Myfab Annual Report 2013

Myfab - The Swedish Research Infrastructure for Micro and Nano Fabrication
www.myfab.se


myfab

MYFAB SUMMARY

Myfab is the Swedish national research infrastructure for cleanroom-based microtechnology, nanoscience, and characterisation, funded by the Swedish Research Council, and the three participating universities[1]. Myfab is an integrated open-access infrastructure serving 647 active users and about 80 companies on an annual basis[2].

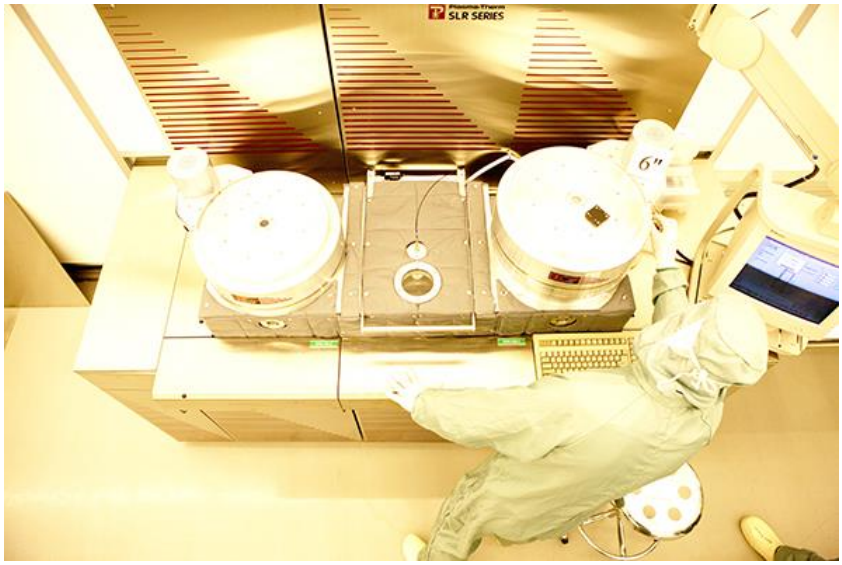
Vision

Myfab is the first choice, world-class infrastructure for micro- and nanoscale fabrication and characterization, enabling researchers and innovators to solve the grand challenges of the future.

Mission

Myfab provides cleanroom-based resources for microtechnology and nanoscience, supporting researchers and innovators in achieving world-class results and developing products for the needs of society.

Myfabs ambition is to offer the best available tools and support to its users in a timely manner. Since nanoscience and nanotechnology is one of the most important fields for research and development, and since the field develops very rapidly, it is of the utmost importance for the competitiveness of Swedish researchers and innovators that the development of Myfab continues.



1 *The three universities are Chalmers University of Technology in Gothenburg, KTH Royal Institute of Technology in Stockholm and Uppsala University. The university and external funding consists of base support from the universities and academic and external user fees.*

2 *From Myfab LIMS data for year 2013. Active users are users who perform activities themselves within the cleanrooms. Such users are typically part of user groups in the near environment of Myfab: in measurement laboratories or in companies, continuing the work by performing analyses, integration tasks etc.*

Common values

1. **Sharing**
   We share common resources, knowledge and opportunities. We pass our knowledge on to others to enable continuous improvement.
2. **Supporting**
   We have an open and generous environment with a framework for supporting each other to constantly enhance our results.
3. **Taking responsibility**
   We take individual responsibility for everything we do and we act for quality.

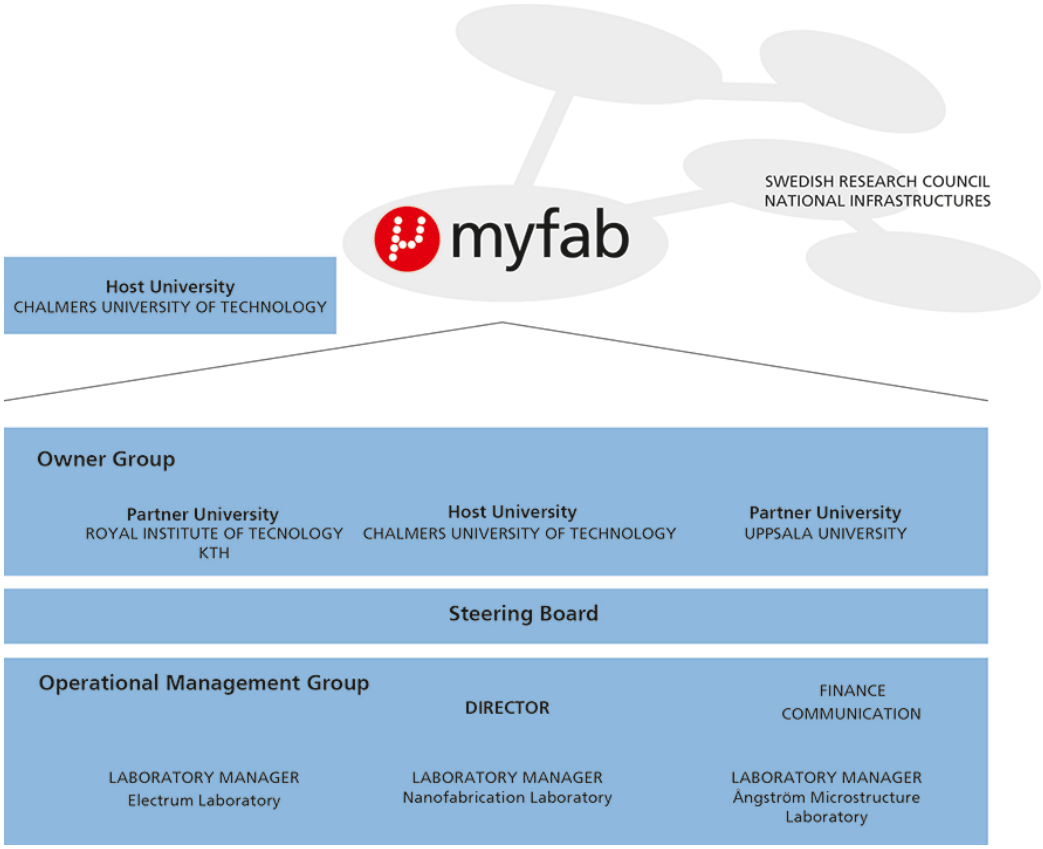
Myfab – the focal point of the nation's efforts[3]

Being Sweden's national research infrastructure for microtechnology and nanoscience, Myfab attracts the vast majority of Sweden's nanotechnology researchers and entrepreneurs within its field. Compared to the first year when Myfab LIMS was introduces at all Myfab laboratories (2008), the number of active users has increased from 493 to 647 (+31.2 %) in 2013. This is an "all time high" for the sixth year in row. In 2013, 536 (82.8 %) users come from academia and 111 (17.2%) were commercial users from either industry or institute. Myfabs annually serves about 80 companies. New and potentially returning users, with no previous experience from Myfab, are invited to apply for funding for their first project through *Myfab Access*.

During the last years, Myfab together with Lund University have had close collaboration and since a few years, a process aiming to fully integrate Lund Nano Lab (LNL) into Myfab has matured into a decision by the Owner Groups Representatives of the Myfab Universities and Lund University to apply for funding together for *Myfab IV – i.e.* Myfab during its 4th period op operation, starting 1 January 2016. LNL uses Myfab LIMS, and reports 145 active users during 2013. Adding this number to Myfab's 647 active users gives altogether 792 active users, which indicates the size of the future Myfab IV.

[3] The Swedish Research Council: Interim Evaluation of 11 National Research Infrastructures – 2012. Vetenskapsrådets lilla rapportserie 10:2012, ISBN 978-91-7307-219-9.

MANAGEMENT



Myfabs owner group

Myfab is a joint undertaking of three Myfab universities: Chalmers, KTH Royal Institute of Technology and Uppsala University. Each Myfab Universities own the local cleanroom laboratory. Myfab's Owner group is therefore formed to address matters where Myfab's undertakings and the University's strategy overlap. The Owner Group during 2013 consists of: Prof. Dag Winkler, MC2, Chalmers (representing the host university), Prof. Mikael Jonsson, Uppsala University, and Prof. Carl-Mikel Zetterling[4], KTH. The participating universities have agreed to collaborate according to the Consortium Agreement, and to the Main Contract between the host university (Chalmers) and the Swedish Research Council (SRC).

