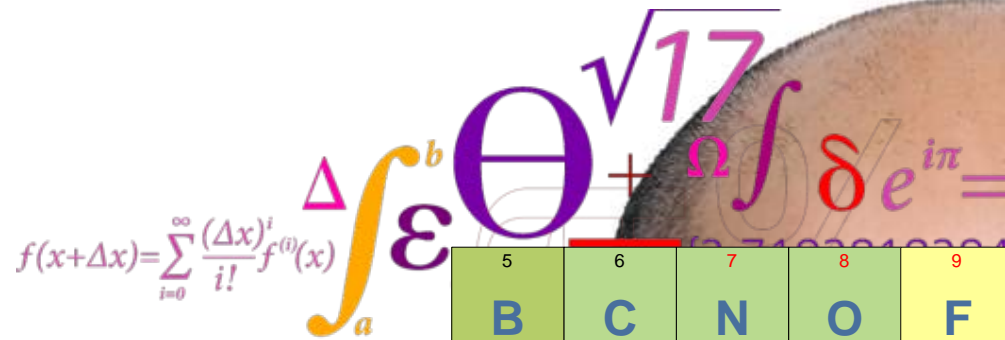


# Danchip Techforum 2-2015

1 H											5 B	6 C	7 N	8 O	9 F
3 Li											13 Al	14 Si	15 P	16 S	17 Cl
11 Na	12 Mg	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br
19 K	38 Sr	40 Zr	41 Nb	42 Mo		44 Ru	45 Rh	46 Pd	47 Ag		49 In	50 Sn	51 Sb	52 Te	53 I
		72 Hf	73 Ta	74 W	68 Er		77 Ir	78 Pt	79 Au	70 Yb		82 Pb			



# AGENDA



**Payment model, Jörg**

**Education, Jörg**

**Facility, Leif**

**Decommissioning of tools, Leif**

**Equipment and technology, Leif & Flemming**

**wrap-up, Jörg**

# PAYMENT MODEL

## CUSTOMERS, USERS, PARTNERS

Payment model

# free access to Danchip for all DTU departments

**External projects cover their cleanroom costs** (part of the budget when submitting the application)

**this part of the budget goes directly to 101**

Danchip does not see this money and does not receive part of it in any form

Economy centers get the registration from Lab Manager and bill the respective projects accordingly

## CUSTOMERS, USERS, PARTNERS

customer vs. service provider

not a suitable relationship for research projects

**users of the cleanroom facility  
with Danchip as a partner**

CUSTOMERS, USERS, PARTNERS

# WHY ?

**We believe that the cleanroom facilities at DTU will be used more efficiently with a partner relationship where all parts take full responsibility**

# EDUCATION

# experimental education in micro/nano fabrication

## why ?

- Students with very different background with respect to cleanroom work
- Students with very different interest in cleanroom work
- In many cases supervisor expert on application not fabrication technology

All experimental research work should be based on technical insight and understanding :

- use the most appropriate tool
- use the most appropriate process flow
- use the most appropriate method of process development

All student projects should have a:

