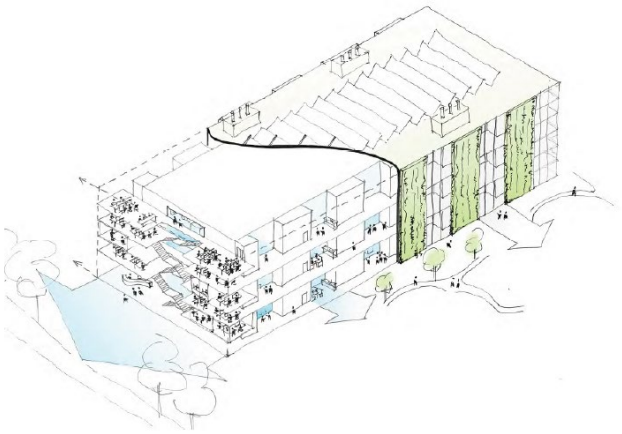
Cleanroom Baseline Lab Newsletter

Else Kooi Laboratory

Kavli Nanolab Delft
Enabling nanodevice fabrication

Volume 4, year 1

Dear cleanroom user,



We are pleased to present the fourth combined newsletter of Else Kooij Laboratory and Kavli Nanolab. In this newsletter, we will keep you informed about all activities within the shared TU Delft cleanroom infrastructure, including updates on new equipment, procedures, introductions to new colleagues, and other exciting developments.

We hope you enjoy reading it!

On behalf of the EKL and Kavli Team,

Pieter Telleman, Bruno Morana, and Marc Zuiddam

Introducing Loïc Roure

My name is Loïc Roure, I'm 28 years old and I graduated with a Master degree in Applied Physics from TU Delft. During my Master's I purposefully selected theoretical courses in Quantum mechanics, Solid-state mechanics and Nanotechnology so I could join the vanderZant group. There I was tasked with the project to develop an experimental method for measuring Magnons in resonating van der Waals materials. For this I needed to design and nanofabricate a device in the Kavli Cleanroom. I enjoyed working with cutting edge techniques in the cleanroom and really appreciated the help the Kavli team would offer me as a student when I had questions. When they offered me a position as Process Engineer I took it immediately. I am really looking forward to getting better at nanofabrication!

When I'm not working on research, I like to have an active lifestyle. I enjoy becoming stronger by doing fitness and I try to get better at bouldering. In the summer I like to go to the beach and sometimes I use my longboard to get there. On average I bike 10 km a day. With friends I like to play strategic games such as poker or chess but I also love hanging around in bars and having a drink or go to a music festival or a night party.

Diamond Cleaning at 200°C using Microwave Ethos Lean (@ Kavli Nanolab)

Recently, a new microwave at Kavli Nanolab has become available that enables cleaning diamond samples using a tri-acid mixture at 200°C (!). The tri-acid cleaning consists of 65% nitric acid, 70% perchloric acid, and 95-98% sulfuric acid (in a 1:1:1 ratio). These are mixed together and placed in a vessel along with the diamond sample. The vessel is then placed in the microwave, and the process is initiated. Additionally, three other vessels filled with DI water are used to maintain balance in the rotor.

