Process technologies and devices chaired by Niels Tas/Reza Nematollahi – room 8

11.45-12.00	*UV-based Nano-Imprint Lithography for Ultra-High Frequency Silicon Acousto-Electronics* Robert Ukropec (NE)
12.05-12.20	*Miniaturizing the Trench MOS Barrier Schottky (TMBS) rectifier* Bernhard van der Wel (IDS)
12.25-12.40	*Wafer scale fabrication of laterally confined and strongly curved tunnel junctions* Bjorn Borgelink (MCS)
12.45-13.00	*Adaptive XUV and SXR mirrors based on piezoelectric film actuator* Mohammadreza Nematollahi (XUV)

UV-based Nano-Imprint Lithography for Ultra-High Frequency Silicon Acousto-Electronics, Robert Ukropec (NE)

Quantum acoustics, a phonon analogue of quantum optics on a chip, is an emerging field which harnesses sound as an additional means of control in the growing quantum information technology (QIT) toolkit. To enter the quantum regime, both ultra-high frequency (UHF) (>10 GHz) surface acoustic waves (SAWs) and suitable host materials are indispensable. In our work, UHFs are achieved via small SAW wavelength transducers (down to 260 nm, feature size 65nm) fabricated by UV-based nano-imprint lithography (NIL). NIL is a pattern transfer lithographic method which replicates one to one features on a premade quartz stamp onto a substrate. The process is substrate-independent, fast, has high critical dimension control and resolution, and is highly reproducible. With this method we can integrate UHF-SAW technology with silicon-piezoelectric multilayers for future acoustically driven experiments, such as carrier and spin acousto-transport.

Miniaturizing the Trench MOS Barrier Schottky (TMBS) rectifier, Bernhard van der Wel (IDS)

The aim for lower cost and higher power efficiency in solid state high voltage rectifiers can be accomplished by minimizing the leakage current and specific on-resistance for a specified off-state breakdown voltage. The aforementioned can be achieved by depleting the drift region from charge carriers in reverse bias, for which several structures have been proposed. In this work we take an initial step towards the miniaturization of the Trench MOS Barrier Schottky rectifier by using vertical nanowire (VNW) arrays. Demarcated arrays of VNW's have been fabricated at full wafer scale through combining conventional lithography with Displacement Talbot Lithography and employing an Al_2O_3 thin film hardmask in combination with a continuous-Bosch process. The curved, vertical surface area of the VNW's is insulated using LOCOS whereafter all arrays on the Si wafer (n-type) are contacted with Pt, creating a Schottky contact at the top surface of the VNW's. The fabricated devices have been varied in VNW height and substrate doping, and show a rectifying behaviour as expected. The results show higher breakdown voltages and less leakage for the VNW TMBS in reverse bias compared to planar counterparts. However, the forward current-voltage characteristics show an increasing ideality factor for larger VNW heights.

Wafer scale fabrication of laterally confined and strongly curved tunnel junctions, Bjorn Borgelink (MCS)

Tunnel junctions having an asymmetric V-I characteristic can potentially serve as high frequency rectifying components for future energy harvesting systems. From STM experiments it is known that asymmetry is expected, even in symmetric material systems, if the tunnel junction is sufficiently curved. This is explained by the slight difference in average barrier height in forward and reverse bias, caused by the non-uniform electric field in the curved barrier. We introduce our efforts to fabricate strongly curved tunnel junctions in a massive parallel fashion using silicon technology. Currently, we have managed to obtain functional Metal-Insulator-Semiconductor (MIS) junctions with silicon oxide barrier thicknesses in the 2 – 3 nm range and with similar or even smaller radii of curvature, in two different fabrication processes. Both processes will be discussed, together with the challenges to proceed to the formation of curved MIM tunnel junctions.

In one of the processes, inverted pyramids are etched into silicon nano-pillars and the junctions are formed at the apex of the inverted pyramids in a self-aligned fabrication sequence. As different numbers of junctions are measured in parallel in different devices, the current as a function of applied voltage is normalized to the number of junctions. Both the reasonable overlap of normalized V-I curves, as well as the order of magnitude of the measured current densities confirm the functionality of the fabricated MIS-devices.

Adaptive XUV and SXR mirrors based on piezoelectric film actuator, Mohammadreza Nematollahi (XUV)

Multilayer mirrors (MLMs) are key optical elements for the extreme ultraviolet (XUV) and soft X-ray (SXR) wavelengths. Adaptive MLMs are needed to compensate the thermally generated aberrations and to reach the theoretical diffraction-limited resolution in the optical systems. In this work, we present a functional actuator based on piezoelectric thin films. The piezoelectric films are deposited in a columnar microstructure to minimize the substrate clamping effect that allows reaching a high effective out of plane extension. We also demonstrate the generation of gradually varying surface profiles by including a resistive mediation layer on the piezoelectric film and in-between the pixels. The mediation layer is capable of producing a continuously varying voltage profile between the pixels. White light interferometry is used to show the level of control in generating arbitrary surface profiles at the nanoscale.