investigation of oxide coatings on pure aluminium and some aluminium alloys formed by special two-step anodising (TSA) process are presented. The TSA technology developed by us supposes high-voltage reanodizing of porous alumina films in boric acid solution [1]. It was stated that in high-voltage re-anodizing of porous templates d ˜ 0.01mm thick the formation of dense alumina films (d ˜ 0.045mm thick) with the excellent dielectric properties occurs. So, these films possess absolute value of breakdown voltage at direct current ˜ 3.5kV. But, the breakdown voltage of such films at alternating current does not exceed 400V. To improve insulating properties, it was proposed to increase thickness of porous alumina using “hard” anodizing technology. It was found out that the increase of oxide thickness up to ˜ 0.50 mm results in the greater breakdown voltage of oxide coatings on Al at alternating current up to ˜2.4kV, while in ”hard” anodizing of the Al alloy with Mg (0.4-0.7 wt.%) it does not exceed 1kV. Only high-voltage re-anodizing of porous alumina allowed increasing the value of breakdown voltage at alternating current of alumina formed both on Al and on the alloys above 3kV. X-ray diffraction and electron microscopy study of coatings formed at the different stages of TSA enabled to propose the model explaining the character of transformations of porous templates during re-anodizing. In the frame of the model the TSA formation of amorphous oxide films characterizing with the excellent insulating property results from the synergetic action of the processes forming a new oxide and dissolving initial porous film.

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OPTIMISED CURING OF SILVER NANO INK BASED PRINTED TRACES

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Manufacturing electronic devices by printing techniques with low temperature sintering of nano-size material particles can revolutionize the electronics industry in coming years. The impact of this change to the industry can be significant enabling low-cost products and flexibility in manufacturing. implementation of a new production technology with new materials requires thorough elementary knowledge creation. It should be noticed that although some of first electronic devices ideally can be manufactured by printing, at the present several modules are in fact manufactured by using hybrid techniques (for instance photolithography, vapor depositions, spraying, etc...). However, in future advances in printing technology may enable the printing of major part of the future electronic modules and interconnections. The main challenge of such opportunity is to provide sufficient quality of interconnecting traces by appropriate materials manipulation and sintering, more precisely appropriate material deposition, process control and sufficient electric conductivity of printed interconnections. In this paper optimal curing conditions of Ag-nano ink deposited by ink-jet printing technique is elaborated. To achieve good product quality, minimal stresses and adequate energy deposition (for sintering of metallic nano particles) have to be understood and optimized. In other words optimal curing technique and energy deposition have to be combined in such a way that stresses are minimized in the whole assembly and manufacturing process. Theoretically minimal stress is obtained if localized energy deposition (only to the nano-ink traces) is used. However, localized heating is challenging requirement for mass applications (slow and low volume process). More adequate solutions take advantage of volumetric curing by optimized thermal management of entire assembly. In such constellation the heat propagation has to be well understood and the whole process optimized. In this work we investigated the effects of curing conditions on the materials micro structure and electrical conductivity of the cured nano-ink traces. Experimental part involved a set of test vehicles for resistance measurements and variation of energy depositions. A set of nano-ink traces, different in length and thickness were exposed to different curing conditions. Quality of the sintered traces was examined by structural, electrical and numerical methods. By drawing

correlations between relevant parameters optimal curing profile for the Ag-nano ink was found. Thermo mechanical modelling and simulations and adequate stress analysis were performed by using ANSYS software.

EFFECT OF HYDROTHERMAL TREATMENT CONDITIONS ON THE PHOTOCATALYTIC ANTIMICROBIAL ACTIVITY OF NANOSTRUCTURED TITANIA PARTICLES

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In the present study, nanostructured titania particles were synthesized by using hydrothermal processing and the photocatalytic antimicrobial activities were evaluated. Sol-gel synthesized TiO2 samples were processed by two step hydrothermal treatment under the alkaline and neutral conditions. Scanning Electron Microscope (SEM) images showed that alkaline treatment yields nanoplates and further treatment of nanoplates with distilled water results with crystal growth and the formation of bipramidal crystalline particles. The photocatalytic antimicrobial activity of the samples was determined against Escherichia coli under UV irradiation for 4 hours. Antimicrobial activity was enhanced by alkaline treatment. However treatment under neutral conditions had adverse effect on the antimicrobial activity in spite of the increase of crystallinity. The effect of surface hydroxyl species and dehydration of surface during hydrothermal treatment was related with photocatalytic activity.

NANOSTRUCTURED HYDROXYAPATITE CERAMICS AS NEW CARRIER FOR THE IMMOBILIZATION OF YEAST CELLS

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Hydroxyapatite (HAP) was considered as new possible carrier for the immobilization of yeast cells. HAP ceramics was assembled from HAP nanoparticles. Properties of HAP particles were explored both theoretically and experimentally. Computer simulation was employed to understand the HAP clusters (Ca5(PO4)3OH) structural and electrical (dipole momentum and polarization, surface charge/potential) features. The computer simulation demonstrated that the size (X) of the cluster has

a strong influence on its surface charge, dipole momentum, surface potential and as the result on the electron work function (F). Moreover these parameters depend on concentration of the oxygen couples trapping protons. The experimental approach was directed to measure such a surface feature as F and energy spectra of electrons of HAP nanoparticles. The magnitude of F was directly proportional to X. This result is in accordance with computer simulation. The solgel technology has been applied to reach the nanostructured HAP ceramics, having channels. A surface of the ceramics was provided with the electrical charge to deliver an influence on the yeast cell immobilization. It was shown that traditional approaches for the obtaining of efficient immobilization of microorganisms were not suitable in the case of the use of HAP ceramics.

New method for the immobilization of yeast cells on the surface of HAP ceramics was developed on the basis of the knowledge on the mechanisms of yeast anhydrobiosis. Investigations with preparations of immobilized yeast were realized for the understanding of the possibility to use HAP for the biotechnological purposes. It was shown that the immobilization procedure changed the physiological and biotechnological characteristics of yeast cells. The research has been realized in the frames of the EC project NMP3-CT-2003- 504937.

INVESTIGATION OF NANOSTRUCTURED ELECTROCATALYSTS FOR PEM HYDROGEN ENERGY CONVERTER IN AN EASYTEST CELL

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Recently we have developed a novel electrochemical test cell for express testing and optimization of the active materials (catalysts, catalytic supports, polymer membrane electrolytes) and electrode structures utilized in contemporary hydrogen PEM energy converters, called an EASYTEST CELL. The main advantage of this cell is its independence from any periphery systems such as gas supplying lines, pumps and conditioners (humidifiers, heaters, condensers, etc.) which are unavoidable for the conventional test cells and hinder essentially the implementation of fast, efficient and safe laboratory research. The body of the novel cell incorporates all necessary elements to set, monitor and regulate the experimental conditions (temperature, partial pressure, humidity, etc.) and thus, the cell is completely autonomic. In addition, the design of the cell allows in one experimental run to study the performance of the selected materials in both a fuel cell and an electrolyser mode. In several previous publications we have presented the working principal of the cell and have demonstrated its advantages by investigation of the partial reactions proceeding on the hydrogen electrode in fuel cell and electrolyser mode - oxidation of hydrogen and reduction of protons (evolution of hydrogen), respectively. In the present work we present the improved cell design allowing to investigate the reactions proceeding on the oxygen electrode. The new test possibilities are demonstrated with a research on the electrocatalytic properties of nanostructured Pt and IrO2 catalysts. The results obtained in the EASYTEST CELL are referred and discussed in a comparative way to those obtained in a conventional three electrode PEM electrolytic cell.

PREPARATION OF NANOSCOPIC UNIFORM CHOLESTEROL UNIVESICULAR SYSTEMS BY DELOS-SUSP PROCEDURE. COMPARISON WITH CONVENTIONAL MIXING METHODOLOGIES.

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Nowadays, uniform univesicular molecular systems attract a great interest as intelligent materials, since they are sensitive to external stimuli like pressure, pH, temperature and concentration changes in the medium. The control of the supramolecular organization of these systems is of profound importance for applications from material science to drug delivery in cells and tissues. Therefore, the development of reproducible, efficient and environmental friendly methodologies for the production of vesicular systems with controlled size and supramolecular organization is of great industrial interest. We have recently developed a novel eco-efficient method called DELOS-SUSP, for the preparation of uniform vesicular systems, based on the precipitation technology DELOS, which uses compressed

CO2 as a co-solvent. The driving force of a DELOS-SUSP process is the fast, large and extremely homogeneous temperature decrease (i.e.; 80 degrees in milliseconds) experienced by a CO2-expanded solution when it is depressurized from a given working pressure to atmospheric pressure. The temperature decrease is extremely homogenous over time and space at all the system, enhancing solution supersaturation evolution without the need of stirring systems, favouring the production of vesicular systems with a mean particle size of 100nm and a very narrow particle size distribution. In this work, using cholesterol as model compound and cetyltrimethylammonium as surfactant, we show the goodness of the DELOS-SUSP process for the production of nanoscopic uniform univesicular systems and for the achievement of supramolecular organizations and particle size distributions non reachable by conventional mixing preparation methodologies.

STRUCTURE, MAGNETIC AND FREQUENCY PROPERTIES IN NANOCRYSTALLINE FE-(NI,CO) ALLOYS

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Fe-Ni and Fe-Co alloys are two kinds of important soft magnetic materials, which have been widely applied in the field of electronic devices and industry. The soft magnetic property of Fe-Ni alloys would change with Ni content: lower coercive field (about 80 at.% Ni), higher saturation magnetic induction (about 50 at.%Ni) and lower permeability but higher electrical resistivity (about 35 at.% Ni). So Fe-Ni alloys were extensively investigated on many aspects, such as martensitic transformation, Invar, spin-disorder resistivity and so on. For its good soft magnetic properties, Fe-Co was also extensively studied on many aspects such as electronic structures, mechanical properties, structural transformations etc. Most of all, Coey pointed out that the spontaneous polarization of bulk Fe65Co35 (Js=2.45 T) is highest in alloys. Mechanical alloying (MA) based on ball milling has been utilized as an alloying method, which imposes a high-energy impact force to secure very granular powders by mechanically alloying several element powders, and has being improved continually. Recently, the structure and properties of alloys prepared by high-energy ball milling were studied widely. On the other hand, with the development of the computer technology, the information technology and the electronic technology, it is necessary to actualize devices higher applied frequency and lower loss. But, losses in the megahertz range are a bottleneck for the development of switched-mode power supplies, and permeability at frequencies in the high megahertz range is becoming an obstacle for the further development of high-density recording. From these points of view, we fabricate Fe-based alloys with Ni- and Co-doping by high-energy milling and present their results on structures and magnetic properties. From the
X-ray diffraction (XRD) results, it has been demonstrated that Fe-Ni and Fe-Co solid solutions, i.e. nanocrystalline Fe-Ni and Fe-Co alloys, respectively, were formed. Coexisting of BCC and FCC structures is observed for some Fe-Ni alloys while all Fe-Co samples exhibit the only BCC phase. The effect of Ni- and Co-doping on the frequency
properties of Fe-based soft magnetic alloy was systematically investigated. The results show that the grain sizes linearly increase with the lattice strains for Fe-Co, while exponential do for Fe-Ni. The nickel doped decreases the cut-off frequency of Fe-Ni alloy but the cobalt doped increases one of Fe-Co. At the meanwhile, the larger the cut-off frequency is, the smaller the initial permeability is. For all samples, the initial permeability varied in a manner being inversely proportional to the coercivity on the whole. At 7.69 at.% doped content, the initial permeability at 10 kHz reaches a maximum while the coercivity does a minimum for both Fe-Ni and Fe-Co. The saturation magnetization increases monotonically with the Ni content for Fe-Ni, whereas it reaches a maximum at 7.69 at.% Co for Fe-Co. The present results on average atomic moments are not consistent with the Slater-Pauling relation as far as magnitude and regularity are concerned.