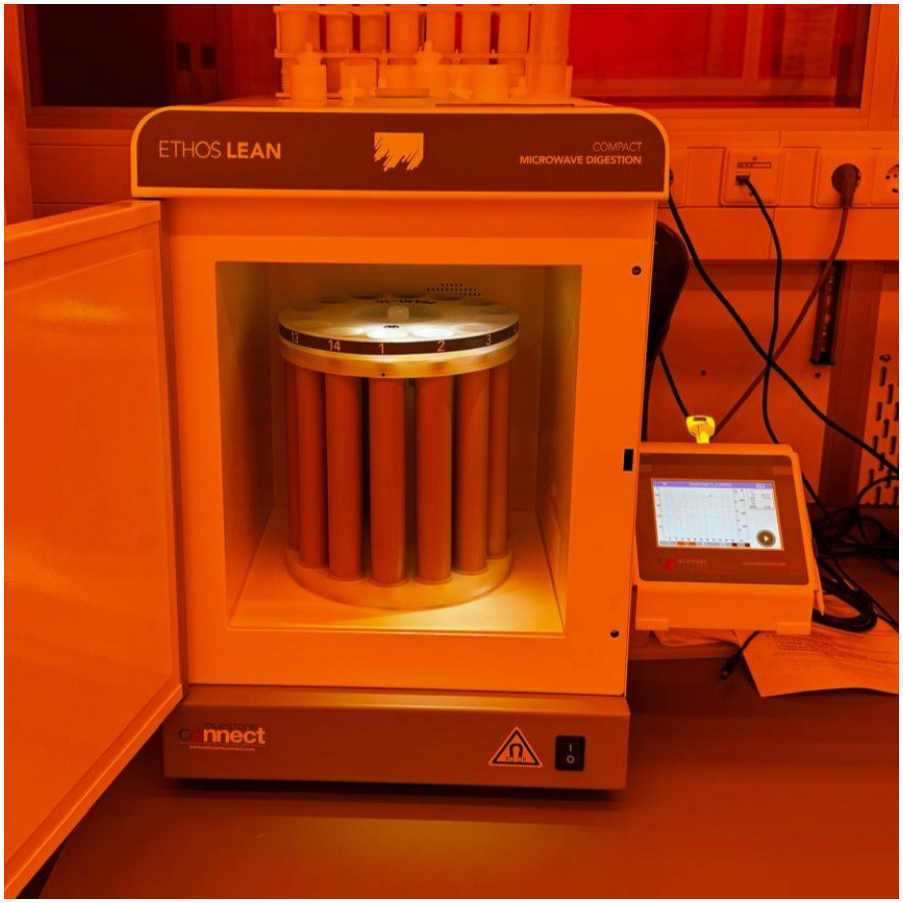
After various tests and measurements, it was concluded that only the hottest vessel is measured with an infrared laser; in this case, that is the tri-acid solution. This is also shown in the graph. Additionally, the maximum power of

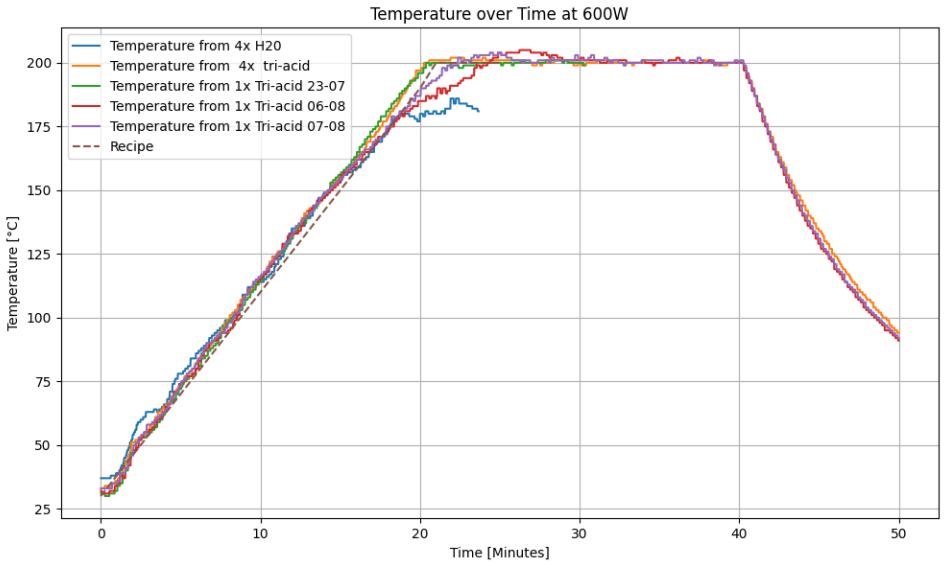
the microwave is set to 600W, and three different solutions were made to prove this: 4 vessels with DI water, 4 vessels with tri-acid solutions, and 1 vessel with tri-acid solution + 3 vessels with DI water.

