Kavli Nanolab Delft
Enabling nanodevice fabrication

Dear cleanroom user,

This is the 29th edition of **Kavli Nanolab News**. In this :

- General info
- Introduction Marinus Fischer
- Investments
- New gowning room TNO
- Containment booth in Atrium
- ICPCVD is up and running
- EBPG5200Plus replacing EBPG5000Plus
- Rebooting equipment
- Goodbye message Pauline Stevic
- Kavli group activities

General info

Week 26 (June 27th –July 1st) is our yearly maintenance week. During this week, the cleanroom will be closed for all users. Besides the standard activities, maintenance will be done on the elevator and the bulk gasses and we will proceed with replacing the cleanroom armatures by LED lights.

Beginning of August, there will be no intake of new users. The first intake after the summer will be at August 29th.

Quite often I get the question what to do when you suddenly are not able to reserve equipment anymore in NIS. In most cases, this has to do with an expired safety course. One of the modules we still need to develop in NIS is the so called safety Questionnaire. The idea is that once your safety expires, you have to do the safety test and after passing the test your safety will be granted. Because this NIS module isn't working yet, we automatically grant your safety course once you apply for it. Applying for the safety course can be done under …/institute/courses.

Introduction Marinus Fischer

Since June 1st I joined Kavli, busy to get the hang of the many thin film deposition machines and to get a picture of the people using them. Machines can malfunction, but it is always a nice sight when things are working again after the problems are solved.

I grew up in the port city Harlingen, "city" is more about the so called "stadsrechten" then it is an indication for its actual size. My parents were working in tourism and are still living there. During my youth I liked to tinker with lego and simple electronics, my brother and I had a small boat in the

canal near our parents' house. So if the weather allowed it we were often sailing in the weekend and during holidays with friends, later even now and then as a side job. I studied applied physics in Twente and thereafter the opportunity to be a researcher in thin film photovoltaics in Delft seemed a fitting challenge. Again found a living place next to the canals, instead of sailing I picked up soaring at a local club. It is oddly enough very similar to sailing in the sense that one tries to get the most out of the current weather conditions and that you have to rely on each other. The last few years I had been working in industry as engineer energy technology. Lately soaring has become less of a part of my leisure time, so if I will pick it up again or find a new challenge is yet to be seen. I do still try to keep a '86 car on the road with now and then the needed tinkering and I can value a (sci) fiction series or movie now and then. One of the teachings from soaring which seems true in many environments, the ease someone does something is a combination of someones experience and currency. The lab environment definitely feels well known, but I can note that it takes some time to again be at home.

I share the office with Bas; D118, my email is m.fischer@tudelft.nl

Investments

Tendering of the following equipment is done/ongoing:

- EBPG, will be delivered end of 2023. (replacement of the old 5000+)
- 3 furnace stacks with 10 tubes (for LPCVD, oxidation and anneal purposes), expected delivery around March/April 2023
- Oxide/nitride etcher. Tender is being published, we expect to be able to order the system after the summer.

New gowning room TNO

The construction of the TNO gowning room is almost complete. Week 27 the gowning room will be handed over to TNO by the constructor. In week 27 and 28 the replacement from the standard gowning room to the new one is scheduled.

