Europe-Taiwan MEMS Workshop

R107, Engineering Building 1
National Tsing Hua University (NTHU)
Hsinchu, Taiwan
September 16th, 2019

Philippe Robert

CEA-Leti, France

10am-11am: Recent Achievements and New Technologies for High Performance MEMS Sensors and Actuators

Frank Niklaus

KTH, Sweden

11am-12pm: Unconventional Heterogeneous Integration and Manufacturing Technologies for MEMS and NEMS

Michael Kraft

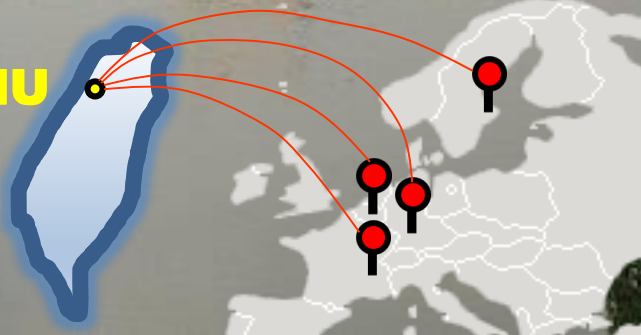
KU Leuven, Belgium

14pm-15pm: Micro and Nanosystems: An Enabling Key Technology for the 21st Century

Alfons Dehé

U of Freiburg, Hahn-Schickard, Germany

15pm-16pm: Applied MEMS Research and Development: Form Silicon Microphones for Commodity to Custom Specific MEMS for SMEs

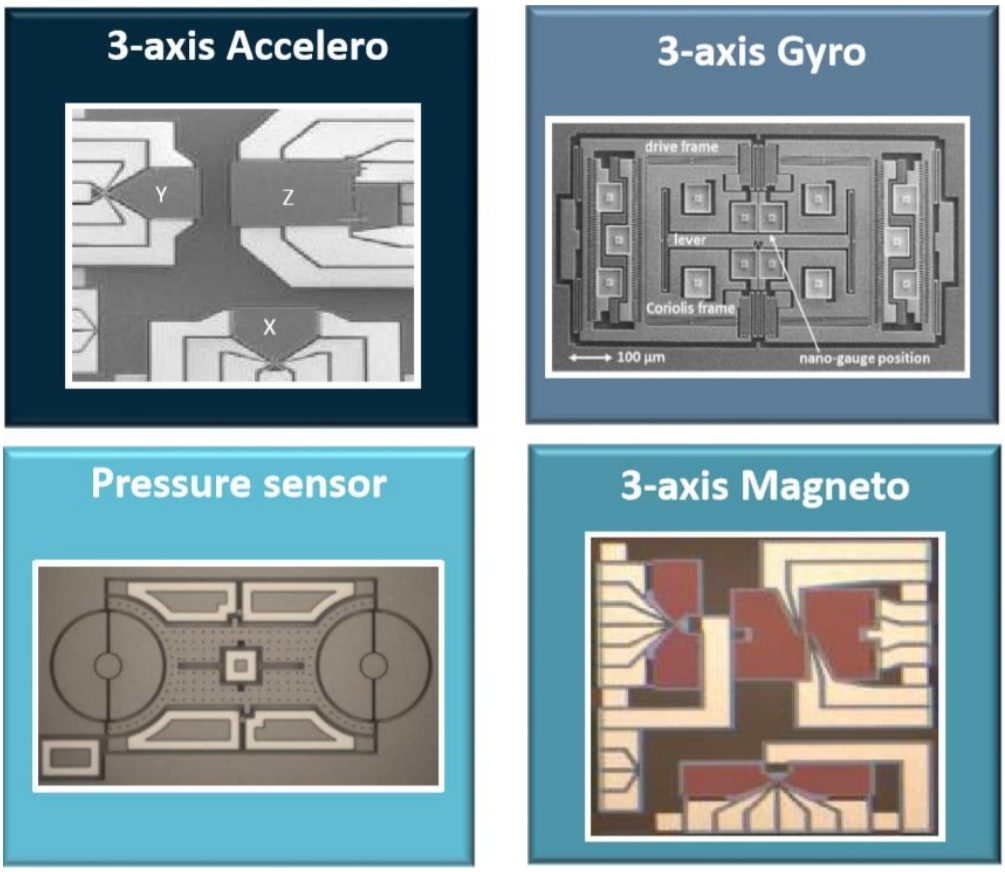


主辦單位：國立清華大學動機系/奈微所
協辦單位：微感測器與致動器產學聯盟

Recent Achievements and New Technologies for High Performance MEMS Sensors and Actuators

Dr. Philippe Robert
Microsystems Section, CEA-Leti, Grenoble, France

With more than 200 people involved in MEMS development and dozens of successful industrials transfers already achieved, CEA-LETI is one of the world's largest R&D institute in this field and at the forefront of the MEMS technologies R&D. This presentation will give a short overview of CEA-LETI's MEMS activities with a focus on recent developments and technologies to meet the new markets trends and challenges like: ultra-miniaturized high performance inertial sensors for ADAS, high efficiency haptics devices for smartphone, Optomechanics for bio-sensing, etc.