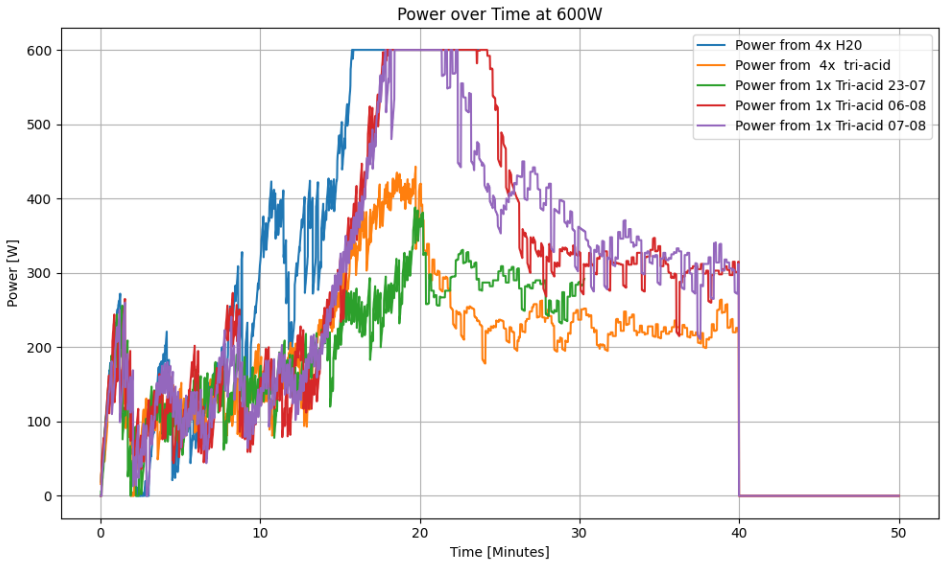
The microwave stops heating the solution when the measured temperature deviates from the set temperature. This is shown for the 4 vessels with DI water (blue line) because the measurement was stopped. Therefore, it is possible for the tri-acid solution to reach this temperature with 4 of these solutions or just 1.

Currently, there are no Teflon baskets available for this setup. They are being designed and will be handmade at a later stage. However, it is possible to request training at NIS or contact Esther or Eugene.

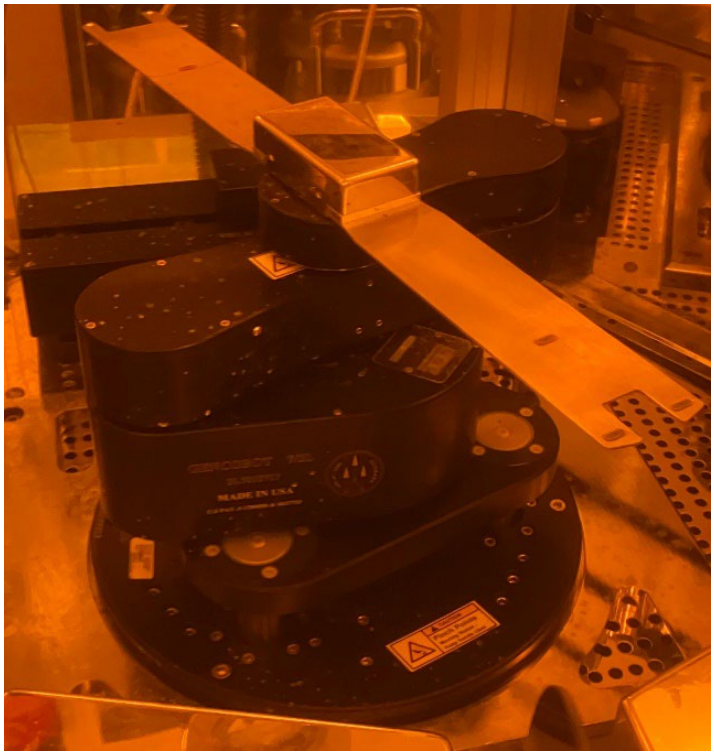
For the tri-acid cleaning, it is important that the wet bench in TU03 is available at that time. There will be a note placed above the wet bench when it is occupied for this process.