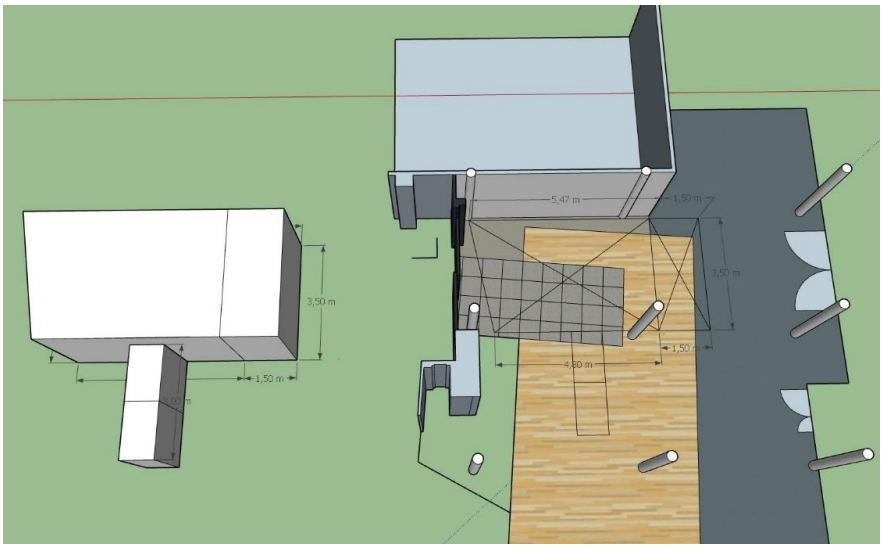
From that moment on, the standard gowning room (p.00.070) will be ours, so we will have 60+ additional hanger positions, which will be divided over the user community.

Containment booth in Atrium

On June 20 (week 25), a containment structure will be built in the VLL-Atrium, see sketch below for an impression. The purpose of this is to ensure maximum safety for people and the environment during the dismantling and removal of the MBE (project for Microsoft). The work is expected to be completed after three weeks and the containment will be dismantled again. The advantages of performing the decommissioning in a containment compared to the cleanroom lab are:

- Safer way of working, as there is no interference from cleanroom clothing and glove bags in the cleanroom
- Safer for cleanroom users in case of emergency, because of recirculation in the cleanroom
- Containment with negative pressure and Hepa filters
- Separate transport and gowning lock for users of the containment

Hindrance outside the containment can be kept to a minimum when it is in use. The route to the transport lock and the emergency exit will be kept clear. Safety officers, a.o. Remco Visser and Rolf Wilms (both TNO), are involved in the project RI&E.



ICPCVD is up and running

The ICPCVD is up and running, but what does ICPCVD mean for us nanofabricators ? Let's cover the two main reasons:

1. Significant increase in 'quality' of film (quality is expressed in wet etch rate, ergo etch resistance):

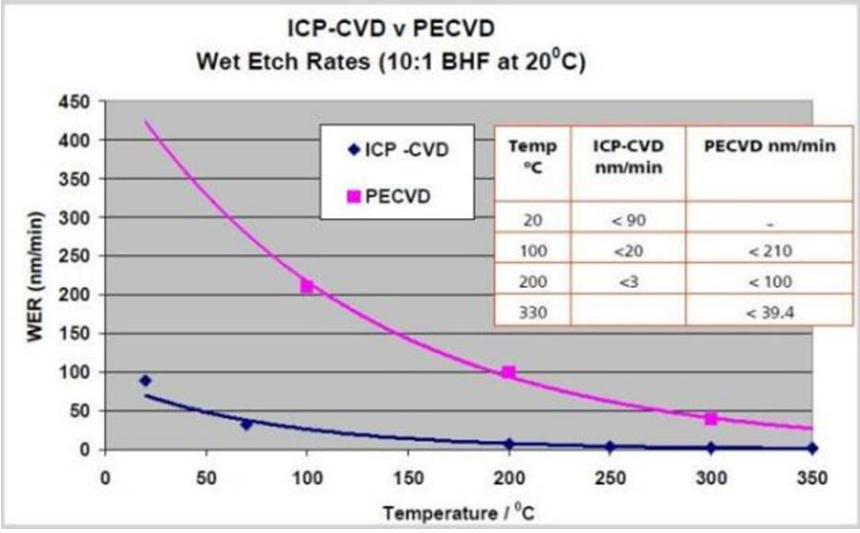


Figure 1: PECVD purple and ICPCVD blue, we can see for instance that 75C ICPCVD film is almost equivalent to 210C PECVD.