THERMOPHYSICAL CHARACTERIZATION OF NANOMATERIALS

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The thermal characterization of nanomaterials during synthesis, part preparation and control of final product properties is made with various thermoanalytical techniques. The quantitative determination of the thermophysical properties of carbon nanotube materials, mainly the thermal diffusivity and

conductivity, the thermal expansion and the heat capacity reveals results, which are not in the expected range. Especially the thermal transport properties are measured far below the often predicted high range. Calorimetric methods, like DSC and simultaneous Thermogravimetry and DSC (TG-DSC) are applied to study melting of nanosized metal powders or nanosized clusters in a metallic matrix, the temperature-induced reactions of nanosized materials and their stability ranges. Barium titanate ceramic powders were grinded in the NETZSCH disk agitator ball mill to nanosized powders. Specially prepared sample tablets were measured in the dilatometer up to the end of the sintering process. The tablets pressed from nanosized powders show a much earlier completion of the densification in the sintering step, compared to materials with grain size in the micrometer range. This sintering characteristic could also be demonstrated by thermal diffusivity measurements with the Laser Flash technique on functional oxide ceramics for fuel cells. The measuring techniques for the thermal characterization of nanomaterials will be described and typical results on different types of nanomaterials will be discussed. KEYWORDS CNT, nanopowders, thermal diffusivity, thermal conductivity, thermal stability, sintering

UNDERSTANDING THE INFLUENCE OF SYNTHESIS PARAMETERS ON THE GROWTH OF CARBON NANOTUBES

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The exceptional electronic and mechanical properties of Carbon Nanotubes (CNT) are expected to have a significant impact in future nanoelectronics applications, extending and even replacing materials currently used in microelectronics manufacturing. The fabrication of CNT-based devices, however, is still obstructed by the lack of control over CNT synthesis. So far, CNT cannot be produced with predetermined and reproducible properties, because a complete understanding of the growth mechanism is missing. For that purpose, we are studying Catalyst-mediated Chemical Vapour Deposition (CCVD) for CNT growth on different substrates and using conditions compatible with existing Si-technology. Several parametric studies show that the type of grown carbon nanostructures depends on the growth conditions. Nevertheless, the exact influence of each parameter on the morphology is unclear. In this communication, we report on the influence of various synthesis parameters, including temperature, pressure, and gas flow systematically explored on their ability to catalyze CNT growth on 0.5, 1 and 2 nm Ni and Co films, sputter deposited on Ti/TiN and SiO2 substrates. Using X-ray photoelectron spectroscopy (XPS) and high resolution microscopy analysis, we show that there is an associated set of growth conditions to each nanoparticle size in which it is possible to grow defect-free CNT. Moreover, we reveal why in some cases a grown nanostructure becomes a carbon fibre or why sometimes growth is even stopped. Finally, combining our observations with a thermodynamic analysis we explain how a CNT grows after the nucleation of the initial cap. Further studies following these concepts might provide the key for controlling the chirality and fully integrate CNT into nanoelectronics.

DYNAMICAL NONLINEARITIES OF PIEZOELECTRIC MATERIALS

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Proper understanding of dynamical nonlinearities of piezoelectric materials requires information

about material properties also at crystal level. In this study, these issues are studied by three different methods; measurements of displacement of bulk material, measurements of nanometre scale surface structure of the material by an atomic force microscope (AFM), and numerical modelling. First, we have performed laser interferometer measurements of the deformations of a piezoelectric material, d31 type PZT sheet, under voltage loading with different frequencies. This yields information about the dynamical hysteresis behavior, such as the shape and area of the hysteresis loops as a function of the frequency applied. Relaxation behaviour of the same material has been measured by an AFM. Topography of the piezo sheet was measured before and after applied DC voltage. Local time dependent changes of crystal structure were detected, which allows for a comparison of the two characteristics of the nonlinearities of the material. We have numerically studied using a Ginzburg-Landau-Devonshire (GLD) -type model the frequency dependence of the hysteresis phenomenon, specifically the area of the hysteresis loop of the polarization in the material as a function of the frequency. Also the power spectrum of the polarization behaviour when a sinusoidal loading is applied to the model have been considered. These results from the soft-spin -like GLD model are also being compared to a Potts-type model with similar dipolar interactions.

EFFECT OF TEMPERATURE TO THE SUPERHYDROPHOBIC AND ANTIREFLECTIVE PROPERTIES OF THE BOEHMITE FILMS MADE BY SOL-GEL TECHNIQUE

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Boehmite thin film with 50-100 nm surface roughness has been synthesized on AISI 316 type austenitic stainless steel and on glass by immersing the boehmite gel film into the boiling water. When coated with hydrolyzed (heptadecafluoro-1,1,2,2-tetrahydrodecyl) trimethoxysilane (FAS), the boehmite film becomes superhydrophobic with contact angle for water above 150o. The superhydrophobic property results from both the nanoscale surface roughness and the low surface energy of the FAS top layer. On the other hand, such film also has broadband antireflective property based on the nanoscale porosity and the gradient refractive index which results from the density increase from the surface to the interface with the substrate. In this study, effect of temperature to the superhydrophobic and antireflective properties was studied. When using austenitic stainless steel as substrate, with heat-treatment at 200 oC for 15 min, superhydrophobic film can be already obtained. Such films can be synthesized by the same route until the heat-treatment temperature is 600 oC. Below 200 oC and above 600 oC, such superhydrophobic properties cannot be achieved. When applying glass as substrate, heat treatment at 300 oC for 15 min with film thickness 230 nm gives the best light transmission about 96% for wavelength from 350 nm to 900 nm.

PREPARATION OF MULTI-COMPONENT NANOSIZED POWDERS BY THE THERMAL PLASMA TECHNIQUE

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The further improvement of physical, mechanical and chemical characteristics of materials and development of new materials is tightly bounded with wider application of nanostructured materials based on refractory compounds and their composites. However, the wide-spread application of promising nanostructured materials strongly depends on the development of large-scale, cost efficient and simple processes for preparation of starting nanopowders and their homogeneous particulate composites and fast sintering methods. Currently, nanosized particles can be prepared by several solid state, liquid phase and gas phase methods. Each preparation method has its characteristic advantages and disadvantages with regard to the particle size and component distribution, purity, and production rate and cost. The paper describes the development of the thermal plasma technique for producing multi-component nanosized powders based on nitrides, carbides or oxides, explores characteristics of the produced powders and presents experience of commercial production. The plasma technique is based on the evaporation of coarse-grained commercially available metal, oxide or salt powders in inductively coupled nitrogen, air or oxygen plasma. The evaporation of raw products is controlled by varying particle size, their feed rate and injection velocity. The growth of product particles, their phase and chemical composition are

regulated by introducing cold gas (ammonia,
hydrocarbons, nitrogen, air) into vapours. The nanosized nitride-metal, nitride-nitride, nitride-carbide, nitrideoxide, oxide-oxide powders with the specific surface are in the range of 20-80 m2/g have been prepared with the production rate of 0,3-0,9 kg/h. The specific surface area of the produced powders depends on formation temperature and the ratio of components, the cooling rate of the products and the concentration of particles in the plasma flow. A characteristic feature of the produced multi-component powders is the formation of coated particles because a component formed at a higher temperature acts as the nucleus for condensation of other components. The coated particles increase homogeneity of particulate composite and characteristics of manufactured materials.
The phase composition of the prepared particulate composites depends on the thermodynamic characteristics of components, their ratio, particle size and cooling rate of the products as well as on the temperature of additional calcinations. The commercial production of the developed particulate composites is organized in two spin-off companies. The production experience shows that the close collaboration between produces and end users is necessary for successful processing and application of nanosized powders.

ALD LAYERS FOR PASSIVATION AND FUNCTIONALIZATION OF MICRO- AND NANO PORES AND MEMBRANES

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Atomic layer deposition (ALD) provides excellent uniformity, conformality and thickness control of the layer in the nanometer range. Additional advantage of this technique is a relatively low deposition temperature, what is quite important for polymer substrates and biochemical application. The range of the possible materials is widening.
In this work the results of conformal coating of high aspect ration structures, including porous silicon and porous alumina membranes by ALD technique will be presented. Layers of aluminum oxide, zinc oxide and titanium oxide, several tens to several hundreds of nanometer thick, will be investigated. Optimization of ALD process parameters will be done for different type and size of the pores and channels. Several applications of such a functionalized structures will be shown.

ELASTOMER NANOSTRUCTURED CARBON COMPOSITES FOR MECHANICAL AND CHEMICAL SENSING

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Our recent achievements in design, processing and studies of physical properties of elastomer - nanostructured carbon composites (ENCC) as prospective materials for mechanical strain sensors and chemical sensors are presented. Highly structured carbon black (HSCB) as well as multiwalled carbon nanotubes (MWCNT) were used as filler. Mechanical, electrical and gas sorption properties

as well as structure have been investigated by electrically conductive atomic force microscopy (AFM), positron annihilation life time spectroscopy (PALS), wide frequency (1kHz 2THz) dielectric spectroscopy, and small angle neutron scattering (SANS).

A variation of electrical resistance over several orders of magnitude in ENCC is observed in the vicinity of the percolation threshold of the HSCB. PALS and SANS were used to investigate changes of the microstructure and nanostructure in situ as a function of applied tensile strain and HSCB content in the range of the percolation threshold. The PALS and SANS experiments confirm measurements of the electrical resistance as function of strain. As a result multifunctional polymer-nanostructured carbon composites presenting simultaneous strain sensor and gas sensor properties have been obtained and models of sensing effects improved.

NANOCRYSTALLIZATION BEHAVIOUR OF SOFT MAGNETIC FINEMET-TYPE RIBBONS
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Different kinds of magnetic anisotropies were induced during the nanocrystallization process of amorphous ferromagnetic Finemet-type ribbons (Fe73.5Nb3Si13.5B9Cu) using diverse procedures like the application of a constant stress (500 MPa) or an axial magnetic field (750 A/m) during the annealing process. Two different types of samples have been obtained from a change of the chemical composition by partial substitution of Fe atoms respectively by: a) Co ones ((Co77Si13.5B9.5)90Fe7Nb3) and b) Ni ones (NixFe73.5-x Nb3Si13.5B9Cu) with x = 5, 10, 20. Magnetization measurements of the samples by a fluxmetric method in quasistatic conditions evidence the anisotropy of the treated finemet samples. The main goal of this work has been the structural analysis of the treated ribbons by using X-ray Diffraction (XRD) and Atomic Force Microscopy (AFM), detecting substantial differences in the crystallization state and grain size of the samples depending on the treatment that was carried out. Moreover, AFM measurements revealed in all the treated samples a strong nanocrystallisation of the surface without evidences of amorphous matrix, which contrast with Transmission Electron Microscopy measurements that have shown a high content of amorphous material in the bulk of the ribbons in accordance with XRD results. In order to go deeper in this different behavior in the surface and in the bulk, magneto-optical Kerr effect measurements have been performed with the aim to elucidate the complex magnetic behavior that is expected for the surface of the ribbons, measuring surface hysteresis loops that show much higher coercive field values than in the bulk.

OPTICAL PROPERTIES OF SILICON NANOCLUSTERS
Authors: Aitola, Kerttu

Silicon nanoclusters embedded in insulator materials, i.e. silica, barium fluoride, calcium fluoride, are a promising new material in nanophotonics because of the clusters' unique optical properties. When excited with laser light, Si nanoclusters emit light of distinct wavelength. The reason for emission is still unveiled, but it is thought to originate
either from quantum confinement, defects in the matrix material, Si=O double bonds between cluster surface atoms and host matrix atoms, or possibly from all of these. We have carried out a study of Si nanoclusters implanted in a bulk silica matrix with different implantation energies, doses, and annealing temperatures, and measured the photoluminescence and Raman spectra of the nanoclusters. We have found out that at low implantation doses, the emission seems to be due to implantation defects, and at high implantation doses, high annealing temperatures improve the emission from the nanoclusters.

