Myfab Report 2017

Myfab - The Swedish Research Infrastructure for Micro and Nano Fabrication

www.myfab.se

Myfab, the Swedish Research Infrastructure for Micro and Nanofabrication enables about 800 researchers and entrepreneurs to carry out their nano visions. With more than 700 tools strategically located in cleanroom laboratories at Sweden's four leading nanotechnology universities, we offer charge based user access with practically no waiting time to experienced and new users, from academy and industry. Myfab's clean-room staff and expertise serves the users by developing and maintaining processes and tools, and by holding educational courses, process advice and support.

Myfab is the place where synthesis – or creation – of new materials, structures, devices and miniaturized systems on the nanoscale are made. It is the birthplace of ideas and the playground for their realization. Myfab is the starting point for value chains, where devices are integrated as key enabling components in a system. It could be transistors for world leading low-noise or high power amplifiers, detectors for infrared light or superconducting quantum interference devices (SQUID), which enable neurologists to "look" into the human brain or form the essential building block for future quantum computers.

Myfab's distributed research infrastructure (RI) offers both the flexibility that is needed to advance state-of-the-art in science and technology, as well as a quality assured environment for small and medium size manufacturing for spin-off companies and Small and Medium Sized Enterprises (SMEs). Today approximately 100 companies use Myfab, and during a 5-year period, typically 20 – 30 start-ups emerge from the environment.

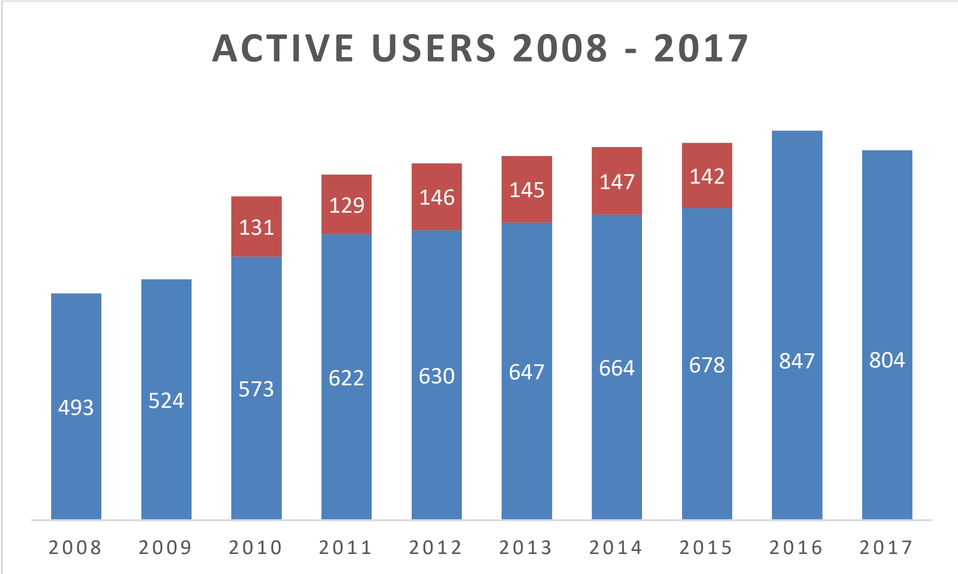
The academic output from the Myfab environment is amazing: during the current financing period (*i.e*. during two full years, 2016 – 2017) Myfab's user community produced 1551 peer-review publications and 105 persons finalized their PhD studies within Myfab. Myfab has set the standard in Europe for efficient user access, follow-up and planning through our operations practices supported by the tailor-made Myfab LIMS system. Myfab LIMS itself, is continuously developed through a community formed by Myfab and five other national RI's in Finland, Norway, Ireland, France and Portugal.

Myfab is part of the Nordic Nanolab Network (NNN), which encompasses collaboration at the management-, expert- and user levels in all five Nordic Countries. Following a series of four biennial events in Sweden, Myfab co-arranged, as part of the NNN, the fist Nordic Nanolab User Meeting (NNUM'17 in Trondheim in May, attracting more than 260 participants. Following NNUM, NNN, in collaboration with EuroNanoLab, arranged the first European Nanofabrication Research Infrastructure Symposium (ENRIS'17) with 122 leaders and experts from about 38 cleanroom laboratories in 20 countries. ENRIS is arranged biennially; next time 2019 in the Netherlands. An essential part of NNN is the Nordic Nanolab Expert Network (NNEN) where interactions are on-going more or less continuously, involving experts from about 20 Nordic clean-room laboratories. The NNEN has formed five topological groups that meets once or twice every year.

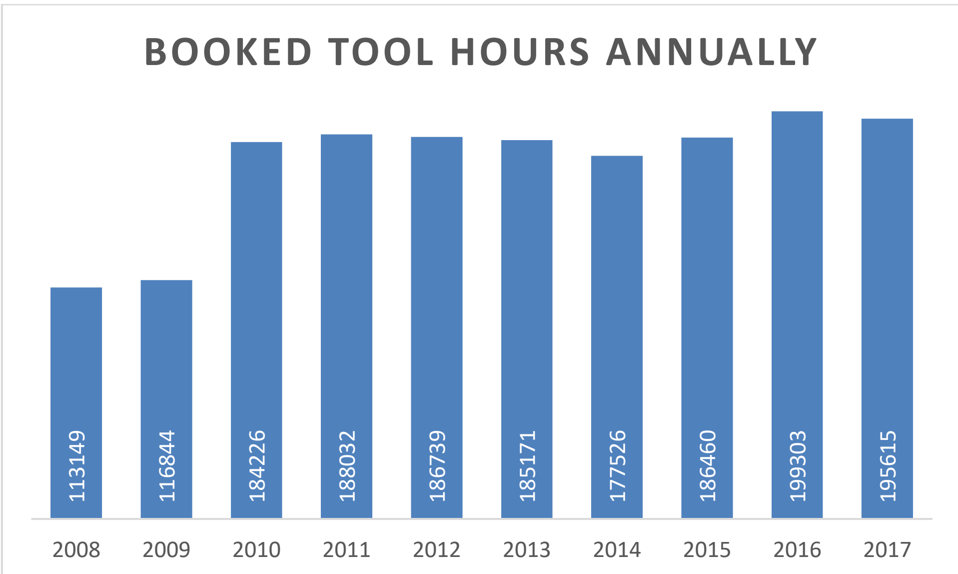
Myfab – the focal point of the nation's efforts

Being Sweden's national research infrastructure for microtechnology and nanoscience, Myfab attracts a vast majority of Sweden's micro- and nanotechnology researchers and entrepreneurs within a wide range of fields. Myfab LIMS was introduced at all Myfab laboratories in 2008, and over the last decade we have seen an increase in number of active users as well as booked tool hours.

In 2017, 669 (83 %) users come from academia and 135 (17 %) were commercial users from either industry or research institutes. Myfab annually serves approximately 100 companies. The total number of booked tool-hours was 195615. New and potentially returning users, with no previous experience from Myfab, are invited to apply for funding for their first project through *Myfab Access*.



Active Myfab users 2008 – 2017. Users at Lund Nano Lab are represented in red on top of the Myfab columns during the period they used Myfab LIMS without being part of Myfab (2010 – 2015). LNL is included (full year) in the Myfab data from 2016.



Tool-hours booked annually 2008 – 2017. Users at Lund Nano Lab are included in the statistics from 2010.

ORGANISATION

Myfab's owner group

Myfab is a joint undertaking of four universities: Chalmers University of Technology, KTH Royal Institute of Technology, Lund University and Uppsala University. Each university owns the local cleanroom laboratory. The owner group has been formed in order to address matters where Myfab's undertakings and the University's strategy overlap. The participating universities collaborate according to the Consortium Agreement, and according to the Main Contract between the host university (Chalmers) and the Swedish Research Council (SRC).

