KATHOLIEKE UNIVERSITEIT
LEUVEN

Capita Selecta Lectures of Nanoscience and Nanotechnology H6L3 & H6N2

Prof.dr.ir. Jo De Boeck
K.U.Leuven, Belgium

Imec, Kapeldreef 75,
B-3001 Leuven, Belgium

Program and Abstracts

Academic Year 2017-2018

Introduction

How does so-called Nanoscience and Nanotechnology impact on modern society?
What are important scientific and technological nanotech fields at present?
What novel properties are created by precise manipulation of materials at atomic scale?
Can we construct novel building blocks with nano-scale precision and for what purpose?
What is the link between nanotech and life science?
What are there ethical or legal aspects we should know and care about?
What business opportunities arise in e.g. life-science, biotech, ICT or consumer products?

In the academic year 2017-2018, the 12th edition, Capita Selecta Lectures of Nanoscience and Nanotechnology[1], comprises of **11** lectures that will address a.o. the above questions. The lecturers are local and international experts on the selected topics, of which you can find the program details in this brochure. The topics are selected with input from the Erasmus Mundus program partners[2] and input from the students.

The topics, dates and location of the 2017-2018 lectures are as follows:

	Name	**Affiliation**	**Titel**	**Host**
13-Feb	De Wael Karolien	Univ. of Antwerp	Innovative electrochemical sensing strategies	KULeuven
20-Feb	Magdanz Veronika	IFW-Leibniz Inst. For Solid State & Mat. Res. Dresden	Teaming up nanotechnology with biological components to create hybrid microswimmers	Dresden
27-Feb	Johansson Göran	Univ. of Chalmers	Quantum Technology in Superconducting Circuits	Chalmers
6-Mar	Rafai Salima	CNRS, LIPHY, Grenoble	Flowing Active Suspensions: Chlamydomonas Reinhardtii, a model active particle	Grenoble
20-Mar	Korten Till	B CUBE, TU Dresden	A tiny step for a protein, a giant leap for nanotechnology: Nanotechnological applications of biomolecular motors	Dresden
27-Mar	Wieczorek Witlef	Univ. of Chalmers	Mechanical resonators as novel quantum devices	Chalmers
17-Apr	Faugeras Clement	LNCMI-CNRS, Grenoble	Using light to investigate the electronic properties of 2D crystals	Grenoble
24-Apr	Op de Beeck Maaike	Imec & Univ. Gent	Ultrathin flexible encapsulation technology for electronic implants	KULeuven
8-May	Cherednichenko Serguei	Univ. of Chalmers	Superconducting nano detectors: from terahertz to infrared	Chalmers
15-May	Ryckaert Julien	Imec	Design-Technology Co-optimization for advanced nodes: from scaling boosters to 3D Logic	KULeuven
22-May	Chenevier Pascale	CEA-Grenoble	Carbon nanoobjects: a wide source of new conductors and semi-conductors for electronics and energy	Grenoble

All lectures are broadcast live by the Audio-Visual department of the K.U. Leuven (ICTS) to all Erasmus Mundus partner universities using a Virtual Classroom concept. The lectures are open to everyone interested in the field and compulsory for the students in both Master programs. All lectures are always followed by a discussion session involving the lecturers, the students and nanotechnology professionals.

We look forward to welcome you at the Capita Selecta Lectures.

Prof. Jo De Boeck, Coordinator H6L3/H6N2
January, 2018.

[1]These lectures are organized in the frame of the Courses H6L3 "Capita Selecta of Nanoscience and Nanotechnology" within the Master of Nanoscience and Nanotechnology at the K.U.Leuven and H6N2 "Erasmus Mundus Lectures on Nanoscience and Nanotechnology".
[2]K.U.Leuven, TU Dresden, Chalmers University and the Université Jean Fourrier Grenoble.