Myfabs steering group

Myfabs steering group was appointed by Chalmers University of Technology (Chalmers) for the period 2013-01-01 – 2014-12-31, and consists of seven members: Hans Hentzell, CEO Swedish ICT (chairman), , Gunilla Bökmark (CEO Sahlgrenska Science Park), Håkan Engqvist (Prof. Physics, Uppsala University), Ludvig Edman (Prof. Physics, Umeå University), Per-Erik Hellström (Docent Solid-State Electronics, KTH), Susanne Holmgren (Prof. Emerita Zoophysiology, University of Gothenburg), nominated by SRC, Nils Mårtensson (Prof. Physics,

[4] Prof. Carl-Mikael Zetterling succeeded Prof. Mikael Östling as KTH's representative from 1 April 2013.

Uppsala University), nominated by SRC). The steering group is in charge of Myfab's activities during the current period of operation 2010 – 2014[5].

Steering group meetings

Myfabs steering group met four times during 2013, in Lund on January 16, in Uppsala in April 16, in Gothenburg on September 10 and in Stockholm on November 19.

Operational management

Myfabs operation is managed by the Director Thomas Swahn in collaboration with the communication manager Christina Caesar, and the laboratory managers Peter Modh (Chalmers), Stefan Nygren (Uppsala University) and Nils Nordell (KTH). Project managers and representatives from Myfabs owner group participate in some meetings, projects and workshops.

Myfabs International Science and Technology Advisory Board

Myfabs International Science and Technology Advisory Board (ISTAB) consists of two members: Prof. William Stanchina (University of Pittsburgh, PA, USA) and Prof. Alain Cappy (IEMN, University Lille1/RENATEC, France). On April 16 the ISTAB Inaugural meeting was held at the Ångström Laboratory, Uppsala.

Workshops for strategic planning

Myfab annually arranges 2 -3 workshops for strategic planning, usually with a specific topic in focus. Two such workshops have been held during 2013, one in May and one in October.

Myfab workshop 6-8 May at Nidingen, Kungsbacka

Based on input from Myfabs evaluation 2012 (reported early 2013), Myfabs current strategic plan, the steering group meeting on 16 April, and on the current contracts with SRC, Myfabs operations management and owner group, with support from Susanne Holmgren from Myfabs steering groups carried out a two-day meeting at Nidingen, Kungsbacka, to decide on updates and improvements on Myfabs strategic plan.

Myfab Workshop 22-23 October in Gothenburg

Myfabs operations team and participants from Myfabs steering groups and owner group worked together on the Myfabs applications for operations (and investments) grants for 2015 – 2019.

[5] On 10 February 2014, the SRC informed Myfab and 10 other national research infrastructures that they will extend the financing period through 2015, at the budget level of 2014. The decision was motivated by the fact that the SRC will improve the support model for large national research infrastructures, and the new model will be introduces by 1 January 2016. Myfab, together with the SRC, will have to make suitable updates to the current contracts and board appointments etc.

MAJOR EVENTS DURING 2013

Myfab evaluation

The report from the mid-term evaluation of Myfab and 10 other national research infrastructures was published on 8 January 2013. The evaluation itself took place during 2012. The outcome of the evaluation report was very positive for Myfab. We refer to the full report[6] from the Swedish Research Council.

Visit to Southampton University

Peter Modh visited Southampton University and their, after the devastating fire, re-built cleanroom. Their management have interest in Myfab LIMS, and have now access to the evaluation environment for test.

LIMS statistics for 2013

We have generated an annual report from Myfab LIMS, using the standard format. The report is attached as a supplement to this report. Compared to 2012, the total usage is roughly constant: we see a small increase of the number of active users, from 630 to 647, at the same time as the total number of booked tool hours decreases slightly from 137402 to 131923.

[6] The Swedish Research Council: Interim Evaluation of 11 National Research Infrastructures – 2012. Vetenskapsrådets lilla rapportserie 10:2012, ISBN 978-91-7307-219-9.

Myfab quality project

The aim of the Myfab quality project is to coordinate common quality interests and help each other in their individual quality work. To do that, representatives from the Myfab laboratories has formed a quality group. The work so far has been concentrated to information about ISO 9001 work and certification (Electrum) to the other Myfab laboratories and vice versa, updating introduction and safety courses, setting up process tags for tools to make it easier to find processes/tools between the different laboratories, discussion about how document storage shall be handled for Myfab laboratories, and coordination meetings (telephone and in person) within the Myfab quality group.

Kåre Bremer's investigation of Swedish Research Infrastructures

Prof. Kåre Bremer was appointed by the General Director Mille Millnert of the SRC to make a one-man investigation of 30 Swedish research infrastructures. Gothenburg University and Chalmers was contacted and on 1 March 2013 Thomas Swahn and Peter Modh met with Kåre during one hour. Later during spring, Kåre also met with Nils Nordell, Carl-Mikael Zetterling and Ulf Karlsson at KTH, and with Lund University.

Kåre's viewpoints and recommendations are reported in "Synpunkter på planering, organisation, styrning och finansiering av Svensk nationell infrastruktur för forskning med stöd från Vetenskapsrådet genom rådet för infrastruktur" (in Swedish), Vetenskapsrådet, ISBN 978-91-7307-227-4.

Myfab consider the recommendations and improvements outlined in Bremer's report being very well-thought out, and in-line with the outlook of Myfabs steering board, management team and owner group. Some of the more bold ideas will probably take time to get decided upon and implement, but in the mean time they are still worth to support and develop.

Meeting in the Swedish Parliament Building concerning utilization of research infrastructures10 April

Myfabs Director Thomas Swahn was invited to a meeting concerning utilization of research infrastructures in the breakfast dining-room of the Swedish Parliament building on 10 April. In addition to Myfab, also SP (Asta Zero), Sandvik and AstraZeneca participated at the meeting. About 35 persons, most of them members of the Parliament, attended the meeting. In the invitation, Myfab was asked to present how come Myfab is so successful in attracting a relatively large share of commercial users (about 20%; from 80 companies annually). Myfab presented its operation model of open access to a distributed infrastructure.

Göran Sandberg, executive member of Knut and Alice Wallenberg's Foundation (KAW) visited Myfab's Nanofabrication laboratory (NFL) at MC2, Chalmers.

KAW have contacted Chalmers to arrange a visit. During one hour on 11 April, Göran Sandberg was guided in the cleanroom and a follow-up on how the contributions from KAW Materialized into important instruments. Through usage statistics gathered by Myfab LIMS, we can see that KAW have financed about 1/4 of all tools in the cleanroom, and that the

number of hours these tools are used corresponds to 1/2 of all booked hours in NFL. These instruments thus constitutes an exclusive and attractive minority.

Visit by NanoLab NL, 13 February 2013

Frank Dirne and Arnold van Run from TU Delft/Kavli Institute Delft, the Netherlands, visited Chalmers as a follow-up of the visit from our side on 21 November 2012. They wanted to see a presentation of Myfab LIMS, as well as have a meeting and discussions with Chalmers concerning e-beam lithography. Both Myfab/Chalmers MC2 and TU Delft/Kavli Institute Delft are about to invest in new e-beam lithography equipment.

Visit by CNRS LAAS, Toulouse, 11 – 12 March 2013

On 12 March, three representatives from CNRS LAAS, Toulouse, visited MC2. The purpose was to meet with representative from the research groups and to investigate possible collaboration with Myfab and other similar organizations in Europe.

Follow-up on the mid-term evaluation of Myfab

After receiving a very positive report from the mid-term evaluation of Myfab in January 2013, Myfabs director and steering groups proposed a follow-up meeting with the Swedish Research Council (SRC), to plan how to implement the proposed recommendations. In the beginning of Juni we were invited to meet Juni Palmgren on 26 June. At the meeting, Hans Hentzell, Susanne Holmgren and Thomas Swahn participated from Myfab. The meeting was very positive and Juni stated clearly that Myfab has been very successful and was a long-term commitment for SRC. Myfab should prepare itself to apply in April 2014 for prolonged financing for the next five your period of operation 2015 – 2019. At the meeting several strategic aspects of Myfab were discussed, as well as the recommendations made by Kåre Bremer in his report from his evaluation of Swedish Research Infrastructures during spring 2013. At the meeting we were informed that Myfab was invited to meet the preparatory group 2 (beredningsgrupp 2, BG2) of RFI for a follow-up meeting on 28 august in Stockholm

Meeting with SRC-RFI preparatory group (BG2) on 28 August

Hans Hentzell, Susanne Holmgren and Thomas Swahn participated from Myfab at a meeting with the preparatory group 2 (beredningsgrupp 2, BG2) of SRC RFI, as a follow-up meeting after the very positive mid-term evaluation. At the beginning of the meeting, we presented Myfab and a resume of the steering groups recommendations of strategic improvements. Following the presentation, the participants of BG2 were given the opportunity to ask questions and to comment on Myfab. Unfortunately, the meeting never addressed strategic planning for Myfab or specifically, BG2 did not follow-up on the recommendations given in the evaluation report.