NANO-PROCESSING OF MERCURY SENSING MOLECULES FOR SELECTIVE ENVIRONMENTAL DETECTION
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Society is asking for solutions to reduce the increasing contamination of the environment. Mercury pollution can occur as a result of a variety of natural and anthropogenic sources. Mercury causes serious environmental and health problems because marine aquatic organisms convert inorganic mercury into methyl mercury. Methyl mercury has a high potential neurotoxin activity, and its implication as a cause of mercury related diseases, has been demonstrated. In order to increase the understanding on the deleterious effects of mercury, efforts have been made in the development of new mercury-sensing devices able to measure even the smallest amounts of it, present in the environment. For the selective recognition of soft heavy metal ions, nitrogen binding sites might be a choice. With this aim, we have design, synthesized and studied a family of molecules with metal ionic sensing capabilities.1 Our target molecules consist of disbustituted diaza butadienes bearing two ferrocene groups (1) and one photoactive pyrene and p-methoxyphenyl group (2). This structural motifs yield combined optical, fluorescent and redox sensor
capabilities in a sensing molecule. With these compounds it has been possible to check for the first time the ability of the azine bridge to complex Hg2+ selectively as well as its high sensitivity and selectivity for Hg2+ in aqueous environment which is very important for environmental issues and higher than previously reported sensors. The sensor capabilities of our target molecules have been checked on solid substrates which are the promising probes for future applications. In the literature, there are not many selective molecular mercury sensors, and the number of these, able to detect mercury supported on a solid substrate is limited. In this presentation we will see how using these probes it is possible to easily perform naked eye detection of ppms of Hg ions and also how using nanoprocessing techniques it is possible to increase the probes sensitivity in order to detect even lower concentrations (ppb) of this highly toxic metal.

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RAMAN SPECTROSCOPY OF ATOMIC-LAYER-DEPOSITED METAL OXIDE THIN FILMS

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Thin nanocrystalline films of refractory and stable metal oxides like TiO2, Cr2O3, ZrO2, HfO2, have attracted great attention in many applications from the use in optical coatings to the components for chemical gas sensors and as high-k materials that could replace SiO2 in electronic industry. Atomic layer deposition occurred to be quite flexible method to prepare these thin metal oxide films with controllable phase composition and thickness by varying growth conditions and post growth treatment. To characterize the material prepared Raman spectroscopy method shows high sensitivity to probe the crystalline phases in thin films with nanometer size particles. The method was used for structural characterization of various metal oxide thin films TiO2, Cr2O3, ZrO2, HfO2, grown on silica, r-cut sapphire, and Si substrates. The Raman spectra were recorded in a backscattering geometry by using a home-made micro-Raman spectrometer. The effect of growth and annealing temperatures on crystallinity and phase composition of films are revealed and discussed. Also attempts to enhance the Raman signal by using of freestanding film and films grown on SERS active substrates were made.

SYNTHESIS OF POLYDIENE NANOPARTICLES AND THEIR STYRENE COPOLYMER NANOPARTICLES VIA MINIEMULSION POLYMERIZATION INFLUENCE OF THE DIENE MONOMER ON CELLULAR UPTAKE

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Polybutadiene, poly(butadiene-co-styrene) (PB and PB-co-PS), polyisoprene and poly(isoprene-co-styrene) (PI and PI-co-PS) nanoparticles have been prepared via radical polymerization in aqueous miniemulsion. The ratio of styrene to diene monomer has been varied from 90:10 to 10:90 copolymer ratios in the case of isoprene, for butadiene the chosen ratios were 25:75, 50:50 and 75:25. Different types of initiators have been used for the preparation of polydiene particles, the water soluble potassium peroxodisulfate and various hydrophobic azo-initiators. Stable dispersions could be obtained for all applied ratios. All experiments show that the particle size can be adjusted by the amount of surfactant in the size range between 80 and 300 nm with a narrow size distribution. For the cellular uptake investigations, the particles were labelled with a fluorescent dye. The cellular uptake of PI and PB nanoparticles as well as the corresponding coplymer nanoparticles was studied using adherent HeLa cells and the suspension cell line Jurkat. Both cell lines showed a high uptake of PI and PB particles. The uptake rates of the copolymer particles were strongly dependent on the composition of the copolymer in respect to the styrene fraction. All particle types showed low cy to toxicity.

VERTICALLY ALIGNED CARBON NANOTUBES BY SIMPLE CATALYTIC CVD METHODS

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In this work, arrays of carbon nanotubes have been grown normal to the surface of electrically conducting supports by the simplified method of catalytic CVD. Catalytic sites were formed due to surface break-up during oxidation of the support in laboratory air. The only conducting support was heated by electric current during the CNT growth process. Ethanol, deposited on the surface, was used as a source of carbon by decomposition at high temperature near the surface of support. The process conditions were an open air laboratory atmosphere and no chamber or inert gas ambient was used. The nichrom wire ((80% Ni, 20% Cr) was used as a catalyst and support. The process temperature was in the range of 1030 - 10700C. Straight CNTs with average diameter of 70 nm and length of 50 µm were obtained during minutes. The diameter and surface density of nanotubes produced is controlled by the method of catalyst preparation and by the process parameters.

PREPARATION OF FIBROUS NANOSTRUCTURES IN ELECTRIC FIELD AND THEIR APPLICATION IN FILTERING

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Electrostatic field, which is arranged between a nozzle and a collector, can be use to form nanostructures from polymer solution. Polymer solution is ejected from the nozzle towards the collector due to electric force. The morphology of nanostructures forming onto collector varies from droplets (electrospray) to fibres (electrospinning) depending on solution and process properties. Diameters of formed droplets or fibres are typically sub-micron range. This kind of structures have applications in many areas, e.g. fibres collected as interconnected nanofiber web onto surface of fibrous substrate can be used in filtration. The nanoscale fibre diameter and high specific area of electrospun materials are favourable for filtering applications because the filtering efficiency increases with the decreasing fibre diameter. In HEPA (High Efficiency Particulate Air) and ULPA (Ultra Low Penetration Air) filtration electrospun fibres can make remarkable difference, since their ability to capture sub-micron particles is better than of larger fibres. Other advantages of electrospun fibres in filter applications are good interconnectivity of pores and the possibility to add functionality into electrospun fibres. The packing density and thickness of an electrospun nanofibre web can be adjusted to optimum level by altering the process parameters and coating time respectively. In this poster electrospinning method is presented as well as SEM pictures of different morphologies formed using this method. Main idea

is still the use of nanofibre layer in filtration, which will be discussed in poster, and results of measurements indicating clear improvement of filtration efficiency of fibrous filter due to nanofibre layer are also presented.

INFLUENCE OF OPERATIONAL PARAMETERS ON CHOLESTEROL VESICULAR SYSTEM PREPARED BY A NEW CO2-BASED METHOD

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Influence of operational parameters on cholesterol vesicular system prepared by a new CO2-based method.

NANOPARTICULATE AND NANOSTRUCTURED CONDUCTING POLYMERS FOR SENSING APPLICATIONS

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Conducting polymer electrode interfaces are an important foundation for electrochemical sensing platforms, allowing mediated electron transfer, enhanced electron transfer efficiency, and selectivity properties. We have created a range of nanomaterials based on polyaniline which include nanoparticles, nanocomposites, nanopores, core-shell and hollow sphere structures. We have characterised these materials using microscopic and electrochemical techniques and we have applied them to a range of sensing applications. We will show that these materials are exhibiting improved behaviour over bulk polymer materials, while also offering many advantages in terms of polymer processing. Such materials have excellent potential in the area of polymer electronics.

REACTIVITY OF DIAMOND-LIKE CARBON COATINGS WITH OIL ADDITIVES AND THEIR EFFECTS UNDER BOUNDARY LUBRICATION AT THE NANOSCALE

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Due to great improvements in the properties of diamond-like carbon (DLC) coatings and their ability to operate under more severe conditions in last decade, it has become obvious that for the appropriate and broad implementation of DLC coatings in various machine components they also need to operate under lubricated conditions, remembering that these conditions are often poor and/or starved, i.e. in the boundary regime. For this reason, an increased number of recent studies have focused on the properties and mechanisms of boundary-lubricated DLC coatings using different lubricants, coatings and experimental conditions. In terms of results that would indicate the possibility to control and modify the friction and wear behaviour, there are two important distinctions between these reports: a) some results indicate that the DLC coatings are inert against the oils and additives, and b) some results show that DLC coatings can interact with the oils and additives. In this work we present the wear and friction behaviour of boundary-lubricated, hydrogenated, amorphous, diamond-like carbon coatings (a-C:H), in self-mated a-C:H/a-C:H contacts, at three different testing temperatures: 20, 80, 150oC. We present results from Auger electron spectroscopy, X-ray photoelectron spectroscopy and Raman analyses relating to the chemical and structural changes in the diamond-like carbon coatings during sliding in the presence of mineral oil, with and without additives. We show, that chemical reactions between the a-C:H coatings and the oil additives take place, which are dependent on the temperature, on the presence of additives and the type of additives used. At high temperatures the extreme pressure additive interacts with the diamond-like carbon surface and forms a tribochemical layer with a four-times lower sulphur/phosphorous ratio than the additive formulation.

In the absence of additives, however, graphitisation of the coating occurs under these conditions, which results in high-wear and low-friction behaviour. Another result from this study is that a-C:H coatings can oxidise during room-temperature experiments, suggesting that some interactions and adsorptions are also possible at lower temperatures. These phenomena significantly affect the wear mechanisms, as well as friction behaviour.

ORGANIC NANOCOMPOSITE SHOWING ELECTRICAL IMPEDANCE SWITCHING AND NEGATIVE DIFFERENTIAL RESISTANCE

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Future organic electronics and nanoelectronics will need organic memories which, however, until quite recently have not been much studied. Recent discoveries allow organic bistable devices that may be used for nonvolatile memory applications. A simple device structure allows for low-cost production at a large scale. Proposed device structure involves only one active organic layer of conducting/semiconducting nanoparticles dispersed in an insulating matrix. In order to optimize the device, basic research is needed to understand the functionality of the nanoparticle dispersions, and to understand the chemical processes required for the optimal nanostructured film. In this research a novel concept is developed using the Buckminster-fullerene (C60) that may be suitably functionalized in order to form the desired nanostructure controllably dispersed in e.g. polystyrene or a self-assembled block copolymeric matrix. Also metallic nanoparticles have been applied as charge acceptors. These devices are strongly non-linear; a requirement for large matrix addressing, which correlates with the nanoscale character of the active media. The main objective of this work is to develop working organic memory units that may be manufactured using a rapid and economical fashion and to establish a device operation mechanism that scientifically explains its operation and the relation between morphology and performance of the nanostructured material.

CONDUCTING POLYMER BASED NANOCOMPOSITES: CHARACTERIZATION AND POSSIBLE APPLICATIONS

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Due to the perspectives of combining together the different properties of the individual components, conducting polymer/inorganic compound composites are in the focus of researches, as they open opportunity for the combination of electrical and optical, magnetic or photocatalytic properties, leading to electrodes of special capabilities. We intend to report on different nanocomposites: 1. Poly (3-octylthiophene)/γ-Fe2O3 (POT/ Fe2O3) 2. Polypyrrole/ iron oxalate (PPy/ Fe-ox) 3. Poly(3-octylthiophene)/iron oxalate (POT/Fe-ox) The nanocomposites are characterized on the basis of results obtained by ICP-AAS, UV-Vis, FT-IR spectroscopy, MALDI-TOF MS, XRD, XPS, TEM, SEM, impedance and electrochemical measurements. Fe2O3 and Fe-ox containing polymer composites

are promising as new electrodes possessing magnetic and photocatalytic behaviour.

IMPURITIES IN ATOMICALLY-THIN METALLIC NANOWIRES

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Metalic nanowires have attracted a great deal of attention lately, since they show very interesting properties from a basic science viewpoint, as well as great potential in applied fields such as nanoelectronics [1]. In this work we have investigated, trough ab initio calculations [2], the effects of the presence of Oxygen and Carbon atoms in atomically thin gold and silver nanowires [3,4]. We have considered several structural configurations, and have also obtained transport properties, based on the coupling of Non-Equilibrium Green's Functions and Density Functional Theory formalisms. The aim of the simulations is to compare these theoretical predictions to recently published experimental results [5].

