Tuesday March 18th

MEMS AND NANOTECHNOLOGY THROUGH SCIENCE AND APPLICATIONS

SCIENTIFIC DAY OF NANOWAL
The Wallonia network for nanotechnologies

9:30 AM Welcome to participants
10:00 AM Introductory word – Prof. Bernard Nysten, *Université catholique de Louvain, Belgium*
10:10 AM « From Microelectronics to Microsystems » – Prof. Jean-Pierre Raskin, *Université catholique de Louvain, Belgium*
11:00 AM Coffee Break
11:20 AM « RF-MEMS : An enabling technology for reconfigurable radio front-ends » – Dr Harrie Tilmans, *IMEC, Belgium*
12:00 AM « Acousto-electric MEMS : Simulation and Implementation » – Dr Sylvain Ballandras, *CNRS FEMTO-ST, France*
12:40 PM Sandwich lunch with posters and demonstrations session
2:00 PM « New generation of atomic force probes based on resonators for operation in a liquid medium »
Dr Lionel Buchaillot, *Institut d'Electronique, de Microélectronique et de Nanotechnologie, France*
2:40 PM « Special issues in the integration of microsystems for medical implants » – Dr Hercules Pereira Neves, *IMEC, Belgium*
3:20 PM NanoWal closing session – Prof. Bernard Nysten
3:30 PM Parallel sessions with Coffee Break :
– NanoWal General Assembly
– Posters and demonstrations session
4:30 PM Welcome to Microsystems Chair participants

INAUGURAL SESSION OF THE MICROSYSTEMS CHAIR

5:00 PM Introductory session by Professor Laurent Francis
5:20 PM « RF MEMS at EADS : concept, designs, and applications »
by Dr Bernhard Schönlinner, Research Scientist at EADS Innovation Works, Germany
6:00 PM « MEMS industry and market overview » by Jérémie Bouchaud,
Vice-President of Market Research at WTC Wicht Technologie Consulting, Germany
6:40 PM Closing session and Best Poster Award by Professor Bernard Coulie
6:50 PM Walking cocktail and networking

If you wish to present a poster or a demonstration, inform us during your registration. The organisers will then contact you back for practical arrangements.

Wallonia Network for Nanotechnologies

Auditorium Sainte Barbe, place Sainte Barbe
B-1348 Louvain-la-Neuve, Belgium
Access : follow indication panels « NanoWal – MEMS Chair »
Parking P11 - Sainte Barbe, GPS coordinates : 50° 40.067 N, 4° 37.295 E

Please reply **before the 7th of March 2008**, by e-mail (**cath.dumont@uclouvain.be**), by fax (**+32 10 47 31 95**), by phone (**+32 10 47 31 26**) or by internet (**http://www.uclouvain.be/chair-microsystems**).
ACCESS FREE OF CHARGE, REGISTRATION MANDATORY

The Microsystems Chair is supported by the
FONDATION LOUVAIN

Université catholique de Louvain UCL

From Microelectronics to Microsystems

Abstract - Silicon-on-Insulator (SOI) technology is emerging as a major contender for heterogeneous microsystems applications. It is indeed well known that SOI CMOS integrated circuits yield quasi-ideal properties for micropower, RF functionalities, radiation as well as for high-temperature operation up to e.g. 350°C. In addition SOI substrates offer unique opportunities for implementing sensors and MEMS. Indeed, the buried oxide can be used as a structural layer for the formation of a suspended membrane or as a sacrificial layer in the case of surface micromachined MEMS or NEMS. Such devices and circuits can further be combined to co-integrate high-performance intelligent / smart micro-systems on a single SOI substrate. The present talk will report recent SOI developments of thin three-dimensional (3-D) released microsensors (temperature, flow) and thin dielectric membranes (flow, gas, pressure). The assembling of the 3-D microstructures relies on the control of the stresses building up in multilayered systems upon depositions. The great interests of micromachining techniques for mechanical testing of nanometer scale films under various constraints (traction, compression, shear, etc.) will be also highlighted. Indeed, MEMS can also be extremely useful to support the progress of micromechanics by allowing the design of new experimental tools to probe mechanical responses at very small scales.