Representing Chalmers:	Professor Mikael Fogelström
Representing KTH:	Professor Carl-Mikael Zetterling
Representing Uppsala University:	Professor Mikael Jonsson From 1 September: Professor Pär Weihed
Representing Lund University:	Doctor Anneli Löfgren

Myfab's steering group

Myfab's steering group consisted of the following members during 2017: Anne Borg, (Prof. Physics NTNU, Norway), Hans Hentzell, (chairman), Susanne Holmgren (Prof. Emerita Zoo physiology, University of Gothenburg), Anneli Löfgren, (Admin. Research Director Lund Nano Lab), and Jonas Wallberg, (Director ICT, the Association of Swedish Engineering Industries, Teknikföretagen).

Operational management

Myfab's operation is managed by the Director Thomas Swahn in collaboration with the laboratory managers Ivan Maximov (Lund University), Peter Modh (Chalmers), Stefan Nygren (Uppsala University) and Nils Nordell (KTH). Cristina Andersson, Chalmers, acts as support systems officer and project manager.

Myfab LIMS

In 2017 we have added four new international cleanrooms to the Myfab LIMS user community (three in France and one in Latvia). We have continued the development and improvement of the system. The development included around 40 different new functionalities and improvements. However we have been delayed in the development of the Process Manager module due to lack of programming expertise. This was solved in December and an additional programmer is now working the first half year of 2018 with this development.

MYFAB'S FOUR CLEANROOM LABORATORIES

Myfab Chalmers – Nanofabrication Laboratory

During 2017 we have established our new electron beam lithography system in operation and it now has almost as high work load as our older system. The new system has also attracted a number of new external projects contributing to the increased income during 2017. The used SEM bought and installed during the second half of 2016 is now in full operation and we have initiated the procurement of a new DRIE for Si to replace a more than 20-year-old system that has reached the end of its lifetime.

The financial result for 2017 came out substantially better than budget. This is mainly due to three reasons: increased income from both academic and commercial projects, lower staff cost due to a reduction in staff, more parental leave than budgeted, and lower costs for the operation. We expect to reach a balanced result for 2018.

Myfab Lund – Lund Nano Lab

During 2017 the laboratory purchased and installed new equipment: in addition to the new ICP-RIE machine, partly funded by an SSF-RIF grant to Ivan Maximov (Research Infrastructure Fellow), a critical point drier (CPD) and an HDMS oven were delivered. In December, four open wet benches in the process lab area were upgraded by installing closed cabinets and sashes to improve the chemical safety in the lab.

In 2017 LNL was very successful in obtaining funding for additional equipment. For example, the LMK Foundation, Lund University and NanoLund supported the laboratory with grants to buy a Talbot displacement lithography tool, another plasma etch tool, a mapping spectroscopic ellipsometer, an Atomic Force Microscope, a stylus Profilometer, an e-beam evaporator and a few other critical tools. Due to the limited space in the cleanroom, most of the new tools will replace old equipment.

In November 2017, the lab organised a 2-nd LNL-Plasma-Therm Plasma Processing Workshop with about 60 participants from Sweden, Norway, Finland and Denmark and hosted a joint NNEN meeting on Dry Etching/Thin Films with 23 participants.

In connection with plans to move Lund Nano Lab to Science Village Scandinavia (SVS) at Brunnshög, close to MAX IV and the European Spallation Source (ESS), a new strategy for funding of new tools for LNL has been developed for equipment purchases during 2017-2023. At the same time, work continued with specifications of the new LNL at SVS, including detailed equipment and facility requirements.

The lab personnel continued to work within NFFA-Europe and SSF-RIF projects with a focus on high-resolution patterning, including nanoimprint. Within the Transnational Access program of the NFFA-Europe project, several groups from other countries have used the LNL facilities to perform processing and characterization of their samples.

Myfab KTH – Electrum Laboratory

A new laboratory engineer – Mikael Sjödin – is employed to the lab operations group. This is part of a long term plan to introduce new employees to replace the three persons in the group already above 60 years old.

A tool for CMP (Chemical Mechanical Planarization) – partly financed by an SSF grant to Nils Nordell as Research Infrastructure Fellow – was installed. The pre-defined processes for oxide and silicon carbide planarization are certified and now regularly utilized by the user groups.

The second phase of the H2020 Widening project CAMART2 is funded with 15 MEuro during a period of 7 years to develop the education, research, open access laboratories, and innovation system at Institute of Solid State Physics at University of Latvia. KTH and Acreo will participate in a consulting role as partners from advanced countries.

A new Flip-Chip tool is installed by one of the industrial partners at the laboratory.

Future Friday – the yearly event in Kista to inspire high school students to choose an IT education at KTH – attracted around 1800 students this year, and 150 of them attended the Electrum Lab tour.

KTH is establishing a new form for handling infrastructures, and Electrum Lab applies to become an approved KTH Infrastructure.

The economic situation is stable at the Electrum Laboratory, mainly due to the high level of industrial usage, the Research Infrastructure Fellow grant from SSF and the EU financed CAMART2 project.

Myfab Uppsala – Ångström Microstructure Laboratory

The new TEM and XPS instruments were installed, tested and released for regular operation. A new ALD system, with in-situ spectroscopic ellipsometry, was installed and will primarily be used to deposit oxides, sulphides and selenides. A home built ion beam etcher was put in operation and procurement for a new optical profilometer was initiated. A basic upgrade in lithography (new spinners, hotplates, microscope, etc.) has been started and will continue 2018.

Together with the new board (from 2017) a new procedure for investments has been established. The new model is based on parallel tracks for reinvestments (replacing old tools) and new investments (adding new capabilities). User groups are invited to make proposals for the latter category and primary stakeholders are requested to provide part of the investment funding.

As a result of the diminished SRC funding, the MSL staff has been reduced by two full time equivalents. This was done by internal (within department or faculty) redeployments. Recruitment has been initiated to replace two staff members due to retire during 2018.

MYFAB ACCESS

Myfab offers new users the option to apply for free access to Myfab through the Myfab Access program. The aim is to give new user groups practical experience of using Myfab. Interested users should present a project proposal. Applicants must hold a position at a Swedish university/institute or SME, and should not have any previous experience of micro-nanofabrication at Myfab. The program has a tutorial and informative focus, and applicants are supported and informed about the possibilities with nanotechnology already in the application phase.

MYFAB SUCCESS

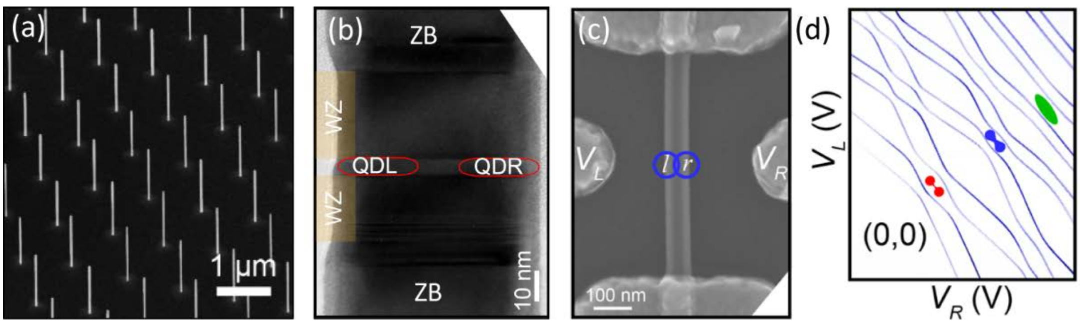
Myfab's users produces a very large scientific output in a broad range of scientific areas. Below are some examples – success stories from 2017 – we want to highlight.

Artificial molecules based on nanowire quantum dots

This project relies on advanced epitaxy of III-V materials, here in the shape of nanowires, which is one of the focus areas of Lund Nano Lab (LNL) within the Myfab network. We directly control the crystallization of the semiconductor in the nanowire epitaxy, and introduce designed crystal structures, which is not possible with top-down processing methods. InAs nanowires with embedded crystal-phase quantum dots are grown from gold nanoparticle arrays processed by electron-beam lithography (EBL) and lift-off.