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NEW NANO SCALE DOMAIN CONTROLLED ACRYLIC THERMOPLASTIC ELASTOMER - LA POLYMER AND ITS APPLICATION STUDY FOR MOBILE PHONE

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Elastomers are important materials for many consumer products, also mobile devices, as they provide feeling of soft touch and good grip for handling the device. Therefore, traditional thermoplastic elastomers such as styrene copolymers and polyurethanes have been used in many applications. On the other hand, transparent materials are attractive to improve product outlook. Methacrylic resin (PMMA) and polycarbonate resin(PC) are the typical transparent polymers for this purpose. It has been a big challenge to develop materials having both characteristics together, i.e. elasticity and transparency, because these characters are often in trade-off relations. For example, adding rubber fragment inside transparent polymer makes the material semitransparent. On the other

hand some of the existing transparent elastomers lack mechanical and thermal properties required. Kuraray has developed new acrylic thermoplastic elastomer gLA-polymerh which is MMA-nBA-MMA block copolymer with nano phase separation. LA polymer has very high transparency comparable with acrylic glass (PMMA) and having excellent elastic property even under low temperature. Kuraray and Nokia Research Center have examined new design solutions for mobile or wearable devices using LA polymer integrated with other materials. The high transparency, good flowability and adhesion capabilities of the LA polymer have enabled unique hybrid structures e.g. thin paper, metal foil and delicate fabrics such as lace embedded inside the transparent elastomer.

THE EFFECT OF SOL-GEL NANO-COATINGS ON THE MOISTURE BEHAVIOUR OF WOOD

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Wood and wood-based composites are favourable construction, furnishing and decorating materials for their ecological aspects and due to the appealing appearance of wooden surfaces. However, due to its chemical and structural composition wood easily absorbs water and water vapour, which causes dimensional changes in wooden products and even biological problems if the moisture loads are severe and prolonged. Traditionally, paints and lacquers are used to protect wood against direct contact with water. In this study, sol-gel hybrid coatings have been developed to improve the moisture behaviour of coniferious wood (Pinus sylvestris, thermally treated Picea abies). The performance of the hybrid coatings on wood substrates was evaluated by means of contact angle measurements, water vapour permeability measurements and water floating tests. In addition, the performance of the coatings after a short term natural weathering was respectively evaluated. The study included two sol-gel coatings based on multifunctional alkoxysilanes. The coatings differed from each other in terms of the length of the attached organic aliphatic chain. The analysis (SEM-EDS, FTIR-PAS) results showed that both sol-gel nano-coatings were able to penetrate into the wood surface. In addition, the length of the organic aliphatic chain determined the penetration ability of the coating. The results obtained from the contact angle measurements and water floating tests showed that both nano-coatings improved the water repellence properties of pine sapwood and thermally treated spruce forming quite hydrophobic surface properties and they decreased the water uptake of the lateral surfaces of the wood samples. The water uptake properties of the sol-gel coated wood specimens remained unchanged after three months' outdoor weathering. The nano-treatments had no effect on the water vapour permeability of the samples.
This leads to the suggestions that sol-gel hybrid nano-coatings designed for wood material have selective barrier properties with the prevention of penetration of water and permitting the movements of the water vapour.

RF THERMAL PLASMA SYNTHESIS OF MICRO- AND NANOSIZED SILICA POWDERS FOR PROLONGED DRUG RELEASE

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Micro- and nanosized silica powders were synthesized in a radiofrequency (RF) thermal plasma system from different precursors, such as commercial silica powders, colloid silica sol and ethyl-silicate solution. Effects of synthesis conditions on the properties of products were studied in details. Synthesis conditions included plate power of RF generator, composition and flow rate of central and sheath gases, composition, feed rate and the way of injection of precursors. The products were characterized in terms of morphology (SEM, TEM), particle size distribution (LD-PSA) and specific surface area (BET). Special emphasis was placed on the protein adsorption capacity of the as-synthesized silica powders. Adsorption of bovine serum albumine (BSA) and human serum albumine (HSA) was studied at different pH and concentrations. It was found that from the solid precursors and from the colloid sol dense or hollow silica particles were formed in the 1-100 □m range. Use of ethyl-

silicate solution as precursor, however resulted in nanopowders with BET specific surface area of 130-140 m2•g. No direct relation was detected between the specific surface areas of silica powders and their adsorption capacities. During RF thermal plasma synthesis powders of highly active surfaces are forming which have rather high adsorption capacities even at rather low specific surface area (30-40 m2•g). Release of adsorbed proteins was studied and evaluated against time in different conditions. Particular drug carriers seem to the prolong release of proteins in a remarkable extent.

ELECTROCHEMCIAL FUNCTIONALIZATION OF SINGLE WALLED CARBON NANOTUBES WITH CONJUGATED POLYMERS IN ROOM TEMPERATURE IONIC LIQUIDS

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Carbon nanotubes have attracted intensive attention for their extraordinary mechanical and electronic properties. Reliable methods to functionalize the carbon nanotubes will extend their application and may implant new functions that can not otherwise be acquired by pristine ones. Electrochemical functionalization will provide an efficient, clean, and more versatile alternative to the common chemical modifiations. SWNTs/conjugated polymer devices have been demonstrated to have good photovoltaic properties 1-3 Single walled carbon nanotubes (SWNTs) are covalently functionalized during the electropolymerization of aniline in ionic liquids. In our experiment, 1-butyl-3-methyl-imidazolium hexafluorophosphate ([BMIM][PF6]) containing 1 M trifluoroacetic acid (CF3COOH) was selected as the ionic liquid media to individualize SWNTs and to perform the electropolymerization of aniline within. The morphology of the resulting composite material of SWNT and polyaniline (PANI) was studied by scanning electron microscopy (SEM). Covalent bonding was evidenced by the increase of intensity ratio of the D band vs. G band in the Raman spectrum, whilst SWNTs may also be incorporated as big dopant anions to the PANI backbone. We developed a novel method by which large amount of SWNTs (15 mg/ml) can be modified by aniline electrochemically. Conjugated polymers and SWNTs can thus be copolymerized and applied to organic optoelectronics.

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UV/OZONE TREATMENT IN THE SYNTHESIS OF TEMPLATE-FREE ZEOLITE MFI THIN FILMS

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A method of non-thermal, photochemical calcinations is described for an efficient and spatially controlled removal of the organic structure-directing agent in the preparation of thin zeolite MFI films. High silica MFI films followed a previously published procedure were illuminated using an ozone generating short-wavelength ultraviolet light in ambient environments and characterized using Fourier-transform infrared spectroscopy, X-ray diffraction, and scanning electron microscopy measurements. Results indicate that the UV/ozone treatment under nominally room temperature conditions leads to complete removal of template from as-synthesized films comparable to thermal calcination. Furthermore, spatially addressing the UV/ozone illumination pattern using a physical mask results in the lateral confinement of the template removal from the film leaving behind a composite film composed of templated and template free regions of the MFI film. Subsequent chemical treatment of the patterned film selectively removed the as-synthesized, unexposed regions of the film thereby providing a means for the creation of isolated zeolite film islands at predetermined locations on the substrate surface.

AQUEOUS DISPERSION, SURFACE THIOLATION AND DIRECT SELF-ASSEMBLY OF PRISTINE CARBON NANOTUBES ON GOLD

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Possible applications in materials science and nanotechnology set strict criteria to the carbon nanotube materials. The central challenges for the science and technology of single-wall carbon nanotubes (SWNT) are their solubilization,1 and ionic modification for controlled self-assembly. The use of nanotubes for biomedical and biological applications requires their positive charging and processing in aqueous media. In addition, for direct self-assembly of SWNTs on gold surface, they must be thiolated. The presented work2 is an attempt to find a general solution to all abovementioned problems at once, and, what is important, without preliminary purification or pretreatment of the as-produced nanotube material. For this purpose we used newly synthesized ionic liquids (IL), which are cationic imidazolium-based surfactants1-dodecyl-3-methylimidazolium bromide (1), and 1-(12-mercaptododecyl)-3-methylimidazolium bromide (2). Optical absorption spectra as well as resonance Raman (RR) data of obtained aqueous SWNT-1,2 dispersions are consistent with debundled and noncovalently functionalized nanotubes whose electronic properties have not been disturbed. Additionally, the dispersion of pristine nanotube material with surfactants 1 and 2 leads to high-degree purification from carbonaceous particles. The chiralities of 14 smallest semiconducting HiPco SWNTs in resonance with Raman excitation at 1064 nm (1.165 eV) were determined in SWNT-2 aqueous dispersions using UV-Vis-NIR and RR spectra. SWNT-1 and SWNT-2 nanocomposites have been adsorbed from aqueous solutions onto gold substrates, in latter case directly on bare gold. The X-ray photoelectron spectroscopy (XPS) and surface enhanced resonance Raman scattering (SERRS) spectroscopy of SWNT-2 sub-monolayers on gold verified encapsulation of individualized SWNTs with IL surfactants, the cleavage of S-S disulfide bonds formed in aqueous SWNT-2 suspension and direct chemisorption of SWNT-2 composite on bare gold via Au-S bond. Our approach for purifying pristine nanotube material and producing water-soluble, positively charged nanotubes with pendant surface-active thiol groups may be also translated to other carbon nanotubes and carbon nanostructures. Self-assembled and positively charged sub-monolayers of SWNTs can be further used for applications in cell biology and sensor technology.

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SELF-ASSEMBLED MULTILAYERS PREPARED FROM WATER-SOLUBLE POLYTHIOPHENES: STRUCTURE AND MORPHOLOGY

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Water solubility of semiconducting polymers, polythiophenes (PTs), is important for biocompatibility

and for the detection of biological compounds in aqueous media. Processability and solubility of polythiophenes (PTs) can be modified by the side chain substitution with cationic, anionic or zwitterionic groups. The application of these materials for sensing purposes takes advantage of the co-operative tendency of individual water-soluble conjugated polymer chains to self-assemble into supramolecular structures, which manifests itself as a change in the optical properties. The use of pendant ionic groups in the PT backbone opens a way for the film preparation by the electrostatic layer-by-layer self-assembly. 1 In presented work we studied the structure and morphology of self-assembled polyelectrolyte multilayers prepared using poly(styrene sulfonate) (PSS) and four different cationic poly(alkoxythiophene) derivatives bearing methylimidazolium-terminated ionic side chain at the 3-position of the thiophene ring: poly(1-methyl-3-[3-[3-thienyloxy]-propyl]-1H-imidazolium) (P3TOPIM), poly(1-methyl-3-[6-[3-thienyloxy]-hexyl]-1H-imidazolium) (P3TOHIM), poly(1-methyl-3-[2-[(4-methyl-3-thienyl)oxy]-ethyl]-1H-imidazolium) (P4Me-3TOEIM), and poly(1-methyl-3-[6-[(4-methyl-3-thienyl)oxy]-hexyl]-1H-imidazolium) (P4Me-3TOHIM).2 All the multilayers exhibited regular growth. Their layer-by-layer growth was followed by polarization modulation infrared reflection-absorption spectroscopy (PM-IRRAS) and ellipsometry, and the morphology of the films was studied by atomic force microscopy (AFM). The surface density of created organic semiconducting nanoparticles greatly depended on the structure of polythiophene, being favored by polymer regioregularity and the length of the side chain. The side chains remained disordered in all the multilayers but with PTs having hexyl chains both the imidazolium and thiophene rings tended to orient themselves more perpendicular to the surface than in films containing shorter chains (C2 or C3). The relative water content of the multilayers (at 7.1 % relative humidity) did not depend on the film thickness, and was the lowest for P4Me-3TOHIM.

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Ink Jet Printing of Nanoinks

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In contrast to thermal ink jetting that uses heat to generate fluid drop ejection, MEMS-constructed piezoelectric ink jet printheads use a thin PZT slab bonded to a silicon diaphragm to generate acoustic energy that drives drop formation without heat. This novel, non-contact, and nondestructive printing process immobilizes a variety of functional materials while retaining activity. By formulating an ink and determining jetting parameters, drop on demand immobilization of a variety of functional materials can be established for one-sided deposition. We have formulated a variety of inks for the printing of nanomaterials including silver, DNA, peptides, proteins, dendrimers and carbon nanotubes using both direct inking and scaffold carriers for their immobilization. After dendrimeric printing, patterned silicon dioxide thin films are grown on the material measuring less than 170 nm. We have demonstrated the strength and utility of this technique to print electronic components, and further directions will be to integrate these additive processes and couple them to device manufacturing.