Myfab's, NorFab's and LNL's user meeting 17 – 18 April in Uppsala

Myfab co-arranged with NorFab and Lund Nano Lab (LNL) a common user meeting with about 230 participants in Uppsala during 17 – 18 April. This was Myfab's third bi-annual user meeting, and this time it was co-arranged with Lund Nano Lab and NorFab, the Norwegian national research infrastructure. Focus was on current and potential users and on technical sessions. Several technology teams were formed well in advanced, to set up a program and to give tutorial classes on a broad range of technologies found within our infrastructures. The

program also included several invited inspiring seminars by international experts, guided clean room tours etc., and a conference dinner.

Norway – Forskningsrådets infrastructure meeting in Trondheim – Hell
On 23 – 23 May, Myfab's director participated at an infrastructure meeting arranged by the Norwegian research council. The concept to share experiences between leaders of national infrastructures, as well as the proposed Norwegian (compulsory) model (leiestedsmodellen) for unified calculation of costs of premises etc. were both very interesting, and could be interesting for Sweden to consider.

Nanoforum, 15 May
Myfab presented itself through a small exhibition with roll-ups and folders at the annual Nanoforum, arranged by SwedNanoTech in Stockholm on 15 May.

Myfab and NorFab initiates "Nordic Nanotechnology Network Meetings – thematic group 'dry etch' – Pilot study"
During 13 – 14 November, 18 experts in dry etch technologies from 11 Nordic nanotechnology laboratories met at Chalmers for the first meeting in a pilot study of this form of collaboration. Myfab hosted this first meeting, and the initiative was taken by Myfab and NorFab as a spin-off from the co-arranged user meeting in Uppsala in April 2013.

Myfab visit to RENATECH and LAAS-CNRS
During 15 – 16 October, Thomas Swahn and Peter Modh visited LAAS – CNRS in Toulouse, one of six laboratories within RENATECH, the French National Nanofabrication Network. In addition to a clean-room tour, we participated in a workshop with RENATECH (about 15 - 20 participants from all RENATECH labs). The goal was to present Myfab, Myfab LIMS, RENATECH and two software tools being developed by RENATECH: SULTAN, a software tool for processes, and the RENATECH LIMS, which is focused on projects. The RENATECH software tools have been developed since about a year, and have not yet been formally introduced. They complement Myfab LIMS in a very interesting way, and at the workshop we have had discussions on if we could co-develop the software tools for mutual benefits. Also RENATEC's Director Michel de Labachelerie indicated a strong interest on behalf of RENTECH for Myfab LIMS, and we are now awaiting response whether we should proceed with Myfab LIMS implementation for LAAS alone or with the whole of RENATECH. We plan a follow-up workshop in Gothenburg in the beginning of 2014, where – preliminary – Myfab, RENATECH and NorFab meets to inform and discuss future ambitions regarding these three software tools.

NANoREG project meeting 12 November at Chalmers
SwedNanoTech arranged a project meeting within the NANoREG project on 12 November at MC2 Chalmers. The project focus is nanosafety. Myfab provided guided tours to the Nanofabrication laboratory, a mini-exhibition and an oral presentation of Myfab for the participants.

Chalmers Industriteknik visit at Myfab and Chalmers MC2 NFL
During the afternoon of 4 November, about 25 persons from Chalmers Industriteknik visited MC2 NFL for a guided tour to the clean room, presentation of Myfab, and to discuss project collaboration.

FP7 NANoREG, arranged by SwedNanoTech at Chalmers
Myfab and Myfab Access were presented on 12 November at the NANoREG nanosafety workshop at Chalmers. Furthermore, interested participants were invited to guided tours to the cleanroom. In total there was about 60 participants, and after the meeting Myfab's Director had a follow-up meeting with the NANoREG project manager, who also represents the Dutch Ministry of infrastructure and environment, on European networking and a vision to develop Myfab LIMS into a broader, common European model for open access and support to companies, match-making etc.

Myfab and NorFab joint meeting on 26 – 27 November in Stockholm
A joint meeting with the operations managements of Myfab and NorFab was held in conjunction with "Nordic Infra". Both organisations are in the phase of applying for funding for their next period of operation which was an important topic for the meeting. Continued collaboration and expansion of the successful Nordic Nanotechnology Expert Network (pilot study) into additional technology fields was also discussed. Next meeting is preliminary scheduled to May 2014, in Norway.

Nordic Infra – Joint Focus on Research Infrastructures – Looking to the Future
Arranged by the Nordic Council of Ministers, NordForsk, the Ministry of Education and Research and the Swedish Research Council (http://www.vr.se/NordicInfra2013). The conference's main focus was the large infrastructures: MAX IV and ESS, their need of additional funding and how to attract users. Myfab had the option to meet with representatives from the Nordic Council of Ministers and NordForsk, to present and discuss the "grass-root" Nordic Nanotechnology Expert Network which has been established. There is an interest for the involved parties to follow-up on the discussion to see if a formal support to this could be made by NorForsk.

MYFAB LIMS

Myfab LIMS has been updated with a new GUI adopted to mobile devices with touch displays. The underlying framework has also been updated, this will, in addition to maintain a modern development environment, for example improve the performance and handling of pages in the application where we present data from Myfab LIMS in form of tables.

COMMUNICATION

The overall communication strategy is to strengthen the image of Myfab as an open, flexible, world-leading and reliable infrastructure for micro and nanofabrication. This will position Myfab as the first choice for nanofabrication in Sweden. Myfabs most prioritized target group is researchers at all levels within the academic system, but also at high-tech companies, mainly start-ups, and companies that perform research.

Over the course of 2014, Myfab will become increasingly visible to a broader target group, especially toward new users in small and medium-sized companies and within academia, to funding agencies and the general public.

A communication plan has been developed, presented to the Myfab board in January 2013. Work towards a new Myfab brand strategy was initiated in 2013 to strengthen Myfabs positions as one unified infrastructure. New Myfab roll-ups have been produced and used at exhibitions and meetings during the year. Success stories have been identified that originate from Myfab-related research and they will increase the understanding and possibilities of nanotechnology.

During 2013, Myfab continued with inviting researchers, industry and the public to visit our laboratories and gaining an understanding of what resources are available for them to use in Myfab. In October MC2 and Chalmers was honoured to receive a visit from the Swedish king Carl XVI Gustaf.

The *Myfab User Meetings* (bi-annual) held in April 2013 attracted 230 participants and have become the largest national meeting place for nano-researchers. In 2013 the user meeting was widened and done in collaboration with NorFab (Norwegian equivalent to Myfab).

Figure: King Carl XCI and IVA visits the Myfab cleanroom at MC2, Chalmers.

OUTREACH ACTIVITIES

Several outreach activities were carried out by Myfabs operational management during 2012; below are some of the most important.

Royal visit at MC2

King Carl XVI Gustaf honoured Chalmers and MC2 with a visit in October - and ended up with a tennis racket made of graphene. The king produced graphene in the cleanroom using the Nobel award-winning tape method. "The king was methodical, careful and managed very well," was the positive review from nano researcher Niclas Lindvall afterwards.

The International Science Festival in Gothenburg 2013

The Nanofabrication Laboratory and MC2 as usual hosted the very popular 'Nanoscientist for a day' during the Science Festival. During the activity, one class of 11 year old schoolchildren visits the cleanroom each day for some hands on experiments.

The International Science Festival in Gothenburg

Future Friday

The tour of the Electrum Laboratory was a highly appreciated item at the annual Future Friday event at KTH School of ICT. Future Friday is intended primarily for students in grades two and three in high school and inspires to future studies within the field of information and communication technology. http://www.futurefriday.se/

Technet_nano

Myfab is through Electrum Laboratory represented in Technet_nano, a network of more than ten research and development facilities with cleanrooms and numerous researchers in the Baltic Sea Region. Technet_nano has been established with financial support from the

INTERREG IVB Baltic Sea Region programme. The network provides easy access to the facilities with competences within micro- and nanotechnology to a variety of users including small and medium-sized enterprises. Technet_nano has rganized lab visits for SMEs and a number of workshops thorough the year. In November 27–28, 2013 a conference with the title "Breakthroughs in Sensor Technology" was hosted by Electrum Laboratory and Acreo Swedish ICT in the framework of Technet_nano and Competence Center IMAGIC (Imaging Integrated Components). The event attracted 110 participants from seven European countries, representing industry and academia.