We then use a micromanipulator to transfer individual wires to a second chip, where a set of source, drain and gate electrodes are fabricated close to the quantum dot. At low temperatures, we found that the gates can be used to split the dot into two coupled dots. Owing to very strong quantum confinement, we can tune the electron transport to involve only the very first electron orbital in each dot, and create a textbook-like quantum mechanical system. Here it is possible to control the tunnel coupling of the orbitals, and thus tune the strength of the first molecular bond over a wide range. By applying a magnetic field, we can also control and study the spin states of the system. The first publication on the topic recently appeared in Nano Letters.

Our research is motivated foremost by basic science, but is of relevance for possible future applications in spin-based quantum computation. It is also one of the corner stones in the 5-year KAW research project "Controlled atomic scale 3D ordering for exotic electronic phases" with start in 2018.



(a) InAs nanowire array. (b) Nanowire crystal phase quantum dot, where two wurtzite (WZ) tunnel barriers embedd a zinc blende (ZB) dot. (c) Contacts are made for electrical measuremens and to split the dot in two. (d) Ground state evolution in the artificial molecule as function of gate voltages.

Ref: Malin Nilsson, I-Ju Chen, Sebastian Lehmann, Vendula Maulerova, Kimberly A. Dick, and Claes Thelander, Parallel-Coupled Quantum Dots in InAs Nanowires, Nano Letters 17, 7847 (2017)

Shape sorting of bacteria

To help better understand the underlying mechanisms controlling the change between the different shapes of bacteria (e.g. Streptococcus pneumoniae) and the effects of shapes on virulence, we have developed a microfluidic sorting device that fractionates a mixed bacterial population into subpopulations based on the shape of the bacteria. In this way, we have successfully demonstrated the purification of single cocci and diplococci as well as the enrichment of chains from a standard sample of cultured bacteria. In addition, we have demonstrated the fractionation into pure subpopulations of encapsulated and non-encapsulated bacterial strains from a mixed sample.

The devices are made using soft lithography based on a mold defined using UV-lithography. The mold is treated with fluorosilanes before PDMS silicone is poured to facilitate demoulding. Once the PDMS is cured, it is peeled off, treated with oxygen plasma, and sealed to a PDMS covered glass slide forming microfluidic channels. To avoid sticking of the bacteria, the device is first treated with PLL-g-PEG before introducing the sample. The experiments were run in our BSL2 facility using a computerized pressure controller for flow control and a standard inverted microscope for observation.

The work was performed together with our collaborators (group headed by Prof Birgitta Henriques-Normark) at the Karolinska Institute in Stockholm and was published recently (Beech et al., Analytica Chimica Acta 2018). The work took place within the project LAPASO (EU FP7 project 607350). The devices were made in Lund Nano Lab.

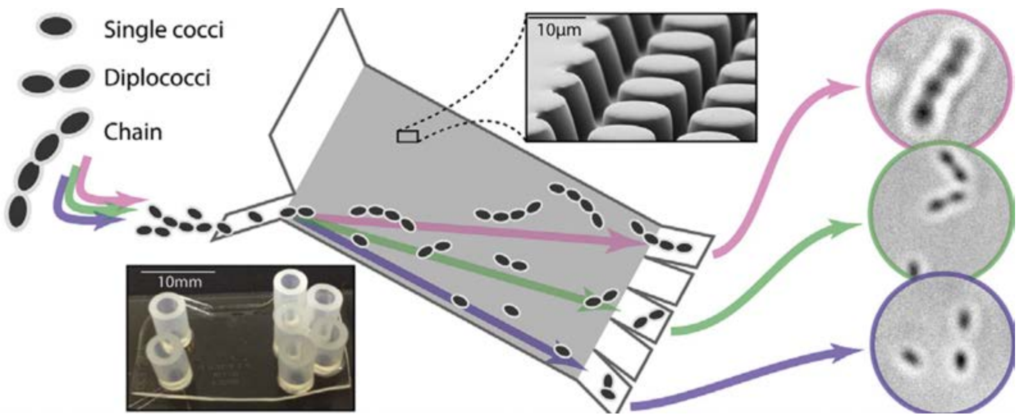


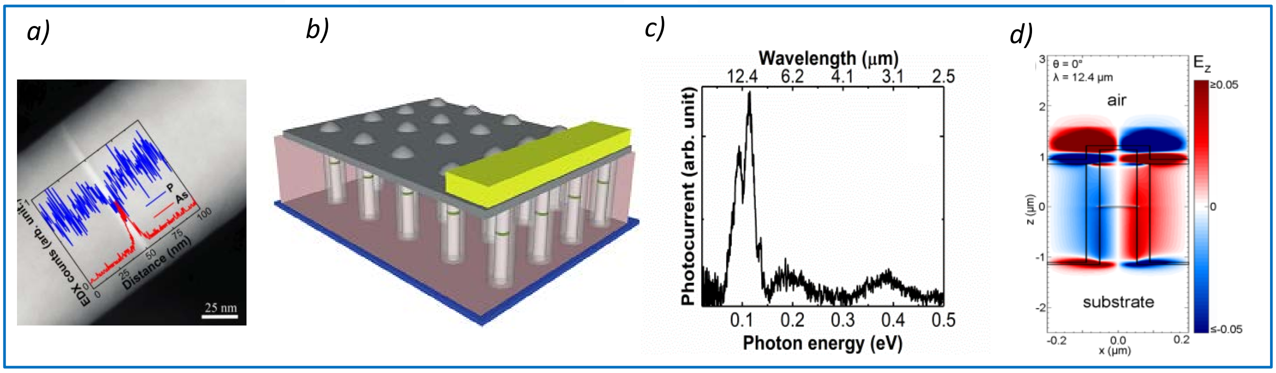
Figure 1. Graphic summary of the bacterial shape sorting project. A mixed population of the bacteria enter the device at the left-hand side in the small entrance channel. The trajectories of the bacteria now depend on the state of the bacteria. Single cocci move straight. Chains are entirely deflected. Diplococci move in intermediate trajectories.

Beech, J.P., B.D. Ho, G. Garriss, V. Oliveira, B. Henriques-Normark, and J.O. Tegenfeldt, Separation of pathogenic bacteria by chain length. Analytica Chimica Acta, 2018. 1000: p. 223-231.

First nanowire long-wavelength infrared photodetector realized

The advanced processing equipment available at Lund NanoLab made it possible to fabricate the first reported long-wavelength infrared photodetector in a nanowire (NW) geometry. The incoming radiation is converted to a photocurrent by internal excitations of trapped electrons in the embedded quantum discs. The device also shows unexpected sensitivity to normal incident radiation, which is explained by excitation of optical modes in the photonic crystal formed by the nanostructured portion of the detectors. The main advantages of the demonstrated detector include engineered broadband infrared sensitivity at normal incidence in a design that can be grown and processed directly on a silicon substrate.

Read the paper published in Nano Letters: "*Intersubband Quantum Disc-in-Nanowire Photodetectors with Normal-Incidence Response in the Long-Wavelength Infrared*" by M. Karimi, M. Heurlin, S. Limpert, V. Jain, X. Zeng, I. Geijselaers, A. Nowzari, Y. Fu, L. Samuelson, H. Linke, M. T. Borgström, and H. Pettersson. Nano Lett., 2018, 18 (1), pp 365–372.
DOI: 10.1021/acs.nanolett.7b04217