NANOTECHNOLOGY AND PERSPECTIVE NANOMATERIALS FOR LITHIUM-IONIC ACCUMULATORS WITH HIGH ELECTRIC PARAMETERS

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It corresponds to theoretical specific capacity of graphite 372 mAh/g. Theoretical specific capacity of metal lithium (3840 mAh/g). By us it is established, that electrodes show specific capacity up to 1500 mAh/g - 2300 mAh/g (it is no limited!) on the basis of carbon nanomaterial, received with use plasmas nanotechnology. Application such nanomaterials will allow to increase power characteristics lithium - ionic accumulators on 30 % - 50 % and more.

TRANSFER CHARACTERISTICS OF MULTIWALLED CARBON NANOTUBE FIELD EFFECT

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Multiwalled carbon nanotube field effect transistors (MWCNT-FETs) are often built on Si wafers covered with a dielectric layer of SiO_2. The Si wafer acts as a back-gate with which the conductance of a semiconducting nanotube can be controlled. We have studied the performance of MWCNT-FETs both at room temperature as well as at cryogenic temperatures. It is shown here that the transistors may exhibit hysteresis in their transfer characteristics at room temperature which may be due to mobile charge carriers in the dielectric. Lowering the temperature reduces significantly the hysteresis in the MWCNT-FETs. While hysteresis is unwanted for a FET, it may be useful for memory applications.

EVAPORATION IN ALUMINUM OXIDE NANO-FLUID

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Nano-fluids are playing an important role in the development of nano-technology based devices. The possibility of enhancing the thermo-physical properties of the vector fluid – usually water or alcohols – by adding a peculiar dispersion of particles of nano-metric size has created a great interest both scientific and industrial. An interesting aspect that up to now has not received a detailed explanation concerns the mechanisms and the phenomenology correlated to the evaporation of nano-fluids. It is not yet completely clarified the behavior of the dispersed particles during evaporation and boiling especially for what concerns the possibility for the particle to be evaporated with the vector fluid. Moreover, it is of great interest for applications in the cooling system devices for electronics to determine the variations of the evaporation rates due to the presence of a dispersed phase of nano metric size in the liquid phase. In this work, an experimental apparatus has been assembled to try to answer to the two above-mentioned question. The nano-fluid used consists in a dispersion of Al2O3 in water 2.5% in volume. The size of the particle is centered around 30nm. The typical test has been performed as follows: the test cell filled with a known volume of nano fluid has been heated thanks to a magneto-electro heater that allowed also for continuous mixing of the fluid. The temperature was raised of about 0.4° C per minute. The vapor was re-condensed and separated in a water-cooled condenser whose temperature was of about 20°C. The main results coming from the preliminary tests were that the re-condensed vapor contains Al2O3 particles, even if the concentration was sensibly inferior than that in the liquid. More tests are foreseen to quantitatively evaluate the particles evaporated and the change in evaporation rate occurring respect to the condition of pure water.

CHARACTERISATION OF THERMAL AND TRANSPORT PROPERTIES OF NANO-FLUIDS

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Literature provides transport properties of nano-fluids that are of relevance for instance in heat transfer enhancement. This property is particularly promising when boiling or wet spots must be

avoided, as in biological material thermal manipulation and cooling of temperature sensitive materials (including electronics). The measured thermal conductivity of nano-fluids published in literature is systematically higher than predicted, but the dispersion in measurements published in literature is very important. We have started for this reason a campaign of measurements of such quantities with suitable techniques. They require large experimental efforts, but have in their principle a signature identifying the heat transport mechanism: they allow for instance discriminating between heat conduction, and convective heat transport. Nano fluids are produced in well controlled and identified conditions. Nano particles produced by CRIF are dispersed in liquid by CoRI. Transport properties are measured by ULB and UR1. The measurements show unexpected behaviour. It is though that the results could be understood with measurements in microgravity. The discrimination between conductive and convective heat transport seems to be the only way to optimize the nano-fluid thermal and transport characteristics. The starting work is hard, but the expected results are a real improvement of the understanding of transport properties of nano-fluids, and therefore a real predictive of their required characteristics.

BIO-INSPIRED HYDROGEL-CALCIUM CARBONATE CORE-SHELL PARTICLES

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Formation of hollow particles and core-shell particles (microencapsulation) has earned significant attention for many applications. In this poster, we present a bio-inspired encapsulation process to create nanocluster-assembled core-shell particles under aqueous, room temperature and non-toxic conditions. The approach to synthesize calcium carbonate hollow particles (~ 500 nm) is accomplished by employing a Polymer-Induced Liquid-Precursor (PILP) process. We demonstrate the templating calcium carbonate as a uniform coating around a core of hydrogel nanoparticles, and subsequently its solidification and crystallization. We investigate that the hydrogel nanoparticle can be used as a template for the deposition of the mineral nanoclusters. The organic hydrogel appears to influence the transformation of mineral phases, stabilizing the amorphous phase of calcium carbonate, presumably by hindering the rearrangement of ions to the ordered crystal structures and retarding the dehydration process.

RECOGNITION OF THE TYPE OF A QUANTUM DOT BY AN OPTICAL-ONLY MEASUREMENT

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We consider an optical-only method for distinguishing between the types of semiconductor nanostructures. We point out and summarize significant differences between the photoluminescence of type-I and type-II quantum dots, as well as that of ionized traps in quantum wells. These three situations can be distinguished by comparing qualitative photoluminescence features, what finds experimental confirmation for known structures.

CHEMICAL MODIFICATION OF CARBON NANOTUBES

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Carbon nanotubes are an interesting new form of carbon, which have a high mechanical strength electrical conductivity and heat conductivity. Mechanical properties of carbon nanotubes can be used to reinforce polymeric materials. Their electrical properties are useful for the preparation of conductive materials from non-conductive polymeric materials. Mixing of carbon nanotubes into a polymeric matrix contains some difficulties. A suitable chemical modification of the surface of carbon nanotubes can improve their interaction with a polymeric matrix. Carbon nanotubes have been commonly modified by acid treatment leading to the opening of the tips and oxidation at the ends. The acidic groups can be further modified by using their characteristic reactions. Besides strong oxidants cause defects on the surface of carbon nanotubes. We have studied the lithiation of carbon

nanotubes in liquid ammonia and their subsequent substitution. This methodology simplifies entangled bundles typical to carbon nanotubes, and hence exposes more surface of nanotubes for the functionalization and improves their further manipulation.

COMPUTATIONAL STUDIES OF LIGHT EMITTING SILICON NANOCLUSTERS

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Freestanding silicon nanoclusters have been found to be light emitters with strong luminescence in the energy range from red to blue depending on their size. The luminescence mechanism and molecular structure of the functional unit responsible for the luminescence are still not unraveled. Computational studies of the optical properties of silicon nanoclusters are feasible by employing density functional theory (DFT) and time-dependent DFT (TDDFT) approaches. Here, we present TDDFT calculations of electronic absorption spectra of hydrogen terminated silicon nanoclusters. Luminescence spectra were obtained analogously using the optimized cluster structure for the excited state [1]. The largest cluster studied is Si329H196. The calculations show that the band strengths of hydrogencapped silicon nanoclusters are several orders of magnitude smaller than obtained experimentally [2-4]. Thus, the silicon nanoclusters responsible for the observed light emission must have some kind of functional units emitting the light. Various oxidized silicon clusters with siloxane groups and capped with hydroxides were studied but none of them was found to be strongly luminescent. TDDFT calculations on silane capped silicon nanoclusters and silane bridged silicon nanocluster dimers yielded on the other hand strong low-lying transitions; the energies and oscillator strengths were in accordance with experiments. The excitation threshold is practically independent of the length of the silane chain terminating the cluster, whereas the band strength is linearly dependent on the length of the silane chain [5].

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MECHANOCHEMICAL ROUTES FOR SYNTHESIS OF NANOSTRUCTURED MATERIALS

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Nanosized and nanostructured materials find large application in different branches of contemporary industry, instrument-making, medicine. The methods of mechanochemistry are widely used for synthesis of nanostructured materials due to their obvious advantages comparing to the others synthesis methods. In the present paper methods of mechanically assisted synthesis and direct mechanochemical synthesis of nanostructured TiNi shape memory alloys are studied. The method of mechanically assisted self-propagating high-temperature synthesis is also demonstrated by synthesis of nanosized MgB2 – a high temperature superconductor surprised scientists during the last years wit its properties. For that purpose stoichiometric amounts of Ti-Ni and Mg-B powders were subjected to intense mechanical treatment followed by thermal alloying or self-propagating high-temperature synthesis (SHS). The methods of SEM/TEM and XRD are used to study morphological changes of reagents during their mechanical treatment and peculiarities of product particles and their phase composition. It is shown that after 30 hours of mechanical treatment in a planetary type mill the synthesis of TiNi shape memory alloy proceeds at 550oC and the product consists of particles with mean size of 20-30 nm. This temperature is at least with 400oC lower than the temperature used for the traditional thermal alloying process. It was also shown that prolonging milling time up to 40 hours leads to direct mechanochemical synthesis. The product contains mainly TiNi and Ti2Ni phases with crystallite sizes of 34 and 38 nm respectively. It is shown that a single-phase MgB2 can be obtained after 2 hours of mechanical activation of Mg-2B mixture and current pulse density of 30A.cm-2. The average size of MgB2 particles synthesized in this way is 70-80 nm. The process of SHS proceeds in a protective Ar atmosphere. The properties of TiNi and MgB2 synthesized by the methods of mechanochemistry are compared to these of the same products obtained from the same reagents without mechanical treatment using the classic method of thermal

alloying and the advantages of mechanochemical synthesis methods are shown.

MANUFACTURING OF POLYMER AND CERAMIC FUNCTIONAL NANOSTRUCTURES

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Nanostructures such as nanofibers and nanotubes based on polymers (synthetic and natural) and ceramics can be processed by electrospinning. Electrospun nanostructures are an exciting class of novel materials due to several unique characteristics, including their nanometer diameter, the extremely high surface area per unit mass, the very small pore size, and their tunable surface properties. To this may be added their cost effectiveness. Significant progress has been made in this field in the past few years, and the resultant nanostructures may serve as a highly versatile platform for a broad range of applications in areas such as medicine, pharmacy, sensors, catalysis, filter, composites, ceramics, electronics, and photonics. Some latest developments in the processing of nano-structured polymers by electrospinning will be presented.

THE DEPENDENCE OF TENSILE YIELD STRENGTH ON GRAIN SIZE IN NI3AL - BASED MICRO AND NANOCRYSTALLINE INTERMETALLIC ALLOY

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Efforts, made to develop high strength Ni3Al-based intermetallic foil useful for future structural applications (e.g. in the form of honeycomb structures) have been described in the paper. It has been shown that fully dense Ni3Al (doped by zirconium and boron) intermetallic foil can be successfully fabricated by heavy rolling and subsequent annealing. Changing the temperature of rolling – from room temperature to liquid nitrogen temperature, and the temperature of subsequent annealing a wide range (from micro- to nano) grain sizes of homogeneous gamma prim single-phase alloy or nearly single-phase gamma prim/gamma intermetallic alloy was obtained. The rolled foils with crack-free, smooth and shiny metallic luster surfaces were large enough to prepare flat tensile sample with traversing length equal 20mm, for tensile tests which were conducted at room temperature in air. Special attention was paid to control of processing flaws absence – detrimental to the properties of the tensile samples, especially with nanocrystalline structure. On the basis of tensile testing results for micro-range grain sizes alloy very good agreement with conventional Hall-Petch relation (power expression with exponent close to (-1/2)) was obtained while inverse Hall-Petch effect was proved for nano-range grain sizes. The inverse trend of yield strength dependence on grain sizes in nanocrystalline Ni3Al-based intermetallic foil was found much weaker than conventional Hall-Petch trend for microcrystalline alloy. Thus the nanocrystalline Ni3Al-based intermetallic has shown softening effect along with grain refinement. Extending strain-line approximation of classic and inverse trend for both micro- and nano-crystalline regions permit us to estimate the maximum value of Ni3Al-based intermetallic tensile yield strength reaching level over 3 GPa at critical grain size about 160 nm. The possible effect of plateau in intermediate grain size regime has also been discussed for investigated alloy. Additionally, it was confirmed that the nanocrystalline Ni3Al-based intermetallic alloy has enough margin of plasticity to undertake further plastic working.

