

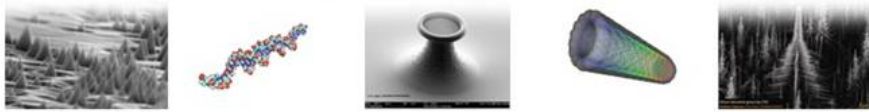
Vingt-deuxièmes
entretiens Jacques Cartier



CONNECTING TO THE NANOWORLD SE CONNECTER AU NANOMONDE

November 30 & December 1, 2009

Ecole Centrale de Lyon,
36 avenue Guy-de-Collongue,
69134 Ecully
France



www.labn2.fr

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Committees

Organising committee

France

Thierry BARON, Chercheur CNRS, Laboratoire des Technologies de la Microélectronique, Grenoble.

Jean-Pierre CLOAREC, Maître de conférences, Institut des Nanotechnologies de Lyon, Ecole Centrale de Lyon

Emmanuel HADJI, CEA, Laboratoire Silicium, Nanoélectronique, Photonique et Structure, INAC/SP2M, Grenoble

Abdelkader SOUFI, Professor, Institut des Nanotechnologies de Lyon, INSA de Lyon

Québec

Mohamed CHAKER, Professor, INRS Energie, Matériaux et Télécommunications, Varennes, Québec.

Paul CHARETTE, Professor, Département de Génie Electrique et Génie Informatique, Université de Sherbrooke, Québec

Scientific committee

Claudine ALLEN, Université Laval, Québec, Canada

Vincent AIMEZ, Université de Sherbrooke, Sherbrooke, Canada

Danièle BLANC-PELLISSIER, Institut des Nanotechnologies de Lyon, site INSA de Lyon

Yann CHEVOLOT, Institut des Nanotechnologies de Lyon, site Ecole Centrale de Lyon

Jean-Louis LECLERCQ, Institut des Nanotechnologies de Lyon, site INSA de Lyon

Richard MARTEL, Université de Montréal, Québec

Ian O'CONNOR, Institut des Nanotechnologies de Lyon, site Ecole Centrale de Lyon

Johane PATENAUDE, Université de Sherbrooke, Sherbrooke, Canada

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Web site credits

Jean-Pierre CLOAREC & Raphael LOPEZ

Theme of the workshop

English

Ever since Feynman's famous "*There is Plenty of Room at the Bottom*" talk in 1959, scientific exploration of the "nanoworld" has led to countless discoveries and the ability to precisely engineer chemical and physical material properties at the nanoscale. There are two complementary approaches to fabricating structures and devices at the nanoscale, both having their own unique set of challenges:

- the **bottom-up** approach, which can be likened to a mason building a complex structure from elementary units (bricks). The bottom-up approach seeks to tailor the material properties (geometry, optical, mechanical, electrical, chemical, etc.) of relatively simple nano-objects and to assemble these elementary units into an organized structure.
- the **top-down** approach, which can be likened to a sculptor building a structure by removing material from an initial bulk form. The top-down approach seeks to increase the integration and interconnection density of complex nanoscale devices, using for example hybrid integration and 3D architectures.

Both approaches face the **difficult technical challenge of interfacing** between the nanoworld and our own, macroscopic, world in order to make nanotechnologies useful in everyday life.

In addition, **nanotechnologies can only be ultimately relevant if they are embraced by the public as a safe and useful technology**. Therefore, this workshop will also address issues related to the use and impacts, both positive and negative, of nanotechnologies.

The objective of this workshop is to bring together recognized experts from various fields related to nanotechnologies (fabrication, characterization, systems engineering, chemistry, biology, social sciences, and others) for broad-based discussions on **connecting to the nanoworld**.

Français

Les nanotechnologies impliquent la fabrication à l'échelle nanométrique d'objets, permettant de conférer à la matière des propriétés physiques ou chimiques inédites. Deux approches complémentaires permettent de fabriquer des objets à l'échelle nanométrique : l'assemblage de briques élémentaires, tel un « maçon » : on parle d'approche « bottom-up » ; et l'usinage de matériau, tel un « sculpteur » : il s'agit de l'approche « top-down ».

Ces deux approches présentent des problématiques spécifiques : la voie bottom-up nécessite de contrôler et combiner les propriétés des briques élémentaires et d'agencer simplement ces nano-objets individuels en système organisé. La voie top-down cherche à améliorer les densités d'intégration des nanodispositifs, par exemple en passant de systèmes 2D à des systèmes 3D.

Dans les deux approches, la maîtrise technologique des connections entre nano-objets et notre monde à l'échelle macroscopique est un problème à résoudre pour rendre effectives et utilisables les nanotechnologies. Afin d'explorer l'articulation entre les approches top-down et bottom-up, l'objectif du colloque sera de rassembler des spécialistes de différentes origines disciplinaires, présentant des savoir-faire variés (nanofabrication, nanocaractérisation, composants et systèmes, chimie, biologie) issus de domaines d'application clé des nanotechnologies telles que les technologies de l'information et les nanobiotechnologies. Ce colloque sera aussi une occasion de discuter des défis démocratiques posés par les impacts, positifs comme négatifs, liés à ce domaine d'exploration.

Program**Monday, November 30, 2009**

8h30	Welcome	
9h00	Official opening of the workshop : Patrick Bourgin , director of Ecole Centrale de Lyon	
	Session "synthesis of nanoparticles and nanostructures" Chairman : Emmanuel Hadji (CEA)	
	Speaker	Subject
9h15	Lin Guo (BeiHang University , Beijin, China)	One-Dimensional Transitional Metal and Compound Nanomaterials: Design, Characterization and Properties
9h45	Claudine Allen (Université Laval à Québec, Québec, Canada)	Colloidal Quantum Dots: the Aftermath and New Undertakings
10h15	Pause	
10h45	Pascal Perriat (INSA Lyon, France)	Lanthanide-based hybrid nanoparticles for diagnosis and cancer therapy
11h15	Dongling Ma (INRS, Varennes, Québec, Canada)	Synthesis and characterization of Nanostructures for biomedical and energy applications
12h15	Lunch	
	Session "surfaces and addressing" Chairman : Paul Charette (Université de Sherbrooke)	
	Speaker	Subject
14h00	Cristophe Vieu (LAAS-CNRS, Toulouse, France)	Surface Nanopatterning of biomolecules for biochips, biology and biophysics :Tools, Process and Applications
14h30	David Peyrade (LTM-CNRS, Grenoble, France)	Colloidal assembly and nanodevices : towards nanorobotics
15h00	Federico Rosei (INRS, Varennes, Québec, Canada)	Strategies for Controlling Assembly at the Nanoscale
15h30	Pause	
16h00	Eliane Souteyrand (INL-CNRS, Ecully, France)	Adressing molecules on surfaces using chemical and biological fonctionnalisation
16h30	Aidan Quinn (Tyndall Research Center, Ireland)	Nanocrystal-Molecule Nanostructures and Assemblies: Formation, Plasmonic Properties and Electrical Contacting
17h00	Poster session	