Capita Selecta of Nanoscience and Nanotechnology

Program, Abstracts and CV's

Program

Tuesday, 13 February 2018, 5-7pm (Broadcast from Leuven, Aud. "De Molen")
Dr. Karolien De Wael, Univ. of Antwerp, Belgium
Innovative electrochemical sensing strategies

Tuesday, 20 February 2018, 5-7pm (Broadcast from Dresden)
Dr. Veronika Magdanz, IFW-Leibniz Inst. For Solid State & Mat. Res. Dresden, Germany
Teaming up nanotechnology with biological components to create hybrid microswimmers

Tuesday, 27 February 2018, 5-7pm (Broadcast from Chalmers)
Dr. Johansson Göran, Chalmers University of Technology, Sweden
Quantum Technology in Superconducting Circuits

Tuesday, 6 March 2018, 5-7pm (Broadcast from Grenoble)
Dr. Salima Rafai, CNRS, LIPHY, Grenoble, France
Flowing Active Suspensions: Chlamydomonas Reinhardtii, a model active particle

Tuesday, 20 March 2018, 5-7pm (Broadcast from Dresden)
Dr. Till Korten, B CUBE, TU Dresden, Germany
A tiny step for a protein, a giant leap for nanotechnology: Nanotechnological applications of biomolecular motors

Tuesday, 27 March 2018, 5-7pm (Broadcast from Chalmers)
Dr. Wieczorek Witlef, Chalmers University of Technology, Sweden
Mechanical resonators as novel quantum devices

Tuesday, 17 April 2018, 5-7pm (Broadcast from Grenoble)
Dr. Faugeras Clement, Grenoble High Magnetic Field Laboratory (LNCMI-CNRS), France
Using light to investigate the electronic properties of 2D crystals

Tuesday, 24 April 2018, 5-7pm (Broadcast from Leuven, Aud. "De Molen")
Dr. Maaike Op de Beeck, Imec, Belgium
Ultrathin flexible encapsulation technology for electronic implants

Tuesday, 8 May 2018, 5-7pm (Broadcast from Chalmers)
Dr. Cherednichenko Serguei, Chalmers University of Technology, Sweden
Superconducting nano detectors: from terahertz to infrared

Tuesday, 15 May 2018, 5-7pm (Broadcast from Leuven, Aud. "De Molen")
Dr. Julien Ryckaert, Imec, Belgium
Design-Technology Co-optimization for advanced nodes: from scaling boosters to 3D Logic

Tuesday, 22 May 2018, 5-7pm (Broadcast from Grenoble)
Dr. Pascale Chenevier, CEA-Grenoble at Univ. Grenoble Alpes, France
Carbon nanoobjects: a wide source of new conductors and semi-conductors for electronics and energy

Capita Selecta of Nanoscience and Nanotechnology

Abstracts & CV's

Tuesday, February 13, 2018, 5-7pm
Karolien De Wael, University of Antwerp, Belgium

Innovative electrochemical sensing strategies

Today the demand for ultra-sensitive and selective on-site detection systems resounds from the health, food and environmental sector. These systems must be able to detect and quantify target molecules, important in point-of-care testing and for assessing the level of contamination in food and environmental samples for example. Electrochemical sensors are very attractive for monitoring the presence and concentration of pollutants as these devices are fast, portable and extremely sensitive and selective towards electro-active species.

After a short introduction on electrochemical principles, innovative concepts in electrochemical sensing will be discussed by focusing on topics with high societal and industrial relevance.

Prof. dr. Karolien De Wael

Karolien De Wael obtained her PhD in Chemistry at Ghent University in 2005. In 2011, she was appointed as Research Professor at the University of Antwerp. Prof De Wael has an expertise in (bio)electrochemistry and she is Spokesperson of the AXES Research Group at the University of Antwerp in Belgium. She is the main organiser of the SMOBE (Summer meeting on Bio-electrochemistry, (https://www.uantwerpen.be/en/conferences/summer-meeting-bioelectrochemistry/).
Website of her group:
https://www.uantwerpen.be/axes/ and https://www.uantwerpen.be/en/staff/karolien-dewael/
Information regarding group members, research topics, highlights, projects, education, news and events, equipment etc can be found on the website.

Tuesday, February 20, 2018, 5-7pm

Veronika Magdanz, IFW-Leibniz Inst. For Solid State & Mat. Res.
Dresden, Germany

Teaming up nanotechnology with biological components to create hybrid microswimmers

The development of microdevices that are able to move autonomously under physiological conditions is one of the fascinating goals of current research in nanotechnology. Using biocompatible actuators is a necessity for aiming at biomedical applications and has thus motivated researchers to integrate biological power sources. In this lecture, I will give an overview of recent approaches to harness cells (bacteria, sperm cells, muscle cells) or other biological components (molecular motors, enzymes) for the actuation and advanced functionalities of microdevices. These approaches, in combination with nanotechnology and material science, contribute to the development of smart micro(bio)robots which are envisioned to perform fascinating tasks in the future such as minimal invasive surgery. sensing, drug delivery and more.