Jean-Pierre RASKIN (M'97, SM'06) was born in Aye, Belgium, in 1971. He received the Industrial Engineer degree from the Institut Supérieur Industriel d'Arlon, Belgium, in 1993, and the M.S. and Ph.D. degrees in Applied Sciences from the Université catholique de Louvain (UCL), Louvain-la-Neuve, Belgium, in 1994 and 1997, respectively. From 1994 to 1997, he was a Research Engineer at the Microwave Laboratory, UCL, Belgium. He worked on the modeling, characterization and realization of MMIC's in Silicon-on-Insulator (SOI) technology for low-power, low-voltage applications. In 1998, he joined the EECS Department of The University of Michigan, Ann Arbor, USA. He has been involved in the development and characterization of micromachining fabrication techniques for microwave and millimeter-wave circuits and microelectromechanical transducers/amplifiers working in harsh environments. In 2000, he joined the Microwave Laboratory of UCL, Louvain-la-Neuve, Belgium, as Associate Professor. Since 2007, he has been a Full Professor and Head of the Microwave Laboratory of UCL. His research interests are the modeling, wideband characterization and fabrication of advanced SOI MOSFETs as well as micro and nanofabrication of MEMS / NEMS sensors and actuators. He is an IEEE Senior Member, EuMA Associate Member and Member of the Research Center in Micro and Nanoscopic Materials and Electronic Devices of the Université catholique de Louvain. He is author or co-author of more than 350 scientific articles.

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RF-MEMS: An enabling technology for reconfigurable radio front-ends

Abstract - Future handheld wireless communication devices are becoming complex multi-band multi-standard radio's, capable of operating in global cellular standards (like GSM), and in others like GPS, DVB, WLAN and WiMax. To satisfy the constraints on size, battery life, functionality and cost, the radio front-end asks for a higher degree of integration combined with further miniaturization of the components, and, moreover for devising novel front-end architectures relying on *reconfigurability* of the radio front-end. In this presentation, RF-MEMS is discussed as a key enabling technology for reconfigurable radio's, not only offering a large plethora of flexible (or reconfigurable) components, but in addition a high degree of integration. Candidate RF-MEMS components addressed include switches, bulk acoustic wave (BAW) devices, voltage-tunable capacitors, and micromechanical resonators.

Harrie A. C. TILMANS received the M.Sc. degree in Electrical Engineering from the University of Twente (The Netherlands), in May 1984, and the Ph.D. degree in Electrical Engineering from the same university in January 1993. He has over 20 years R&D experience in the field of micromechanics or MEMS. Dr. Tilmans has held MEMS R&D positions at the University of Twente (The Netherlands), Boston University (US), the University of Wisconsin-Madison (US), Catholic University of Leuven (Belgium), Johnson Controls Inc. (US), and CP Clare Inc. (Belgium). His research covered micromechanical resonators, low-range differential resonant pressure sensors, resonating MEMS force sensors, MEMS-CMOS process integration technology, mechanical properties of MEMS thin films and microrelays. Since September 1999 he is with IMEC (Leuven, Belgium) where he is responsible for the research and development of RF-MEMS components and systems.
Dr. Tilmans has (co-)authored over 160 papers and issued 8 patents in the area of MEMS. Dr. Tilmans is a member of the IEEE's CPMT, of the IEEE MTT-S of the International Microelectronics and Packaging Society (IMAPS) and of the European Microwave Association (EuMA). He is an associate editor of Sensors and Actuators A: Physical (Micromechanics section). In 2001 he received the Eurosensors XV Fellow award for his pioneering work on microresonators.

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Acousto-electric MEMS : Simulation and Implementation