Program

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Tuesday, December 1st, 2009																																																			
8h30	Welcome																																																		
Session "nanotubes and nanofabrication" Chairman : Mohamed Chaker (INRS)																																																			
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Colloidal Quantum Dots: the Aftermath and New Undertakings

Claudine Allen

Professor, Département de Physique,
Université Laval, Québec

When colloidal quantum dots (cQD) grown by bottom-up organometallic synthesis were made water-soluble, they were almost instantly hailed as a revolutionary fluorophore due to their brightness, photostability and tunable emission wavelength. Surprisingly, one can now find a large amount of biologists unsatisfied with cQD. To expose the roots of the disappointment, this presentation will begin with a critical analysis of the cQD pros and cons. For example, while blinking observed in cQD photoluminescence is a well-known phenomenon, their emission wavelength also shifts when blinking occurs (spectral diffusion) and some cQD never emit light (dark population). Nonetheless, with a good semiconductor heterostructure design, one can obtain well-passivated cQD that are better suited for biological experiments needing long lasting fluorophores and/or multiplexing. I will present some of our results in this field about the imaging of receptor protein diffusion on the surface of neurons. Keeping in mind their strengths, cQD can be used in other applications such as refractive index sensing and solar cells. In our laboratories, we develop the former by measuring spectral shifts of whispering gallery modes in microbeads. cQD are embedded in these optical microcavities to act as the light source coupling directly into the modes which interact with the surrounding environment through their evanescent field. We also investigate cQD miscibility in bulk heterojunction organic solar cells and I will comment their effect on charge separation and transport. The heart of our work on cQD is the research of new synthetic protocols and the characterization of their optoelectronic properties. Since the aforementioned difficulties have common origins in surface effects and crystalline defects, I will review our progress on the localization of exciton wavefunctions in dopant atoms of CdSe/CdxZn1-xS cQD to minimize interactions with the surface and on strain control to reduce defects.

Multiscale and multiphysical approach to understand
the CVD process for multi-walled carbon nanotube

Jinbo Bai

and Delong He, Hao Li, Jing Shen

Laboratoire de Mécanique des Sols, Structures et Matériaux, CNRS UMR 8579, Ecole Centrale Paris,
Grande voie des vignes, 92290 Chatenay Malabry, FRANCE

Abstract

Carbon nanotubes (CNTs) have been extensively investigated in the last decades for their possible applications in a large variety of fields. Chemical vapor deposition (CVD) is one of the most used methods for large scale synthesis of CNTs. However, the mechanisms of CNT nucleation and growth are still not clear up to now due to the complexity resulted from the multi physical-chemical processes during the CVD synthesis. Here, in order to get a comprehensive understanding, a multi-scale physical-chemical approach is proposed to systematically investigate most of the major controlling factors, both experimentally and theoretically. The investigation was carried out separately on three aspects: gaseous phase space, substrate structure and the interface between them. For the gaseous phase area, the analyses were focused on the mass transports of carbon sources and of catalyst precursor, on the heat transfer and the related chemical decomposition and the polymerization. For the gas phase-substrate interface, theoretical simulation and experimental works trend to uncover the complex species diffusion and physic/chemical adsorption process, the nano catalyst particle formation and the nucleation process of CNT via the adsorption-diffusion- saturation-precipitation of C atoms in the catalytic particles and the open-end growth of CNT. Finally, the influence of substrate materials and structures on the CNT growth and organization has been experimentally demonstrated. By combining various analysis techniques, like HRTEM, SEM, Raman, XRD, Mass spectrometer, and theoretical simulation, the roles of each of the multiphase-chemical processes mentioned above have been given. This comprehensive and systematic research may give more insights in the understanding of the CNT formation mechanism and can help us to achieve the controllable production by CVD.

CV

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1988 - 1991: PhD at Laboratoire de Matériaux, Ecole Centrale Paris.
1982 - 1985: Master of Solid of Mechanics, Xi'an Jiaotong University, P.R. China.
1977 - 1982: Engineering Bachelor of Metal Forming: Xi'an Jiaotong University
1985 - 1988 Assistant and Lecturer of "Mechanics of Materials" et "Experimental Mechanics"
at Northwestern Polytechnic University, China
10/1997 Habilitation à diriger des recherches
From 10/1991 CNRS researcher then Director of Research, Head of group "Nanotubes and
nano/microcomposites" at Lab. MSSMAT, UMR8579, Ecole Centrale Paris,
92290 Chatenay Malabry, France
Research fields : Multifunctional nano/microcomposites; CVD process, Carbon nanotubes
Zircaloy-H,O,Irradiation.

The College of Nanoscale Science and Engineering: Overview and Research Examples

James Castracane

Professor, Head of Nanobiosciences. Director, CATN²
College of Nanoscale Science and Engineering, University at Albany-SUNY

This presentation will focus on the evolution and current status of the College of Nanoscale Science and Engineering (CNSE) of the University at Albany including an overview of the infrastructure, personnel, operational model and representative examples of ongoing research projects. CNSE is the first college in the world dedicated to research, development, education, and deployment in the emerging disciplines of nanoscience, nanoengineering, nanobioscience, and nanoeconomics. CNSE's Albany NanoTech Complex – a \$4.5 billion megaplex that has attracted over 250 global corporate partners – is the most advanced research complex at any university in the world.

Research examples will include the current status of a five year project through NIH/NCI to develop a micro/nano-scaled implantable sensor to attract, collect and quantify tumor cells. This so-called NANIVID is designed to help establish the dynamics of cell migration away from primary tumor sites. A second project will illustrate the integration of nano-porous materials with MEMS device production to yield a new approach for multi-channel optical interconnects for the semiconductor industry. Finally, a third project will be described which will focus on the development of spintronics materials, diagnostics and devices under development at CNSE for next generation switches and full system architectures. The goal is to use this new method as a high efficiency, low power alternative to standard CMOS approaches.

James Castracane, Ph. D.