Dr. Veronika Magdanz

Veronika Magdanz received her Diploma degree in Biotechnology from the TU Braunschweig, Germany in 2010. She pursued her PhD studies on „Rolled up microtubes for the capture, guidance and release of single spermatozoa" at the Institute for Integrative Nanosciences, IFW Dresden, and completed her degree at the TU Dresden with „summa cum laude" in 2016. Dr. Magdanz is currently Open Topic Postdoc at the Chair of Applied Zoology at the TU Dresden, Germany. Her research interests span from sperm migration to the development of artificial and biological microswimmers as diagnostic tools.

Tuesday, February 27, 2018, 5-7pm
Göran Johansson, Chalmers University of Technology, Göteborg, Sweden

Quantum technology in superconducting circuits

In his talk, he will give a brief overview of the field called Quantum Technology, where a new European Flagship project will start in January 2019.
In particular, he will discuss why it is interesting to build a quantum computer and how it can be done using superconducting circuits.
He will also outline our plans for building a superconducting quantum computer at Chalmers in the coming ten years.

Dr. Göran Johansson

Professor at the Department of Microtechnology and Nanoscience, Head of the Applied Quantum Physics Laboratory, Chalmers University of Technology, Göteborg, Sweden.
He is fascinated by quantum physics, both fundamental aspects as well as applied quantum technology. One example of an interesting fundamental effect is the dynamical Casimir effect, where photons are created out of the vacuum by a mirror accelerating to velocities close to the speed of light. A more applied question is how to build a quantum computer, where the quantum mechanical phenomena superposition and entanglement are used to solve problems that are beyond the capabilities of today's supercomputers.
A working quantum computer can find detailed properties of large biological molecules, which can lead to new medicines and other novel medical treatments. A quantum computer could also enhance artificial intelligence and gives us qualitatively new possibilities to find structures in large set of data and find better solutions to optimization problems, such as traffic control to avoid congestions.
He is head of the Applied Quantum Physics laboratory and also co-director of Chalmers' Area of Advance Nano.
He has also received two prizes:
Edlundska Priset 2016 by the Royal Swedish Academy of Sciences.
Albert Wallin Science Prize 2015 by the Royal Society of Arts and Sciences in Gothenburg.

Tuesday, March 6, 2018, 5-7pm
Salima Rafai, CNRS, LIPHY, Grenoble, France

Flowing Active Suspensions: Chlamydomonas Reinhardtii, a model active particle

Suspensions of motile living organisms represent a non-equilibrium system of condensed matter of great interest from a fundamental point of view as well as for industrial applications. These are suspensions composed of autonomous units - active particles - capable of converting stored energy into motion. The interactions between the active particles and the liquid in which they swim give rise to mechanical constraints and a large-scale collective movement that have recently attracted a great deal of interest in the physical and mechanical communities. From the industrial point of view, microalgae are used in many applications ranging from the food industry to the development of new generations of biofuels. The biggest challenges in all these applications are the processes of separation, filtration and concentration of microalgae. There is therefore a real need for a better understanding of the flow of active material in order to ensure optimal control of these systems.
I will show how one can use a living system as a model active particle to establish general features and characteristics of active matter.