Abstract - Acoustic devices has revealed their capabilities in numerous application fields. Mainly based on piezoelectric effects, they exploit the possibility to launch and detect waves propagating in the bulk or at the surface of various solids. For signal processing, their passive nature allows for the devlopment of low consumption components such as narrow and wide band filters in the RF band 50MHz-5GHz. The extremely stable properties of single crystal are also well adapted for frequency synthesis, for which they are used as resonators in oscillator loops. They are particularly well suited for sensors as their sensitivities to various parametric phenomena can be accurately controlled. Furthermore, they can operate wirelessly and some configuration is capable to withstand the presence of organic bodies (viscous liquids) in the wave propagation region, still allowing for signal detection. Exploiting such a capability, microbalance applications are developed allowing for mass adsorption detection.
As most of these applications are developed on well characterized single crystal materials (quartz, lithium niobate, lithium tantalate, ...), a high level of design and analysis can be achieved. As a consequence, the development of advanced models accounting for the actual geometries of the devices, their interaction with external phenomena (temperature, stress, pressure, etc.) and their operation in actual conditions (within the associated electronic systems) has been engaged for more than 20 years, yielding a very high level of understanding of the device operation but also many innovative solutions developed using simulation and analysis tools. This different topics will be developed and illustrate in this talk.

Sylvain BALLANDRAS was born in Strasbourg in 1965. He joined the CNRS in 1991, after receiving his Ph.D. in Engineering Sciences from the Université de Franche-Comté. From 1991 to 1995, he was working on surface acoustic wave (SAW) devices and also involved in the development of micromachining technologies (development of LIGA techniques in France, and also micro-stereo-photolithography for the manufacture of 3D actuators). In 1995, he oriented his research activities toward industrial and medical applications of ultrasound transducers and also elastic waveguides devoted to signal processing. He joined TMX in 1997 for a one year industrial training project. From 1999 to 2005, he was responsible of the research group entitled "Acoustique et Microsonique" at the LPMO. He has created his own consulting office to answer specific demands from industry. In October 2003, he was promoted to Research Director at the CNRS in the newly created FEMTO-ST Institute in Besançon. In June 2005, he assumed the direction of the joined laboratory between TEMEX and FEMTO-ST devoted to SAW filters and sensors. He is also developing close collaboration with SENSeOR in the field of SAW sensors for various applications. His main interests concern elastic waveguides for high frequency signal processing and acousto-electric sensors.

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New generation of atomic force probes based on resonators for operation in a liquid medium

Abstract - The dynamic modes of the AFM allow measurement of force variations under the picoNewton range. That is the reason why so many labs try to use the oscillating modes to probe soft matter or biological nanosystems dynamics in liquid environment. At present, these attempts face the difficulty of the liquid motion which dampens the oscillating cantilever. Compare to molecular sizes to be probed, the cantilever induces motion of a great mass of liquid that spoils the oscillating properties. To minimize the hydrodynamic forces, we propose to change the overall oscillator and to choose an oscillation mode that reduces the velocity gradient between the active tip and the surface. More precisely, the project aims at developing GHz MEMS/NEMS sensors for a new generation of high sensitivity Atomic Force Microscopes (AFM). This AFM will be an unprecedented tool for *in situ* imaging of biological and chemical systems with a resolution better than the nanometer and the possibility of kinetic spectroscopy in liquids. The design of the NEMS sensor is based on a silicon nano-electromechanical resonator with integrated actuation/detection and nanotips. The aspect ratio of the tips must be very high, and will be obtained by grafting carbon nanotube (CNT) at the apex.

Lionel BUCHAILLOT, 41, Research Director at CNRS in the Institut d'Electronique, de Microélectronique et de Nanotechnologie, Lille, France. Head of the Micro and Nano Systems Group. Ph.D. in Mechanical Engineering (1995), Japan Society for the Promotion of Science Post-Doctoral Fellow (1995-97) hosted in the University of Tokyo, Fujita Lab. R&D engineer for the SFIM company in 1997. CNRS researcher since January 1998. Expert and coordinator of the NEMS Group for the Observatoire des Micro et Nano Technologies. TPC member for IEEE MEMS Conference (2006, 2007), DTIP Conference (2007, 2008). Author of more than 140 papers. CNRS Bronze Medal in 2002. His research focuses on Micro and Nano Systems (MNS), MNS actuation, thin film characterization, and resonators.

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Special issues in the integration of microsystems for medical implants

Abstract - The stark dissimilarities between living systems and artificial implants imply a number of challenges which are particularly significant if the implants are meant for long term use. Besides the difficulties posed by the chemical, structural and mechanical mismatches between the implant and the surrounding tissue, we are faced with a very complex reaction process which is not completely understood. This talk will focus on the particular issues pertaining to implantable microsystems, with particular emphasis on their use for cerebral applications.