Dr. Castracane is Professor (Founding Faculty) and Head of the Nanobioscience Constellation in the College of Nanoscale Science and Engineering (CNSE) at the University at Albany-SUNY and Director of the New York State Center for Advanced Technology in Nanomaterials and Nanoelectronics (CATN²). Dr. Castracane received his BS degree in Physics from Canisius College (1976) and his Ph.D. in Physics from The Johns Hopkins University (1982). Dr. Castracane has received research funding from numerous Federal agencies including NIH, NSF, DOD, DOE, DARPA, and NASA as well as a significant portfolio of State and corporate sponsors. His publication record spans over 100 articles, numerous invited or keynote presentations and 10 patents issued/pending. Dr. Castracane is a member of APS, OSA and SPIE.



His research interests encompass fundamental materials science, nanobioscience, optoelectronics, MEMS, and emerging fields such as molecular electronics and spintronics. Under Dr. Castracane's guidance, CNSE has assembled a multi-faceted Nanobioscience program to establish the critical technologies for effective integration of tailored biochemistries of cells/tissues/proteins with innovative nanofabricated structures.

Prior to joining CNSE in 1998, Dr. Castracane's private sector experience involved positions at high technology R & D companies including Chief Operating Officer at InterScience, Inc. from 1994-98. In his current position as CATN² Director, Dr. Castracane has continued to assist in the development of the business potential of numerous companies through technical interactions and management counseling.

Integration of monoelectronic components with CMOS technology

Dominique Drouin

Vice director, Centre d'Excellence en Génie de l'Information, Université de Sherbrooke,
Sherbrooke, Québec, Canada

Abstract

Since the creation of the integrated circuit, more than 4 decades ago, a tenfold increase in computing performance is achieved every 5 years. The most significant impact of this trend is the continuing decrease of cost-per-chip which has led to significant improvement in economic productivity and overall quality of life through the proliferation of computers, communication and electronics in general. This outstanding improvement is essentially due to the scaling down of the CMOS technology (Complementary Metal Oxide Silicon). The International Technology Roadmap for Semiconductors anticipates that to continue this trend, innovative solutions must be introduced for post-CMOS technology within the next 10 years. To achieve this, a tremendous research effort on emerging devices or materials must be deployed to bring these technologies to an acceptable maturity level. These emerging research devices will need to be compatible with existing CMOS technologies in order to be heterogeneously integrated with CMOS circuits and capitalize on the established semiconductor industry. Also, these devices have to address the issue of power dissipation ($<100 \text{ W/cm}^2$) to be considered for a viable solution. My team and I have developed a radically new approach for the fabrication of single electron transistors (SETs) one of the emerging research devices proposed for post-CMOS technology. This engineering breakthrough has allowed us to achieve SET with low impedance and extraordinarily small capacitances (paving the way for high-speed memories and logic devices), and concomitant reliable operation 100°C above room temperature. This talk will present potential solutions to the issue of energy consumption by capitalizing on the previously developed high power efficiency single electron device platform to heterogeneously integrated SET with CMOS technology.

CV

Dominique Drouin is a member of the Nanofabrication and Nanocharacterization Research Center and professor in electrical engineering department at the Université de Sherbrooke, Canada since 1999. Dominique received his B.Eng. in electrical engineering and is PhD in mechanical engineering both at the Université de Sherbrooke. Before joining Université de Sherbrooke he was a postdoctoral fellow at University of Western Australia and University of Technology Sydney in Australia. He is involved in the field of nanoelectronic devices fabrication (Single electron devices, single electron memory) and advances materials characterization (GaN, ZnO, InAs quantum dots). He is also co-author of a world-renowned research program (CASINO) on imaging simulation software for the scanning electron microscope. This software is available on the Internet (www.gel.usherb.ca/casino) and used by over 10000 users worldwide. He has published more than 150 papers in international journals and conferences in the field of high temperature single electron devices, cathodoluminescence, electron beam lithography and electron-materials interaction modeling. He has given 9 invited presentations at international meetings. From 2000 to 2006, Dominique was VP operations of Quantiscript, a company in the field of resistless e-beam lithography.



Novel Si-based nanowire devices for MOSFETs scaling and integrated circuits hybrid integration.

Thomas Ernst

CEA-LETI, CEA / DRT/D2NT//LDI, 17, av. des Martyrs 38054 Grenoble Cedex

Abstract

3D CMOS nanowire matrices and 2D thin film technologies recently developed enable not only sub-22nm CMOS device scaling but also ultimate co-integration of novel functionalities. For CMOS scaling, Silicon-On-Insulator (SOI) or innovative Silicon-On-Nothing (SON) based 3D nanowires are proposed with common or independent gates. Ultra-low static consumption ($I_{OFF} < 50 \text{ pA}/\mu\text{m}$) as well as high driving current (up to $I_{ON} = 6.5 \text{ mA}/\mu\text{m}$) were achieved thanks to 3D stacked Gate-All-Around (GAA) nanowire channels. The top-down nanowire techniques also open up new opportunities for hybridizing CMOS with novel functionalities such as 3D memories, nano-oscillators and bio nano-sensors. In order to study these new opportunities, we present an innovative hybrid research platform that integrates the first Nano-Electro-Mechanical-Systems (NEMs) for VLSI with advanced CMOS and show related experimental results.

CV

Thomas Ernst received his Ph.D. degrees from the National Polytechnics Institute of Grenoble, France, in 2000. From 1997 to 2000, he developed advanced SOI CMOS electrical characterization, simulation and modelling methods at STMicroelectronics with IMEP laboratory. He then joined CEA-LETI to develop novel strained-channel CMOS architectures for 32 nm technology. In particular, he was leading strained SOI, strained Germanium, and SiGeOI CMOS integration at Leti. Since 2005, he is leading the 3D multi-channels and nanowire CMOS devices developments. His expertise is in the area of novel CMOS devices fabrication technology and MOSFETs analytical modelling for electrical characterization. Dr. Ernst is author or co-author of over 100 technical journal papers and communications at international conferences on CMOS devices integration, modelling and characterization. He is author or co-author of 13 patents.



One-Dimensional Transitional Metal and Compound Nanomaterials: Design, Characterization and Properties

Lin Guo

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Beijing University of Aeronautics and Astronautics, Beijing 100083, China
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Abstract

We demonstrate a chemical solution method for the synthesis of 1D nanostructures including ZnO, Ni, Co nanomaterials. Regularly shaped single crystalline ZnO Nanorods with wurtzite structure were prepared using dodecyl benzene sulfonic acid sodium salt (DBS) as the modifying and protecting agent. One-dimension nickel nanomaterials (including nickel nanochain, nanorod and nickel complex nanotube) modified by polyvinyl pyrrolidone (PVP) were synthesized via a series of novel and mild chemical methods in an ethylene glycol system. The synthesis and morphology control of three kind of 1D structures have been realized. Morphology and size control can be achieved by adjusting the kind of the reactants, the concentration of reactants, ratio of modified reagent/surfactant to reactants and refluxing time. Therefore, it offers a novel and attractive path to the preparation of 1D nanomaterials with different shapes and controllable sizes.