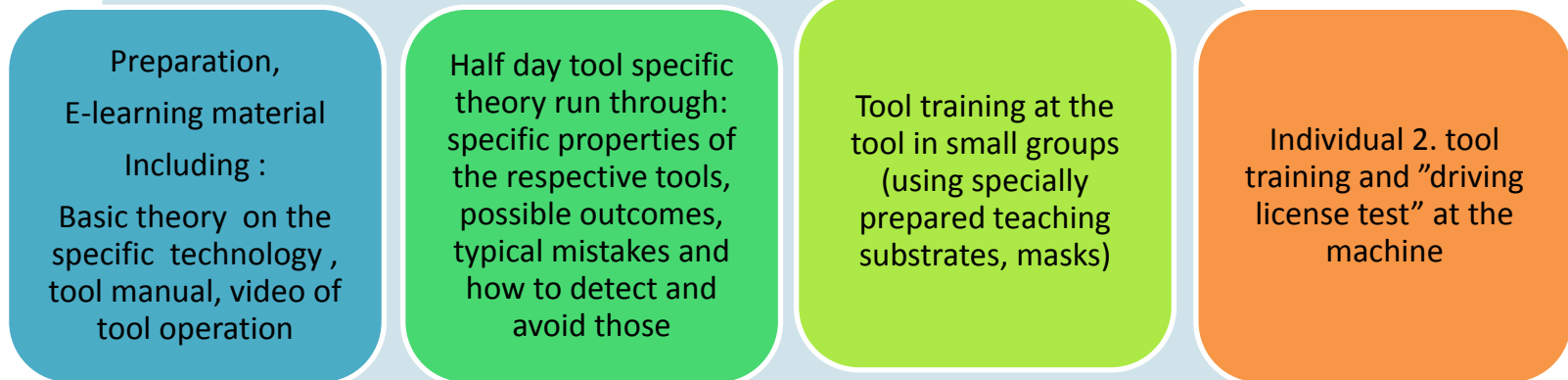
- realistic time plan
- risk assessment concerning the experimental work
- cleanroom work reflected in the teaching goals



# experimental education in micro/nano fabrication

Goal: Ph.D. students are trained (theoretical background and experimental methods) to a level allowing them to pursue experimental cleanroom work without permanent supervision.

## I. New form of training- scheduled tool package training (STPT):



# experimental education in micro/nano fabrication

## II. Ph.D. course in “methods of micro/nano fabrication”, 5 ECTS points

### Individual course

Self-study of e-learning material used in course  
number 33255

Scheduled exercises

Participation in Journal Club  
course number 33903?

At least one presentation

Establish process flow for own  
project present and defend to  
supervisor and Danchip contact  
(Danchip co-supervisor)

STPT 1

Safety course  
Hands-on chemical  
handling

STPT 2

Characterization

STPT 3

At least 2 more tool  
package training  
units

STPT 4

# experimental education in micro/nano fabrication

## III. Mikro/ Nanofabrication learning goals part of project plan for all students doing project in the cleanroom

- Somewhere in a not too distant future all project students have a Danchip staff member as contact person for their cleanroom project (this will be introduced slowly and continuously)
- Ideally the contact person is somehow involved in establishing the teaching goals (reality check on timeline and risk level)
- The contact person can be official co-supervisor or just a cleanroom mentor/guide
- Students signed up for safety course are aware of project title, supervisor and learning goals

# experimental education in micro/nano fabrication

## IV. Danchip/Cen participation in 3 weeks summer university frame courses 33470/33471

- Danchip/Cen contributes to summer university via these courses (assistance as well as course responsible, Cen might contribute also to similar courses at Fysik)
- Danchip aims to incorporate machine training and individual certification in selected cleanroom 3 weeks courses (conducted by Danchip as well as Nanotech)
- Special interest/discussion groups on selected technologies (not permanent, emerge and disappear according to interest)

# experimental education in micro/nano fabrication

## V. Establish dialog and discussion for a with focus on fabrication/characterization technology

- Journal club course (33903????)
- Yearly DTU internal conference, poster session on micro/nanofabrication and characterization technology
- Special interest/discussion groups on selected technologies (not permanent, emerge and disappear according to interest)

# Summer schools

2 summerschools plus summer university in week 34

**this year will be a logistical nightmare if we do not plan week 34 like a military operation**

- All supervisors have to attend a special planning session
- Have to prepare access, shoes, suits etc.
- Special instructions/planning concerning bottlenecks in gowning area, at certain equipment (stampede prevention measures (SPM))
- Access has to be handled in good time before planned entry
- All supervisors have to ensure access (and are trained) for the relevant equipment
- Identify backups in case of equipment breakdown

**We will not compromise safety or cleanliness (because of sloppy preparation)**

# **VARIOUS FACILITY THINGS**

# Construction work B345C

- Tar work on roof (tagpap) did not lead to smells
- Barbequeue during "rejsegilde" caused an evacuation alarm
- A few vibrations the last couple of days.
- Vibrations may be expected when B346 is opened up to B345C
- Very good information from CAS and the contractors