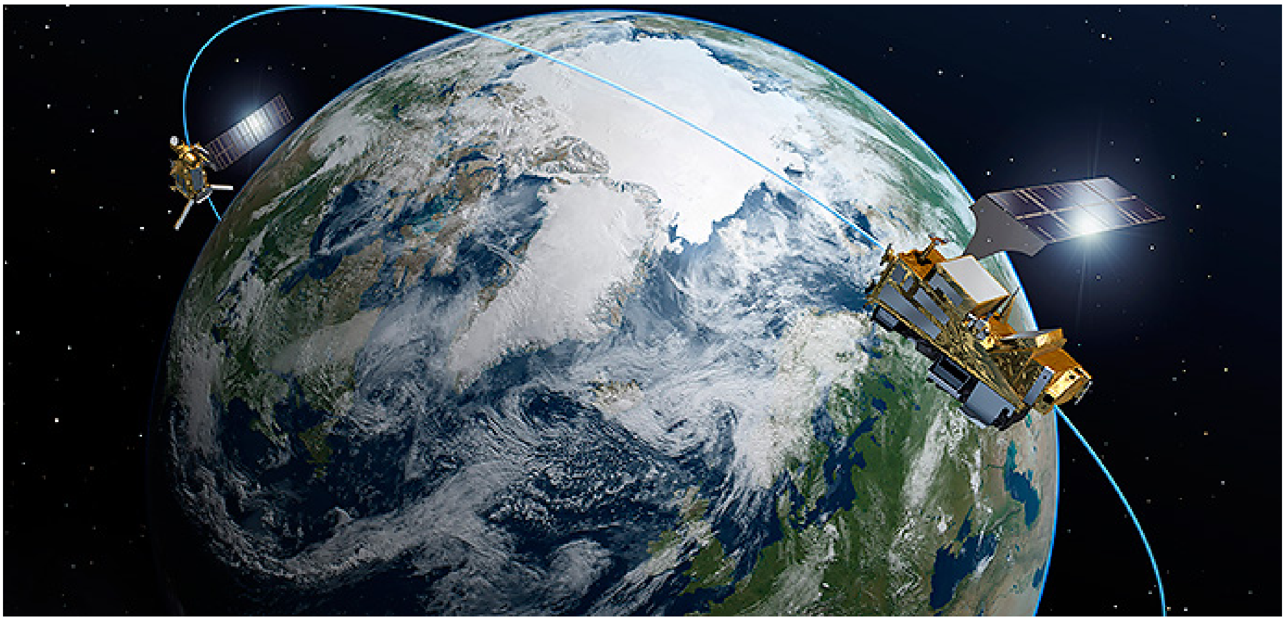


a) TEM/EDX image of an InP NW with one embedded InAsP quantum disc. b) Schematics of a fully processed NW detector element. The NWs are isolated from each other by a thin SiO2 coating and embedding in a resist. The upper part of the detector comprises a transparent conductive ITO top contact which connects the NWs in parallel, after removal of the SiO2 at the NW tips, and a final Au bondpad. c) Spectrally resolved photocurrent measured between bottom substrate contact and top ITO contact. d) Electric field distribution along a NW for normal incident radiation.

Devices from Chalmers going to space

Schottky diodes fabricated at the Nanofabrication Laboratory at MC2 are becoming important components of the second-generation weather satellite space project MetOp, scheduled for launch in 2019. The diodes were delivered to Omnisys Instruments in May. It is the successful outcome of a five-year journey pursued by Vladimir Drakinskiy and Peter Sobis, and the latest example of research utilisation from MC2. “We are very proud of our achievement and already see the effects in upcoming projects with the European Space Agency (ESA)”, says Vladimir Drakinskiy.

The weather satellite project MetOp is one of the biggest projects at the European Space Agency (ESA). Apart from improving the observations of the first MetOp generation, and observing precipitation and cirrus clouds, it will also further improve weather forecasting and climate monitoring from space in Europe and worldwide. The project will yield benefits from 2022 onwards to further improve forecasting.

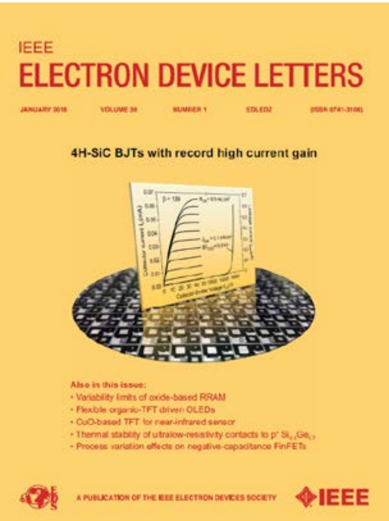


https://www.chalmers.se/en/departments/mc2/news/Pages/Devices-from-Chalmers-going-to-space.aspx

15 kV-Class Implantation-Free 4H-SiC BJTs with Record High Current Gain

PhD students Arash Salemi and Hossein Elahipanah, supervised by Prof. Mikael Östling and Carl-Mikael Zetterling, at KTH EECS Schools, has successfully designed and implemented a 15 kV SiC bipolar junction transistor (BJT) with a current gain of 139. The devices were fabricated on 100 mm SiC wafers with more than 125 μm of epitaxy, and processed through six reactive ion etches and four metallization layers, in total 10 lithographic layers.

The measurement of the 15 kV breakdown voltage was a challenge for the measurement facilities, and PhD student Keijo Jacobs (also EECS) made important contributions. Arash Salemi and Hossein Elahipanah defended their theses during 2017 and are now at Purdue University and Ascatron AB, respectively. The article was published in IEEE Electron Device Letters January 2018, and was featured on its cover. DOI: 10.1109/LED.2017.2774139. Contact: Carl-Mikael Zetterling, bellman@kth.se



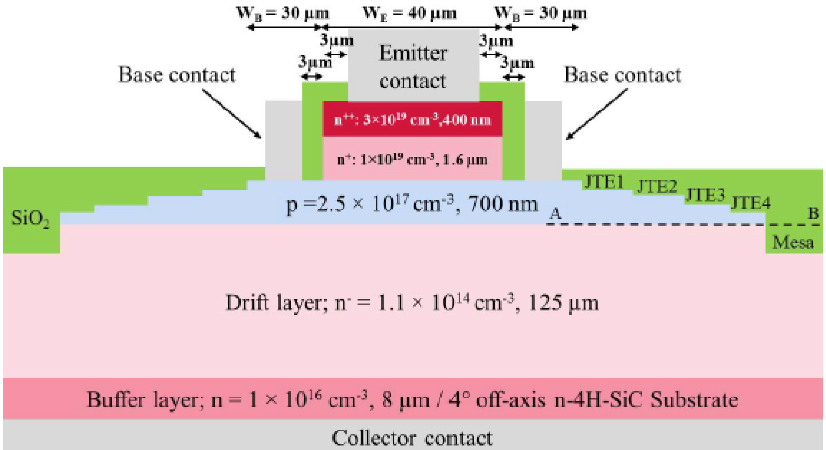


Fig. 1. Schematic cross-sectional view of the fabricated 4H-SiC BJT. The A-B cutline used in the simulation is marked in the cross-section.