Lin GUO

Lin Guo got Ph.D. degree in materials science and engineering from Beijing University of Institute of Technology (BIT) in 1997. He went to Institute of High Energy Physics, Chinese Academy of Science in 2, 1997 as a postdoc research assistant for 20 months and get associate professor in 12, 1998. Then, he went to Prof. Shihe Yang's lab as a visiting scholar in Hong Kong University of Science and Technology for 1 year. He got the professor position in 6, 2001 in BUAA. Then, he went to Dresden Technology University do as Humboldt Fellowship for 2 years before he become the Director of Center of Chemistry in 6, 2003. Synthesis and characterization of zero-, one and two-dimensional nanoscale materials is his focused research area. He had published more than 100 publications in this field till now. His awards include the Humboldt Fellowship Award, Germany in 2001 and Ministry of education of the people's republic of China Prize for Outstanding Young Teacher in 2001, the program for New Century Excellent Talents in University in 2004. He got Outstanding Youth Fund from Nature Science Foundation of China in 2007. Now, he is vice dean of school of chemistry and Environment.



Single-Molecule Devices Based on SWNT Electrodes

Xuefeng Guo

Beijing National Laboratory for Molecular Sciences (BNLMS), State Key Laboratory for Structural Chemistry of Unstable and Stable Species, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, P. R. China.

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Abstract

In the scenario of device miniaturization motivated by the limits of the inherent quantum effects of conventional silicon-based devices, a recent research is that we have developed a reliable and reproducible e-beam lithographic method to covalently wire conjugated molecules into gaps in the range of 1-10 nm on precisely-cut single-walled carbon nanotube electrodes (SWCNTs) through amide linkages.¹⁻⁴ This strategy is robust and allows a wide-variety of single molecules or a small collection of molecules to be tested electrically. Based on this, we not only demonstrated a universal platform of how to utilize the diversities of single molecules with special functions and how to install functionalities on molecule-bridged single-walled carbon nanotubes, allowing the conductance of the single-molecule devices sensitive to external stimuli, such as proton, light, ion, and chemical effect, but also demonstrated a powerful tool of SWCNTs as ultras-small point contacts to realize polyacene monolayer and single column transistors, which indicate the interesting chemoresponsive or efficacious light-to-current converting semiconducting properties. These studies apparently provide the deeper understanding of the interplay between molecular structure, assembly, and emergent functions at the molecular level and consequently the novel insights into designing and creating novel molecule-scale optoelectronic devices.

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Xuefeng GUO

Prof. Xuefeng Guo was born in Luzhou, Sichuan Province in 1975. He received his Ph.D. in 2004 from the Institute of Chemistry, Chinese Academy of Science, Beijing under the guidance of Daoben Zhu and Deqing Zhang. In 2006, he gained the National Top 100 Excellent Ph. D. Thesis Award in China. From 2004 to 2007 he was a postdoctoral scientist at Columbia University with Colin Nuckolls and Philip Kim. He joined the faculty as a professor under Peking "100 Talents" Program at Peking University in 2008. His research focuses on the design, fabrication and optoelectronic properties of nanometer/molecular devices. He has over 50 scientific papers, including *Science*, *Acc. Chem. Res.*, *Nature Nanotech.*, *PNAS* and *JACS et. al.* and 5 patents.



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Challenges of Nanophotonics Integration

Andrew Kirk

Director, McGill Institute for Advanced Materials, Associate Professor,
Department of Electrical and Computer Engineering, McGill University

Whilst great progress has been realised in recent years in the development of photonic integrated circuits (PICs), they remain far from the level of integration that has been achieved in microelectronics. In this talk I will review the role of nanophotonic structures in achieving photonic integration. These nanostructures include: i) photonic crystals, which can be used to engineer very high quality factor resonators, wavelength shifters and highly dispersive structures; ii) nanowire waveguides which can achieve very high confinement and small bend radii in order to fabricate ring resonator filters and modulators and iii) gratings for assisting in the vertical integration of active and passive materials. I will illustrate this talk with examples of recently developed devices from our laboratories and elsewhere, including photonic crystal demultiplexers, hybrid silicon lasers and integrated space switches, all of which make use of nanostructures in different ways in order to increase the level of integration. Nanophotonics integration is critically dependent on the fabrication technology that is employed, and I will consider the role and capabilities of various techniques, include deep UV optical lithography and electron beam writing. Finally I will consider review the recent work of David Miller of Stanford University on the fundamental limits to integration volume, based on an analysis of the modal volume necessary to distinguish different wavelengths or pulses, in order to better understand the ultimate possibilities for nanophotonics integration.

CV of Andrew Kirk

Andrew Kirk received the Ph.D. degree in Physics from the University of London (King's College) in 1992 and was subsequently awarded a post-doctoral fellowship at the University of Tokyo followed by the Brussels Free University, Belgium. He has been a member of the Department of Electrical and Computer Engineering at McGill since 1996. In 2000 he was awarded a William Dawson Scholar Chair at McGill (an internal award equivalent to a Canada Research Chair Tier II), which was renewed in 2006, and he is a co-winner of the 2006 NSERC Synergy Award. He has twice been awarded the Principal's Prize for Excellence in Teaching at McGill (in 2001 and 2004).



He is author of more than 60 refereed journal articles and 120 conference presentations, including numerous invited papers and presentations, and has 4 patents and patent applications. His research interests include photonic materials, diffractive and refractive micro-optical systems, photonic integration techniques for planar waveguide devices and applications of surface plasmon resonance for optical biosensors. In 2006 he was appointed Associate Dean for Research and Graduate Education in the Faculty of Engineering at McGill and in September 2007 he was appointed as Director of the McGill Institute for Advanced Materials (MIAM). He is currently Chair of the IEEE-Photonics Society Nanophotonics Technical Committee.

Synthesis and characterization of nanostructures for biomedical and energy applications

Dongling Ma

and Haiguang Zhao, Teng Zhang, Ibrahima Ka, Jianming Zhang, Daria Riabinina, My Ali El Khakani, Mohamed Chaker

Institut national de la recherche scientifique, University of Quebec, Varennes, Qc, Canada

We present herein our work on PbS nanocrystals, PbS/Carbon-NanoTube (CNT) nano-hybrids and Au nanoparticles, which have potential applications in biomedicine and/or photovoltaics.

