MNF Day TALKS

2022

Thursday, April 28th
9am-6pm

MNF Day Keynote

Prof. Carsten Schuck and Maik Stappers (MNF, University of Münster)

MÜNSTER NANOFABRICATION FACILITY

We will revisit the MNF story from how it came into being, to what it is today, and where we are headed. You will learn who the MNF is, who its users are, and how you can get involved. We will show what the MNF is and how its capabilities will expand in the near future. We are excited to guide current and future users through a day filled with activities that should provide a basis for strong and lasting engagement between the facilities and the users who drive it.

A versatile FIB-SEM nanofabrication instrument and its applications in nanoscale science and engineering

Dr. Torsten Richter (RAITH Nanofabrication)

RAITH NANOFABRICATION

Raith has advanced FIB instrumentation over the last fifteen years with the vision that special FIB-nanofabrication requirements should drive the development of FIB technology.

With a FIB-centric setup where the ion beam is always perpendicular to the sample plane the VELION takes advantage of stability, large and fully corrected write fields at lowest beam tails. The use of a laser interferometer-controlled sample stage at nm accuracy enables more sophisticated applications that involve overlay and write field stitching. These components, associated workflows and high level of automatization are mandatory for plasmonics and nano-photonics, which require high resolution nanolithography with tight dimensional control over areas much larger than a single field-of-view.

Here, we present updates about latest applications such as plasmonic arrays, zero mode waveguides, sensing biological molecules, solar absorber arrays, maskless ion implantation or large area photonic structures, as well as the combination of EBL and FIB.

With the appreciation that the ion's properties can have dramatic consequences on the physical and chemical nature of the resulting nanostructures, we also discuss the motivations behind applications employing universal ion sources such as Gold-Germanium-Silicon (AuGeSi) or Gallium-Bismuth-Lithium (GaBiLi).

From simple dot to complex chip - creating functional interfaces

Dr. Sylwia Sekula-Neuner (n.able GmbH)

n.able:

In order to alter the surface properties of a material or device a new functionalization needs to be introduced. Surface functionalization with specific inorganic, organic, biological, or polymeric materials can be a powerful tool to achieve unique surface properties. Often such functionalization needs to be spatially resolved adding another level of complexity to the experimental set-up. Controlling the where and when of a reaction, rather than just the if, can be an essential component in the successful development of applications.

I would like to present few examples where spatial control over the molecules deposited on the surface was a prerequisite to address a specific scientific question. I will present few bio-medical examples of receptor clustering on antibody arrays, capturing tumor cells on micropatterns and localized synthesis of the peptide arrays. Additionally, I would like to present how functionalization of graphene or nanophotonic circuits can be easily realized using bottom-up approach. Those examples will demonstrate the importance of localized deposition of molecules in the design of potential diagnostic research solutions.

Technically those applications can be easily realized using the bottom- up approach using various targeting molecules and the right instrument. n.able GmbH has developed a modular and flexible Molecular Printer with scientists and multidisciplinary projects in mind. I would like to engage with the audience to learn on their specific project needs and how our Printer could enable and accelerate their research.

3D device fabrication based on crystallographic nanolithography

Prof. Niels Tas (Faculty of Science and Technology, MESA+ Institute, University of Twente)

MESA+ INSTITUTE

Rather complex 3D-nanostructures with details in the sub-10 nm range can be fabricated in a massive parallel fashion by combining self-aligned nano-patterning techniques, in particular retraction edge lithography [1] and corner lithography [2 -3], with anisotropic etching of the silicon substrate. Self-multiplication schemes are employed to increase the density of features [4]. This so-called “crystallographic nanolithography” can be combined with other 3D nanofabrication techniques, such as Reactive Ion Etching (RIE) to further modify the aspect ratio of fabricated features [5, 6]. A summary of the main 3D-nanomachining platforms will be given, followed by examples of realized devices in the nano-electronic [6], NEMS and nanofluidic [7] domains.

[1] Zhao, Y. *et al.*, Multi-silicon ridge nanofabrication by repeated edge lithography, *Nanotechnology*, **20**, art. no. 315305 (2009).

[2] Berenschot, E., Tas, N.R., Jansen, H.V., Elwenspoek, M., 3D-Nanomachining using corner lithography. *Proc. 3rd IEEE International Conference on Nano/Micro Engineered and Molecular Systems, NEMS*, art. 4484432, 729-732 (2008).
[3] Berenschot, E.J.W. *et al.*, 3D nanofabrication of fluidic components by corner lithography, *Small*, **8**, 3823 (2012).
[4] Berenschot, E.J.W., Jansen, H.V., Tas, N.R., Fabrication of 3D fractal structures using nanoscale anisotropic etching of single crystalline silicon, *J. Micromech. Microeng.*, **23**, 055024 (2013).
[5] Berenschot, J.W. *et al.*, Wafer-scale nanostructure formation inside vertical nano-pores, *Proc. 12th IEEE International Conference on Nano/Micro Engineered and Molecular Systems, NEMS*, art. 8016973, 57-60 (2017).
[6] Pordeli, Y. *et al.*, Wafer-Scale Self-Aligned Fabrication of Nanometric Curved Tunneling Junctions, *20th International Conference on Solid-State Sensors, Actuators and Microsystems and Eurosensors XXXIII, TRANSDUCERS 2019 and EUROSENSORS XXXIII*, art. 8808559, 2376-2379 (2019).
[7] Van Kampen C.P., *et al.*, Massive parallel NEMS flow restriction fabricated using self-aligned 3D-crystallographic nanolithography, *Proc, IEEE International Conference on Micro Electro Mechanical Systems (MEMS) 2020*, 1106-1109 (2020).