Robot refurbishment of EVG120 Coater-Developer track (@EKL)



The EVG120 Coater-Developer track at EKL is used to coat and/or develop hundreds of wafers each week, and at its heart is a Genmark robot system that swiftly pre-aligns and transports wafers between cassettes, wet processing stations and various hot plates.

This robot system is due for major refurbishment, which requires complete removal of the robot from the EVG120. Without the robot system, the EVG120 will be completely unavailable.

The refurbishment process will consist of three steps:

1. First the robot system will be removed from the EVG120 and sent to an external refurbishment company. This is scheduled to take place on Monday September 30th starting from 10:30.
2. The refurbishment itself takes place over the next three weeks, so calendar weeks 41 – 43. This overlaps with EKL's facility maintenance period, which will close the EKL cleanrooms during weeks 41 and 42.
3. Finally, the refurbished robot system will be reinstalled and its settings restored over a period of 2 days in calendar week 44.

In short, the EVG120 system will be unavailable from September 30th through October 31st, give or take a day or two. During this period the coating and development of photoresist layers at EKL will have to be performed manually in the Polymer Lab. Please take this into account when planning your processing steps for next month.

New Tempress furnaces

The new Tempress furnaces are going to replace the old systems currently available in KN and EKL. The new furnaces will be located in EKL and will be accessible by all TUDelft users as it is already the case for most of the tools present in both labs. Trainings will be offered to the users who will need to make use of these systems. For users of KN who will need to access EKL exclusively for using these system a compact version of the EKL "Safety & Introduction" training will be made available. Below some useful information regarding the status and capabilities of the new furnaces

Atmospheric stack (1x):

- Four tubes in total
- Installed and operational
- Wet and dry oxidation processes on both wafers and samples up to 1050 °C
- Annealing processes on both wafers and samples up to 1050 °C
- Dedicated tubes for processing green or red metal contaminated wafers or samples
- Annealing in N2 or Ar atmosphere available
- Annealing in 1-10% H2/N2 available starting from week 43/44

LPCVD stacks (2x):

- Six tubes in total
- Installation is ongoing
  - Facility installation expected to be completed in week 42
  - Finalization of the system installation + starting commissioning from week 43/44
  - Systems expected to be fully operational starting from week 49/50
- LPCVD layers: SiNx, TEOS, Si (poly/amorphous, undoped/doped), SiCx (poly/amorphous, undoped/doped), pure-B
- Deposition of LPCVD layers possible on both wafers and samples
- Deposition of LPCVD SiNx and SiCx layers possible also on green and red metal contaminated wafers or samples

NanoLabNL user meeting Monday October 28th 2024 Technical University Eindhoven

You are cordially invited to the first edition of the NanoLabNL User day on Monday, 28 October 2024, in Eindhoven. We plan to organize two sessions during the day, with speakers from all five NanoLabNL locations (AMOLF, University of Groningen, Twente University, Technical University of Eindhoven and Technical University of Delft). Of course, there will be plenty of room for networking and exchanging knowledge and expertise.

The User day will occur during the first day of the annual International MicroNanoConference (iMNC), which is organized by MinacNed. We kindly invite you to attend the plenary session with keynote lectures by Sjoerd Verduyn Lunel (ASML), Prof. Dr. Bert Meijer (Eindhoven University) and Prof. Dr. Albert van den Berg (University of Twente) and use the networking opportunities with companies, knowledge institutions, and students.