High-quality near-infrared emitting PbS nanocrystals with a narrow size distribution have been synthesized in an organic phase. In order to explore their biomedical applications, various approaches have been applied to transfer them into aqueous environments. It has been found the photoluminescence behavior of these nanocrystals after phase transfer is highly sensitive to initial surface ligand structures. Optimal phase transfer conditions have been secured based on detailed structural and photophysical investigation. On the other hand, for the first time, PbS nanocrystals have been synthesized, in a controlled fashion, directly on various substrates using a laser deposition method, which promises to lead to simplified fabrication of photovoltaic devices. Tunable photoluminescence has been achieved by adjusting deposition parameters.

Both chemically and physically prepared PbS nanocrystals have been hybridized with CNTs and the interesting optoelectronic properties of the nano-hybrid will be presented.

We have also attempted a new physico-chemical approach to synthesize Au nanoparticles with better control over the size, shape and dispersion as compared to a physical laser method used alone. Preliminary studies show that such synthesized Au nanoparticles are partially oxidized. The effect of the change of surface chemistry of Au nanoparticles on the particle stability, adsorption and dye-Au interactions as well as on the optical and catalytic properties of Au nanoparticles will be discussed. These partially oxidized Au nanoparticles could have advantages over pure Au nanoparticles in certain applications.

Assistant Professor Dongling MA

Dongling Ma has been an assistant professor at the center of Énergie, Matériaux et Télécommunications, Institut national de la recherche scientifique (INRS), University of Quebec in Canada since July 2006. Her research interest consists in the development of novel nanoparticles (NPs) and nanocomposites for applications in biomedical and energy sectors.

Before joining INRS, she had worked as a Natural Sciences and Engineering Research Council (NSERC) Fellow with Dr. Benoit Simard at the Steacie Institute for Molecular Sciences, National Research Council of Canada for about 2.5 years (Feb 2004- June 2006). During that period, she mostly focused on the development of various core@shell nanostructures, e.g., superparamagnetic-core@dye-doped-silica-shell NPs, for biomedical applications.

She received her Ph.D. in Materials Science and Engineering at Rensselaer Polytechnic Institute in Troy, NY (Sep 2000-Jan 2004) under the supervision of Profs. Linda S. Schadler and Richard W. Siegel, a leading figure of Rensselaer Nanoscale Science and Engineering Center. Her research work was concentrated on NP surface modifications and their effects on the electrical properties of polymer nanocomposites. In parallel, she worked on the self-assembly of NPs into a microscale tube structure.

Carbon Nanotubes Electronics by Chemical Assembly

Richard Martel

Regroupement Québécois sur les Matériaux de Pointe et Département de chimie, Université de Montréal, Québec, Canada

Abstract

The semiconducting single-walled carbon nanotubes have been used since 1998 as conductive channels for making high performance field-effect transistors. The potential use of metallic nanotubes in electronics has also been highlighted in many different ways through the demonstration of robust interconnects, field-emitters, and transparent conductive electrodes. This talk will first review simple concepts and models that can be used to describe the basic electrical transport properties of nanotubes and nanotube networks. These models will then be applied to the results obtained from key experiments on individual and network channel devices, including p/n junctions. Last, examples will be shown in order to highlight recent development toward the chemical processing, manipulation and assembly of nanotubes from solution. While the main focus is put on the single-walled nanotubes, the talk will also present results on double-walled carbon nanotubes.

CV

Richard Martel, an Associate Professor of Chemistry at the Université de Montréal, holds a Canada Research Chair on electroactive nanomaterials and interfaces. Martel is known internationally for his leading role in forefront research on carbon nanotube electronics. He received his Ph.D. in 1995 from the Université Laval in Quebec. After postdoctoral work at IBM Research, he worked at the IBM T.J. Watson Research Center (NY, USA) from 1998 until 2003 as a Research Staff Member of the Nanometer Scale Science and Technology group. His early work focused on electronic excitations and dissociative electron attachment in molecules adsorbed on surfaces. His interest is now focused on electro-optical phenomena in novel electronic nanomaterials, such as carbon nanotubes, molecular nanostructures and assemblies. His current work includes experiments on carrier transport, injection, recombination/separation and transfer in electroactive nanostructures. He has published over 95 technical papers, co-authored several patent applications, and presented many invited and contributed talks at international conferences. Martel is a fellow of the American Physical Society and received in 2000 and 2002 two IBM outstanding achievement awards and an IBM Research Division Award in 2004 for breakthroughs in the field of nanotube electronics. His work on carbon nanotube electronics was selected breakthrough of year 2001 by Science and one of the Chemistry Highlights of 2003 by C&EN.



Anything more than size in nanoelectronics ?

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SE-581-83 Linköping, Sweden,

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Abstract

With the advance of fabrication techniques, integrated circuits (IC) industries have been merged into the nano-technology realm, and soon the 32 nm technology will be used for commercial chip production. It is evident that Si as the backbone material for IC electronics will still keep going for quite some years, and continue to give power to the world economy. The issue is how to further pursue the race? Every body knows there must be an end for the size competition, since the separation between the source and drain can't be zero. Therefore, as a trend and also the vision of industries, the chip production would not only go further for structural miniaturization (more Moore), but also extend the chip functionalities (more than Moore) to involve various novel device architectures using on-chip or off-chip integration solutions for a new generation of electronics systems with high added values for the end customers. This thus requires interdisciplinary and diversification of knowledge, in particular challenges materials science for new material systems that are designed and engineered through nanotechnology.

In this talk, a survey of recent efforts at National Nano Device Laboratories (NDL) and Linköping University for Si-based devices and architectures that maybe implemented along the roads toward 15 nm-node CMOS and beyond for more and more than Moore will be given, in particular, to deal with some device solutions using Ge or III-V semiconductors for enhancing performance and functionalities, and issues relating to so-called heterogeneous integration of these devices with the existing Si chip systems. Furthermore, some routes to integrate functional devices for electronic-photonic convergence and bio-electronic applications will also be discussed.

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Wei-Xin Ni, PhD from Linköping University (LiU) in Feb. 1991, and professor in surface and semiconductor physics at LiU since 2003. He has a long experience and established competence in the field of Si-based nanostructured materials and devices. Already in 1987, he successfully grew one of the world earliest SiGe-HBTs using solid source MBE in Linköping. He has been extensively working on material synthesis and characterizations of layered and low-dimensional heterojunction semiconductor materials, as well as the devices, including light emitting devices, detectors (HBT and FET detectors), RF power HBTs, ballistic junction devices, etc, based on the nano-structures of Si-based materials. He was awarded with a TSMC distinguished professorship in connection to Taiwan National Chiao Tung University (NCTU) in 2004, and was the director of general of National Nano Device Laboratories in Taiwan during 2004-2008.