# Importing Samples to the Cleanroom

## - An important message

- Too many users have been found bringing samples from the outside directly into the cleanroom.
- No change of sample carrier
- No cleaning of samples
- **This behaviour damages a lot of other user's work!**
  - Contamination of sensitive equipment (furnaces etc.)
  - Cross contamination of other people's wafers
  - Yield killer
- **Nobody really want to destroy other people's work – do they?**
- **You may NOT take outside samples to SEM, Dektak etc. without cleaning. Cross-contamination!**

## What does LabAdviser say?

### *Items that have been outside the cleanroom*

*Items that have been outside the cleanroom should always be **cleaned in soap and ultra sound followed by a 7-up or Piranha clean** before entering the cleanroom.*

- All supervisors must inform their students about this basic rule.
- If in doubt, always ask. We can usually find a solution.



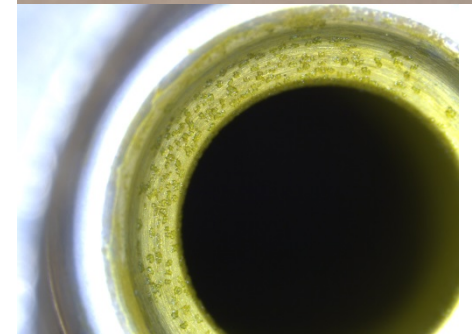
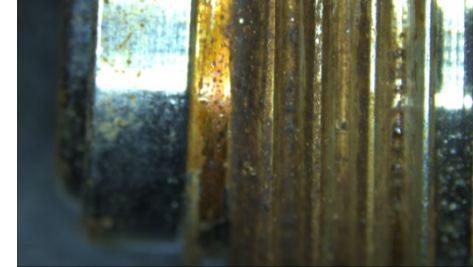
## New N2 purifier

- Present N2 purifier is 20 years+
- 3 stops in Feb-Mar
  - All at 14:29
  - All lasted 10min
  - Probably caused by leaking valves
- Spare valves now in stock
- No service available
- New ordered December 2014
- Behold: Salvation is at hand!
- Expected delivery within the next days.
- Installation this summer – few days without purified N2



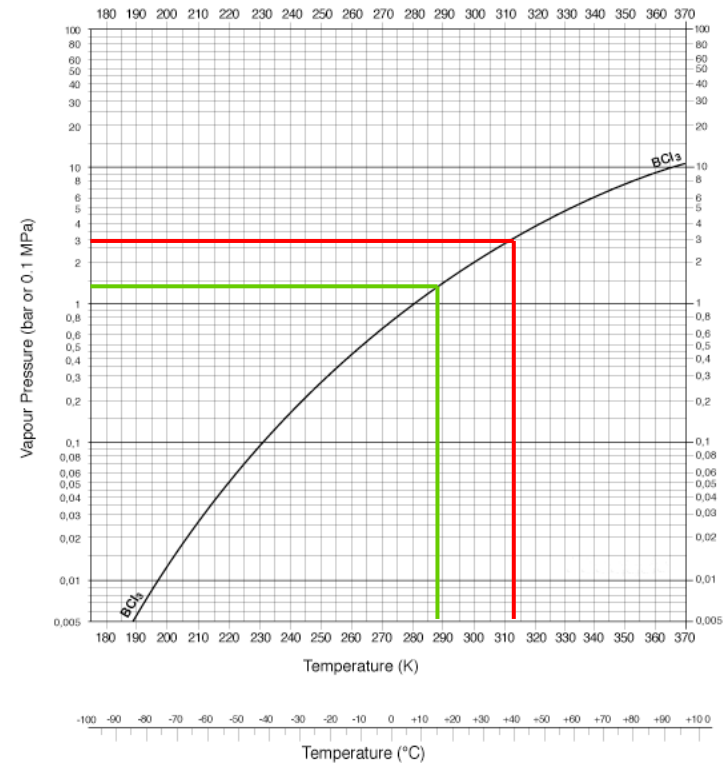
# Cl<sub>2</sub> update

- Leak in one fitting in gas cabinet
- Cl<sub>2</sub> etched the fitting – hole became larger
- Gas pipes vented through leak with atmospheric air (Cl<sub>2</sub> traces still in gas line)
- H<sub>2</sub>O + Cl<sub>2</sub> → HClO + HCl . Etches steel.
- Entire gas line and all valves had to be scrapped
- Endless waiting time for parts and gas contractors
- *Very* thorough testing of new line before commissioning
- Cl<sub>2</sub> is now back.
- Downtime almost 5 months
- Damage amounts to > 300 000 DKK
- Line was only 5 years old...