The outline programme for Monday 28 October is as follows:

08.30 - 09.30 hr: Walk-in with coffee and tea
09.30 - 11.00 hr: Start programme, with keynote lectures by Sjoerd Verduyn Lunel and Prof. Dr. Bert Meijer
11.00 - 11.30 hr: Coffee and Tea break
11.30 - 13.00 hr: First session for NanoLabNL User day
13.00 - 14.30 hr: Lunch and networking
14.30 - 16.00 hr: Second session for NanoLabNL User day
16.00 - 16.30 hr: Coffee and Tea break
16.30 -18.30 hr: Afternoon program with a keynote lecture by Prof. Dr. Albert van den Berg
18.30 hr: Start evening program and social networking (optional)

Location: TU/Eindhoven

Registration open now
More information about the programme for the NanoLabNL User day sessions will follow soon, but registration

is now open. We value your attendance, and therefore, NanoLabNL will cover 50% of your application fee.

Please note that the NanoLabNL User day sessions will only take place on the first day of the iMNC, Monday, 28 October. Of course, you are very welcome to attend both days of the iMNC. If you register for both days, NanoLabNL still covers 50% of the application fee for the first day.

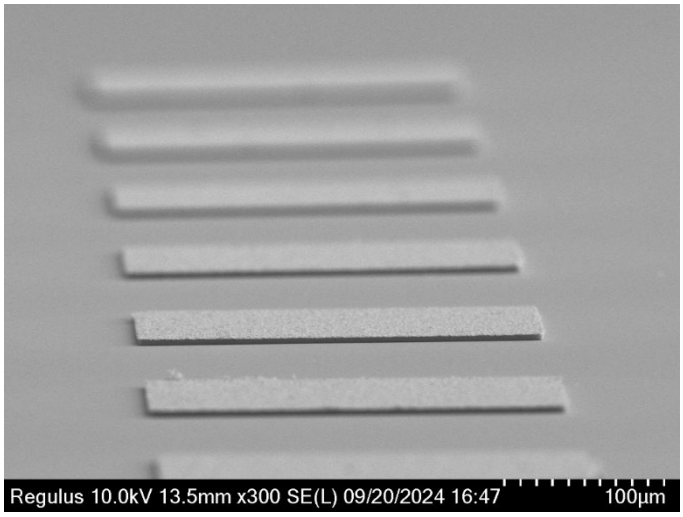
Register here: https://www.aanmelder.nl/157457/subscribe

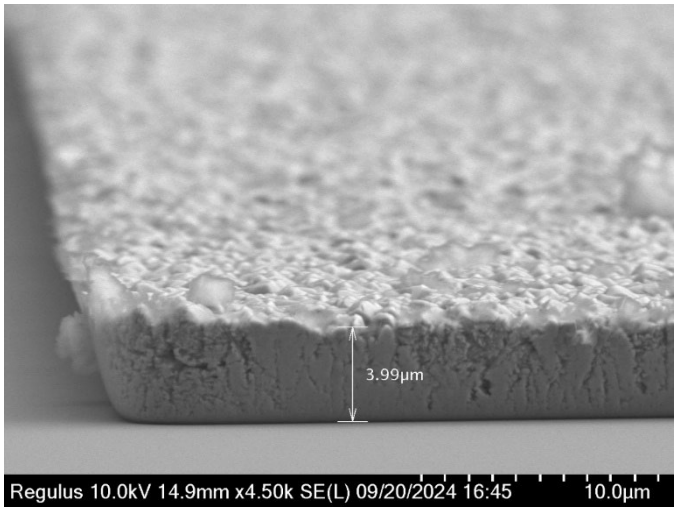
Hiring stop at faculty EEMCS

We were informed last week that no job openings at EEMCS, which includes Else Kooi Lab, can be filled due to the financial situation of the faculty. We are hit hard by this measure because we were in the process of hiring several candidates to fill openings left by previous staff members that have left. Effectively, it leaves EKL with a reduction of 25% of its staff for the foreseeable future. The hiring stop is in place until at least the end of this year. A slight opening is offered by considerations of the faculty to maintain and secure critical operational parts of the organization. A 25% reduction of EKL staff will have impact on operations of EKL. We are in the process to decide how we will implement this reduction of staff.