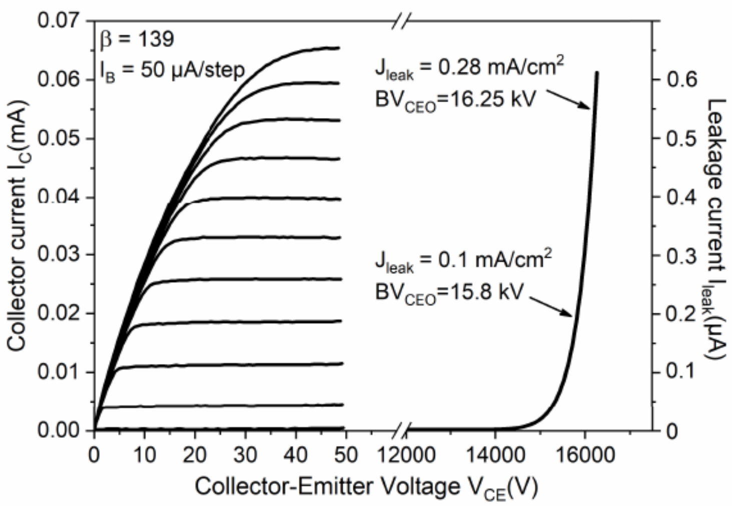
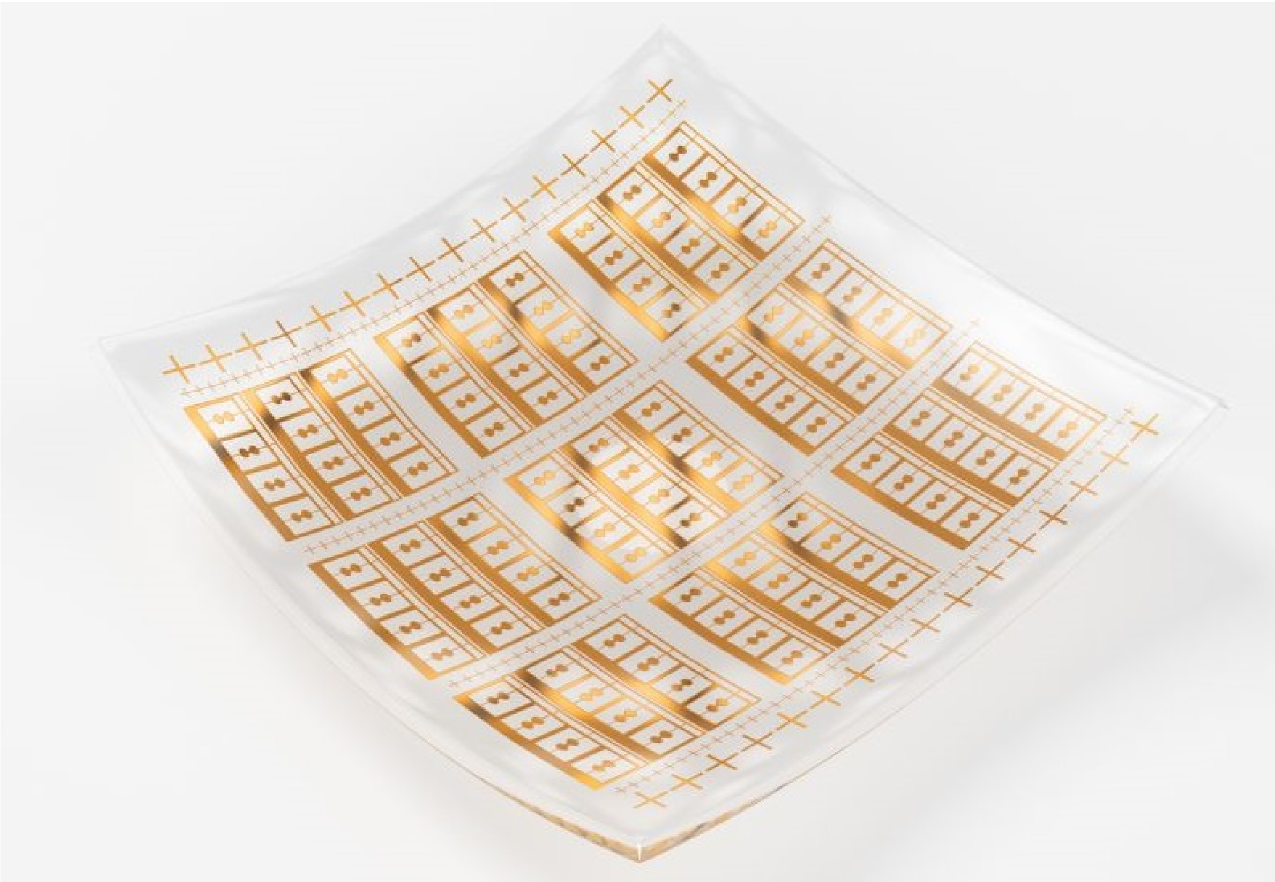


Fig. 2. Room temperature *I–V* characteristics of the fabricated 0.08 mm² (active area of 0.18 mm²) 4H-SiC BJTs with emitter width of 40 μm.

Graphene enables high-speed electronics on flexible materials

A flexible detector for terahertz frequencies has been developed by researchers at the Terahertz and Millimetre Wave Laboratory, using graphene transistors on plastic substrates. It is the first of its kind and can extend the use of terahertz technology to applications that will require flexible electronics, such as wireless sensor networks and wearable technology. The results were published in the scientific journal Applied Physics Letters.



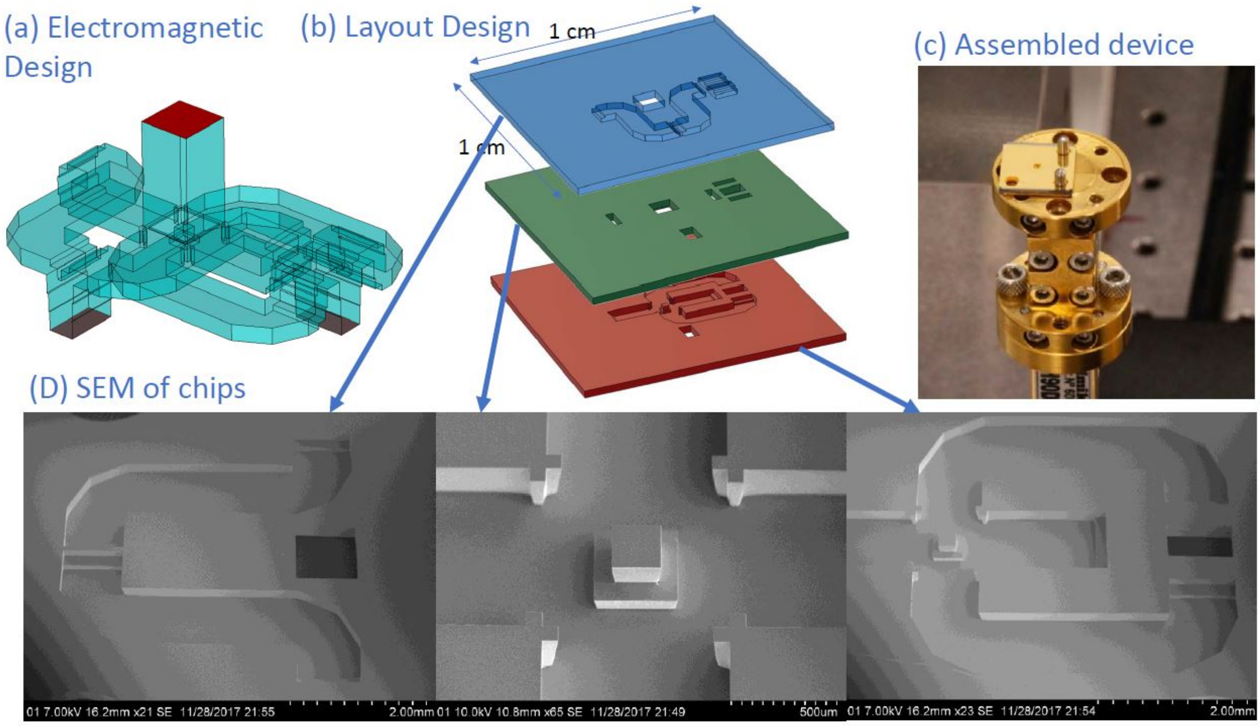
With the help of the two-dimensional material graphene, the first flexible terahertz detector has been developed by researchers at Chalmers. Illustration: Boid – Product Design Studio, Gothenburg.

http://www.chalmers.se/en/departments/mc2/news/Pages/Graphene-enables-high-speed-electronics-on-flexible-materials.aspx