Stockholm vision 2015

Open access research and innovation infrastructures, as a motor for innovations and industrial applications, is one of five prioritized work areas within the Stockholm County Administrative Board (Länstyrelsen) vision to make Stockholm the world's most innovation driven economy by 2025. Electrum Laboratory is part of the project group, coordinated by KTH.

FP7 NANO-TEC Ecosystem Technology (https://www.fp7-nanotec.eu/)

The FP7 NANO-TEC project, where Myfab participated and where Chalmers was responsible for arranging four workshops, was completed during 2013. The project has published its Recommendations on Beyond CMOS Nanoelectronics Research here:

> https://www.fp7-nanotec.eu/content/now-online-recommendations-technology-design-ecosystem-nanoelectronics

Furthermore, NANO-TEC Yellow Pages on European Competences in future Nanoelectronics are presented through a press-release:

> https://www.fp7-nanotec.eu/content/yellow-pages-european-competences-future-nanoelectronics-available

The NANO-TEC Yellow Pages are available to the public here:

> https://www.fp7-nanotec.eu/search_yp

QualityNano (Earlier.QNANO)

The EU-funded infrastructure for nanomaterial safety testing aims to create an integrated hub for nanosafety research within Europe. Together with 27 other top European facilities in nanotechnology, medicine and natural sciences, Myfab Ångström participates in joint research activities and provides transnational access to the lab resources.

MYFAB ACCESS

Myfab Access offers free access to the cleanroom facilities for a limited test or start-up project. The aim is to make potential new users aware of the resources available through Myfab, and the major opportunities that exist for companies to get assistance in developing innovations in their respective areas of operation.

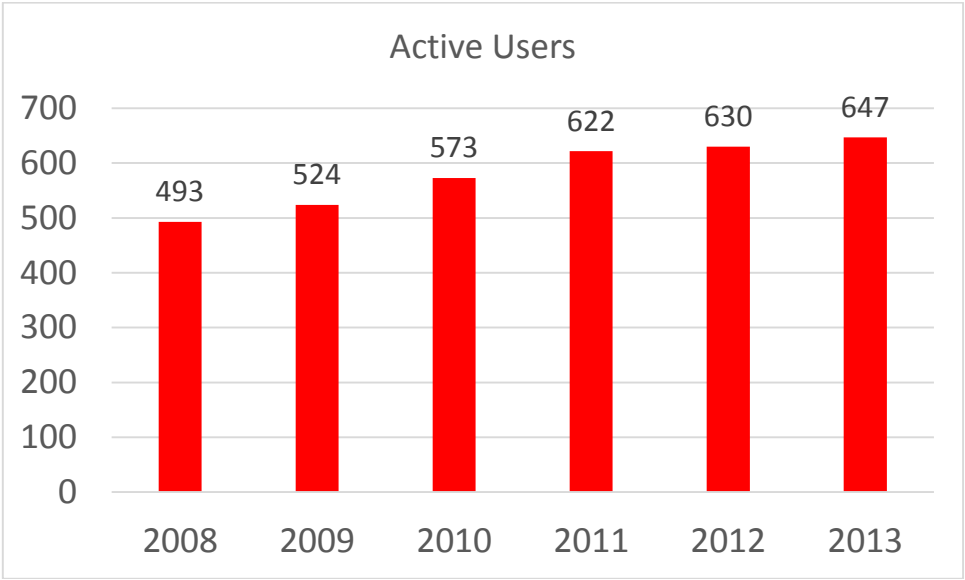
A program selection panel with members from all of the three Myfab laboratories/universities distributes the funding based on project quality and guidelines prioritising users from academia and SMEs who are expected to be returning users. The program manager for Myfab Access is Ulf Södervall, Chalmers (former project manager for FP6 MC2 Access), and the program selection panel consists of Niclas Roxhed (KTH), Nils Nordell (KTH), Greger Thornell (ÅSTC & chairman for MSL steering group), Stefan Nygren (UU), Göran Alestig (Chalmers) and Peter Modh (Chalmers).

SPECIFIC POINTS REQUESTED BY SRC IN THE ANNUAL REPORT

In the contract between the Swedish Research Council and Myfab, it is stated that Myfab should address the ten points listed below in the annual report.

1. Number of users, including new groups

Myfab introduced its in-house developed Myfab LIMS system by 1 January 2008 in all Myfab laboratories, and we have thus used the system during sex full years now. The number of active users show an increase over there years, and last year we reported 647 active Myfab users. An active user is a person who personally was performing at least one activity in a Myfab laboratory, *i.e.* a person who has the competence to perform such work and who dresses up and enters into the cleanroom.



At Chalmers, five new academic user groups two new companies (one start-up) started to use the cleanroom infrastructure. In Uppsala two new groups from SLU (Swedish University of Agricultural Sciences), one group from KTH (Division of Coating Technology) and one company added new users to the infrastructure.

2. Major changes of the organisation

New representative in the Myfab Owner Group

Carl-Mikael Zetterling replaced Mikael Östling as KTH's representative in Myfabs Owner Group, as a natural step as Mikael has retired after serving as Dean for the School of Information and Communication Technology (ICT). Carl-Mikael, a former Ph.D. student of Mikael, now a professor at KTH and vice-dean of ICT, is very familiar with Myfab and the Electrum Laboratory, so we expect "seamless" transition o responsibilities within Myfabs Owner Group.

3. Number of peer-reviewed articles related to the infrastructure = 671

The number of peer-review articles by authors or projects using Myfab during 2013 is 671, an increase from 627 in 2012. The number is the result from a process where each publication is manually selected if the work reported is based on Myfab usage to a significant extent, using data lists from available databases at the participating universities, which are compulsory for the affiliated staff to keep updated. Currently, Myfab does not have a routine of its own to register publications, so the actual number of publications is likely to be higher than we report here.

4. Number of patents related to the infrastructure

Myfab has more than 600 active users who bring about project activities involving 1500 – 2000 persons or even more taking into account that each active Myfab user typically collaborates with 2 – 3 persons when outside the cleanroom laboratory. This extensive group of researchers and entrepreneurs is spread around a large number of research groups and companies. It is not mandatory for Myfab users to report patents emerging from the infrastructure, and neither is there a process through which patents or other IP rights are gathered. The reason for this is that Myfab does not track nor control the use of results among its users. The number of patents is therefore difficult to determine, and we are not prepared to answer the question in any other way than this. From a manual investigation some data is available: KTH reports one patent and two patent applications during 2013.

5. Economical account including other major contributions applied for or received

The total operations grant during 2013 from SRC was 31 000 000 SEK. Most of the funding was distributed to the three Myfab laboratories according to the established key number (so called X-funding): Chalmers 40%, KTH 30% and UU 30%. The corresponding amounts are: 9 960 000 SEK 7 595 000 SEK and 7 595 000 SEK, total: 25 150 000 SEK. 1 500 000 SEK was distributed to the further development of the Myfab LIMS and Myfabs website, 3 000 000 SEK was distributed to Myfabs administrative account, 550 000 SEK to the Myfab Access project.

The sum of administrative costs 2013 is 4 108 363 SEK which includes remuneration to the steering board, salaries to the director and communication officer, consultant costs, advertising, information, printing costs, travel expenses, rent for premises etc. The balance of Myfabs administrative account is positive, but decreased to 868 927 SEK by 31 December 2013 (2 536 170 SEK by 2012-12-31).

The LIMS account has balance of: 75 537 SEK (-202 226 SEK 2012-12-31), and the Myfab Access account holds: 1 458 354 SEK by 2013-12-31.