Electroplating Cobalt for Thicker Layer Deposition (@Kavli)

For electroplating, there is a demand to produce thicker layers $(3 - 10\ \mu\text{m})$ of cobalt, because these thicknesses cannot be achieved with the machines currently available in the cleanroom. Research has been conducted over the past few weeks to determine if this is possible, as little is known about the process. During this experiment, cobalt(II) chloride ($CoCl_2$) dissolved in deionized water (DI-water) was used. Using a closed circuit, unipolar pulse plating was applied with an electroplating duration of 15 minutes and a current of $3.2 \cdot 10^{-3}$ A for $6.0 \cdot 10^{-2}$ s, resulting in a thickness of 3.8 – 4.0 µm. Palladium (Pd) was chosen as the substrate because it is a good conductor, like copper. The images below show the initial results. The setup still needs to be further optimized and characterized to validate the results.

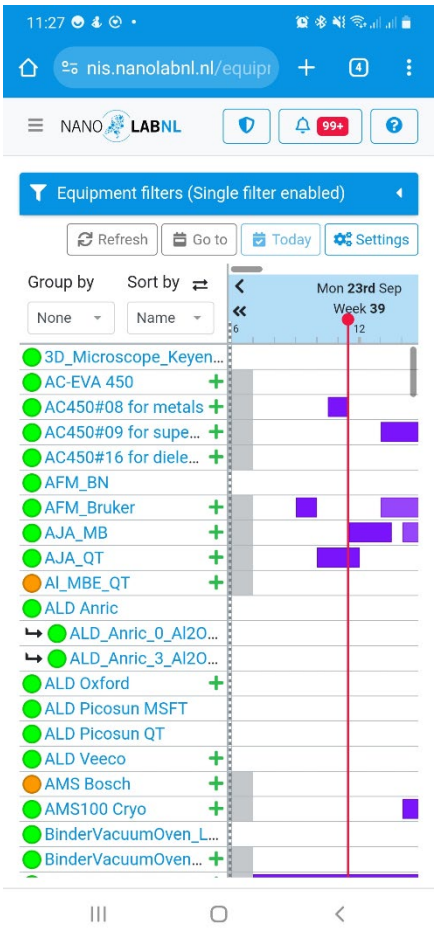


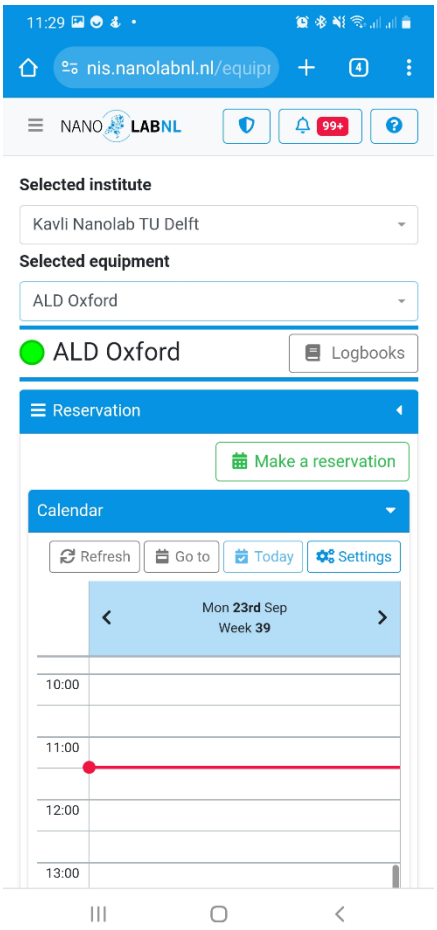


Improvements NIS on smartphone

Maybe you noticed already, a few weeks ago the operation of NIS on a smartphone screen was greatly improved. Dragging the view in the Equipment planner is now possible without opening an 'add reservation' modal right away!

However for the best experience it is recommended, instead of using the Menu option Equipment – Planner (left screenshot), to use Equipment – Details (right screenshot) where you can select one specific piece of equipment. Specially on a smartphone, but even on a laptop browser, the Equipment – Details screen will load much faster than the Equipment - Planner screen and the information is less densely packed showing more details.