HYDROGEN STORAGE IN ACTIVATED CARBON AND CARBON NANOTUBE

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Hydrogen is a cleaner energy, but some technical problem should be resolved for its application, especial in hydrogen storage. Activated carbon (Norit) and carbon nanotube were selected for hydrogen storage in this study. Carbon nanotube was made by the chemical vapor deposition (CVD) method. The Ni and Pd nitrate sol gels were prepared and coated on the Al2O3 film substrate-plate

with a spin coater. Each catalyst-coated substrate-plate was calcined at 400 oC to remove impurities. Each calcined-plate was then reduced under a hydrogen atmosphere at 300 oC in a CVD furnace. Acetylene was selected as the carbon source and decomposed on the Pd and Ni catalysts. Carbon nanotubes were formed at 500 oC with a C2H2/N2 mixture. Hydrogen storage was run by a high-pressure thermal gravimetric analyzer (TGA, thermal Cahn). Results indicated the hydrogen adsorption was 1.5 wt% on activated carbon and up to 5.8 wt% on carbon nanotube at 75 bar.

NANOCATALYSIS

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Totally over 90% of all chemicals in industry are produced over heterogeneous catalysts. Production of better than existing pharmaceuticals, healthy food ingredients, perfumes, other fine chemicals, which are of immense importance for improving quality of life, is often limited by low selectivity in their synthesis over heterogeneous catalysts. In general research in nanotechnology and nanoscience is expected to have a great impact on the development of new catalysts, the reason being, that detailed understanding of chemistry of catalytic materials on the nano-scale and the ability to control their preparation will lead to rational and cost-efficient catalyst design. Examples addressing different issues, related to nanocatalysis, will be discussed the lecture. In particular metal nanoparticles formed in various media and stabilized by different mechanism are the objects of intense studies not only due to their unique properties, which are significantly influenced by a nanoparticle size, organization of the nanoparticle crystal lattice and nanoparticle surface, but also due to the chemical nature of the microenvironment surrounding the nanoparticle. Selectivity of these catalysts, bearing metals of nanoparticle size, could be enhanced by carefully adjusting the size and environment of metal nanoparticles.

STRUCTURE AND PROPERTIES OF COMPOSITE CERAMICS PREPARED FROM HYDROXYAPATITE NANOPOWDERS AND SOL-GEL DERIVED COMPOSITIONS

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Pavlovska, Ilona
Lazdina, Daina
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The preparation of nanosized hydroxyapatite (HAp) particles, the influence of thermal treatment procedure on the structure of composite hydroxyapatite ceramics prepared by the use of partially hydrolyzed alkoxides and Hap particles and the resulting structure of ceramics have been investigated. The surface morphology of the ceramics has been evaluated by the methods of optical, atomic force and scanning electron microscopy. Material structure has been clarified using the methods of X-Ray diffraction and infrared absorption spectroscopy. In order to characterize the mechanical properties of the obtained materials such characteristics as the compression strength, the modulus of elasticity, the density and the apparent porosity have been determined. The chemical durability has been studied by the behaviour of the ceramics in the solutions of various pH. It has been established that the circumstances of HAp nanoparticle preparation, drying and sintering procedures of composite ceramics considerably influences the structure and properties of obtained materials.

STRUCTURAL STUDY OF PTX-PD1-X NANOPARTICLES SUPPORTED ON SILICA BY HIGH RESOLUTION ELECTRON MICROSCOPY.

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UNAM, Mexico
Ramiro Perez
Instituto de Ciencias Fisicas, Mexico

Bimetallic nanoparticles structures and properties are distinct from those of pure elemental clusters. Particularly nanoalloy clusters finely dispersed onto high surface area supports, play an important role in heterogeneous catalysis because the performance of a supported metal catalyst can be related to design, which is crucial for the development of novel catalytic processes[1-3]. Ptx-Pd(1-x) nanoparticles supported on amorphous silica (SiO2) were prepared by wetness impregnation techniques with choroplatinic acid (H2PtCl6) and palladium chloride (PdCl4) with different

concentrations of Pt and Pd at about 1% in overall metallic weight. The structural and physic characterization of these samples were carried out by BET Surface Area, X-Rays Diffraction (XRD), Transmission Electron Microscopy (TEM), attach with X-Ray and Energy Dispersive Spectroscopy (XEDS). Our interest in Pt-Pd system has been initiated by both practical and theoretical reasons. Both metals, in supported or unsupported forms, are active in skeletal isomerization, C5-cyclization, aromatization, and, to a lesser extent, hydrogenolysis. Of the two metal blacks, Pd was more selective toward C6 product formation from various hexane isomers than Pt. Compared to the catalysts containing only Pt, Pt alloys are more stable, more selective, and showed higher activity in the conversion of hydrocarbons. By XRD technique we observe that nanoparticles have a single phase alloy, with face centered structure. In this work, we observed the distribution of Pt and Pd in nanoparticle alloy by HREM . Ptx-Pd(1-x) Nanoalloy are made of a single solid solution of Pt and Pd atoms, and the particles diameter of about 4 nm was estimated by HREM and Bright field image, the Pt-Pd nanoparticles were found mainly to have cuboctahedral structures with fcc packing,. by using energy dispersive X-ray spectrometry (XEDS) and their values were found to be close to the stochiometric relative concentrations in weight of the metals in the precursor aqueous solution.

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SELF- ASSEMBLY AND PROPERTIES OF LOW DIMENSIONAL ORGANIC NANOSTRUCTURES

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One-dimensional nanostructures, such as nanowires and nanotubes, represent the smallest dimension for efficient transport of electrons and excitons and thus are ideal building blocks for hierarchical assembly of functional nanoscale electronic and photonic structures. We have developed some technique to fabricate large oriented arrays of organic conductor nanowires and organic snall molecular nanostructures based self-assembly and organic vapour solid phase reaction and have demonstrated for the ability to control the size of nanorods and nanowires of organic complexes. The size effects on physical properties of these nanomaterials are observed.

POLYMER NANOCOMPOSITE COATINGS WITH EMBEDDED METAL NANOPARTICLES FOR FUNCTIONAL APPLICATIONS

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Schürmann, U
Greve, H
Pochstein, C
Chakravadhanula, V.S.K
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Recently, there is much interest in hybrid materials consisting of metal nanoparticles dispersed in a dielectric matrix due to their novel functional properties offering hosts of new applications. Polymers are particularly attractive as matrix. The present talk is concerned with the preparation of polymer-based nanocomposites by vapor phase coand tandem-deposition and the resulting functional properties. Properties that are not observed for macroscopic feature sizes include electronic conductivity ranging from single-electron hopping and tunneling to percolation, particle plasmons giving rise to characteristic optical absorption, and strong enhancement of catalytic activity. The techniques involve evaporation [1,2] and sputtering [3], respectively, of metallic and organic components and allow to obtain composite films with well-defined and reproducible properties. These were done by a suitable control over nanoparticles growth, size distributions and particle matrix interaction. Emphasis will be placed on electrical and optical properties near percolation threshold. Also nanocomposite sensors and antibacterial coatings will be addressed. In our co-deposition processes polymer films are produced either by evaporation of the monomers and polycondensation on the substrate or by thermal cracking of suitable polymers like Teflon AF and repolymerisation of the fragments on the substrate. The metals or alloys are co- or tandemly evaporated and cluster

during deposition or subsequent annealing. Vapor phase codeposition of noble metals and various polymers (Nylon 6, TAF, and PMMA) was successfully used to produce polymer/metal nanocomposite with a wide range of the metal volume filling factor. The relationship between nanostructure and physical properties of nanocomposite films is the key to understand how these properties can be controlled by the ratio of metal/polymer rate of deposition. For nanoparticle alloys, extremely thin rods with a very large aspect ration were obtained above a critical ratio of the metal/ organic deposition rates and not too low temperatures [4]. This route to nanorods may have applications in high density date storage and other fields. If the nanoparticles are small compared to the optical wavelength, light scattering is avoided, and the composites are transparent even at high metal filling factors. Thus the index of refraction can be tuned over a wide range, and surface plasmons, occurring for noble metals in the visible range. Different applications of nanocomposites prepared by our present techniques are described in [2,3]. Our approach is also very attractive for the development of high-frequency (> 1 GHz) softmagnetic materials. Currently [5], we are exploring co-sputtering of Ag and other noble metals and alloys together with an organic component as a method to produce antibacterial coatings, where the precious metals are only incorporated in a thin surface layer. Moreover, they are finely dispersed as nanoparticles, thus saving additional material and providing a very large effective surface for metal ion release.

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COMPOSITE ALUMINA-ZIRCONIA NANOPARTICLES MADE BY LIQUID FLAME SPRAY (LFS)

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Composite alumina-zirconia nanoparticles made by Liquid Flame Spray (LFS) Juha-Pekka Nikkanen 1), Helmi Keskinen2), Mikko Aromaa 2), Jyrki M. Mäkelä 2), and Tapio Mäntylä 1) 1) Institute of Materials Science, Tampere University of Technology, P.O. Box. 589, FIN-33101 Tampere, Finland. 2) Institute of Physics, Aerosol Physics Laboratory, Tampere University of Technology, P.O. Box. 692, FIN-33101 Tampere, Finland.
Flame sprays are very practical and cost-effective methods for composite nanoparticle production. Alumina-zirconia system has been extensively investigated because Al2O3 with dispersed tetragonal ZrO2 has shown transformation toughness, which is based on micro scale structural details. However, there is little information of the structural details, phase composition and mechanical properties of nanocomposites within the same system. In this study Liquid Flame Spray (LFS) was used to make composite alumina-zirconia nanoparticles for processing bulk composites. Precursors were aluminium-isopropoxide and zirconium-isopropoxide in xylene solution. In the LFS method a turbulent, high-temperature (Tmax˜3000 oC) H2-O2 flame is used. The liquid precursor is atomized into micronsized droplets by high velocity H2 flow and introduced into the flame where they will evaporate. Evaporated compounds decompose and the reaction product re-condenses into particulate material. Particle production rate was 20 and 40 g/h. Particles were analyzed by TEM-EDS, SEM and XRD. The particulate material contained micron sized agglomerates consisted nanosized primary particles. The particulate material was mostly amorphous. Only some t-ZrO2 was detected.

Nanotechnology instruments and tools

ELECTRODE PREPARATION FOR EXTRACELLULAR RECORDINGS OF CELL ELECTRICAL ACTIVITY

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Insulated W-wires with uninsulated tips are conventionally used as extracellular electrodes in electrical measurements. We have applied new methods to improvement on these types of electrodes. Very sharp electrodes were produced with high yield using Schrodinger's Sharpener electrochemical etching equipment. As a result tips with ca. 100 nm diameter were achieved. The tips were coated with electrical insulator, which was removed from thip. Coating thicknesses of PMMA (Poly(methyl methacrylate)) down to 20 nm were created and the break down voltage was tested to be >30V, suitable for the recordings. Special contacts were created with carbon nanotube coatings, that were applied via electrolysis on opening created on the tip.

DEVELOPMENT OF MEMS-BASED OPTICAL SYSTEM ACOUSTIC EMISSION FOR STRUCTURAL DAMAGE DETECTION

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Dr. Mohamed Saafi
Alabama A&M University, United States

Extreme events like earthquakes and blasts generated by terrorist attacks can cause enormous damage to the health of civil infrastructures without producing any apparent visible damage. Such damage can result in life threatening conditions evolving in the structure, either in the immediate aftermath or long after the actual event has occurred. In addition, structures also undergo deterioration over its life span due to corrosion, carbonation, alkali-aggregate reaction, fatigue, temperature, etc... Consequently, the necessity to monitor and verify their performance and safety is a matter of urgent concern. Acoustic Emission (AE) can be used to monitor these structures and to gain a better understanding of their conditions. However, current AE systems are expensive, too large to handle and require complex signal processing filtering which in return requires high power consumption. The problem with the transducers used for Health Monitoring nowadays is that even though they have good sensitiveness, most of the time they capture background noise rather than the mechanical wave released by the source within the tested object or structure. To overcome the shortcomings of the current AE transducers a new MOEMS AE system was designed for Heath Monitoring to detect damage in structures. The fiber optic cable that will be used for the interrogation and communication process to improve the signal-to noise ratio will get a "pure signal". This paper will show the advantages of fiber optics for AE and the new optical interference patter micro sensor will be presented.