Herc NEVES earned his Ph.D. degree in Microelectronics from the University of Edinburgh, Scotland, in 1991. He has held academic positions at Federal University of Minas Gerais, Brazil, Cornell University and University of California in Los Angeles (Biomedical Engineering Inter-Departmental Program). In 2003 he joined IMEC as Biomedical Microsystems Principal Scientist, where his work focuses on implantable microsystem technology. He is Program Manager of IMEC's Smart Implants program. Dr. Neves is also the Coordinator of the European project NeuroProbes.

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Microsystems Chair of the Louvain School of Engineering

Abstract – Microsystems are micrometer scale heterogeneous devices build to perform sensing or actuation in combination with electronics. Their fabrication method are alike miniaturization techniques used to obtain transistors, that are the elementary bricks of computers. Since early 70's, the miniaturization follows Moore's law that predicts a rough doubling in amount of Silicon-based transistors per chip every 18 months. Around 2005-2010, the ultimate physical limits are reached and, now, European's microelectronics research is focused on the so-called *More Moore*, *Beyond CMOS* and *More than Moore* concepts to break the limits. More Moore is concerned about extreme downsizing with advanced fabrication processes. Beyond CMOS is looking after Silicon replacement by other semi-conducting materials or nano-structures, mainly silicon nanowires, carbon nanotubes or graphene. More than Moore is fetching the classical Si-based circuits to add them new functionalities (optical, biochemical, mechanical, thermal, …), still at the micrometer scale. In this research frame, Université catholique de Louvain aims at sustaining more than 30 years of pioneer research in SOI devices (Silicon-on-Insulator, a variety of Si substrate) and developing further an expertise in innovative microsystems initiated at UCL around 2000. In 2007, the existing cleanrooms were upgraded to a state-of-art facility called WINFAB and the Microsystems Chair was created with the support of Fondation Louvain. The Chair aims at 1) enhancing micro- and nano-systems research done at UCL with regional, european and global partners, 2) implementing microsystems at industrial level with help of key partners, in line with Wallonia's Marshall Plan, and 3) bringing more education related to micro- and nano-technologies to students enrolled at the Louvain School of Engineering by the way of new cursus and regular seminars.

Laurent A. FRANCIS was born in Ottignies-Louvain-la-Neuve in 1978. He received the M.Eng. degree in materials science and the PhD degree in applied sciences from UCL in 2001 and 2006, respectively. Since September 2007, he holds the Microsystems Chair position at UCL as associate professor. His PhD thesis was related to acoustic-wave based microsystems for biosensing applications and resulted from collaboration between the department of materials science of UCL and IMEC (Interuniversitary MicroElectronics Center) in Leuven. Between 2000 and 2007 he was with IMEC as researcher, successively in the Biosensors and RF-MEMS groups. His scientific interests are related to thin films integration for microsystems components (mainly piezoelectric and diamond-like materials), acoustic sensors, bio-inspired approaches, extreme miniaturization and device packaging. During his studies, Laurent Francis was board member of Junior Ingénieur Conseil and of the Belgian Confederation of Junior Enterprises. He is regular member of IEEE and of the UCL Alumni.

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RF MEMS at EADS: concept, designs, and applications

Abstract - What has started in the 1970's with a few small research groups to investigate Microtechnology and the fascinating things that you can do with it, has long found its way into our daily life. MicroElectroMechanical systems are part of our environment and make our life easier with their functionality, capability, and often inexpensiveness. The most prominent example is probably the use of MEMS-accelerometers as sensor for the airbag system in cars but their are throusands of other examples which are more or less visible to the user.
And there is no end in sight! Technology to fabricate MEMS or NEMS is advancing, problems that arise in the microworld are better understood, new functionalities are found, new ideas pop up, and new applications and the demand for ever increasing performance are strong drivers for ever more research in microtechnology and ever more MEMS products.
EADS Innovation Works in Munich has a long history of 20 years in MEMS research. An actual topic that is seen as relevant in an aerospace company like EADS is RF MEMS switches. Even though they have seen more than 15 years of world wide research, there is no product available in Europe as of now. This is - apart from political reasons - mostly due to reliability problems. Although RF MEMS switches come in different types, the main technical challenges are similar and it boils down to very few issues. For some there are well known solutions for others not and the challenge is to overcome all problems in one switch concept. The approach that was taken on by EADS about 5 years ago tries to cope with the main challenges and requirements without compromising its performance. Once the device is available as a product, it will enable a variety of interesting applications in aerospace and defence, like electrically steerable phased array antennas for all kinds of purposes in communication and radar, switching matrices for communication satellites and measurement equipment, or tunable filters and matching networks for multiband or secure communication.