2. Significant increase in small sample uniformity:

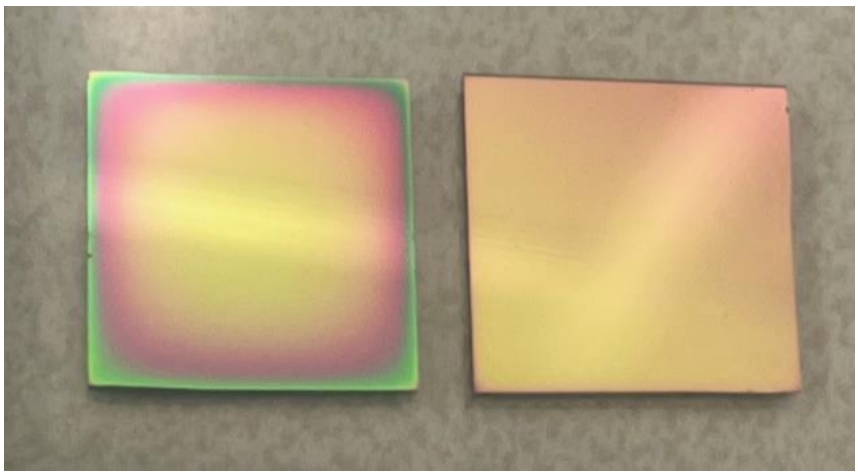


Figure 2: To the left PECVD and to the right ICPCVD, we can see colour changes that mean thickness differences due to thin film interference.

Of course other notable differences are higher plasma density, lower pressure, lower surface roughness and controllable bias to name a few. However, It's main selling point remains of course room temperature capabilities.

Currently I'm developing recipes for general use. There are 3 temperature regimes that I will develop: 75C, 150C and 400C. Of course other temperatures are also possible on request, but these 3 all fulfil a certain strategy. Specifically low roughness recipes are also possible, but those films will be slightly more

hydrogenated. Feel free to request a recipe (i.e. 75C SiN, uniformity < 5%, stress <300MPa, rq<1.5 nm). Recipes will be developed on full wafers (to measure stress), of course some specs might vary slightly for smaller samples. Daniel van der Plaats, our intern, has been developing special a-SiC recipes on the ICPCVD. Specifically high-n or low-k recipes. His recipes will be available for everyone of course.

Roald van der Kolk

EBPG5200Plus replacing QBPG5000Plus

In our cleanroom, electron beam lithography is an essential for most of our users in order to fabricate nanostructures with both ultrahigh and low resolution components on a scale from less than a few microns up to centimetres in a fast and flexible way. Most substrates used have lateral dimensions from several millimetres up to full 4” wafers, and thicknesses up to a few millimetres. Also 8” wafer or 6” mask size and thicknesses up to ten millimetres are possible.

Our current EBL systems are an EBPG5000Plus, installed in 2003, and an EBPG5200 that was installed in 2015.

The aging EBPG5000Plus has been running very reliable, but over the last years needed more service and suffers from spare parts becoming obsolete and unavailable.

The more recent EBPG5200 has among others newer, lower noise electronics, a more up-to-date vacuum control system and a better column vacuum. Also, the larger (8” instead of 6”) holders have more substrate tables, and holder handling is more robust as compared to the EBPG5000Plus.

The EBPG5200Plus was presented last year by Raith (picture taken from (https://raith.com/product/ebpg-plus), and will replace the EBPG5000Plus. It has among others a reworked column with less and lighter ion pumps in order to reduce vibrations, better stability and improved main deflection electronics and a different high tension unit as compared with the EBPG5200.

Over time, the universal pattern generator, which we already have on our current EBPG systems, evolved and nowadays advanced individual shapes like arcs, (inverted) circles and ellipses instead of only trapezia can be generated by the UPG itself. Newer versions of GenISys’ BEAMER pattern data preparation support this development more and more. With the oncoming Firebird option, using the workstation for shape calculation, the overhead time when exposing many unique or complex shapes will be much less.