Salima Rafai

Research experience :
2017 HDR « Active Suspensions in Flow »
2008- CNRS Researcher “Flowing active suspensions” LIPhy - Grenoble
2005-2007 Postdoc at WZI – University of Amsterdam
2001-2004 PhD in Physics – Fluctuations effects on phase transitions: Wetting LPS ENS Paris
2001 Master degree “Physique des Liquides” Univ. Paris Diderot VII
Awards & Grants
2015 Scientific Excellence Award (Prime d’excellence scientifique), France.
2014 Bronze Medal of CNRS INP
2012 French Agency of Research ANR Grant Young researcher
2009 Regional Grant “Créativité Innovation”
2005 Inaugural Winner of the “Young Female Scientist Price” of the Parisian City Government
PhD Students’ Supervision
Marvin Brun-Cosme-Bruny (2017-)
Matthieu Martin (2014 – 2017),
Michaël Garcia (2009 – 2013, co-supervision 90%)
Levan Jibuti (2008 – 2011, supervision 10%)
Institutional Responsibilities
2014 – 2018Board member of the French-German Doctoral School « Living Fluids »
2009 – 2015 Board member of the Physics doctoral School of Grenoble Univ.
2008 – 2009 Board member of LIPhy Laboratory
Outreach
Coordinator for the LIPhy lab at the outreach event “Fête de la science”
Creation of the ‘Experimentarium du LIPhy’ (a designated room for high-school students experimental projects)

Tuesday, March 20, 2018, 5-7pm
Till Korten, B CUBE, TU Dresden, Germany

A tiny step for a protein, a giant leap for nanotechnology: Nanotechnological applications of biomolecular motors

Proteins have been optimized by evolution for billions of years to work on a nanometer scale. Therefore, they are extremely promising for nanotechnological applications. In particular, cytoskeletal motor proteins are ideally suited for nanotechnological devices, because they perform mechanical work using the chemical energy of ATP-hydrolysis.

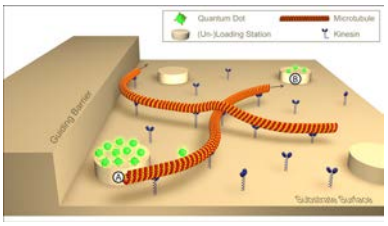

Figure 1: Microtubules transporting cargo on a kinesin-1 coated surface

This lecture will give an overview of important advances in the field of nanotechnological applications of biomolecular motors. Key technologies necessary to make full use of molecular motors in artificial environments include (i) spatial guiding allowing directional control, (ii) molecular switches that allow temporal control, and (iii) versatile methods of molecular attachment allowing loading and unloading of cargo. With these technologies, it was possible to develop more and more complex devices such as molecular sorters, molecular concentrators, detectors and biocomputation devices.

Dr. Till Korten

Dr. Till Korten received his biochemistry degree in 2004 from the University of Tübingen, Germany. He attended the Dresden International Graduate School for Biomedicine and Bioengineering and was awarded his PhD in Biophysics in 2009 from the TU Dresden. From 2009 to 2012 he did a Postdoc at the Max Planck Institute of Molecular Cell Biology and Genetics in Dresden and Since 2012 he is a Postdoc at the B CUBE, center for innovation competence at the TU Dresden, Germany. Since January 2017, Till Korten is co-coordinator of the H2020 EU project Bio4Comp (http://bio4comp.eu)

Tuesday, March 27, 2018, 5-7pm

Witlef Wieczorek, Chalmers University of Technology, Sweden

Mechanical resonators as novel quantum devices

Micro- and nanomechanical devices are recently explored as novel solid-state based quantum systems. Mechanical systems in the quantum regime unlock a novel parameter set in terms of mass, coherence time and versatility in coupling to other quantum systems. These features can be harnessed for utilizing quantum-controlled mechanical devices in quantum-based technologies, for enhancing sensing capabilities and for exploring fundamental physics questions. In this lecture I will present the basics of cavity optomechanical systems, which are a very successful approach to transfer these goals into reality. I will also present some of the above mentioned goals in more detail, especially in the light of the recently launched European effort in form of the Quantum Technology Flagship.

Dr. Witlef Wieczorek

Witlef received his degree in Physics in 2005 from the Technical University of Berlin, Germany and his PhD degree in 2009 from the Ludwig-Maximilians-University Munich, Germany. His PhD research was in the field of experimental quantum optics and took place at the Max-Planck-Institute for Quantum Optics, Garching, Germany. From 2010 until 2017 he was a Post-Doctoral researcher at the University of Vienna, Austria, also in the field of quantum optics with a focus on cavity optomechanical systems and chip-based superconducting magnetic levitation. For the former research he received a Feodor-Lynen Postdoctoral fellowship as well as a Marie-Curie Intra-European fellowship. Since April 2017 Witlef is Assistant Professor at Chalmers University of Technology, Sweden. He is currently setting up his research group with a research focus on mechanical quantum devices.