DYNAMIC FORCES IN NANOCONTACTS

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In present work, the method for visualization the nanocontact of oscillating nanotube with the surface is considered. Visualization is carried inside the Transmision Electron Microscope using special tool. Also, the new type of convenient and easy to fabricate nanotube support, which can be used in various experiments with nanotubes, is described.

CHARACTERISATION OF GRATING PITCH BY LASER DIFFRACTION

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Gratings (1-D and 2-D) are generally used as reference length standards for calibration of scales of scanning probe microscopes (SPMs). As a national metrology institute MIKES provides traceability to the definition of the metre for microscopic dimensional measurements, also. Pitches of 1-D and 2-D gratings can be calibrated by laser diffraction method. The pitch of the sample is derived from the diffraction angle and laser wavelength. A set-up for high-accuracy pitch calibration was developed at MIKES. A precision rotary table with 1” accuracy in angle measurement and a frequency-stabilised He-Ne laser at 543.5 nm are used. The laser beam is directed to the grating and the diffracted beam is adjusted to fulfil the Littrow condition with an aid of a position sensitive detector. Pitches from ˜300 nm to 2000 nm can be characterised. Uncertainties of a few tens of picometres are reachable. Principle of the measurement, the traceability chain and uncertainty estimates will be presented.

INDIVIDUAL AIRBORNE NANOPARTICLE COLLECTION ON TEM GRID

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The rapidly developing field of nanotechnologies presents many opportunities and benefits for new materials with significantly improved properties as well as revolutionary applications in the fields of energy, environment, medicine, etc. However, the potential impact of these new materials on human health and the environment is viewed with apprehension. For this purpose also advanced measurement techniques for nanoparticles detection need to be developed. In many occupational health studies there is a need to collect nanoparticles on a TEM grid as they exist in the gas phase i.e. aerosols. We have built three different devices for collection of individual airborne nanoparticles. The first one does not make any size classification and it collects the particles as gas is pulled through a TEM grid. In the other device, TEM grids are placed on LPI (Low Pressure Impactor) stages and thus size selection is based on impaction. In the third device a TEM grid is placed on an accurately controlled heated substrate. The collection efficiency of different particle sizes can be adjusted by changing the balance between thermophoresis and diffusion. Deposition velocities as a function of particle size were calculated for TEM grid device placed in a cross-flow. The simulations were performed with the model presented in a previous study (Pyykönen and Jokiniemi; 2003). The larger the temperature difference between the substrate and the free flow, the stronger is the dependence of the collection efficiency on particle size. Validation of the TEM grid devices is done with calibrated aerosol source, which produces TiO2-particles in laminar flow reactor via thermal decomposition of titanium tetraisopropoxide (TTIP) (Backman et al., 2004). The reactor enables stable production of TiO2 aerosol, while the number concentration and size distribution can still be easily adjusted. The simple TEM grid device where gas is pulled trough the TEM grid provides reliable and easy to use collection for individual nanoparticles. The other two devices provide some size selectivity, but are more sophisticated to use.

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NANOTUBE OSCILLATORS ARRAY FOR HIGHLY ACCURATE GRAVITY FIELD MEASUREMENTS

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University of Bologna, Italy
Ali Adams
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University of Augsburg, Germany

Recent experimental achievements and theoretical studies on nanotube oscillators followed by an extremely recent breakthrough on self-detecting tunable nanoresonators have made it possible to realize a gravitational sensor that was conceptually proposed by our group in 1999 for ESA's SUCCESS students' competition. Our proposed gravitational sensor uses ultrahigh frequency nanotube oscillators with relatively large and perfectly known masses attached to them to measure the variations in the gravitational field exerted on masses attached to the nanotubes. The sensor is made of 6 square arrays of oscillators where each of these arrays is placed onto the inside walls of a cubic holder skeleton structure that can be large enough to hold an experimental apparatus inside it. The sensor will be a 4D monitor of the gravitational environment in which an experiment is performed. It is also possible to use the sensor for gravitational research or planetary astronomy. The sensor can work both on Earth and in space. We plan to test and calibrate the sensor as a gravitational accelerometer at different values of the local g acceleration by using a centrifuge, ground laboratories and parabolic flights. We finally also plan to use the sensor for microgravity quality monitoring onboard our developing balloon-launched microgravity laboratory (www.omgl.org).

THE USE OF THE ELECTRICAL MOBILITY TECHNIQUE FOR REAL-TIME IN SITU MEASUREMENT OF NANOPARTICLE SIZE DISTRIBUTIONS

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The benefits of sizing aerosolized submicrometer particles using an electrical mobility sizing technique have been well documented. This type of analytical tool has been found to be able to measure particle diameter with an uncertainty of only 0.1% [1]. The National Institute of Standards and Technology (NIST) have been using electrical mobility to measure its 0.1µm Standard Reference Material (SRM) Particles for well over a decade due to its superior accuracy and speed over surface measurement techniques1 {eg. Scanning Electron Microscopy (SEM)/Transmission Electron Microscopy (TEM)}. Scanning Mobility Particle Sizer(TM) spectrometer (SMPS) is a commercially available instrument that utilizes electrical mobility technique for near real-time (as fast as 1 min) sizing of aerosolized particles in the size range of 2.5-1000 nm. Lately, the electrical mobility technique is finding increasing use in the in-situ near real-time sizing of engineered nanoparticles synthesized by a variety of aerosol-based processes like diffusion flame synthesis, spray pyrolysis, thermal plasma etc [2-4]. The near real-time measurement offered by electrical mobility technique accelerates the research and development process of nanoparticle synthesis since it enhances the understanding of the mechanisms of particle formation and growth. An in-situ measurement eliminates the need for sample collection for off-line methods thus minimizing operator error and providing more consistent repeatable results. When combined with electrospray dispersion, the electrical mobility technique has been shown to accurately size nanoparticles suspended in colloids as well [5]. A brief overview of the technology along with a review of case studies that have utilized this technique successfully to size aerosolized nanoparticles will be presented. A comparison of size measurements by electrical mobility and traditional SEM/TEM techniques will be presented as well. Additionally, sampling challenges and how to overcome these will be discussed.

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ACCELERATING THE NANO-REVOLUTION: ADVANCED STRATEGIES IN FOCUSED ION BEAM SCANNING ELECTRON MICROSCOPY (FIB SEM)

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Oliver Wilhelmi
FEI Company, Netherlands

Lucille Giannuzzi
FEI Company, United States

Dominique Hubert
FEI Company, Netherlands

State-of-the-art FIB SEM is making a big impact on nanotechnology applications, thanks to the ability to perform advanced nanofabrication and prototyping, superior-quality specimen preparation for ultra-high resolution imaging and analysis, and novel 3D characterisation. Achieving the highest standards requires an understanding of the physics and chemistry in a system containing ions and electrons of various energies and origins, substrates with a range of electrical and mechanical properties, and reactive gases capable of specific effects on sputtering and re-deposition. We have built up a detailed knowledge of these complex parameters, allowing us either to reveal or generate nanostructures using the latest strategies for high resolution milling and deposition. These will be discussed and demonstrated in the contexts of specimen preparation and nano-lithography.

SCANNING PROBE MICROSCOPY AT THE JYU NANOSCIENCE CENTER
Markus Ahlskog
University of Jyväskylä / Nanoscience center, Finland

Several different types of Scanning probe microscopes have recently been installed at the Nanoscience Center (NSC) of the University of Jyväskylä. Besides standard atomic force microscopes (AFM), these include an environmental AFM and a state-of-the-art scanning near field optical microscope (SNOM). In addition, we are operating the AFM in liquid environment for imaging and probing biological particles. The instruments and some of their applications will be presented.

Partnering Program abstracts

Presented 28th and 29th March at 13.00-14.00 in the Lunch area

Organisation Name: KSV Instruments Ltd
Contact First name: Tapani
Contact Last Name: Viitala
Partnering Type: Framework Programme 7

Abstract: KSV Instruments Ltd is one of the worlds leading manufacturer of research instruments for nanotechnology and surface chemistry. The main products of the company are instruments for surface/interfacial tension and contact angle measurements, as well as so called Langmuir and Langmuir-Blodgett instruments, which are used for preparing and studying nanometer thick organic layers on air-water interfaces and solid substrates.
Furthermore, KSV also manufactures more specialized characterization instruments such as Brewster Angle Microscopes for thin organic film characterization and Quartz Crystal Microbalances for very small (nanogram) mass changes at surfaces during adsorption/desorption processes or reactions taking place at the surface.
KSV is looking for research partners and institutes that are willing to evaluate new developments of above mentioned instruments as well as testing new instrument ideas. KSV is also actively looking for new ideas for instruments to develop or commercialise in the field of nano- and biotechnology and surface chemistry.

Organisation Name: Lappeenranta University of Technology
Contact First name: David
Contact Last Name: Cameron
Partnering Type: Framework Programme 7
Abstract: Capabilities: thin film deposition and characterisation, in particular atomic layer deposition and magnetron sputtering.
Areas of research: coatings on polymers, sensor layers, photocatalysts, wear resistant layers, electrochemical layers, etc.
Looking for: collaborators for FP7 projects.

Organisation Name: PLASMAS Ltd.
Contact First name: Filippov
Contact Last Name: Alexander
Partnering Type: Framework Programme 7
Abstract: PLASMAS Ltd. http:// www.plasmas.spb.ru
The company was founded in 1990.

Researches, development of new plasma technological processes and new materials.
Production, supply of equipment for technological processes, supplies of materials.
Plasmas Seeds
- Heat-resisting materials
- Plasmachemical modification of materials' surfaces.
- Nanotechnology and Nanomaterials.

Technologies and equipment are patented.
Offer: new plasma technologies, nanotechnology and nanomaterials.
the equipment, materials.
We are looking for to find partners for development of works in such area:
plasma technology, nanotechnology, biotechnology.
We are interested in joint development and in industrial use of our new plasma technologies and nanotechnology in such areas as:
- Sources and converters of the electric power;
- Accumulators, supercondensers for storage of the electric power;
- New Nanocomposite constructional materials for aircraft, motor industry, medicine, constructions;
- Nanocomposite optical elements for laser optics;
- Plasma technologies for an agriculture,
- Manufacture of non-polluting food stuffs;
- Sterilization of materials
- Nanotechnology and nanomaterials,
- To industrial use our new plasma technologies and Nanotechnology.

Organisation Name: Darmstadt University of Technology
Contact First name: Udo
Contact Last Name: Schwalke
Partnering Type: Framework Programme 7
Abstract: Institute for Semiconductor Technology & Nanoelectronics, Darmstadt University of Technology, Germany.
The Institute for Semiconductor Technology and Nano-Electronics owns a complete Nano-CMOS clean room facility. The CMOS fabrication line is equipped with e.g. ion implantation, optical lithography and e-beam litho (65nm at present), chemical-mechanical-polishing (CMP), RIE and CVD equipment (also to grow CNTs), advanced wet-chemistry and more. In addition we have advanced characterization tools like AFM, conductive AFM, SEM and elec-trical characterization (parameter analyzer, CV, charge pumping, dielectric reliability test-ing...). For details please see: www.iht.tu-darmstadt.de.
The institute's research work focuses on \"Nanoelectronics for Integrated Information Technologies\" including the fabrication and evaluation of nano-devices, nano-sensors and circuits. These can be either silicon-based (like Si-nanowire devices and high-k damascene metal gate MOSFETs) or non-silicon e.g. carbon nanotube field effect transistors (CNTFETs). Reliability studies on failure and degradation mechanisms of integrated devices and materials complement the institute\'s work in respect of the above-mentioned core research areas.
We are interested in research collaborations in the nano-electronics area and participation in related FP7 research projects.