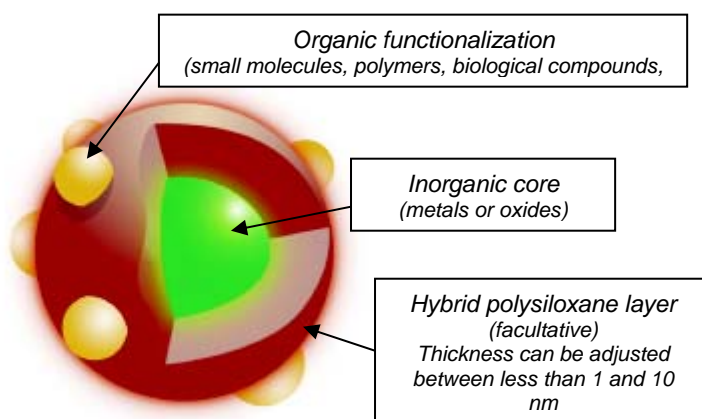
Lanthanide-based hybrid nanoparticles for diagnosis and cancer therapy.

Pascal Perriat¹& C. Billotey², M. Janier², S. Roux³, O. Tillement³¹ MATEIS, UMR 5510, INSA de Lyon (Pascal.Perriat@insa-lyon.fr)² CREATIS-Animage, UMR 5515, Université de Lyon³ LPCML, UMR 5620, Université de Lyon**Abstract**

For a couple of decades, greater and greater connections have been made between nanotechnology, biology and medicine. Initially based on noble metals and semi-conductors, they now become more and more sophisticated with an increased possibility of highly sensitive detection, specific targeting, drug delivery triggering and combination on both diagnosis and therapy. In all cases, the nanometric size is a crucial parameter to confer to particles key properties as stealthiness or high colloidal stability with respect to the environment and of the external medium.

This conference will show how the development of nano-hybrids based on rare-earth oxides may consist of an interesting strategy to elaborate always more efficient probes in the domains of biological detection and imaging that also possess therapeutic properties.

The nano-hybrids developed possess of a core/shell structure, the core being made of a rare-earth oxide and the shell of polysiloxane. The main constituent of the core is Gd_2O_3 or Y_2O_3 doped with luminescent cations as Eu^{3+} , Tb^{3+} (emitting in visible) or Nd^{3+} (emitting in IR). In the polysiloxane shell are encapsulated a multitude of organic dyes and/or magnetic rare-earth ions. These doping species confer to the composite a double luminescence : organic (intense but fairly stable) and inorganic (less intense but highly stable) and/or a paramagnetic behaviour. These ultra-small inorganic composites (between 3 and 100 nm) can be derivatized with biological molecules such as oligonucleotides, biotin, streptavidin, secondary anti-bodies or other small molecules or polymers.

**Multi-functional luminescent probes**

The conference will detail : (i) the procedure of elaboration of such nano-hybrids, (ii) why these nano-hybrids possess great potentiality in biological imaging and cancer therapy, (iii) some examples of in-vivo imaging and therapy (mice).

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Colloidal assembly and nanodevices : towards nanorobotics

David Peyrade

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LTM - CNRS CEA/LETI/D2NT 17, av. des Martyrs 38054 Grenoble Cedex, France

Abstract

Colloidal Nanostructures (CNs) are offently referred as 'artificial atoms' due to the control of the density of their electronic states by changing their composition, size or shapes useful in nanoelectronic. Due to their nanometer size, they scattered or emitted light opening the control of light propagation or optical sensing at the wavelength scale. Moreover, their high specific surface combined with CNs core-shell functionalisation allows the development of biosensing or bidiagnostic applications. Finally, CNs are considered as as potential building blocks in the research field of nanoscience. But to fully study and exploit their nanoscale properties, rapid and low-cost technological ways must be develop to overcome colloidal Brownian motion and localize in a deterministic way CNs on a surface.

My intervention will present you original alternative strategies to handle (assembly, localize, separate,..) CNs and evaluate the asets of these methods in terms of nanoengineering, and nanomachining. The integration of colloidal nanostructures into nanodevices is studied in real-time by Capillary-Force-Assembly (CFA),or Dielectrophoretic (DEP) trapping. The physical properties of colloidal/supra-colloidal nanostructure devices are determined. Finally, I will present a new type of microfluidic chip for 3D-DEP colloidal handling directly inside the fluid. I will show our last results concerning application towards nanorobotics.

CV

Dr David Peyrade graduated from the Physics Department of INSAT. He received the Ph.D. degree from the condensed matter physics department of the University of Montpellier, France, in 2002 for advanced work on SOI Faby-Perot microcavities and GaN photonic crystals. He joined the LTM laboratory (c/o CEA-Minatec - Grenoble) in 2003 as a CNRS research scientist. His main research experiences concerns advanced micro/nanofabrication, nanophotonic and colloidal nanostructures. Since 2006, he creates the "Colloidal Nanodevices" group engaged in interdisciplinary applied physics and device research spanning nanotechnology microfluidic oriented. The team develops original alternative strategies to manipulate in 2D (assembly, localize, separate...on a surface) or in 3D (microfluidic chip) colloidal nanostructures. He is author or coauthor of more than 50 publications.



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Colloidal Nanodevice team website: <http://www.ltm-cnrs.fr/-Nanofabrication-.html>

Recent Experiments in the Nano-Electro-Mechanics of Nanotubes and Nanowires

S.T Purcell

& A. Ayari, P. Vincent, S. Perisanu, M. Choueib, V. Gouttenoire

Laboratoire de Physique de la Matière Condensée et Nanostructures, Université Lyon 1, CNRS, UMR 5586,
Domaine Scientifique de la Doua, 69622, Villeurbanne, Cedex, France**Abstract**

Nanotubes and nanowires (NNs) have been recently attracting sustained attention as mobile elements in nanoelectromechanical systems (NEMS). The extremely small physical dimensions of these nanostructures imply high sensitivity to external perturbations and this opens perspectives for novel ultrasensitive, high speed and low power devices in the MHz and GHz range, as well as original experiments in fundamental physics. Starting with a first experiment on the excitation, detection and tuning of the mechanical resonances of carbon nanotubes in a field emission (FE) configuration [1], we have developed a research program that explores a rich space of linear, non-linear and high frequency response phenomena. In this talk I will discuss two of the orientations we are developing in this field: (1) self oscillations during field emission from SiC nanowires [2] and (2) suspended single wall carbon nanotube (SWNT) oscillators [3].

We have found that at a certain level of DC applied voltage and emitted current, SiC nanowires can spontaneously jump into their natural mechanical vibration (i.e. self oscillations), accompanied by oscillations in the FE current. A model explaining this will be discussed in which the mechanical and electrical equations are coupled by the FE current. It is the dependence of the FE current versus position of the oscillating nanowire apex that allows the injection of energy into the mechanical degrees of freedom of the system. This system constitutes a DC/AC conversion device in which all the physics is in the near nanowire environment.