Tuesday, April 17, 2018, 5-7pm

Clément Faugeras, Grenoble High Magnetic Field Laboratory (LNCMI-CNRS), France

Using light to investigate the electronic properties of 2D crystals

Two dimensional materials have been brought in solid state laboratories about 10 years ago and they display fascinating electronic and optical properties. They are foreseen in a large number of potential applications taking advantage of their flexibility, their mechanical robustness and of the large variety of their electronic properties (semiconductors, superconductors, insulators, …) . Optical techniques, combined with low temperature and possibly high magnetic fields environments, are extremely well adapted tools to study these materials as they are non-invasive and contactless. In this lecture, I will describe how transmission/reflection, photoluminescence and light scattering experiments can reveal the very exotic behavior of charge carriers confined within these purely two-dimensional systems.

Dr. Clément Faugeras

Clément Faugeras received in 2000 an engineering degree and a PhD in 2003 from the University of Grenoble. He then joined University Paris 7 as a postdoctoral fellow where he worked on infrared sources, the quantum cascade lasers. Since 2006, he is a staff member of the Grenoble High Magnetic Field Laboratory where he develops an activity of optical spectroscopy of semiconductor nanostructures and of two dimensional materials in extreme environments, namely low temperatures and high magnetic fields.

Tuesday, April 24, 2018, 5-7pm
Maaike Op de Beeck, imec and Gent University, Belgium

Ultrathin flexible encapsulation technology for electronic implants

Always more electronic devices are used in the medical world. Due to the miniaturization of electronic chips and the development of MEMS, very small microsystems can be fabricated which offer a strong potential for usage inside the human body. Nevertheless, placing a device inside the human body is much more than making a small and smart device: the interaction of implanted material with the body results in dedicated device requirements. The electronic device needs a dedicated hermetic encapsulation which is functioning as a very performant diffusion barrier, to avoid diffusion of toxic materials from the device into the body, as well as to avoid leaching of body fluids inside the implant. Traditionally, a thick and rigid titanium can is used as hermetic encapsulation. But new developments are ongoing to make an extremely thin, soft and flexible encapsulation, by combining biocompatible polymers with high quality ceramic layers being only 10 to 20nm thick... nanotechnology in order to create the electronic implants of the future.

Prof.dr.ir. Maaike Op de Beeck

Maaike Op de Beeck received her electronic engineering degree (1985) and PhD (1993) from the KULeuven, Belgium. She held several research positions at the KU Leuven (Belgium), at Philips (The Netherlands), at Mitsubishi Electric (Japan), and at imec (Belgium). During the first 20 years of her carrier, she was a researcher in the field of IC-CMOS processing, specializing in advanced lithography. From end 2007, Maaike became active in the field of MEMS for biomedical applications. She coordinated research activities regarding microfluidics and chip/device packaging for wearable and implantable medical systems. From June 2012 on, Maaike joined CMST (Centre for Microsystems Technology, an imec associated laboratory at the Gent University, in Belgium) to perform research regarding biomimetic and miniaturized packaging technologies for electronic implants.
During whole her carrier, Maaike was involved in many educational activities, varying from classes to young children about science and electronics, over short courses and tutorials for professionals, to advanced lithography classes for highly specialized scientists. Since 2016 she is part-time professor at the Gent University.

Tuesday, May 8, 2018, 5-7pm

Serguei Cherednichenko, Chalmers University of Technology, Sweden

Superconducting nano detectors: from terahertz to infrared

Detection of photons and energetic particles is an essential part of many scientific experiments, environment and industrial monitoring, space exploration, etc. With a huge variation of photon energies (wavelengths), fluxes, and environments in what sensing to be performed, there is a large variation for detector requirements. Superconducting nano detectors fill an important niche as extremely sensitive and fast detectors from alpha-particles, through visible and IR photons, and till terahertz and microwave photons. Many of those detectors utilize ultra-thin superconducting films, often with nanometer scale dimensions. In this lecture, we will discuss important aspects of designing such detectors, their fabrication, and characterization. We will go through some of great projects, whose success is based on photon detector performance.