Below we present separately the budgets for Myfabs laboratories, including both economical support from the 2013 grant and distribution of money from Myfab's accounts remaining from previous years:

Income [kSEK]	Electrum	NFL	MSL[7]	All Myfab labs
Faculty grants	13 300	26 613	10 964	50 877
Fees, academic	18 300	17 550	6 039	41 889
Fees comp. incl. Acreo	15 400	4 569	4 282	24 251
Myfab	7 595	9 960	7 595	25 150
Financed depr.	0	13 350	3 482	16 832
KAW & VR grants	5 350	0	0	5 350
Income Total	**59 945**	**72 042**	**32 362**	**164 349**
Costs [kSEK]				
Personnel	12 600	15 473	7 744	35 817
Rent premises	10 900	17 838	11 551	40 289
Operation	18 800	13 432	5 165	37 397
Overhead	5 385	4 098	1 976	11 459
Financed depr.		13 350	3 482	16 832
KAW & VR depr.	5 350	0	0	5 350
Depreciations	6 900	7 781	2 364	17 045
Costs Total	**59 935**	**71 972**	**32 282**	**164 189**
Result	**10**	**70**	**80**	**160**

The total turnover of the three Myfab laboratories was 164 189 000 SEK, in which 25 150 000 SEK from Myfabs operations grant (of a total of 31 000 000 SEK) is included. Myfabs operation grant is 18.9 % of the laboratories' total revenues, and its contribution directly to laboratory operation is 15.3 %. Myfab's total turnover, including administrative costs and external costs for support systems (LIMS, homepage) and Myfab Access is 164 189 000 +

[7] *In the compilation for Ångström Microstructure Laboratory, the budget for Ion Technology Center (ITC) is not included.*

5 850 000 + 1 682 200 SEK = 171 721 200 SEK. The last term: 1 682 200 SEK represents the decreased amounts on the Adm + LIMS + Myfab Access accounts.

6. International contacts and collaborations

National collaboration on the Myfab level is particularly strong with Lund Nano Lab (LNL). For more than four years, LNL has been operating in a way very similar to Myfab, e.g. by using Myfab LIMS for tool booking. Also, other Swedish and European laboratories use Myfab LIMS in their operation.

Myfab is a founding member of SwedNanoTech, the umbrella organisation for Swedish nanotechnology actors with the goal of increasing the knowledge of nanotechnology in a broad sense.

In the European arena, Myfab is strengthening the bilateral collaboration with other national research infrastructure networks. The collaboration with the Norwegian NorFab is well developed, with common management meetings. In April 2013 Myfab co-arranged the Myfab + NorFab User Meeting in Uppsala with both NorFab and LNL. The meeting was attended by more than 230 participants.

The Nordic Nanotechnology Expert Network (NNEN) was started through an initiative by Myfab and NorFab in the autumn 2013. Experts from all Nordic countries meet and exchange knowledge, best practices, make cleanroom visits and thus form a grass-root network of experts in topical fields. During 2013, NNEN dry etch was started at a pilot meeting at Chalmers, and during 2014 corresponding groups for lithography as well as thin film are scheduled to start, taking the experiences from the NNEN dry etch pilot into account. A total of 18 participants from 11 different nanotechnology laboratories in the Nordic countries attended the the first NNEN dry etch meeting.

Collaborations with the French RENATEC, NanoLab NL in the Netherlands, and Spanish NANOLITO networks have been initiated and visits have been made to their sites. A focus for Myfab is to influence the call structure of the European Union, and hence Myfab is participating as the Swedish node in the ”Small institutes group", together with partners from Finland, Norway, Ireland, the Netherlands, Belgium, UK, Greece and Spain. Myfab also follows the development in the EIN2 initiative for new calls. In addition, the Myfab nodes are members in the SiNANO institute and participate in the technology platforms of Photonics 21 and ENIAC, and are also members in a number of EU funded infrastructure related projects, e.g., FP7 Nano Connect Scandinavia and NANO-TEC (Chalmers), QualityNano (Uppsala University) and Technet_nano (KTH). Through KTH, Myfab participates in the cleanroom platform collaborative network since 1997, where representatives from eight European laboratories meet twice annually.

7. To what extent the scientific goals have been achieved, or new revised goals

Myfab is a research infrastructure which provides access to a large number of tools for fabrication and characterisation, expertise on process flows and individual tools, as well as on a wide range of applications. Myfab does not produce scientific results itself; its mission is to

support users from academia and industry to achieve their goals. Myfabs goals are therefore managerial and technical rather than scientific.

8. Major scientific breakthroughs

The examples listed below have in all cases used Myfab facilities to some extent

Graphene provides efficient electronics cooling
A layer of graphene can reduce the working temperature in hotspots inside a processor by up to 25 percent – which can significantly extend the working life of computers and other electronics. An international group of researchers, headed by researchers at MC2, are the first in the world to show that graphene has a heat dissipating effect on silicon based electronics. The research has been undertaken in partnership with the Hong Kong University of Science and Technology, Shanghai University and the Swedish company SHT Smart High Tech AB.

Z. Gao, Y. Zhang, Y. Fu, M.M.F. Yuen, J. Liu, Thermal chemical vapour deposition grown graphene heat spreader for thermal management of hot spots, Carbon (61) 342-348, 2013.

Spin inside silicon devices
A strong interest in silicon based spintronic devices stems from the expected long spin coherence length and its industrial importance. However, implementing spin functionalities in silicon, and understanding the fundamental processes of spin transport and manipulation remain the main challenges. Researchers at Chalmers demonstrated large spin polarisations in silicon at room temperature, 34% in n-type and 10% in p-type silicon, using a narrow Schottky and a thin SiO2 tunnel barrier in a direct tunneling regime. Furthermore, by increasing the width of the Schottky barrier in non-degenerate Si, they observed a drastic change in the spin injection and detection processes. These studies provide a deeper insight into the spin transport phenomenon, which should be considered for electrical spin injection into any semiconductor.

A. Dankert, R.S. Dulal, and S.P. Dash, Efficient Spin Injection into Silicon and the Role of the Schottky Barrier, Scientific Reports (Nature publishing) 3, 3196, 2013.

Terahertz sensor aiming for Jupiter´s moons
A high performance terahertz receiver aiming for space missions such as ESA's "Jupiter icy moons explorer" has been developed in a joint European effort, led by researchers at MC2 in collaboration with Omnisys Instruments.
"The unique sensor is compact, light-weight, robust and operates at room temperature, a necessity for satellite missions requiring many years of operation" says professor Jan Stake at MC2, Chalmers.
Cooled integrated circuit amplifies with lowest noise so far
Researchers at MC2 in collaboration with Low Noise Factory have demonstrated an integrated amplifier with the lowest noise performance so far. The 0.5-13 GHz wide-band design exhibited a high gain over 38 dB across the band and an ultra-low noise figure of 0.045 dB. The amplifier offers new possibilities for detecting the faintest electromagnetic radiation, for example from distant galaxies.

J. Schleeh, N. Wadefalk, P.-Å. Nilsson, J. P. Starski, J. Grahn, IEEE Transactions on Microwave Theory and Techniques, 61(2) 871-877, 2013.

Room-temperature operation of transistor VCSELs
The transistor laser is a new device breed that relies on the monolithic integration of a heterojunction-base transistor (HBT) in a semiconductor laser. As such it combines the excellent switching properties of the HBT with the efficient light extraction capability of a semiconductor laser, resulting in a number of potential advantages in functionality and performance such as enhanced modulation bandwidth, voltage and/or current-controlled laser operation, and the possibility for transistor-based design techniques for novel applications. The requirements on cost and power efficiency makes vertical-cavity surface-emitting lasers (VCSELs) the preferred sources for many applications and as the first group world-wide, researchers at KTH Royal Institute of Technology have demonstrated the first room-temperature operation of such transistor VCSELs. This is based on a highly innovative technology leading to mW-range output power, sub-mA threshold base current and high-temperature operation to at least 50°C. For more information, see *Electronics Lett. 49 (3), 208 (2013) and Appl. Phys. Lett. 102, 191101 (2013).*

Quantum-dot based interband photodetectors for thermal imaging
Thermal imaging corresponds to a substantial and rapidly growing market as driven by a number of existing and emerging applications such as night vision, surveillance, search and rescue and medical diagnosis. Two detector technologies are presently dominating these markets as based on mercury-cadmium-telluride, which is a difficult-to-control and costly technology quantum-well infrared photodetecors, which are GaAs-base with cost-efficient fabrication but modest performance. As an alternative approach that potentially can combine the excellent performance of MCT detectors with the manufacturing properties of Quantum Well Infrared Photodetectors, QWIPs, researchers at KTH have in collaboration with Acreo developed a new detector technology based on spatially indirect type-II transitions in the InGaSb/InAs materials system. Photocurrent is demonstrated in the long-wavelength (8-12 μm) infrared atmospheric transmission window, with good potential for implementation in imaging systems. For more information, see *Infrared Physics & Technology, 61, 319 (2013)*