Single wall nanotubes (SWNTs) are the ultimate mechanical element because of their small size, possible structural perfection and high Young's modulus. Despite their small size, Sazonova, et al. [4] succeeded in exciting suspended, double-clamped SWNTs in a transistor configuration and detecting their motion by mixing techniques. Jensen et al. combined the FE configuration and the mixing techniques to show how a singly clamped nanotube in FE can act as antenna, tunable band-pass filter, amplifier, and demodulator for radio signals. We have recently succeeded in our lab in producing transistor-type SWNT oscillators in the high MHz range. Here I will briefly discuss AM, FM and digital demodulation of these devices. We show that the FM technique yields to the suppression of unwanted background signal, reduces noise for the detection of mechanical motion of nanotubes and that digital data transfer rate of standard cell phone technology is within reach of our devices [3].

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Curriculum Vitae

Stephen PURCELL. 53 yrs. Director of Research, Université Lyon1-CNRS, LPMCN.

Team Leader and founder "PNEC".

64 Publications, 2 Patents, 14 Invited International Conferences.

1989 PhD Simon Fraser University, Burnaby, Canada, "Structural and Magnetic Properties of Ultrathin Ni Layers Grown Epitaxially on Fe (001)", Prof. A.S. Arrott, Prof. B.H. Heinrich.

1989-1991: Post doctoral fellow/Research Scientist - Philips Research Eindhoven., Magnetic Coupling, Anisotropies and Optical properties of Epitaxial Ultrathin Films.

Member of the scientific councils of the research organisms : "Science and Applications of Nanotubes" (2002-2008), "Semiconductor Nanowires" piloted by the CNRS, the OMNT working group on NEMS and the European working group on NEMS (J. Brugger, EPFL).

Scientific Advisor: NEWSTEP (PME) - Largescale Advertising CRT screens based on CNTs.

Member "Comité d'Evaluation", ANR PNANO 2007 to present.

Current Scientific Interests

The research programme of the PNEC team covers a broad spectrum interrelated projects within the nanoscience and technology sector: (1) FE electron and ion sources, (2) Growth of CNTs for local probes, FE sources and nanostructured surfaces for microfluidity. (3) The physics of CNTs and nanowires: electrical and thermal transport, optical properties, Young's modulus. (4) Linear and non-linear mechanical resonances of CNTs and nanowires of interest for advanced NEMS devices. The projects mix fundamental and applied research with room for financed and internally supported projects.

Nanocrystal-Molecule Nanostructures and Assemblies: Formation, Plasmonic Properties and Electrical Contacting

Aidan Quinn

Nanotechnology Group, Tyndall National Institute, Lee Maltings, Cork, Ireland.

Abstract

This presentation will focus on development of solution-based processes for assembly of plasmonic nanostructures from gold nanocrystals using bifunctional molecular linkers with sulphur-containing end groups. Each experiment produces a distribution of “ n -mer”, nanostructures where n denotes the number of nanocrystals in the structure, e.g., nanocrystal-molecule(s)-nanocrystal dimers ($n = 2$), trimers ($n = 3$) etc.

UV-visible extinction data, coupled with histogram analysis of nanostructures measured using scanning electron microscopy has shown a characteristic optical response at wavelengths close to 600 nm following formation of dimer and trimer nanostructures using size-similar gold nanocrystals with core diameter $d = 20$ nm.

Simulations based on the Generalized Multiparticle Mie method for dimers comprising $d = 20$ nm Au nanocrystals with edge-edge separation ~ 1.2 nm (expected length for linker molecules) show two main peaks, one close to 520 nm and a second longer-wavelength peak close to 600 nm. This longer wavelength feature is more prominent for case where the field polarisation is parallel to the dimer axis.

Directed assembly processes based on trapping using a.c. fields have also been developed for electrical interfacing of nanocrystals and n -mer nanostructures between top-down nanoelectrode pairs for electrical characterisation. Initial investigations of charge transport in these “few-molecule” devices will be presented.

Brief biography:

Dr. Aidan Quinn is Head of the Nanotechnology Group at the Tyndall National Institute in Cork. His research interests include application of self-assembly to the fabrication of nanocrystal-, nanowire- and molecule-based devices with novel (opto-) electronic functionality, development of low cost nanostructure fabrication methods and interfacing of bottom-up synthesised nanostructures with top-down fabricated nanodevices. Aidan lectures part-time at University College Cork (Departments of Microelectronics and Physics) and has co-developed courses on Nanotechnology and Computational Physics .



Aidan has participated in research projects within the EU Fourth, Fifth, Sixth and Seventh Framework Programmes' Esprit, Marie Curie, IST, IHP, ICT and NMP actions and within the Irish Government Higher Education Authority PRTL Cycles 1, 3 and 4 Initiatives. He also currently holds an Investigator grant with SFI's Research Frontiers Programme and is a co-PI in the FORME Strategic Research Cluster. He has acted as a consultant on future research directions in Nanotechnology in Ireland, both as a member of the ICSTI Nanotechnology Task Force and a panel member of the Forfás NanoIreland Technology Assessment Exercise.

Connecting collective assessment with continuous moral assessment.

Bernard Reber

Research Centre Meaning, Ethics, Society-CNRS-University Paris Descartes

Abstract

Taking into account the “challenges for the democracy, around the positive and negative impacts of nanotechnologies”, we will consider the possibility to match Participatory Technological Assessment (PTA) procedures and “an ongoing normative assessment”, proposed by J-P. Dupuy and Alexei Grinbaum (2005), in the frame of what they call: nanotechnology’s metaphysical research program. We will try to make the list of theoretical problems in the attempt to link moral assessment and political theories. Contrary to them, we will try to take the better of the resources of moral theories and deliberative democracy theory, matched by the precautionary principle, to consider different ways to discuss and make decisions in a context of many levels of uncertainties, between apocalyptic and innovative scenarios and beliefs. We will compare some of PTA examples in (Paris, Taipei, Coimbra), to analyse their normative assessments. Confronting the novelty of the nanos potential risk of hard damages, we will compare this public controversy with another issues, like brain researches to see differences and similarities with technologies that are not well identified by the public. The perspective will be to reach the capacity to assess technologies beyond the discourse around to them.

CV

Current position: Permanent Researcher (1st class) CNRS, Centre de Recherche Sens, Éthique, Société (UMR 8137 CNRS – University Paris Descartes).