Micromachined orthogonal mode transducer

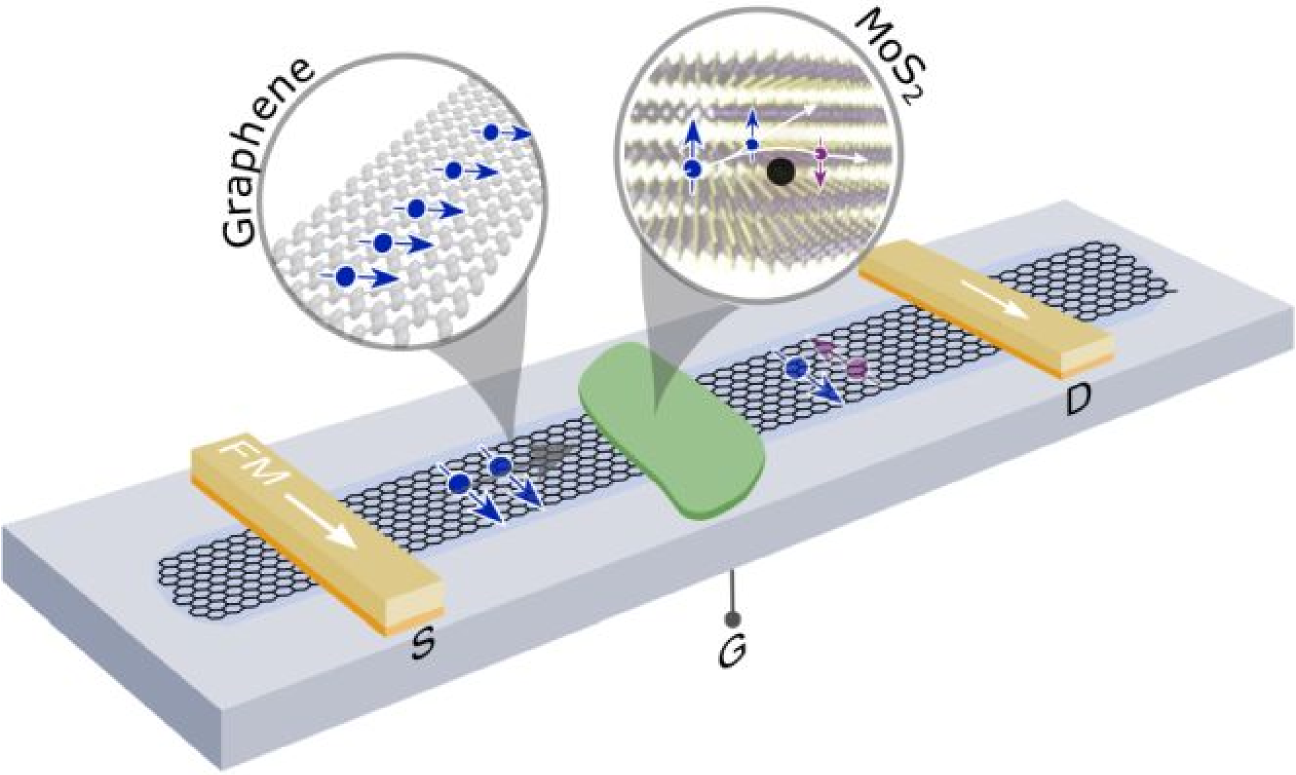
The PhD student Adrian Gomez, supervised by Prof. Joachim Oberhammer, at KTH EECS school, has successfully designed and implemented a micromachined orthogonal mode transducer (OMT) in the 220-330 GHz frequency band. An OMT is a complex waveguide geometry which can split or combine a dual polarized wave into its orthogonal components. This is the first time that a turnstile OMT design could be implemented in any technology above 110 GHz, and it is the first broad-band OMT in any technology above 110 GHz. Only the fabrication accuracy of micromachining allows to implement such devices at such sub-THz frequencies.

With a total of 9 different silicon etch levels in a 3-SOI-wafer bonded stack, this is the most complex micromachined microwave geometry implemented in Europe up to date. Measurement performance is outstanding: 0.5 dB insertion loss for both polarizations, >60 dB cross-polarization isolation. Accepted for publication at IEEE International Microwave Symposium. Contact: Joachim Oberhammer joachimo@kth.se



Spin in graphene: finding elusive surface spins on superconducting can be switched off

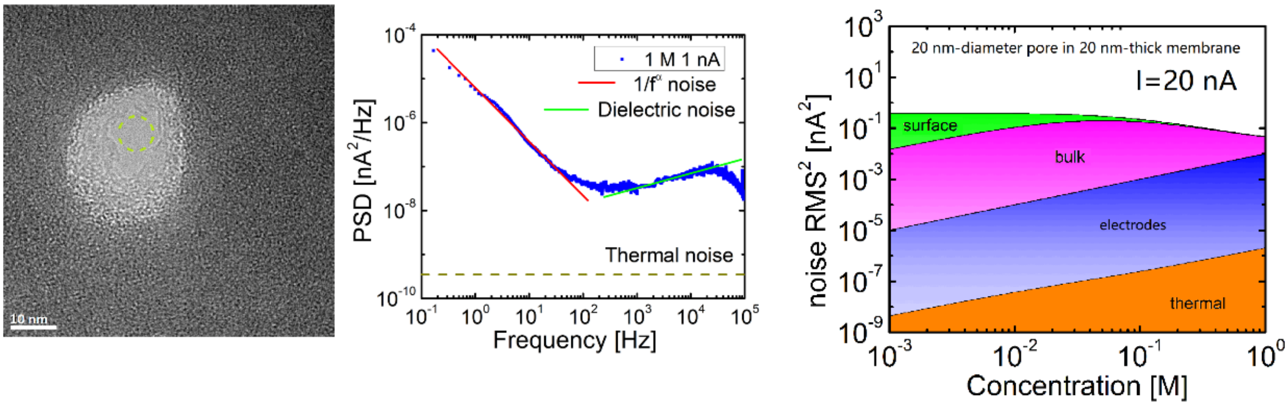
By combining graphene with another two-dimensional material, researchers at the Quantum Device Physics Laboratory have created a prototype of a transistor-like device for future computers, based on what is known as spintronics. The discovery was published in the scientific journal Nature Communications.



Spin as the information carrier can result in electronics that are significantly faster and more energy efficient. It can also lead to more versatile components capable of both data calculation and storage.

https://www.chalmers.se/en/departments/mc2/news/Pages/The-spin-in-graphene-can-be-switched-off.aspx

Low-frequency noise in solid state nanopore

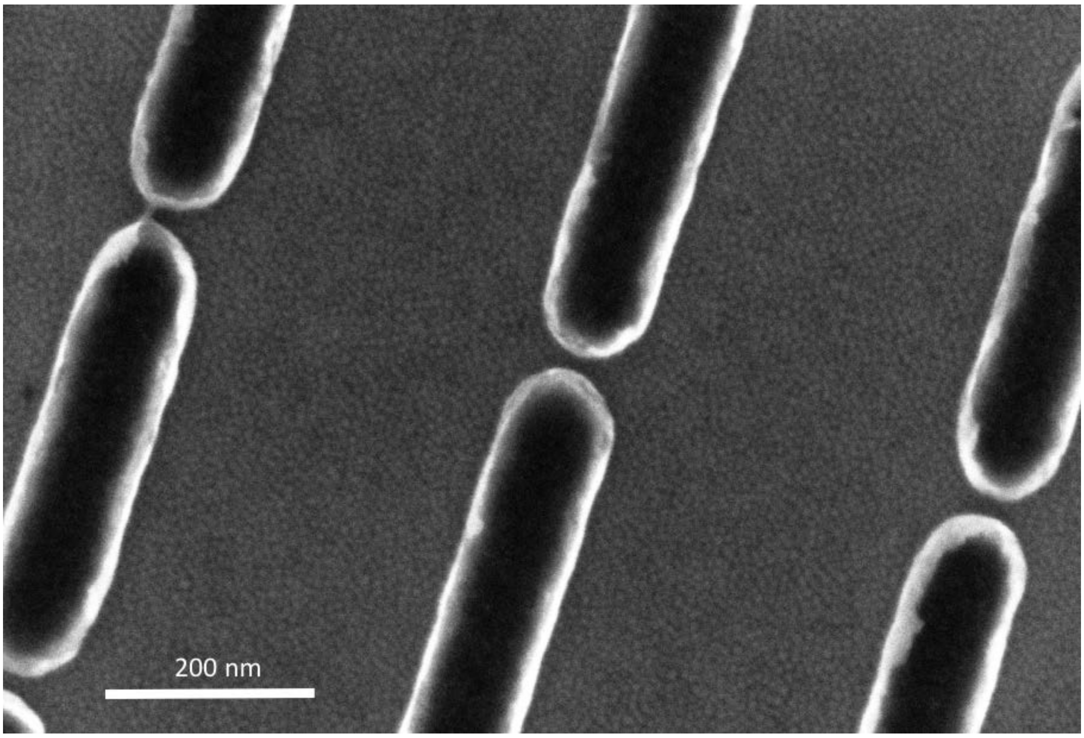


The nanopore technology has been extensively investigated for analysis of biomolecules. Solid-state nanopores (SSNs) have been explored to attain longer lifetime and higher integration density than what biological nanopores can offer, but SSNs are generally considered to generate higher noise whose origin remains to be confirmed. We systematically study low-frequency (including thermal and flicker) noise characteristics of SSNs measuring 7 to 200 nm in diameter drilled through a 20-nm thick SiNx membrane by focused ion milling.