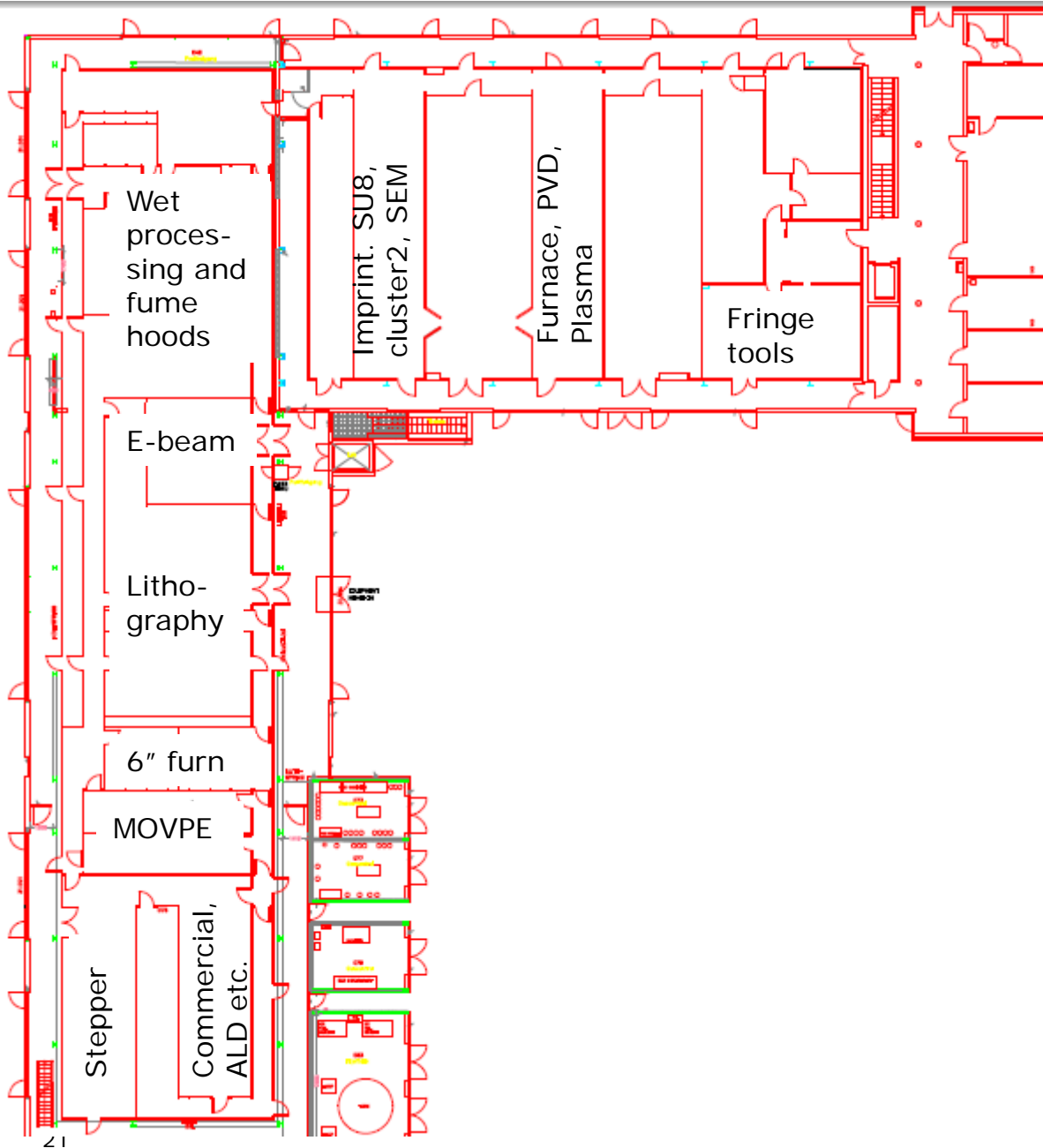


# BCl<sub>3</sub> update

- Long processes (>15-20 min): BCl<sub>3</sub> flow drops on Metal ICP
- Issue limited to Metal ICP
- Something wrong with gas pipes – probably close to bottle.
- If not precisely temperature controlled, BCl<sub>3</sub> may condensate
- We need to open up the line. Corrosions may be observed.



# New cleanroom order



# TOOLS LEAVING

# Some tools have to go...

- Some tools are very old by now
- There is limited space in the cleanroom
- Cleanroom space is very expensive – we won't get more
- Lots of new equipment has been installed with same – and better - functionality

# Tools leaving – decommissioning 2015



## Decommissioning of equipment

- Noble Furnace/old Resist Pyrolysis Furnace (replaced by ATV Furnace)
- PECVD-2 (replaced by PECVD-4)
- SSE Spinner (Maximus) (replaced by Süss Gamma 2M)
- Developer 1+2
- KS Spinner
- III-V aligner
- Laurell spinner (in E-5) (replaced by Süss LabSpin)
- Prism Coupler (?)





# NEW EQUIPMENT



# 2 fume hoods for new Litho E-4

- Installation finished.
- Modifications of ventilation control needed (this week)



# 13 new fumehoods and 5 new wet benches

- Flexible processing activities rise and decline
- New material groups are introduced with constantly increasing frequency
- Same applies for substrates
- No ghettos (sub cultures, local kingdoms)
- Several wet benches need replacement (20 years old...)
- EU tender necessary
  - 1<sup>st</sup> round: Prequalification tender
  - 2<sup>nd</sup> round: "Technical" tender
- 10 million DKK (or more)
- Long time frame: 4-5 months PLUS delivery time (=10 months +)