**Qualifications**

- 1999 Doctoral degree, Political and Moral Philosophy, École des Hautes Études en Sciences Sociales, Paris. Director: Monique Canto-Sperber. Title: La nouveauté éthique des « nouvelles technologies ». Les techniques confrontées à l'exigence apocalyptique, (other members of the jury: Bruno Latour, Pierre Livet, Ruwen Ogien, Laurent Thévenot).
- 1994 Post-graduate degree in Communication Studies, European Media Studies, Bruxelles.
- 1993 Masters in Social and Economical Sciences (4 years), Institut d'Études Économiques et Sociales, (Institut Catholique de Paris).
- 1993 Master in Theology, Institut des Sciences Théologiques Systématiques et Bibliques, ICP, Paris.
- 1991 Bachelor in Philosophie (4 years), Institut Supérieur de Théologie et de Sciences Religieuses du Centre Sèvres, Paris.
- 1991 Bachelor in Theology and Religious Sciences (4 years), Institut Supérieur de Théologie et de Sciences Religieuses du Centre Sèvres, Paris and University of Fribourg (CH).

Selected Publications

Books : La démocratie génétiquement modifiée. Sociologies éthiques de l'évaluation des technologies controversées, to be published, 2009, (330 pages).

Books (coedited): With Brossaud C (dir.). Traité, Humanités numériques 1. Nouvelles technologies cognitives et épistémologie, et Humanités numériques 2. Socio-informatique et démocratie cognitive, Information – Commande – Communication, série Cognition et traitement de l'information, Hermes Science International, 2007.

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Strategies for controlled assembly at the nanoscale

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Abstract

The bottom-up approach is considered a potential alternative for low cost manufacturing of nanostructured materials [1]. It is based on the concept of self-assembly of nanostructures on a substrate. We propose various strategies to control nanostructure assembly (both organic and inorganic) at the nanoscale. Our approach includes:

(i) deposition on naturally patterned substrates, which exploit long-range reconstructions [2]; (ii) we are able to control the size and luminescence properties of semiconductor nanostructures, synthesized by reactive laser ablation [3]; (iii) we have developed new experimental tools and comparison with simulations are presented to gain atomic scale insight into the surface processes that govern nucleation, growth and assembly [4-7]; (iv) by controlling inter-molecular interactions, we demonstrate that it is possible to create specific nanoscale patterns [8-10]; (v) we developed a simple surface modification strategy for biomaterials which enhances biocompatibility [11-14].

Federico Rosei: biographical sketch

Federico Rosei received a Laurea degree (1996) and a PhD (2001) in Physics from the University of Rome "La Sapienza". He worked as a Post-Doctoral Research Associate and Marie Curie Fellow at the Center for Atomic Scale Materials Physics in Aarhus (Denmark) from the end of 2000 until April 2002. He then joined the faculty at INRS-Energie, Matériaux et Télécommunications, Université du Québec as Assistant Professor in May 2002. Only two years later, he was promoted to Associate Professor, with tenure. He is recipient of a Strategic FQRNT Fellowship for New Professors from the Province of Quebec and holds the Canada Research Chair in Nanostructured Organic and Inorganic Materials.



Dr. Rosei's research interests focus on the properties of nanostructured materials, and on how to control their size, shape, composition, stability and positioning when grown on suitable substrates. He has extensive experience in fabricating, processing and characterizing inorganic, organic and biocompatible nanomaterials.

He has co-authored over 80 articles in prestigious international journals (including *Science*, *Physical Review Letters*, *J. Am. Chem. Soc.*, *Angewandte Chemie*, *Nanoletters*, *Small*, *Phys. Rev. B* and *Applied Physics Letters*) and has given over 85 Invited, Keynote and Plenary Talks at international conferences and over 100 seminars at Universities, Government and Industrial Laboratories since 2000.

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Addressing molecules on surfaces using chemical and biological fonctionnalisation

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Chemical and biological fonctionnalisations allow adressing and grafting of a multiplicity of nano-objects (nanoparticles, nanorods, molecules) at proper and precise locations on a support. These strategies have been initially used for biosensing and biomolecular recognition. They can also be employed for exploring new micro & nanofabrication strategies.

We will present several approaches explored in our group, including :

- 1) Using DNA microarrays for immobilising low concentration biomolecules
- 2) Assembling and grafting on a support of particle based structures.
- 3) Combining surface microcontact printing and fluorescence enhancement

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CV

Dr Eliane Souteyrand received her PhD degree (1979) from Paris VI University and the graduate of "Docteur d'Etat" in Materials Sciences (1985). She began her professional activities at IBM (Corbeil-Essonnes) and joined CNRS in 1981 for developing her research activities in Electrochemistry, Photovoltaic and Semiconductors. In 1991, she integrated Ecole Centrale de Lyon and investigated the field of Gas sensors,, Biosensors and DNA chips. In 2000, she received the Award of Innovative Company Creation, followed the entrepreneurial training program at the Lyon School of Business and found Rosatech S.A, a company devoted to "Biochips for diagnostics". Currently, she leads the "Biotechnology for Health" department and managed the "Chemistry and Nanobiotechnologies" team at the Institute of Nanotechnology of Lyon. She is the co-author of more than 70 international publications and holds 9 international patents.



Surface nanopatterning of biomolecules for biochips, biology and biophysics: Tools, Processes and Applications.

Christophe Vieu

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For many applications of biochip technology for medical diagnosis or drug screening, it is necessary to fix probe molecules on a surface at registered position. This technological process is called biopatterning. The spatial resolution and the quality of the arrangement of the probe molecules on the surface are of crucial importance for both the density of the chip and its sensitivity. I will show in the presentation why soft-lithography and more specifically Micro-Contact printing (μ CP) exhibit specific advantages for advanced biopatterning.

In a first part, I will show how μ CP can be used for the fabrication of DNA micro array [1,2]. We have found that the fluorescence signal emitted by DNA hybridization spots created by μ CP is systematically higher compared to similar spots created by conventional tip deposition.

In a second part I will address the key issue of printing different molecules in one step. Two methods have been developed. The first one is capable of generating self-aligned patterns of different biomolecules using PDMS stamps exhibiting several levels of topography [3]. The second one is adapted to the production of advanced microarrays. We have developed and patented a novel method for Multiplexing the μ CP technique which targets the deposition of 100-1000 different molecules in one step [4].

In a last part, I will present the fabrication of submicronic domains of lipidic bilayers using soft-lithography and self-assembly [5]. This method is designed for the investigation of membrane proteins and the assembly of nanomachines like the flagellar nanomotor of bacteria. I will also present some new results showing the versatility of the method for organizing single DNA molecules on surfaces or for the immobilization of single living bacteria [6,7].

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