Integrated nanomembrane lasers on silicon
The full implementation of silicon-photonics requires the integration of efficient light sources on the silicon chip. In this project researchers at KTH-Royal Institute of Technology has in collaboration with researchers at the University of Arlington in Texas, Arlington, and the University Wisconsin-Madison, Wisconsin, been able to integrate very compact nanomembrane-VCSELs on silicon using a transfer-printing technique. For more information, see *Nature Photonics, 6, 615 (2012) and IEEE Photonics Conference, Bellevue Washington USA, September 8-13 (2013)*

Photonic Nanostructures
A variety of photonic semiconductor nanostructures have been developed with high optical quality, and with unique optical properties such as long carrier diffusion lengths in InP nanowire arrays and broad-band antireflection for solar cell applications. New types of photonic crystal waveguide filters with both pass and drop functions, and new technology for

hybrid integration of materials, e.g. optoelectronc InP with Silicon electronics, have been developed. One example is the process for forming GaAs or InP-based multilayer nanopillars, used to generate substrate-free nanodisks displaying excellent photoluminescence properties. A soft-stamping method is demonstrated to transfer the generated nanodisks onto Si exploring alternative ways to integrate GaAs or InP on Si for subsequent layer growth.. For more information, see *S. Naureen, N. Shahid, A. Dev, and S. Anand, "Generation of substrate free III-V nanodisks from user-defined multilayer nanopillar arrays for integration on Si", Nanotechnology 24, 225301 (2013);*

Nanowires for light management

At KTH Royal Institute ocf Technology Si micro pillar or micro pyramid arrays with overgrown ZnO nanowire have been fabricated for light management. The structures show excellent antireflection properties in the whole 300-1000 nm wavelength range. The optical properties and high surface to volume ratio make the structures promising for photovoltaic (PV) and sensor applications. For more information, see *B. Choudhury, A. Abedin, A. Dev, R. Sanatinia, and S. Anand, "Silicon micro-structure and ZnO nanowire hierarchical assortments for light management, Opt. Mater. Express 3 (8), 1039-1048 (2013).*

Amplitude-Dependence Force Spectroscopy

Knowledge of surface forces is the key to understanding a large number of processes in fields ranging from physics to material science and biology. The most common method to study surfaces is dynamic atomic force microscopy (AFM). Dynamic AFM has been enormously successful in imaging surface topography, even to atomic resolution, but the force between the AFM tip and the surface remains unknown during imaging. At KTH Royal Institute of Technology we have developed a new approach that combines high-accuracy force measurements and high-resolution scanning. The method, called amplitude-dependence force spectroscopy (ADFS), is based on the amplitude dependence of the cantilever's response near resonance and allows for separate determination of both conservative and dissipative tip–surface interactions. We use ADFS to quantitatively study and map the nano-mechanical interaction between the AFM tip and heterogeneous polymer surfaces. ADFS is compatible with commercial atomic force microscopes and we anticipate its widespread use in taking AFM toward quantitative microscopy. For more information see the paper *in Nature Communications: http://www.nature.com/ncomms/journal/v4/n1/full/ncomms2365.html*

Active transistors in Graphene

At KTH royal Institute of Technology we have developed a manufacturable process integration for graphene double-gate transistors, sensors and Graphene-based hot electron transistors (GBT), a novel structure with the potential of terahertz operation. The first proof of concept GBT has been fabricated and characterized in the Myfab laboratory at Electrum. These activities are within a three-year European project, Grade, focused on advanced RTD activities necessary to demonstrate the proof-of-concept of novel graphene-based electronic devices operating at terahertz (THz) frequencies. In this project KTH is collaborating with three other academic partners, one research institute, and one semiconductor manufacturer within European countries France, Germany, and Italy. For more information see *Vaziri, S.; Lupina, G.; Paussa, A.; Smith, A. D.; Henkel, C.; Lippert, G.; Dabrowski, J.; Mehr, W.; Östling, M.; Lemme, M. C., "A manufacturable process integration approach for graphene devices," Solid-State Electronics, vol. 84, pp. 185-190, 2013. and Vaziri, S.; Lupina, G.; Henkel, C.; Smith, A. D.;*

Ostling, M.; Dabrowski, J.; Lippert, G.; Mehr, W.; Lemme, M. C., "A graphene-based hot electron transistor," Nano Lett, vol. 13, pp. 1435-9, Apr 10 2013.

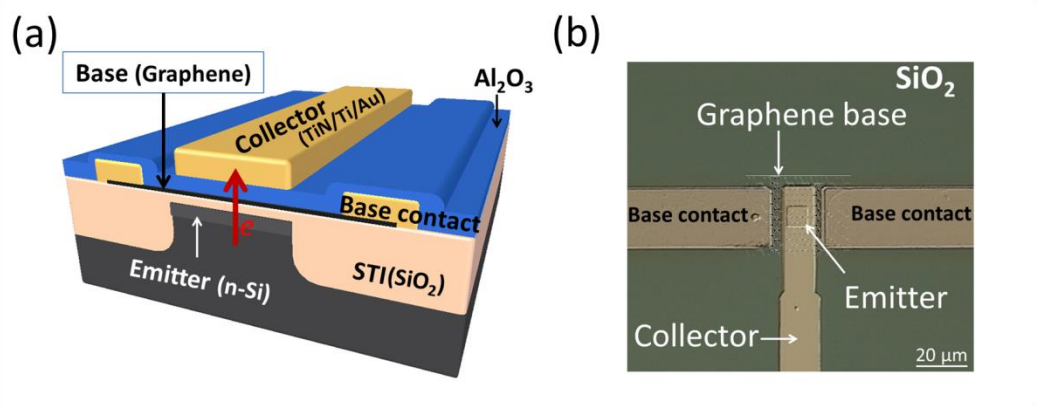


Fig. a) Schematic of novel graphene-based hot electron transistor. b) Micrograph top view of GBT.

Graphene sensors

Graphene sensors technology has improved through creation of ultrahigh sensitivity sensors which outperform conventional pressure sensors. These sensors are not only very sensitive, but they also have a very simple design which allows them to be scaled to smaller sizes. The development of graphene sensors involves several groups at KTH Royal Institute of Technology, together with collaboration partners from Sweden, Germany, Italy, Spain, and Austria. For more information see *A. D. Smith, et al., "Electromechanical Piezeoresistive Sensing in Suspended Graphene Membranes," nano letters, 2013. and A. D. Smith, et al., "Pressure sensors based on suspended graphene membranes," Solid-State Electronics, 2013.*

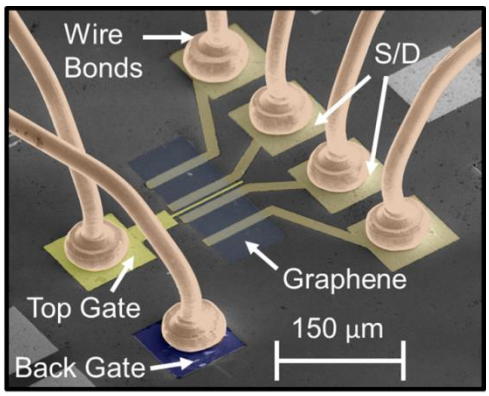


Fig Graphene membrane sensor for gas analysis, pressure and humidity.

Inkjet printing of 2D Materials

An efficient inkjet printing technology has been developed for emerging 2D layered materials, such as graphene and MoS2. In combination with the unique properties of the 2D materials, the inkjet printing technology developped at KTH royal Institute of technology has demonstrated promise in a variety of electronic applications, such as transparent conductors,

embedded resistors, photodetectors and supercapacitors, and hence has received great interest from the community. This research is funded by an ERC Advanced grant (OSIRIS) which aims to develop emerging electronic devices with novel materials other than silicon, and is conducted in collaboration with KTH iPack VINN Excellence Center. The device fabrication and characterization are performed mainly relying on facilities in Myfab labs. For more information see reports on Nanowerk http://www.nanowerk.com/spotlight/spotid=31868.php)and ChemistryViews http://www.chemistryviews.org/details/news/4876471/Efficient_Inkjet_Printing_of_Graphene.html.