Prof. Sergey Cherednichenko

Sergey Cherednichenko, received his Diploma (with Honours) in Physics in 1993 from Taganrog State Pedagogical Institute (Russian Federation), and Ph.D. in physics in 1999 from Moscow State Pedagogical University. From 2000, he works at the Department of Microtechnology and Nanoscience at Chalmers University of Technology (Gothenburg, Sweden). From 2000-2006 he was involved in development and delivery of terahertz band superconducting mixers for the Herschel Space Observatory (flown in 2009-2013); and from 2008 till 2009 in the water vapour radiometer for ALMA. As from 2007 he is Associate Professor at the same department. He is recipient of two European Research Council (ERC) grants (2012 and 2017), and of multiple research grants from Swedish funding agencies. His research interests include: terahertz heterodyne receivers and mixers, photon detectors; THz antennas and optics; thin superconducting films and their application for THz and photonics; material properties at THz frequencies, and terahertz spectroscopy.

Tuesday, May 15, 2018, 5-7pm
Bertrand Parvais, imec, Belgium

Design-Technology Co-optimization for advanced nodes: from scaling boosters to 3D Logic

By 2020 Moore's Law will see an unprecedented pressure. It is already a fact that since the 20nm node, the happy scaling era where dimensional scaling was the fuel to generate cheaper, faster and more power efficient technology nodes ran out of steam. Today, technologists use all possible "technology enablers" or "boosters" to keep the prophecy alive. These techniques trade design requirements with specific technology capabilities in a so-called design-technology co-optimization. Nevertheless, these specific techniques are not endless and soon the "third dimension" will be inevitable to keep density scaling. However, although the migration from 2D to 3D structures worked well in memory technologies, there are number of obstacles that will need to be overcome when applied to logic technologies. Moreover the disruptive migration to 3D is far from straightforward for an industry that is built on a complex eco-system of technology, fabless and EDA companies.

Dr. Julien Ryckaert

Julien Ryckaert received the M.Sc. degree in Electrical Engineering from the University of Brussels (ULB), Belgium, in 2000 and the PhD degree from the Vrije Universiteit Brussel (VUB) in 2007. He joined IMEC (Leuven, Belgium) as a mixed-signal designer in 2000 specializing in RF transceivers, ultra-low power circuit techniques and analog-to-digital converters. In 2010 he joined the process technology division in charge of design enablement for 3DIC technology. Since 2013, he is in charge of imec's Design-Technology Co-Optimization (DTCO) platform for advanced CMOS technology nodes. he is now Distinguished Member of the Technical Staff focusing on the 5nm technology node and beyond.

Tuesday, May 22, 2018, 5-7pm

Pascale Chenevier, CEA-Grenoble at Univ. Grenoble Alpes, France

Carbon nanoobjects: a wide source of new conductors and semi-conductors for electronics and energy

Carbon nanotubes have long been the symbol of nanotechnologies in the papers and on television: nice 3D drawings of their atomic structure coupled to beautiful electronic microscopy pictures and astonishing physical properties propped a hype wave in 1990s that benefited to a handful of high-tech laboratories around the world. Now the graphene hype wave has washed away the remains of this once terrific story... and carbon nanotubes, together with their other nano-carbon counterparts, have reached the level of industrial production and use. This lecture will compare the different families of nanocarbons available today from lab micrograms to industrial tons, and focus on recent development of these materials in future electronics and energy devices.

Dr. Pascale Chenevier

Pascale Chenevier graduated from Ecole Normale Supérieure de Lyon in 1997, received her PhD in physical chemistry from University of Bordeaux in 2001 and held a postdoctoral position in biophysics at Cornell U., USA in 2002-2003. She joined CEA in 2003 as a permanent researcher first in Saclay, near Paris, in the Molecular Electronics Laboratory of IRAMIS research institute, where she worked on carbon nanotube chemical modification to obtain low cost semi-conducting inks for printed electronics. She moved to INAC research institute in Grenoble since 2012 as a CEA senior scientist, where she focuses on conducting nanocomposites: carbon nanotube electrodes for platinum-free hydrogen fuel cells, silicon nanowires for lithium-ion batteries, and semi-conducting nanocomposites for thermoelectric generators. In 2014-2016, she also participated in the creation of a start-up company based on her patents.