# Fume hoods for tender

- Fume hood for acids and bases
- Fume hood for acids and bases
- Fume hood for solvents
- Fume hood for solvents
- Fume hood for graphene
- Fume hood for Nickel and KOH
- Fume hood for III-V materials (acids and bases)
- Fume hood for III-V materials (solvent)
- Fume hood for solvents (Litho)
- Fume hood for solvents (Litho)
- Fume hood for solvents (Litho)
- Fume hood for solvents (Litho)



# Wet benches for tender

- KOH bench
- Nitride etch bench
- Wet etch bench each with 2 etch baths
- Wet etch bench each with 2 etch baths
- Wet bench with 2 baths – one for wafer cleaning and one for mask cleaning
- Wet bench with 2 ultra sonic baths– lift-off & resist strip



# KS Spinner Replacement

- Intention: Modern, hassle-free replacement of the old, unstable KS spinner
- Has been released
- Then:
  - PC issues. New PC installed
  - Spindle broke. Waiting for new spindle



# New bonder tool

- EVG NIL has just been repaired
- Still an old machine
- Pre-aligner can try the patience of a saint
- Idea: Pre-align in KS MA-6 aligner, then bond in KS bonder
- Litho is talking to known user groups
- Trying to obtain a time slot for a demo at Süss



# New FE-SEM: Zeiss Supra 40VP

- Background: SEM-LEO (our training tool) is being used for dedicated lithography applications
  - Raith-ELPHY system
  - Ice lithography (Anpan/William)
- Detectors: SE-, VPSE-, In-lens, & BSD
- 6" samples
- 5-axes eucentric stage:  
x,y :130 mm; z: 50 mm
- After release: Old Zeiss Supra 40VP will be re-located to basement – replace old SEM-JEOL
  - future training tool
  - high-quality FE-SEM outside CR