High transistor inversion mobility at scaled equivalent oxide thickness using thulium silicate interfacial layer and hafnium oxide.
Thulium silicate has been demonstrated as a possible replacement of chemical oxide interfacial layers for extended scalability of high-k/metal gate MOSFETs. In this work, thulium silicate has been integrated in a scaled HfO2/TiN gate-last CMOS process, achieving EOT as low as 0.65 nm and well-behaved and reproducible IV and CV characteristics with almost symmetric threshold voltages, limited subthreshold slope and low hysteresis. Comparison with reference devices employing chemical oxide interfacial layers shows improvement in terms of leakage current density and electron and hole mobility. Specifically, channel mobility at inversion charge density of 1013 cm-2 is enhanced by 20% in N-MOSFETs and by 15% in P-MOSFETs, yielding values of 180 and 75 cm2/Vs at EOT = 0.65 and 0.8 nm respectively. For more information *see E. Dentoni Litta, P.-E. Hellstrom, C. Henkel, and M. Ostling, "Thulium Silicate Interfacial Layer for Scalable High-k/Metal Gate Stacks," IEEE Trans. Electron Devices, vol. 60, no. 10, pp. 3271–3276, Oct. 2013. and E. D. Litta, P.-E. Hellstrom, C. Henkel, S. Valerio, A. Hallen, and M. Ostling, "High-Deposition-Rate Atomic Layer Deposition of Thulium Oxide from TmCp3 and H2O," J. Electrochem. Soc., vol. 160, no. 11, pp. D538–D542, Sep. 2013.*

SiC Integrated Circuits
At Electrum high temperature integrated circuits have been made on 100 mm SiC wafers in the KTH Royal Institute of Technology proprietary bipolar mixed-signal process. Results include basic digital circuits, bandgap voltage references and operational amplifiers for high temperatures: 500 C has been demonstrated. This KTH-devloped bipolar process utilizes a large amount of equipment in MyFab for the 10 mask layer process. For more information see *Lanni, L.; Malm, B.G.; Ostling, M.; Zetterling, C.,"500 °C Bipolar Integrated OR/NOR Gate in 4H-SiC", IEEE Electron Device Letters, vol. 34, pp. 1091-1093, 2013*

SiC Power Electronics
High voltage diodes in SiC have been demonstrated with breakdown voltages of around 8 kV in a design for 10 kV by KTH Royal Institute of Technology in collaboration with Linköping University. First results were presented at ICSCRM 2013: Salemi, A., Buono, B., Hallén, A., Hassan, J., Bergman, J.P., Zetterling, C.-M., and Östling, M., Fabrication of 10 kV PiN Diodes Using On-Axis 4H-SiC, ICSCRM 2013.

SiC High Temperature Electronics
High temperature integrated circuits, so far achieving 500 °C operation on 100 mm SiC wafers, have been developed in the SSF project HOTSiC (High Temperature Power Electronics Systems with SiC Integrated Circuits). The project is a collaboration between the Myfab nodes

at KTH Royal Institute of Technology and Uppsala University. For more information see http://www.hotsic.se

Microfluidic 3D antenna

A novel microfluidic three-dimensional electrically small antenna was demonstrated. It was easy to construct by pneumatically inflating a planar stretchable microfluidic liquid alloy antenna into a spherical cap. Its center frequency was tuned when it was inflated; demonstrating combined high efficiency and a wide tunable frequency range around its hemispherical shape.

Improved Microrocketry

The Ångström Space Technology Centre at the MST program has explored dry etching to create rotationally symmetrical micronozzles for attitude control of micro- and nanosatellites. Evaluation shows that these thumbnail-sized rockets make better use of the propellant and also controls the thrust vector more precisely than conventionally etched thrusters with square cross sections.

Highly Sophisticated Picosatellite

The Ångström Space Technology Centre has also developed a tiny spacecraft intended to assist in the deployment and management of a 20-40 km wide electric solar sail. The craft is equipped with, e.g., an on-board computer, its own power supply, tiny MEMS rockets, and a long-range communication system, but also carries a small beacon and kilometre-long tethers connecting it with its fellow picosattelite in a real mission. Including a very demanding thermal management system and propellant, the craft has a mass of 0.65 kg.

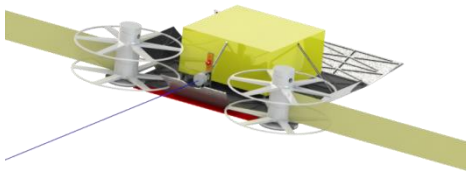


Figure: Picosatellite

A novel back contact passivation strategy for CIGS-based solar cells

Proof of concept of a novel back contact passivation strategy for CIGS-based solar cells using nano-sized openings in combination with a passivation layer. This strategy enables thinning down of the CIGS layer to below half of the normal thickness while keeping solar cell voltage and fill factor values similar to full CIGS layers.

A break-through in the understanding of CZTS-based materials for solar cells, where theoretical calculations on ordering of defects have been verified experimentally.

A solar cell fabrication process

A baseline solar cell fabrication process, which provides solar cells with 19.3 % efficiency (certified by Fraunhofer institute in Freiburg). The solar cell characteristic parameters have

been used to provide input parameters for electrical modeling. Further improvements are expected by optimization of the band-gap profile and CIGS/buffer interfaces.

Record Breaking Magnesium Carbonate Material
Researchers from the Ångström Laboratory have synthesized a novel magnesium carbonate material with a world record breaking surface area of 800 square meters per gram. The material, that has been given the name Upsalite, has a great potential for moisture control in a number of applications. Upsalite absorbs more water at low relative humidities and can be regenerated with less energy consumption than the best materials and processes today.

A new electronic device: ion-gated bipolar amplifier (IGBA), dedicated to ion sensing
Researchers at the Ångström Laboratory have demonstrated a new electronic device: ion-gated bipolar amplifier (IGBA), dedicated to ion sensing:. The IGBA consists of a modified ion-sensitive field-effect transistor (ISFET) intimately integrated with a vertical bipolar junction transistor for immediate current pre-amplification without introducing additional noise. The IGBA is characterized by a sensitivity gain up to 70, compared to the ISFET itself. The IGBA retains the sensitivity boost when it is used for monitoring pH variations in electrolytes. The IGBA concept is especially suitable for biochips with millions of electric sensors that are connected to peripheral readout circuitry via extended metallization.

Gold nanowire based electrical DNA detection using rolling circle amplification
Researchers at Uppsala University have demonstrated a novel electrical sensor concept that uses rolling circle amplification (RCA) of DNA to bridge a 5 µm gap between two electrodes. The DNA strand is only amplified upon recognition of a specific DNA sequence. The resulting long single strand of DNA is stretched across the electrode gap and metalized to form a thin gold wire, closing the electrical circuit. Upon formation of these gold wires the resistance drops billion fold. Combining RCA with electrical detection produces a highly specific and sensitive detection technique and unlike other sensors that are available on the market the readout for this sensor should not be the limiting factor for the biomarker assay, since there is virtually no background noise to interfere with the readout. This study has been published in ACS Nano.

Transfilter
This is essentially a new electronic component developed and patented at the Ångström laboratory. It can be used for passive addressable switches such as stand-by units in TV, video, etc appliances for remote switching, totally passive RFID applications, etc. It can also be used for efficient electromagnetic scavenging.

Solution-processed logic gates based on nanotube/polymer composite
Researchers at the Ångström Laboratory have demonstrated hysteresis-free logic gates capable of operation at 100 kHz. The devices were based on local-gate thin-film transistors with their channel featuring solution-processed composite films of single-walled carbon nanotubes and semiconducting polymer. Using dip-coating for deposition of composite films, the circuit fabrication process was simple and robust. The fabricated transistors that constituted the basic building block for the logic gates were characterized by nil hysteresis, high carrier mobility, large on/off current ratio, low operation voltage, small subthreshold swing, and remarkable scalability.

Light-erasable TFT memories based on semiconducting amorphous In–Ga–Zn–O
Researchers at the Ångström Laboratory have collaborated with Fudan University in Shanghai on fabrication and characterization of light-erasable thin-film transistor (TFT) memory devices. The core constituent of the memory devices is semiconducting amorphous indium-gallium-zinc oxide (a-IGZO). Use of a-IGZO films resulted in TFTs with high effective electron mobility and large ON/OFF current ratio. By incorporating novel interface designs with embedded metallic nanocrystals or modulating storage media in the TFTs, the memory devices were characterized by quick programming, large voltage shift between the ON-OFF states, well-behaving erasing assisted by UV lights and a 10-year memory window of 2.6 V at room temperature.

Enhanced thermal conductivity stability in carbon nanotube polymer composites
A joint research effort between Uppsala University and KTH led to large-scale synthesis of a water-processable and inkjet printable nanofibrillar composite consisting of polyaniline coated on carbon nanotubes. The researchers discovered that the presence of carbon nanotubes results in a significant enhancement in conductivity stability of composites when subjected to heat treatment.