Bio of Dr. Philippe Robert

Philippe Robert is Head of the Microsystems Section at CEA-Leti dealing with MEMS sensors and actuators, 3D integration and packaging.

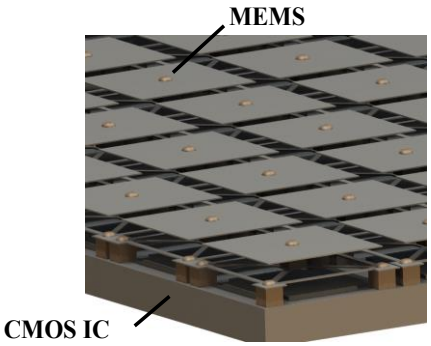
He received a M.Sc. degree in optical electronic in 1991 and a Ph.D. in electrical engineering in 1996 from Grenoble-INP, France. After various positions in the sensors industry, he joined the CEA-Leti in 2001 as project manager on RF-MEMS then as Manager of the MEMS Sensors Group from 2004 to 2013.

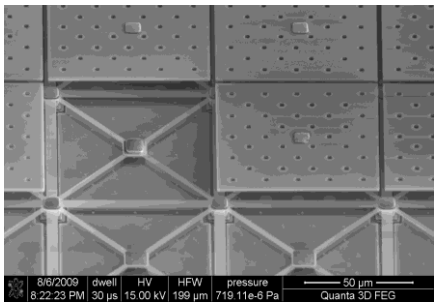
He has authored or co-authored about 40 journal papers and conference contributions, and holds more than 60 patents dealing with MEMS and NEMS. He was member of the IEEE-MEMS Technical Committee in 2007 and 2008 and of the International MEMS Industry Forum Committee at SEMI Europe 2014. Currently, he is member of the International Steering Committee of TRANSDUCERS conference, of the EUROSENSORS conference and of the European MEMS Summit.

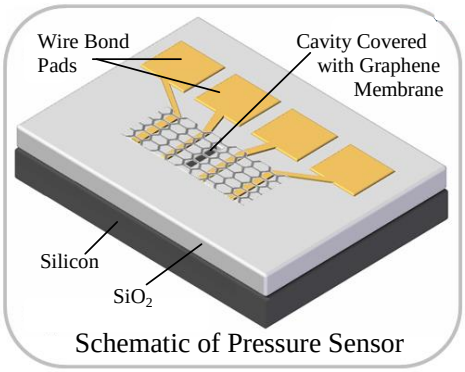
Unconventional Heterogeneous Integration and Manufacturing Technologies for MEMS and NEMS

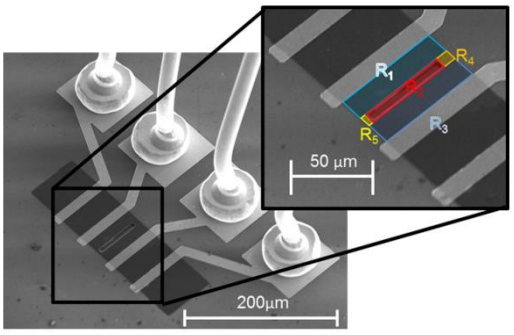
Prof. Frank Niklaus
Division of Micro and Nanosystems, KTH Royal Institute of Technology, Stockholm, Sweden

MEMS and NEMS components are vital for many industrial and consumer products, which have a large impact on society. However, the potential of MEMS and NEMS is still being hampered by their dependence on integrated circuit (IC) manufacturing technologies that are characterized by highly standardized manufacturing processes for realizing 2-dimesnional structures. In contrast, most MEMS structures are 3-dimesnional in nature and the required manufacturing volumes are often counted in a few 100 wafers per month. In this talk, I will present a number of innovative integration and packaging technologies for 3D MEMS and NEMS that extend on the standard semiconductor fabrication technologies and that have recently been developed at KTH. These technologies include wafer-level heterogeneous 3D integration of NEMS and ICs used for IR bolometer arrays, micro-mirror arrays and NEM relays for low-power logic circuits. Furthermore, I will present the use of high-speed wire bonding for realizing devices such as through-substrate vias (TSVs) and IR emitters, and the integration of atomically thin graphene membranes in NEMS for ultraminiaturized pressure sensors.









Bio of Prof. Frank Niklaus

Dr. Frank Niklaus received his M.Sc. degree in mechanical engineering in 1998 from the Technical University of Munich (TUM), Germany. In 2002, he received his Ph.D. degree in microelectromechanical systems (MEMS) from KTH Royal Institute of Technology in Stockholm, Sweden. Since 2013, he is a Professor with the Department of Micro and Nanosystems at KTH, where he is heading the Micro and Nanofabrication Group. The current research interests of Dr. Niklaus include innovative manufacturing, integration, and packaging technologies for MEMS and nanoelectromechanical systems (NEMS) and graphene-based NEMS devices. He has published more than 160 journal and conference papers and has more than 10 granted patents. Dr. Niklaus is a member of the Young Academy of Europe (YAE) and IEEE Senior Member.