Bernhard SCHÖNLINNER was born in 1973. He received his Dipl.-Ing. ("Diplomingenieur") degree from the Technical University in Munich in 2000 and his Ph.D. degree in electrical engineering from The University of Michigan at Ann Arbor, USA, in 2004.
Since 2004, he is with the microwave technology group of the EADS Innovation Works Germany, which is the corporate research center, where he is currently working on the design and characterization of advanced RF-devices and systems for aerospace applications. In particular, he focuses on reconfigurable micro- and millimeter-wave circuits using a patented RF MEMS concept that was and is being developed at EADS.

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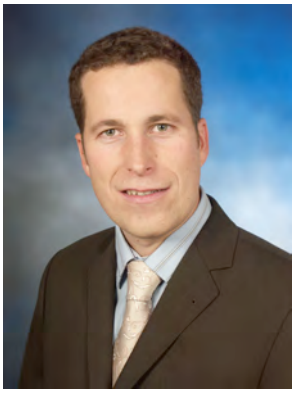
MEMS Industry and Market Overview

The market for MEMS sensors and actuators was worth $7 billion in 2007 and is expected to exceed $12 billion in 2012. IT peripherals and automotive applications have long been the main drivers for innovation and market growth in MEMS. Opportunities for new consumer products such as game controllers and mobile handsets are now also benefiting MEMS sensors and stimulating the market. WTC will present an overview of MEMS products and applications as well as the supply chain. We will also highlight the major changes currently underway in the industry.



Jérémie BOUCHAUD is a founding member of WTC Wicht Technologie Consulting, a renowned consulting company specialised in microsystems and microelectronics. As Head of Market Research for microsystems products he is in charge of project management and analysis. He has gained international reputation as a market expert for RF MEMS. His thorough analysis of the RF MEMS market has been published in the report "The Market for RF MEMS I and II". Jérémie Bouchaud also coordinated the update of the recent "Nexus market analysis of MEMS and Microsystems III, 2005-2009". The NEXUS report is the worldwide reference for MST/MEMS market figures.

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Posters Sessions

1. **Nanometer sized electrodes fabricated by electromigration of Au and Pd nanowires.**
A. Vlad, S. Faniel, B. Hackens, V. Bayot and S. Melinte
CERMIN, Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium
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2. **Controlled growth of single nanowires within a supported alumina template: towards circuit integration.**
A. Vlad, M. Mátéfi-Tempfli, V. Antohe, S. Faniel, A. Crahay, N. Reckinger, B. Olbrechts, V. Bayot, L. Piraux, S. Mátéfi-Tempfli and S. Melinte
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3. **High frequency characterization of polymer membranes with embedded carbon nanotubes for fuel cell applications.**
I. Molenberg, L. Bednarz, F. Hubin and I. Huynen
Microwave Laboratory, EMIC, Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium
E-mail : isabel.molenberg@uclouvain.be

4. **Magnetic tuning of surface acoustic wave devices within high frequency range.**
Celso Cavaco [1], Laurent A. Francis [1, 2], Wim van Roy [1], Liesbet Lagae [1] and Gustaaf Borghs [1]
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5**. MEMS Instruments - Solid understanding at the nano scale.**
Pierre Carbonnelle
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6. **A Perturbation Finite Element Technique for Modeling Electrostatic MEMS.**
Mohamed Boutaayamou [1], Ruth V. Sabariego [1] and Patrick Dular [1,2]
[1] Applied and Computational Electromagnetics (ACE) - University of Liège
[2] FNRS
E-mail *:* MBoutaayamou@ulg.ac.be