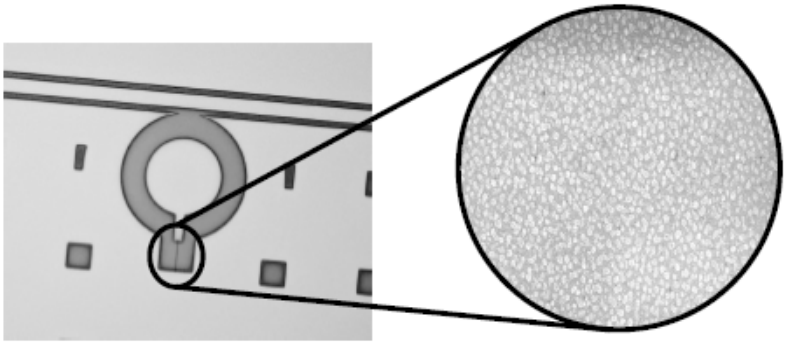
If you prefer to work with the Equipment – Planner it is recommended, instead of always retrieving a full equipment list, to create some filters and split the tools is a few short lists. Under Institute – Documents there is a description how to set up the 'Equipment planner filter settings'.

Granular Aluminium Resonators in Plassys Evaporator (@Kavli)

Within the Kavli Nanolab, there was interest in depositing granular aluminium (grAl) in the Plassys evaporator. To research the feasibility student projects were set up to research the possibility of creating these layers, which owe their high kinetic inductance to the creation of intrinsic superconducting junctions within an inductive AlOx layer. The grAl in this project was researched as a possible candidate to replace the current high inductive Josephson junction array in Andersen lab's fluxonium qubit design.

By evaporating aluminium in an oxide environment, the aluminium layer grown on the sample partially oxidizes. In the SEM images taken of these layers, grains of aluminium can be seen (like hagelslag in pindakaas) surrounded by a layer of aluminium oxide (see figure 1). The difficulty with creating such layers is the instability of the deposition of aluminium. To create the right resistance, the aluminium needs to be deposited with a constant rate, at the right oxygen pressure. The correct value for this needs to be targeted. The quality of the deposition can easily be checked by also evaporating the grAl on clean silicon and measuring the sheet resistance of the layer.

For testing the specific inductivity of the layer, Maarten Meijer, Figen Yilmaz and myself (Bas van Asten) fabricated LC resonators. By then incorporating the kinetically inductive grAl layer in the resonators, the inductivity of the grAl was measured. The relationship between the sheet resistance at room temperature (with four point probe) and sheet inductance (by LC resonator) was found to be



$$R_{\square} = 3\frac{\Omega}{\mathrm{pH}} \times L_{k,\square}.$$

In the future, we will focus on targeting the proper kinetic inductance needed for Andersen lab's qubit design.

New laser writer MLA150 (@Kavli)

Last year we ordered a new laser writer system, the MLA150 from Heidelberg. The FAT, Factory Acceptance Test, on the new system is scheduled for October the 15th and 16th. Hopefully the machine will be accepted and moved to our site as soon as possible afterwards. The system will be placed in the old room of the EBPG5000+.

The system will be equipped with a 375nm high power UV diode laser, which will increase the maximum dose that can be applied at a given speed. The maximum write speed is 285 mm²/min (almost 10 times faster than the µMLA!), allowing a 4" wafer to be exposed within half an hour. Other important specifications of the MLA150 are a minimum feature size of 0.6µm, minimum lines and spaces of 0.8 µm, an overlay alignment between two layers on the front size of 250nm for 5x5mm² exposure areas and 500nm for 100x100mm² exposure areas. The system will also be possible to perform backside alignment with an overlay accuracy of 1µm.

Last but not least, the system will also have an automatic loading unit allowing the user to expose more wafers overnight. A pre-aligner will enable alignment to the wafer flat before loading.

Good bye EBPG5000!

Last Tuesday, our EBPG work horse over the last 15 years has been removed from the cleanroom. Currently, we are busy with the introduction of new users on the new 5200plus system.