The current EBPG5200 will be upgraded with the better main deflection electronics and Firebird option, probably during this year’s maintenance week 48 starting November 28th.

The new EBPG5200Plus won't have the so far hardly used Z-stage option, but one top reference 2x4" wafer holder should give the wafer thickness flexibility the Z-stage of the EBPG5200 is most used for. Also three four-table small sample holders and a large area 525 micron substrate holder will be ordered.

The new EBPG5200Plus is expected by the end of 2023 and will most likely be installed in the room behind the EBPG5000Plus (where currently a.o. the laser writers are located). In order to have two EBPG systems available during installation, the EBPG5000Plus will be dismantled only after acceptance of the new system.

Please contact me if you have questions or suggestions.

Arnold van Run (a.j.vanrun@tudelft.nl)

Rebooting equipment

There seems to be an increasing tendency to reboot PC's, Software and hardware, as soon as the user gets the idea that something is not working properly, or just a little too slow. Disconnecting and reconnecting USB cables on running systems. Some go as far as to randomly pressing 'reset' or 'calibrate' buttons in software, because they changed a setting and don't know how to set it back.

There is a system in KN, where each equipment is designated to a machine owner and a back up. As the term states, the equipment is owned by the machine owner, the user is a guest.

As a user, it is not allowed to do your own repairs on any equipment, not even rebooting software or hardware, unless instructed to do so, by the actual machine owner. If you can't reach the machine owner, the rule is: turn the equipment card to 'DOWN'. And inform the machine owner (and next users), by changing the state in NIS.

Rebooting can damage software and hardware, depending on the equipment and state. Rebooting regularly, can allow the equipment to deteriorate. Not contacting the machine owner, reduces chances to a quick detection of underlying issues, diminishes opportunities to improve equipment quality, minimizing chances of early data retrieval, hindering the process to 'UP' state.

It can be detrimental to the equipment accuracy, frustrating research results of anybody in KN. And eventually it reflects on the overall quality of KN. Which we all work so hard for, to keep as high quality as we can.

Please, work with us. Inform machine owner whenever you think something is not working properly. Contact us if you get stuck in software settings. We are here for you.

Goodbye message Pauline Stevic

This is my official goodbye message to all of you.

In November 2017 I started working at the Kavli Nano lab as a process engineer nanotechnology. My main responsibilities, during this 5 year-period, were the wet bench area, optical lithography, the atomic layer

deposition tools and the dicer. I think most of you know me, as I was working in both the thin film area as the wet bench area, or you got your user box location from me.
During this 5-year period I got to learn a lot about the Technical University of Delft, the cleanroom world, our cleanroom users and myself. I have experienced everything with a lot of fun and had an interesting time working here at the Kavli Nano lab.
During this period I was not only a process engineer, but also a first aid person, firefighter, police, teacher and student, cleaning lady, friend and enemy. My biggest job (and actually for the complete Kavli staff) is/was to keep you all happy and work safe inside of our cleanroom. At least, I tried and hope I succeeded in this as much as I could.
I have met a lot of interesting, nice and funny people in the cleanroom and will definitely miss all of you, as I will soon start with my new journey! My last work day at the Kavli Nano lab will be on the 31st of August 2022, as on the 1st of September 2022 I will start with my new job as a process engineer in Botlek-Rotterdam.

Thank you all for meeting you and thank you all for being you! You are all amazing people.
Take care of our cleanroom and listen to the Kavli Staff. They also need a little bit of love and care sometimes. ;-)

Goodbye & tot ziens allemaal,
Pauline Stevic

Kavli group activities

Besides our cleanroom work, we also had the opportunity to organize some social activities last months. Last Wednesday we enjoyed a “groupsuitje”at the “Delftse hout”. Highland games was the topic. We had a great time together!

Moreover, beginning this year we celebrated a two year delayed dinner to celebrate the fact Marc was 25 years connected to TUDelft. We went to “kookstudio Delft” located at the Rotterdamse weg.

We want to end this newsletter by wishing you a great summer period!