IR correlation nanoscopy with unprecedented spectral coverage

Dr. Bogdan Aurel Sava (Attocube, SNOM Nanoscope)

The neaSCOPE is an application-driven product line for tip-enhanced nanoscale imaging and spectroscopy, serving customer needs in diverse fields of science, engineering and industrial research, which include 2D materials, plasmonics, polymers, materials & life sciences, semiconductor research, cryogenic & ultrafast studies. Nano Fourier transform infrared (**nano-FTIR**) combined with scattering-type scanning near-field optical microscopy (**s-SNOM**) provides infrared spectroscopy at the spatial resolution of atomic-force microscopy (AFM), bringing the analytical power of IR spectroscopy to the nanoscale. In this talk we present nanoscale chemical mapping, spectroscopy imaging with 10 nm spatial resolution.

Materials research at high resolution – connecting macroscopic materials properties to local structures

Prof. Gerhard Wilde (Institute of Materials Physics, University of Münster)

One central aim of materials research is to identify the interrelation between the atomic structure and macroscopic properties of materials. Due to advancements in experimental methods and theoretical and/or computational approaches, more and more complex materials and situations can be tackled, so that today even materials applied in real-world applications can be analyzed and described in increasing detail. Yet, approaches based on understanding the structure of a material with atomic resolution are most difficult in highly interesting situations where the properties of a given material, e.g. any "nanostructured" material, are governed by extended defects of the crystal lattice (i.e. dislocations or grain boundaries) or for materials such as glasses, where periodic long-range order of atomic positions is completely amiss. This presentation will highlight examples where recent developments have allowed pushing the limits of experimental analyses of local structures in complex and/or disordered materials.

From science to start-up – a career option for researchers?

Dr. Anne Vortkamp (REACH EUREGIO Start-up Center)

A broad range of outstanding research projects are carried out every day at universities in Münster and throughout the EUREGIO area, yet many researchers are unaware of the opportunities that start-ups offer as a potential career path. We have established a special service to address researchers, students and members of Münster's universities to support them in their ambitions of becoming business founders. The interdisciplinary REACH-Team encourages and aids interested parties via coaching, teaching, with special workshops and structured programs (e.g. for start-up funding) in order to support upcoming business ideas resulting from intense scientific research and results.

From academic research to industry – lessons learned

Dr. Nicolai Walter, Dr. Wladick Hartmann (Pixel Photonics)

When it comes to scientific research, most students or professors think about publishing their results to the academic world. Less common is the approach of patenting or even creating a whole business in form of a spin-off based on scientific breakthroughs. Based on our start-up Pixel Photonics I want to talk about opportunities and challenges as well as lessons learned going the less common way from academia to industry.

ToF-SIMS and Laser-SNMS analysis of soft nanomaterials

Prof. Bonnie Tyler (MNF, University of Münster)

Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) and its sister technique Laser-Secondary Neutral Mass Spectrometry (Laser-SNMS) are among the most important technologies for characterization of Soft Nano-materials. These methods allow detailed 3D chemical imaging of nano-structured materials with better than 50 nm resolution. Using state-of-the art cluster ion beam technology, label free 3D imaging of atoms, isotopes and organic molecules is possible. Although better than 50 nm resolution is achievable for some materials, for many materials the spatial resolution is limit due to poor ionization efficiency of the chemical species. Our group is investigating a range of methods to improve signal to noise at low lateral resolution. These methods include laser post ionization of sputtered neutral sputter species, matrix enhanced SIMS, and advanced data processing tools.

TERA-print – a new and powerful way to nanofabricate

Jared Magoline (Tera-print)

TERA-print is a nanotechnology company that is transforming how research is done today, from biology and medicine to chemistry and physics. With the innovative TERA-Fab tools, scientists can now unlock the power of rapid prototyping in nanofabrication and design nano-to-microscale devices for sensing, microfluidics, tissue engineering, arbitrary surface patterning, and much more. TERA-Fab technology utilizes a proprietary cantilever-free scanning probe lithography approach known as beam pen lithography (BPL), or maskless light projection to traverse the nano- and microscale. Researchers from 7 countries on 3 continents are already using these tools to take their research to unprecedented levels and to define the future. TERA-print – a new and powerful way to nanofabricate.

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