7. **3-D CMOS compatible MEMS sensors & actuators.**
N. André, S. Sobieski, C. Renaux, D. Flandre, J.-P. Raskin
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Université catholique de Louvain, Louvain-la-Neuve, BELGIUM
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8. **New MEMS - based nanomechanical testing laboratory - application to aluminium, titanium, polysilicon and silicon nitride films.**
M. Coulombier [1,2], A. Safi [1,2], A. Boe [1,3], T. Pardoen [1,2], J.-P. Raskin [1,3]
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[3] Department of Electrical Engineering, ELEC Université catholique de Louvain, B-1348 Louvain-la-Neuve, Belgium
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9. **MEMS for biomedical monitoring.**
R. Puers, M. Driesen, K. Wouters and F. Ceyssens
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10. **MEMS research at KULeuven.**
R. Puers, M. Driesen, K. Wouters and F. Ceyssens
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11. **Superhydrophobic Aluminum surfaces based on fluorinated copolymers.**
Houssein Awada [1], Sandrine Lenoir [2], Christine Jérôme [2], Bernard Nysten [1] and Alain Jonas [1]
[1] Unité de chimie et de physique des hauts polymères (POLY)-UCL
[2] Centre d'étude et de recherche sur les macromolécules (CERM)-ULG
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12. **Comparison of The Protective Properties 4-Nitrothiophenol and 4-Nitrobenzenediazonium Films Grafted on a ZnNi Coating Electrodeposited On Steel.**
François Berger, Joseph Delhalle, and Zineb Mekhalif
Laboratoire de Chimie et Electrochimie des Surfaces (CES), Facultés Universitaires Notre-Dame de la Paix (FUNDP), Rue de Bruxelles, 61, B-5000 Namur, Belgique
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13. **Self–Assembled Monolayers of Alkanethiols and Alkaneselenols on Copper.**
G. Fonder, F. Berger, B. Csoka , J. Delhalle, and Z. Mekhalif
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14. **Grafting of phosphonic's alkane and fluorinated derivatives on aluminum oxide studied by XPS, PM-IRRAS and electrochemical investigations.**
G. Fonder [1], M. Essahli [2], B. Ameduri [2], J. Delhalle [1] and Z. Mekhalif [1]
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15. **In-plane orientational control of discotic phthalocyanine columns.**
Pierre-Olivier Mouthuy [1], Sorin Melinte [1], Yves Geerts [2] and Alain Jonas [1]
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2. LCP, ULB, Brussels, Belgium.
E-mail : pierre-olivier.mouthuy@uclouvain.be

16. **Preparation of biocompatible magnetic nanowires through layer-by-layer assembly of natural polyelectrolytes.**
Delphine Magnin [1], Karine Glinel [2], Luc Piraux [3], Stephan Màtefi-Tempfli [3], Maria Màtefi-Tempfli [3], Vincent Callegari [1], Françoise Blondeau [1], Alain M. Jonas [1] and Sophie Demoustier-Champagne [1]
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17. **Development of Micro- and Nano- Bio- and Environmental SOI-Sensors.**
L. Moreno-Hagelsieb, R. Pampin, O. Bulteel, B. Olbrechts, N. André, B. Rue, J.-P. Raskin, and D. Flandre
Research centre in micro- and nano-scale materials and electronics devices (CeRMiN), Université catholique de Louvain, Louvain-la-Neuve, Belgium
E-mail : luis.moreno@uclouvain.be

18. **Cross-Sensitivities of Ring Oscillators on Thin Dielectric Membrane for Pressure Sensing Applications.**
Benoit Olbrechts, Bertrand Rue, Denis Flandre and Jean-Pierre Raskin
Research centre in micro- and nano-scale materials and electronics devices (CeRMiN), Université catholique de Louvain, Louvain-la-Neuve, Belgium
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19. **60 GHz tunable cavity resonators based on a perturbation by a MEMS array**
Dragos Dancila [1,2], Phillip Ekkels [2], Xavier Rottenberg [2], Laurent A. Francis [3], Harrie Tilmans [2], Walter De Raedt [2] and Isabelle Huynen [1]
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[3] Microsystems Chair, Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium
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20. **WINFAB : Micro and Nanofabrication Platform at UCL**
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