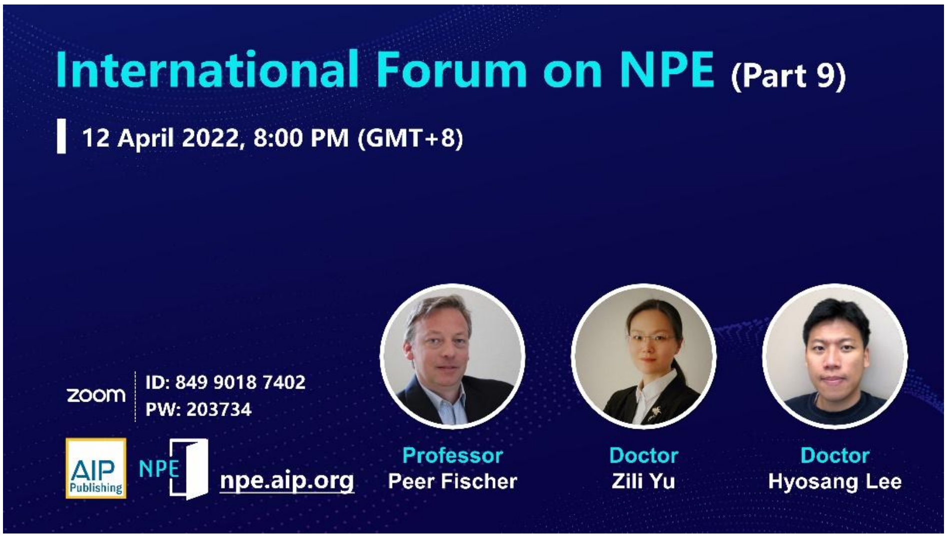
Nanotechnology and Precision Engineering
International Forum Series Part IX



Date: April 12th, 2022 Tuesday

Time: 14:00-16:00 (CEST, German time), 20:00-22:00 (GMT+8, China time)

Forum Chair: **Dr. Tian Qiu**, University of Stuttgart, Germany

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Invited lectures:

1. Title: **Precision 3D fabrication: Assembly and control with magnetic and acoustic fields**

   Speaker: **Prof. Peer Fischer,** Heidelberg University and Max Planck Institute for Medical Research, Heidelberg, Germany

2. Title: **Hybrid Systems-in-Foil — Concept, Design and Applications**

   Speaker: **Dr. Zili Yu,** Institute for Microelectronics Stuttgart (IMS CHIPS), Stuttgart, Germany

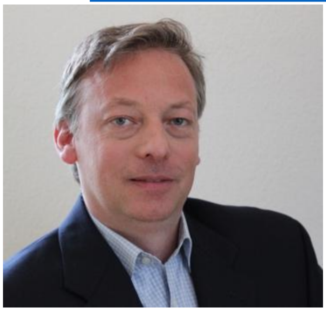
3. Title: **Haptic Sensing with Electrical Resistance Tomography**

   Speaker: **Dr. Hyosang Lee,** Institute of Smart Sensors, University of Stuttgart, Stuttgart, Germany

Invited Lecture 1

Title: **Precision 3D fabrication: Assembly and control with magnetic and acoustic fields**

Speaker: **Prof. Peer Fischer**
Address: Heidelberg University and Max Planck Institute for Medical Research, Heidelberg, Germany
Email: fischer@is.mpg.de



Abstract: Inspired by Richard Feynman's famous lecture "There's plenty of room at the bottom", researchers are striving to build synthetic motors, machines, and robots 'bottom up' from the nanoscale. However, despite progress in crafting static structures of increasing complexity, truly functional dynamic machines are still in their infancy. Building and powering artificial structures that operate at the microscale is very challenging, as it is generally not possible to translate actuation mechanisms and design-concepts from the macro- to the nanoscale. At this scale different physical phenomena are important and there are no ready-made motors and no off-the-shelf parts. In this talk I will describe the fabrication and operation of "nanobots" that can be controlled in fluids with magnetic fields. A focus of the lecture is the nanofabrication of hybrid nanostructures that can be precisely actuated and propelled through fluids. Another means of power transfer is via sound fields. However, existing technologies to manipulate sound have been lacking. I will discuss new means of shaping ultrasound using the acoustic hologram and describe how it can be used to obtain the most sophisticated sound fields to date. The hologram permits the directed assembly of biological cells and for "one-shot" parallel 3D fabrication. Similarly, mean to use sound fields to actuate and position microstructures will be discussed.