Organisation Name: Technical University of Sofia
Contact First name: Slavka
Contact Last Name: TZANOVA
Partnering Type: Framework Programme 7
Abstract: The Technical University of Sofia with Nano-ToolShop Ltd. research is focused on:
- Development of different piezo-resistive MEMS sensors, considered as most promising solution for future integrated systems,
- Special attention in paid on development of sensor arrays with integrated actuators,
- Along with sensors, all specific components for piezo-resistive read-out applications (sensor carriers, connectors, amplifiers, etc.) have to be re-developed, in order to be successfully integrated into complete systems.
We intend to prepare a proposal for "Small or medium-scale focused research projects" for Nanosciences and converging sciences, NMP-2007-1.1-1 Nano-scale mechanisms of bio/non-bio interactions, entitled:

Sensors for bio-chemical recognition and life science (eNose) We are looking for partners for:
- complimentary characterization of our sensors.
- novel MEMS applications
- development of novel sensors and systems.

Organisation Name: University of Szeged, Hungary
Contact First name: Csaba
Contact Last Name: Visy
Partnering Type: Framework Programme 7
Abstract: During the last years we have studied conducting polymer based nanocomposites. Our main goal is to synthesize and characterize composites with new properties and possible applications. Our nanocomposites such as maghemite, magnetite and/or iron-oxalate containing polypyrroles and polythiophenes have been studied by ICP-AAS, UV-Vis and FTIR spectroscopy, MALDI-TOF MS, XRD, XPS, TEM, SEM (with EDX), as well as by various electrochemical techniques including a.c. impedance.
Partners for synthesis of well-organized, more structured nanocomposites and for Mössbauer spectroscopy measurements are welcome.

Organisation Name: Electronic Technology Lab, Ltd
Contact First name: Andrey
Contact Last Name: Vladimirov
Partnering Type: Technology Transfer
Abstract: Technology of Carbon Nanomodification of Concrete Mixes
The Partnering Poster Abstract
We have:
1. a theoretical substantiation and results of experimental research on efficiency of the carbon fulleroid nanostructures as modifiers of concrete mixes.
Modification of concrete mixes using fulleroid nanoparticles is found to cause substantial improvement of their rheological characteristics, and hence a decrease in labor input and energy consumption of the concrete works. As a result of the nanomodification, concrete durability increases, or, with the same durability, consumption of cement is reduced by approximately 20%.
2. a technology of industrial production of Carbon Nanomodification.
3. a pilot-line production supplying Carbon Nanomodification to one of St Petersburg plants.
4. statistics of industrial application of Carbon Nanomodification during half a year.
We are looking for interested partners for:
1. continuation of research in this area
2. implementation of the technology in other markets.

Abstract: The Technology of Modification of Lubricant Materials Using Carbon Nanoparticles of Nanodispersive Fulleroid Modifying Agents.
1. We have:
- an analysis and substantiation of the main technological approaches to industrial usage of nanodispersive fulleroid nanoparticles for production of new lubricant materials for different applications and physical models of the phenomena that permit efficient modification of interphase borders in tribotechnical units by using a unique delocalized system of p-electrons of fullerenes, and also ensure inhibition of reactions of mechanochemical and thermooxidative destruction in block polymers in the space containing the lubricant and in materials of protective coatings.
2. a technology of industrial production of Carbon Nanoparticles 3. a pilot-line production of Carbon Nanoparticles for various engine and diesel oils
We are looking for interested partners for:
- continuation of research in this area
- implementation of the technology in other markets

Abstract: The Technology of the production the Powerful Source with Dynamic Output Volt-Ampere Characteristic Control
We have:
A technology of production of the current source, used for research and development of nanomaterials. The current source have the high-capacity (up to 20kA) with an adjustable output

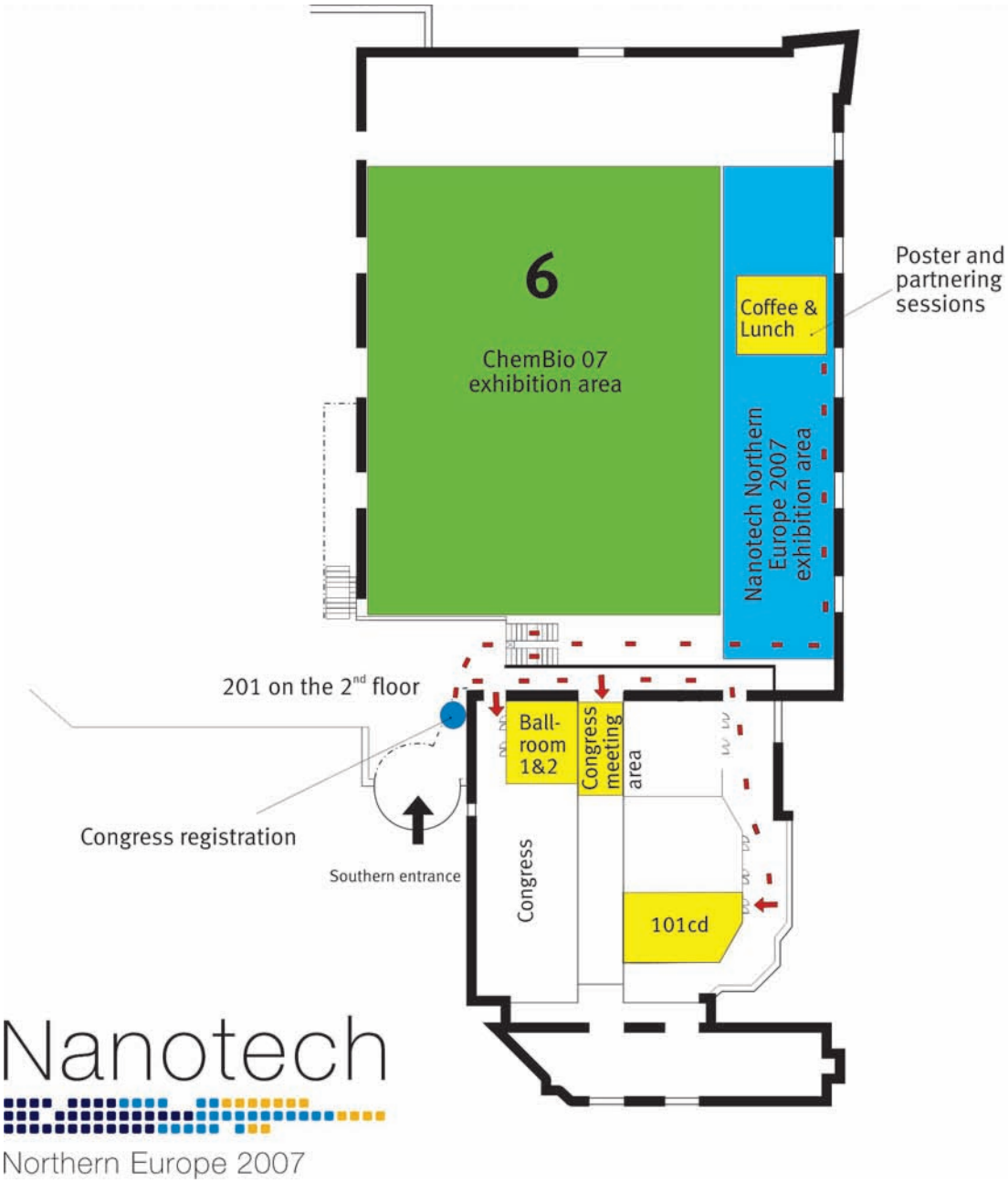
dynamic volt-ampere characteristic that enables the user to maintain modes of current regulation, voltage regulation or complex combined characteristics. The source can also operate in pulse mode reaching the maximum current value within 150 microseconds and falling within 100 microseconds.
We are looking for:
Partners to set up full-scale production of the source for different applications.

Organisation Name: CSEM
Contact First name: Erika
Contact Last Name: Györvary
Partnering Type: OtherOther type: Technology transfer & FP7
Abstract: CSEM, Centre Suisse d' Electronique et de Microtechnique (Swiss Centre for Electronics and Microtechnology), founded in 1984 is a private research and development centre, which has specialised in microtechnology, nanotechnology, microelectronics, system engineering and communications technologies. It offers its customers and industry partners tailor-made innovative solutions based on its technological expertise from applied research.
CSEM is looking for industrial projects & FP7 collaboration.

Organisation Name: Jyväskylä Innovation Ltd
Contact First name: Esko
Contact Last Name: Peltonen
E-mail Address: esko.peltonen@jklinnovation.fi
Participant ID: 1482
Partnering Type: Technology Transfer
Abstract: Third generation of Finnish Centre of Expertise Programme has been launched for the time period of 2007-2013. The programme is constructed on Clusters of Competence that are appointed based on strong and developing research, education and business activities with fluent collaboration between top centres. One of the clusters is called Nano and Microsystems and Future Materials. The cluster has its own role in the Finnish innovation system. Nano and Microsystems and Future Materials cluster is a network consisting of seven Centers of Expertise which operate at regions with strong competence in research and companies utilizing nano or microtehnol-ogy, viz. Helsinki metropoly region, Tampere, Mikkeli, Oulu, Kokkola, Joensuu and Jyväskylä. The cluster brings together best companies, best universities and best research organizations in the country. The clus-ter covers more than 90% of the players in the whole Finland. The vision of the cluster is that Finland will be one of the most important places in EU for applied research and business in nano and microsystems and future materials. To achieve this goal the cluster accelerates and strengthens the use of nano and microtechnologies and future materials in Finnish companies, both in big companies with mass products and in new innovative technology companies. Being a nationwide net-work, the cluster combines and binds regional expertises into national strength. The Finnish cluster Nano and Microsystems and Future Materials is seeking for cooperation with foreign research organisations and companies, both small and big firms, in order to accelerate the breakthrough of nano and microtehnology for the benefit of the society. We offer world class expertise in our universities, research institutes and technology companies. We offer business networks including global players, growth companies and start-ups. In addition, we offer to companies business premises via Science parks. The cluster is coordinated by Jyväskylä Innovation Ltd, the coordinator being Dr. Esko Peltonen. The coordinator is appointed by the ministry of trade and industry.

The cluster, coordinator and seven partners are happy to meet you at the exhibition stand 6b25b during March 27.-29.

General Map of the Congress and Exhibition Area



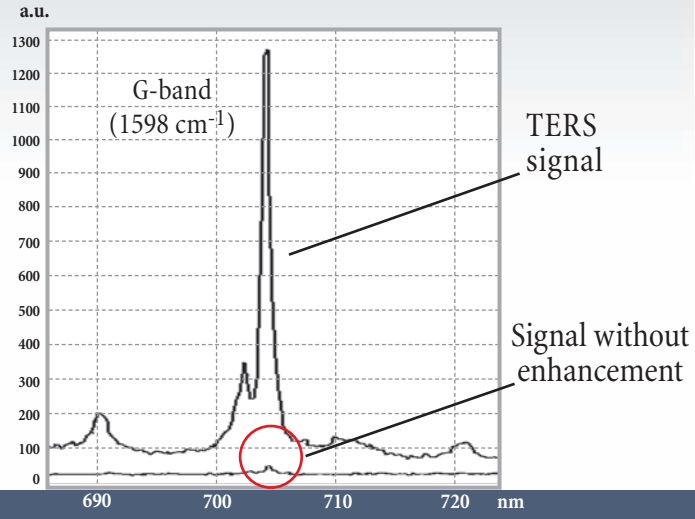
Please note that:

- The Congress Meeting area is located in the Winter Garden
- Room 201 (E.g. Nanoforum Workshop) is located on the second floor, one storey above the Southern Entrance. If you have any questions, please contact one of the congress assistants

Colours do not play at nanometer scale

But you can colour molecules by their Raman spectra

Single molecule detection by TERS – NTEGRA Spectra



Raman spectra of carbon nanotubes with and without tip enhancement.

Data courtesy Dr.Joachim Loos, TU Eindhoven, Department of Chemical Engineering and Chemistry, The Netherlands

Confocal microscope, Raman spectrometer and Atomic-Force Microscope facilities are successfully integrated within a powerful scientific NanoLaboratory for advanced experiments at a molecular level. The so called Tip-Enhanced Raman Scattering (TERS) allows Raman signal enhancement more than thousand-times due to an AFM probe interaction with a focused laser beam, thus enabling even single molecules to be detected by their Raman spectra.

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