Flexible nanotube-based UHF humidity sensor
Another joint research effort between Uppsala University and KTH resulted in a humidity sensor based on functionalized carbon nanotube thin films on a plastic foil using inkjet printing and spraying coating techniques. The operation frequency was successfully increased from 600 MHz to 2 GHz by optimizing the device configuration.

Commercial achievements and prestigious projects

Sol Voltaics, making solar cell development, is using the process facility at Electrum Laboratory for the development of quantum-wire based solar cells in a long-term commitment through 2013-2014.

KTH Royal Institute of Technology has entered a cross-horizontal development project on the development of integrated and compact sources on a silicon platform through the US Air Force/EOARD program: "InP-based heterostructure design and growth for semiconductor nanomembrame optoelectronics on Si and flexible substrates"

Two major collaborative projects on energy related topics include the EU-FP7 project Nanophotonics for energy efficiency (N4E), http://www.nanophotonics4energy.eu/, and the Nordic innovation center project Nanordsun, http://www.iet.ntnu.no/projects/nanordsun/. In the N4E project, the Electrum lab is explicitly included in the resource pack of the network offering visibility and potential external users. In addition, KTH Royal Institute of Technology organized an Industry-academia workshop in Stockholm on nanophotonics for photovoltaics and lighting.

KAW WOV Working on Venus, a new five-year project includes three of the KTH schools and Linköping University to demonstrate all electronics needed for a Venus Lander. The project is financed by K&A Wallenberg foundation. For more information see:
http://www.workingonvenus.se

The TeraComp project was funded by the European Community's Seventh Framework Program (FP7/2007-2013). The project consisted of seven partners from academia, research institutes, industry and end users:

- Chalmers University of Technology, Sweden
- Fraunhofer Institute for Applied Solid State Physics, Germany
- Deutsches Zentrum für Luft- und Raumfahrt e.V., Germany
- Technical University of Denmark, Denmark
- Omnisys Instruments AB, Sweden
- Wasa Millimeter Wave AB, Sweden
- Goethe-University Frankfurt, Germany

9. The infrastructure's significance to direct societal interests

Myfabs premises are all openly available to a broad range of users from academia and industry. Students from the master programs can have access to the cleanrooms during their undergraduate studies and diploma projects, under the supervision of their supervisors and with the assistance of the cleanroom staff. This opportunity to gain relevant training in a real cleanroom environment is rather rare in the rest of the world, where the requirement typically is that you have started as a PhD student or have similar experience.

Myfab actively informs the public of the possibilities which micro and nanotechnology gives society in a popular form. Outreach activities include about 2500 visitors annually to Myfab cleanrooms. In particular, the guided tours to the cleanroom for students and the public during the Gothenburg Science festival and Futrure Friday event at KTH in Kista are very popular. The guided tours to the cleanroom at are probably the activities which are the most fully booked of them all at both these events. The educational aspect is important for society. Students and researchers educated in micro/nanotechnology within Myfab, who later proceed to private enterprises or public organisations, constitute efficient communicators of knowledge during many years. These persons are also important for Myfabs network of experts and are competent procurers of projects etc.

10. The infrastructure's significance to trade, industry and other commercial interests

Myfab was established to provide a research infrastructure that would help researchers to solve the grand challenges of the world today – climate change, energy supply, aging population, diseases etc. Technology on the micro and nano scale is very important in today's electronics, automotive industry, cosmetics, hygiene, clothes, household products, food, sports and toys. Myfab is a supplier of competence needed to increase the competitiveness for Swedish industry, create jobs, improve healthcare and by making better use of the world's resources. Research in these areas is fundamental also to provide state-of-the-art education, attract the best students and so on.

About 30 spin-off companies have been created from research activities within Myfab during the last five years. Spin-off companies from Myfab have a turnover of more than 500 MSEK. Myfab has served about 120 companies during the last 5-year period with cleanroom access, process service etc. Several of these companies have special agreements and rent cleanroom space and install their own equipment in the cleanrooms. Myfab supports a scientific approach to understand and avoid possible safety risks related to nanotechnology.

It is of central importance for Swedish industry to have access to highly educated staff within the growing field of nanotechnology. Such an education must be experimentally hardware-oriented and here, Myfabs flexibility suits the purpose very well.

ANNEX

A. Key numbers for Myfab 2013 - from Myfab LIMS

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

Annex A:

Key numbers for Myfab 2013 - from Myfab LIMS

Related

Statistics for booked time
Statistics for logged time
Statistics for time in lab
Booked time list
Logged time list
Man hours
Bookings without logs
Sibling report
Lab statistics
Cleanroom entrys

Favorites

All bookings
All tools
Booking overview
Fares and Charges
Invoice by project
Invoice by user
Laboratory / Group list
Licences by tool
Licences by user
My licenced tools
My profile
Newsletter
Process line list
Project list
Project members by project
Sibling report
Statistics for booked time
System settings
Tool down time
Tool list
Tool status
University / Company list
User list

Unfavorite this page

Myfab Report

Optional filters for this list *(Hide filters...)*

Predefined time: 2013 Year: 2013

Custom time: Date is not optional to: Date is not optional

Print report

	Statistics for 2013				*Historic values for MyFab*			
	Electrum	MSL	NFL	MyFab	***2012***	***2011***	***2010***	***2009***
Number of:								
Users with access:	386	334	408	**1128**	*1094*	*1040*	*982*	*906*
Active users:	216	209	222	**647**	*630*	*622*	*573*	*524*
Female active users:	47	58	37	**142**	*146*	*145*	*127*	*108*
Gender balance, active users:	22%	28%	17%	**22%**	*23%*	*23%*	*22%*	*21%*
Number of active users from:								
Universities:	157	174	205	**536**	*525*	*512*	*455*	*409*
Institutes:	22	1	1	**24**	*26*	*33*	*35*	*38*
Commercial:	36	34	16	**86**	*79*	*77*	*83*	*77*
Number of companies with own personnel:	18	21	11	**50**	*44*	*43*	*38*	*32*
Number of booked hours:	43250	25569	63104	**131923**	*137402*	*134542*	*126070*	*116616*
Booked hours from:								
Universities:	25782	23270	61138	**110189**	*112550*	*110513*	*103706*	*90306*
Institutes:	13070	33	44	**13146**	*17346*	*16546*	*16054*	*16700*
Commercial:	4397	2266	1922	**8586**	*7506*	*7484*	*6310*	*9609*
Number of tools:	221	192	197	**610**	*592*	*556*	*483*	*453*
Booked tools:	114	75	140	**329**	*330*	*328*	*291*	*285*

Annex B:

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

Myfab – Nanofabrication Laboratory at MC2, Chalmers

Peer reviewed articles and conference papers

1. Abay, S. ; Persson, D. ; Nilsson, H. et al. (2013). Quantized Conductance and Its Correlation to the Supercurrent in a Nanowire Connected to Superconductors. *Nano Letters*. 13 (8) s. 3614-3617.
2. Abuwasib, M. ; Krantz, P. ; Delsing, P. (2013). Fabrication of large dimension aluminum air-bridges for superconducting quantum circuits . *Journal of Vacuum Science & Technology B*. 31 (3) s. 031601.
3. Alavian Ghavanini, F. ; Jackman, H. ; Lundgren, P. et al. (2013). Direct measurement of bending stiffness and estimation of Young's modulus of vertically aligned carbon nanofibers. *Journal of Applied Physics*. 113 (19)
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2. Anand, S. "InP-based Photonic Crystal Waveguide Technology: Material Properties and Applications", Invited, PIERS Progress in Electromagnetics Symposium 2013, Stockholm, 2A2_10:40.

3. Anand, Srinivasan "Nanostructured Semiconductors: Technology, Nanoscale Characterization and Photonic applications", Invited, Workshop on "Organic and Hybrid Photovoltaic Cells : From Molecular Design to Performance Characterization by Scanning Probe Microscopy" University of Mons, 5th March, 2013.

4. Anand, Srinivasan, "Nanostructured semiconductor materials for photonic applications", invited lecture, Advanced optics and photonics – ADOPT center winter school Nano- and Biophotonics, March 22 -25, 2013, Romme.

5. Anand, S. "Top down fabricated semiconductor nanowire arrays and their optical properties", Invited, Sweden-Japan Collaboration Symposium, June 3-4 2013, Lund, P2.

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