Micro and Nanosystems:
An Enabling Key Technology for the 21st Century

Prof. Michael Kraft
MICAS/ESAT, KU Leuven, Leuven, Belgium

This presentation aims to introduce activities at KU Leuven revolving around Micro- and Nanosystems and discuss a variety of projects that my research group have or are currently working on. The portfolio covers the full breadth from blue sky research to commercial viable research and development, and can be broadly classified into three themes:

• High performance micro-sensors: Here, the main focus is on novel approaches for physical sensors and transducers based on silicon on insulator technology (SOI), for example mechanical amplification for high performance inertial sensors, piezoelectric micromachined ultrasound transducers, genetic algorithms as a new design tool for MNS and using "intelligent" system integration for micromechanical physical sensors.

• Microtechnology for bio-chemical and bio-medical applications: Coupled resonators are described which are, among others, a promising approach for bio-chemical mass sensing. Work on innovative packaging concepts for implantable pressure sensors is discussed and a multi-parameter sensor chip for measurements in bio-reactors will be presented. A further focus lies on massively parallel electrode arrays for recording neuroactivities in the brain.

• MNS for Blue Sky Research: Magnetic and electrostatic levitation of micro- and nano-participles can be used to realise a variety of promising and novel sensors and actuators, for example a spinning disk multi axis inertial measurement unit or a micro-mirror with high scanning range. Atom- and ion-chips are quantum labs on a chip and allow the direct manipulation of neutral atoms or ions trapped in magnetic or electrostatic fields. This can potentially enable an entirely new class of sensors based on, for example, atom-interferometry.

Bio of Prof. Michael Kraft

Michael Kraft pursued his Ph.D. at Coventry University, UK from 1994 to 1997 and afterwards joining the University of California at Berkeley, US as a postdoctoral researcher for two years. In 2000, he worked for 13 years at the University of Southampton, where he became a full professor in 2008 and also served as director of the newly established Southampton Nanofabrication Centre from 2010 to 2012. In 2012, he joined the Fraunhofer Institute in Duisburg, Germany heading the department for micro- and nanosystems and concurrently holding a professorship at the University of Duisburg-Essen. In 2015, he went to the University of Liege and subsequently in October 2017 he joined Micas - ESAT at the University of Leuven, Belgium as full professor.

Michael has a broad interest in MEMS and nanotechnology ranging from process development to system integration of MEMS and nano-devices. In 2005, his research group developed the world's first 5th order sigma-delta-modulator (SDM) interface for a MEMS accelerometer, and in 2007 a band-pass SDM MEMS gyroscope. He has done ground-breaking work on electrostatically levitated micro-objects for sensing and actuation applications and developed micro-fabricated atom and ion chips, capable of manipulating clouds of atoms or even single ions. More recently, he extended his activities to biomedical and biochemical sensors and devices, for example working on permanent implants, chips that can measure the conditions in bioreactors and gravimetric sensors that exploit novel transduction principles such as coupled resonators.

He has published over 250 peer reviewed journal and conference publications as an author or co-author. He also contributed to three text-books on MEMS, and edited a book on MEMS for aerospace and automotive applications. He currently serves or has served on several steering and technical committees of international conferences such as Transducers, ISSCC, IEEE Sensors, Eurosensors, MME, MNE as well as being an associate senior editor for the journals Sensors and Sensors Systems and IEEE Sensors Letters.

Applied MEMS Research and Development: From Silicon Microphones for Commodity to Custom Specific MEMS for SMEs

Prof. Alfons Dehé
Microsyst. Eng, U of Freiburg, Hahn-Schickard Inst., Freiburg, Germany

This talk will introduce you to the basics of MEMS microphone development and offer you an insight in the innovation cycle. State of the art mobile applications are addressed with high signal to noise rations in access of 66dB(A) and linearity of more than 135dB SPL. It is discussed how to reach the next level of audio quality level that is close to studio audio quality. Two proposals in competition to each other will be shown.
Such microphones are designed for billion pieces markets a year and the question is answered how to address in contrast solutions for small medium size enterprises. The Hahn-Schickard institute incubates such solutions and examples of MEMS for e.g. inertial and thermal sensing solutions are described.

Bio of Prof. Alfons Dehé
Prof. Alfons Dehé was born 1967 in Aachen has studied solid states physics in the RWTH Aachen. In 1992, he joined the Radio Frequency Technology institute of the Technical University of Darmstadt where he finished with a Ph.D. in 1997 working on compound semiconductor MST. In 1998, Alfons started at Siemens / Infineon Technologies AG activities towards micromachined Silicon microphones for medical, automotive and mobile communication applications. This innovation resulted in products running in billion pieces per year. Further, he was developing integrated SiGe RF circuits and avionic applications. He was driving MEMS innovations further to keep for technology leadership for high-end Silicon microphones and reaching out for micro speakers and gas sensors. He is author and co-author of more than 100 publications and more than 100 patent applications and patent families.
In 2017, he was appointed to the endowed Georg H. Endress professorship “Smart Systems Integration” at the Department of Microsytems Engineering of the University of Freiburg, Germany. He is heading the Hahn-Schickard Institute for Micro and Information Technologies in Villingen-Schwenningen further extending the MEMS activities.