Bio: Peer Fischer is a Professor at the Institute for Molecular Systems Engineering (IMSE), Heidelberg University, and he directs the Micro Nano and Molecular Systems Lab at the Max Planck Institute for Medical Research, Heidelberg. He received a BSc. degree in Physics from Imperial College London and a Ph.D. from the University of Cambridge. He was a NATO Postdoctoral Fellow at Cornell University, and a Rowland Fellow at Harvard where he headed an interdisciplinary research lab. Peer Fischer has been on the faculty at the University of Stuttgart and the MPI for Intelligent Systems. He won a Fraunhofer Attract Award, two European Union ERC Grants, and a World Technology Award. He is a member of the Max Planck – EPFL Center for Molecular Nanoscience and Technology. Prof. Fischer is an Editorial Board Member of the journal Science Robotics and a Fellow of the Royal Society of Chemistry. Peer Fischer has broad research interests including 3d nanofabrication & assembly, micro- and nano-robotics, active matter, interaction of optical, electric, magnetic, and acoustic fields with matter at small length scales, chirality, and molecular systems engineering.

Invited Lecture 2

Title: **Hybrid Systems-in-Foil — Concept, Design and Applications**
Speaker: **Dr. Zili Yu**
Address: Institute for Microelectronics Stuttgart (IMS CHIPS), Stuttgart, Germany.
Email: ziliyu@ims-chips.de

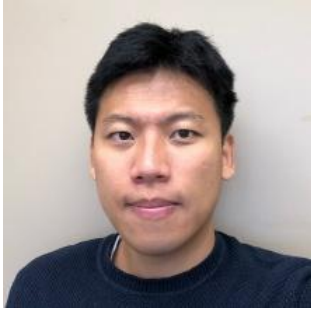
Abstract: Flexible electronics add mechanical flexibility, adaptivity and stretchability as well as large-area placeability to electronic systems, thus allowing for conquering fundamentally new markets in consumer and commercial applications. Despite the fast progress in printed flexible electronics and thin-film transistor technology, there is still a large gap between the device/system performance achieved by printed and thin film electronics and state-of-the-art silicon devices. Hybrid assembly of large-area devices and ultra-thin silicon chips on flexible substrates, i.e., Hybrid Systems-in-Foil (HySiF), is now viewed as an enabler to high-performance and reliable industrial solutions as well as high-end consumer applications of flexible electronics. The HySiF technology takes the complementary merits of the large-area organic for thin-film electronics and of high-performance ultra-thin silicon chip technology.
IMS CHIPS has more than 15 years research in flexible electronics with the focus on ultra-thin silicon chips and later the Hybrid-System-in-Foil (HySiF). Rich know-hows are gained in various aspects of the design. This talk discusses issues in ultra-thin chip fabrication, device modeling and circuit design under bending stress, on- /off-chip sensor implementation, as well as assembly and interconnects for thin chips and distributed large-area components in Hybrid Systems-in-Foil (HySiF). Several distinct application examples are given to illustrate the advantages of the HySiF approach.

Bio: Dr. Zili Yu received her PhD degree in 2012 from the Delft University of Technology (TU Delft), The Netherlands, on Low-Power Receive-Electronics for a Miniature 3D Ultrasound Probe. From 2012 to 2013, she was a post-doctoral researcher at TU Delft, working on ultrasound ASICs. She joined the Institut für Mikroelektronik Stuttgart (IMS CHIPS) in 2013. Since 2016, she has been leading the Department of System Development and later the Department of Sensor Systems, focusing on ASIC designs for various sensor applications, as well as the research on Hybrid Systems-in-Foil (HySiF). Since end of 2021, she has been coordinating the flexible electronics working group at IMS CHIPS.

Invited Lecture 3

Title: **Haptic Sensing with Electrical Resistance Tomography**

Speaker: **Dr. Hyosang Lee**
Address: Institute of Smart Sensors, University of Stuttgart, Stuttgart, Germany.
Email: hyosang.lee@iis.uni-stuttgart.de



Abstract: Haptic sensors are fundamental components of autonomous systems to perceive their surrounding environments physically. Nonetheless, haptic sensors are yet stagnated due to various requirements, such as material compatibility, fabrication simplicity, robustness, as well as their high sensing performance. Recently, tomographic approaches are showing great potential for haptic sensing, since these approaches simplified the sensor design by combining computational methods. Electrical resistance tomography (ERT) is one of the tomographic approaches computing the resistance distribution of a conductive medium from a small number of electrodes. When ERT is applied to piezoresistive material, haptic sensors with a simple design can be achieved while fulfilling numerous practical advantages. This talk introduces the fundamentals of ERT-based haptic sensing and its application to practical and sensitive robotic skin.

Bio: Dr. Hyosang Lee leads a Cyber Valley Research Group of Intelligent Tactile Systems at the University of Stuttgart, Germany. Previously he was a research scientist at the Max Planck Institute for Intelligent Systems, Germany. He received his PhD degree in mechanical engineering from Korea Advanced Institute of Science and Technologies (KAIST), Daejeon, Republic of Korea, in 2017. His research focuses on creating robotic tactile skin in particular smart sensing materials and structures, multiphysics simulation, mechatronics, reconstruction-based tactile sensing, sim-to-real transfer learning, and physical human-robot interaction.

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