Both bulk and surface ionic currents in the nanopore are found to contribute to the flicker noise, with their respective contributions determined by salt concentration and pH value in electrolytes as well as bias conditions. In addition, the noise from Ag/AgCl electrodes can become predominant when the pore size is large and/or the salt concentration is high. Furthermore, based on the experimental results a generalized nanopore noise model is established. It not only gives an excellent account of the experimental observations, but can also be used for evaluation of various noise components in much smaller nanopores currently not experimentally available.

Mesoscopic spin systems

Mesoscopic spin systems are systems of nanofabricated magnetic single domain islands arranged in two-dimensional lattices. These can be designed to mimic model magnetic systems, such as the famous Ising model. The interacting magnetic islands order collectively according to the interaction and lattice geometry. Systems like these serve as excellent model analogues for the study of emergent structures and properties. Using basic concepts from model magnetism, it is possible to engineer condensed matter systems based on thin films. This intriguing class of metamaterials, is composed of a large number of interacting submicron-sized magnetic elements, arranged on periodic 2D lattices. These have length- and energy-scales that are very distinct from those found in atomic spin systems of magnetic materials. The submicron size of these elements is essential, in order to ensure that they behave as single magnetic domain particles, while their small size still allows for thermal fluctuations of their magnetization. As such, the patterned magnetic elements – mesospins – effectively behave as "artificial magnetic atoms", enabling the fabrication of mesoscopic spin systems, which can be designed and tested against celebrated magnetism models.



An example of mesospins fabricated using EBL. The magnetic islands are made of δ-Pd(Fe) layers on a substrate of MgO.

Östman, E., Stopfel, H., Chioar, I.-A., Arnalds, U. B., Stein, A., Kapaklis, V., & Hjörvarsson, B. Interaction modifiers in artificial spin ices. Nature Physics (2018). http://doi.org/10.1038/s41567-017-0027-2 .

INTERNATIONAL COLLABORATION

Nordic Nanolab Network management meetings

Two management meetings were held during 2017, in Denmark and in Sweden.

Snekkersten 18 – 19 January 2017: The Nordic Nanolab Network (NNN) assembled in Snekkersten, Helsingör, Denmark during 18 – 19 January 2017. Main topics to be discussed and planned were the NNUM, the ENRIS conference 8 – 9 May 2017 in Trondheim (http://nordicnanolab.com) and the EuroNanoLab work towards the ESFRI road-map.

Gottskär – Nidingen 28 – 29 August 2017: Focus at the NNN meeting at Nidingen was on follow-up and evaluation of the two big events in May in Trondheim. The general conclusion was that both events had been very well arranged and appreciated by the participants and exhibitors. The economic outcome from both events was also close to their respective budget. Based on both our own and the users feedback, we concluded that the over-all concept was very good but we discussed improvements and possible new options for the next event in May 2019 in Denmark.

The first Nanofabrication Research Infrastructure Symposium (ENRIS), Trondheim, 7 – 9 May 2017

Myfab participated through the Nordic Nanolab Network (and through EuroNanoLab) to the arrangement of the 1st European conference on cleanroom operation, management and user training in Trondheim on 8 – 9 May 2017.

The meeting was initiated with an organ concert in the Nidaros Cathedral, hosted by Trondheim municipality, followed by a welcome reception on 7 May. The following one-and-a-half day program included presentations on the following topics:

- National infrastructures for nanostructuring
- Sustainability
- Laboratory information systems
- Financing models and pricing
- Efficiency
- Community interaction/innovation

In addition, guided visits to NTNU NanoLab were arranged. Altogether, 122 leaders and experts from 38 cleanroom infrastructures and 13 companies, from 20 countries participated at the meeting and the commercial exhibition. ENRIS 2017 was organized by the Nordic Nanolab Network in cooperation with EuroNanoLab. The next ENRIS will take place in 2019 at the University of Twente, The Netherlands.

Nordic Nanolab User Meeting (NNUM), Trondheim 9 – 10 May 2017

Myfab co-arranged and participated with slightly more than 100 participants at the Nordic Nanolab User Meeting (https://www.ntnu.edu/nano/nnum2017) in Trondheim 9 – 10 May. Altogether, the event gathered more than 260 participants.

The Nordic Nanolab User Meeting started after lunch in the same venue as ENRIS. The meeting was organized by the Nordic Nanolab Network and constituted the third user meeting on a Nordic level, continuing the longer tradition of Myfab's user meetings in Sweden.

The aim of NNUM is to offer a meeting place for PhD-students, post docs, researchers and engineers working in the field of nanostructuring and -characterization. These meetings address experimental issues through technical tutorials covering the central disciplines of nanofabrication: etching techniques, thin film technologies, lithography and characterization. As additional inspiration, four invited speakers gave presentations of their work. The participants also had the opportunity to present their own research at a poster session. For the first time, a poster prize of 5000 NOK in travel support to attend an international conference was awarded. The prize was given to Einar Digernes from NTNU for the poster: "Complex oxide samples for scanning tunnelling X-ray microscopy".

Finally, NTNU NanoLab and NorTEM offered guided tours. The interest for these tours exceeded the capacity, due to a tight schedule before the conference dinner on Tuesday evening. All together 263 people attended NNUM2017, which was supported by all the Nordic research infrastructures and by the Research Council of Norway.

The next meeting, NNUM2019 will be arranged in Denmark and hosted by DTU Danchip/Cen.

The Nordic Nanolab Expert Network (NNEN)

The Nordic Nanolab Expert Network is acknowledged for planning and presenting all the tutorials at the Nordic Nanolab User Meeting in Trondheim! We have elevated the quality of the technical program through strong involvement of the NNEN experts and the formation of a program committee!

BUILDING REGIONAL STRENGTH TOGETHER WITH NORDIC COLLEAGUES

NNN has activities on the management level (NNN-meetings and coordination), on the expert level (five Nordic Nanolab Expert Network groups, topological areas), and on the user level (Nordic Nanolab User Meeting). Strategically important tasks for this regional infrastructure alliance are:

- Simplifying the exchange of users between the Nordic countries by unifying the access routines, simplifying the exchange of wafers and materials between the laboratories and establish a common e-learning system for all users.
- Making research within nanotechnology more efficient, by documenting and exchanging fabrication processes between the laboratories.
- Supporting open science, by developing a way of publishing research results within nanofabrication

SEEKING LONG-TERM STABILITY FOR STRATEGIC DEVELOPMENT

RFI visit to Chalmers MC2 and Myfab 11 – 12 May 2017

Myfab hosted a meeting for RFI at MC2 11 – 12 May. This was one of RFI's ordinary board meetings that was located outside of the SRC. During the Evening of 11 May, Chalmers President attended a dinner with RFI, and from 09:00 – 11:00 on Friday 12 May, Myfab met with RFI's board and presented Myfab, arranged a guided tour to the cleanroom laboratory and discussed Myfab's future. In particular, the funding situation was addressed and the option for Myfab, as part of EuroNanoLab, to participate in an application to establish EuroNanoLab on ESFRI's roadmap. RFI approved, and Myfab got political support from Sweden for the application.

EuroNanoLab's application to the ESFRI roadmap

Several meetings and an extensive amount of work has been carried out to prepare the application from EuroNanoLab (http://euronanolab.net/) for the ESFRI roadmap, which was handed in by France in end of August 2017. Major meetings were held in Brno 7 – 8 Feb and in Utrecht 3 – 4 April. Myfab contributed and influenced especially the Quantum Technologies section and descriptions related to flexible and open user access to distributed research infrastructures.

The other research areas for EuroNanoLab were also pointed out in the application: multidimensional nanomaterials and bio-nano including nanomedicine, but the descriptions of these areas were on a more general level. The application reported a completed *design study*, and if the outcome is positive, we will start the *preparatory phase*, preliminary in January 2018. Our very positive experiences from the Nordic Nanolab Network and from Myfab LIMS has been highlighted, and in the application we propose to further develop Myfab LIMS in several ways, especially important in order to handle processes. We expect ESFRI to communicate their decision before summer 2018.

ECONOMY

Myfab's financial report for 1 January – 31 December 2017, submitted separately and undersigned by Chalmers financial controller, has been approved by the Swedish Research Council. The report presents how the Myfab operations grant has been distributed, in accordance with the decisions taken by Myfab's steering group.

The table below present the total economy of the Myfab laboratories and sets the Myfab operation grant in perspective to each laboratory's total economy. The Myfab grant in this table represent the full-year 2017.

Income [kSEK]	**Myfab Chalmers**	**Myfab KTH**	**Myfab Lund**	**Myfab Uppsala**	**Myfab all four labs**
Faculty grants	24756	13800	15871	4085	**58512**
Fees, academic	18328	14400	11318	9057	**53103**
Fees companies incl. Acreo	6465	21600	4759	5100	**37924**
Myfab SRC grant	3350	3350	3350	3350	**13400**
Financed depr.	11100	6500	6230	6862	**30692**
Services	90	800	3352		**4242**
Income Total	**64089**	**60450**	**45080**	**28454**	**198073**
Costs [kSEK]					
Personnel	15094	13600	9352	6571	**44617**
Rent premises	17680	9200	10189	9072	**46141**
Operation	11674	23800	8003	3780	**47257**
Overhead	5087	6900	5403	813	**18203**
Financed depr.	11100	1950	6230	6862	**26142**
Depreciations	4491	4300	3211	1187	**13189**
Costs Total	**65126**	**59750**	**42388**	**28285**	**195549**
Result	**-1037**	**700**	**2692**	**169**	**2524**

ANNEXES

A. **Standard report from Myfab LIMS – key numbers for Myfab 2017**
B. **Key numbers as specified from Appendix 1 (Bilaga 1) to Myfab's contract (Dnr: 2015-06030)**
C. **Publication lists from Publication lists from Myfab's laboratories at Chalmers, KTH Royal Institute of Technology, Lund University and Uppsala University**

ANNEX A

Standard report from Myfab LIMS – key numbers for Myfab 2017

	Myfab	Chalmers	KTH	Lund	Uppsala	2016 Myfab	2015 Myfab	2014 Myfab	2013 Myfab
Users with access	**1611**	466	485	266	394	1592	1476	1412	1371
Active users	**804**	208	202	135	259	847	820	811	792
Female active users	**198**	43	45	36	74	211	193	197	185
Gender balance, active users	**25%**	21%	22%	27%	29%	25%	24%	24 %	23 %
University active users	**669**	184	150	114	221	716	695	672	651
Institutes active users	**11**	0	8	1	2	12	11	22	24
Commercial active users	**124**	24	44	20	36	119	113	117	116
Companies with own personnel	**56**	11	17	4	24	59	50	54	56
Number of booked hours	**195615**	65137	38405	52090	39982	199303	192802	177732	185172
-from universities	**170101**	60648	26572	46235	36644	170980	166520	146940	155650
-from institutes	**3220**	0	3157	1	62	3630	3169	11709	13146
-from commercial users	**22293**	4489	8675	5854	3275	24694	23099	19155	16373
Number of tools	**709**	191	233	84	201	697	683	654	630
Booked tools	**404**	142	109	64	89	399	407	381	386

ANNEX B

Key numbers as specified from Appendix 1 (Bilaga 1) to Myfab's contract (Dnr: 2015-06030)

1). Number of users per Myfab site, including other organisations, companies etc.

See the standard report in Annex A.

2). Number of users per scientific area (SCB-codes, on the 3-digit level)
Number of active users 2017:

		Chalmers	**KTH**	**LU**	**UU**	**Myfab total**
103	Physical Sciences	86	47	29	15	177
104	Chemical Sciences	12	7	2	45	66
106	Biological Sciences	6	1	12	4	23
202	Electrical Engineering	75	100	19	77	271
203	Mechanical Engineering			4	36	40
204	Chemical Technology		5			5
205	Materials Engineering	2			9	11
206	Medical Technology	1	4		15	20
209	Industrial Bio Technology		1		2	3
210	Nanotechnology	26	29	67	34	156
211	Other Technology		8			8
301	Basic Medicine				3	3
302	Clinic Sciences			1		1
304	Medical Biotechnology			1	19	20

3). Number of female and male users

Total number of active users 2017:	804	
Total number of female users active 2017:	198	(25 %)
Total number of male active users 2017:	606	(75 %)

4). Average number of individuals that are connected to a group leader ("PI")

Not available from Myfab data. User affiliation normally recorded on department and division level.

5). Number of users per laboratory (i.e. active users 2017)

Myfab Chalmers	208
Myfab KTH	202
Myfab Lund	135
Myfab Uppsala	259

6). Number of users that has applied for access to the infrastructure but were not given access

No users were denied access.

Myfab applies open user access based on user-fees. The access model, according to "European Charter for Access to Research Infrastructures", European Commission (ISBN 978-92-79-456) is denoted Market-driven access. All users who are qualified, i.e. have the appropriate education and approval from an established research group (liable for all user charges), are given access to the infrastructure. Myfab gives regularly relevant clean-room and tool educations to its users.

7). Number of drivers licenses (individuals) that has passed the compulsory education and are allowed to use the laboratory, reported per laboratory

Total number of users with access:	1611
Myfab Chalmers:	466
Myfab KTH:	485
Myfab Lund:	266
Myfab Uppsala:	394

8). Number of scientific publications and patents, published 2017 and to which the infrastructure has contributed

Number of scientific publications, (journal and conference papers) and PhD exams

	Publications	PhD exams
Myfab total:	740	52
Myfab Chalmers:	206	12
Myfab KTH:	184	10
Myfab Lund:	127	9
Myfab Uppsala:	223	21

Number of patents: Myfab does not have information on user's patents, nor does Myfab require its users to report this kind of information.

ANNEX C

Publication lists from Publication lists from Myfab's laboratories at Chalmers, KTH Royal Institute of Technology, Lund University and Uppsala University

Myfab Publications 2017

Journal and Conference Papers

Chalmers – Nanofabrication Laboratory

1. Fathali, Hoda Mashadi, Dunevall, Johan, Majdi, Soodabeh & Cans, Ann-Sofie (2017). Extracellular Osmotic Stress Reduces the Vesicle Size while Keeping a Constant Neurotransmitter Concentration. *Acs Chemical Neuroscience*. 8:2, s. 368-375
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3. Lovric, Jelena, Dunevall, Johan, Larsson, Anna, Ren, Lin, Andersson, Shalini, Meibom, Anders, Malmberg, Per, Kurczy, Michael E. & Ewing, Andrew G (2017). Nano Secondary Ion Mass Spectrometry Imaging of Dopamine Distribution Across Nanometer Vesicles. *ACS Nano*. 11:4, s. 3446-3455
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6. Saavedra Becerril, Valeria, Sundin, Elin, Mapar, Mokhtar & Abrahamsson, Maria (2017). Extending charge separation lifetime and distance in patterned dye-sensitized SnO2â€“TiO2 µm-thin films. *Physical Chemistry Chemical Physics - PCCP*. 19:34, s. 22684-22690
7. Acimovic, Srdjan, Sipova, Hana, Emilsson, Gustav, Dahlin, Andreas, Antosiewicz, Tomasz & Käll, Mikael (2017). Superior LSPR substrates based on electromagnetic decoupling for on-a-chip high-throughput label-free biosensing. *Light-Science & Applications*. 6
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