# Plasma Enhanced ALD – new system?

## Motivation

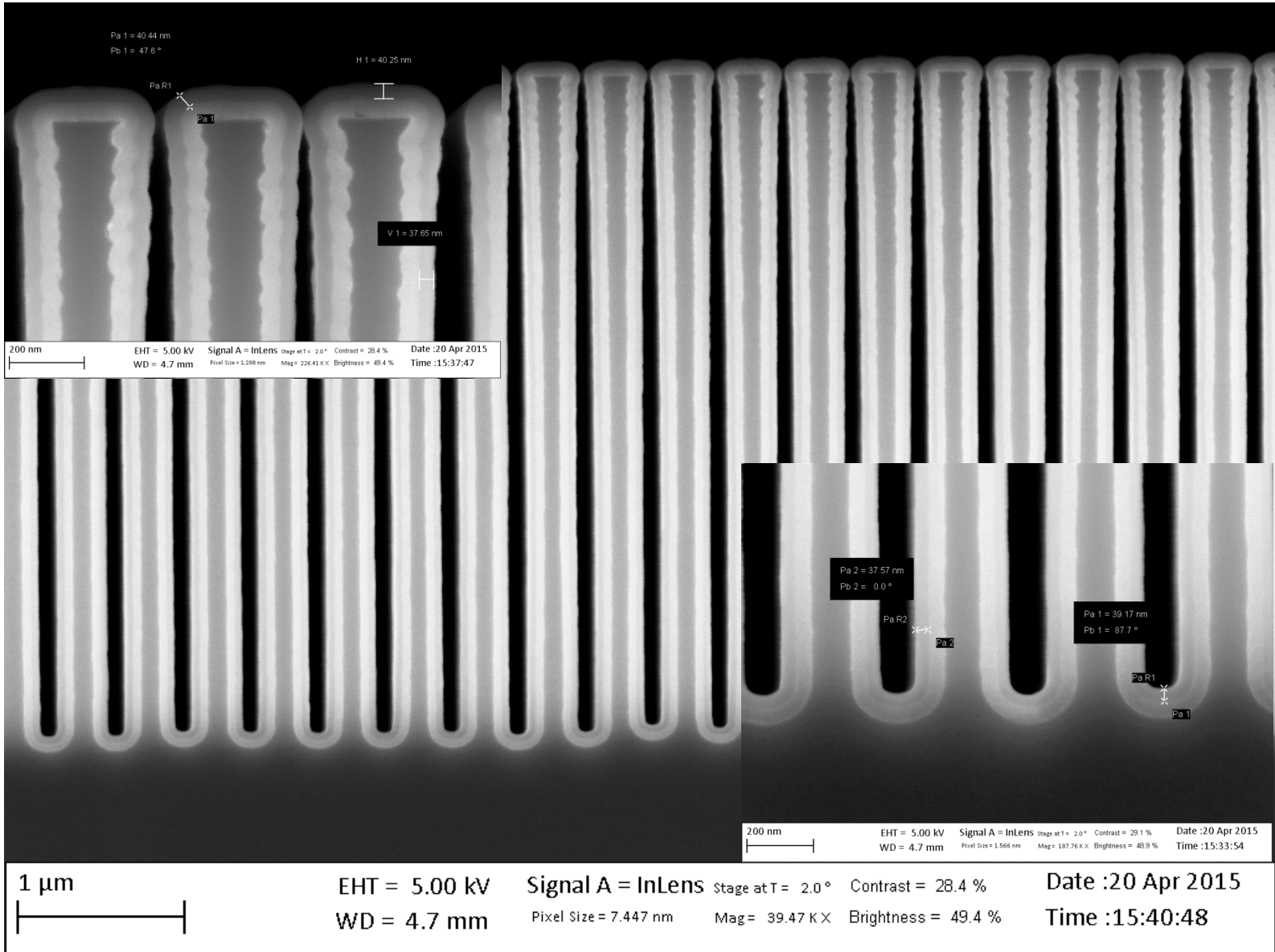
- High utilization, bottleneck tendency
- No in-house back-up
- Limited capacity for new precursors

## Key features

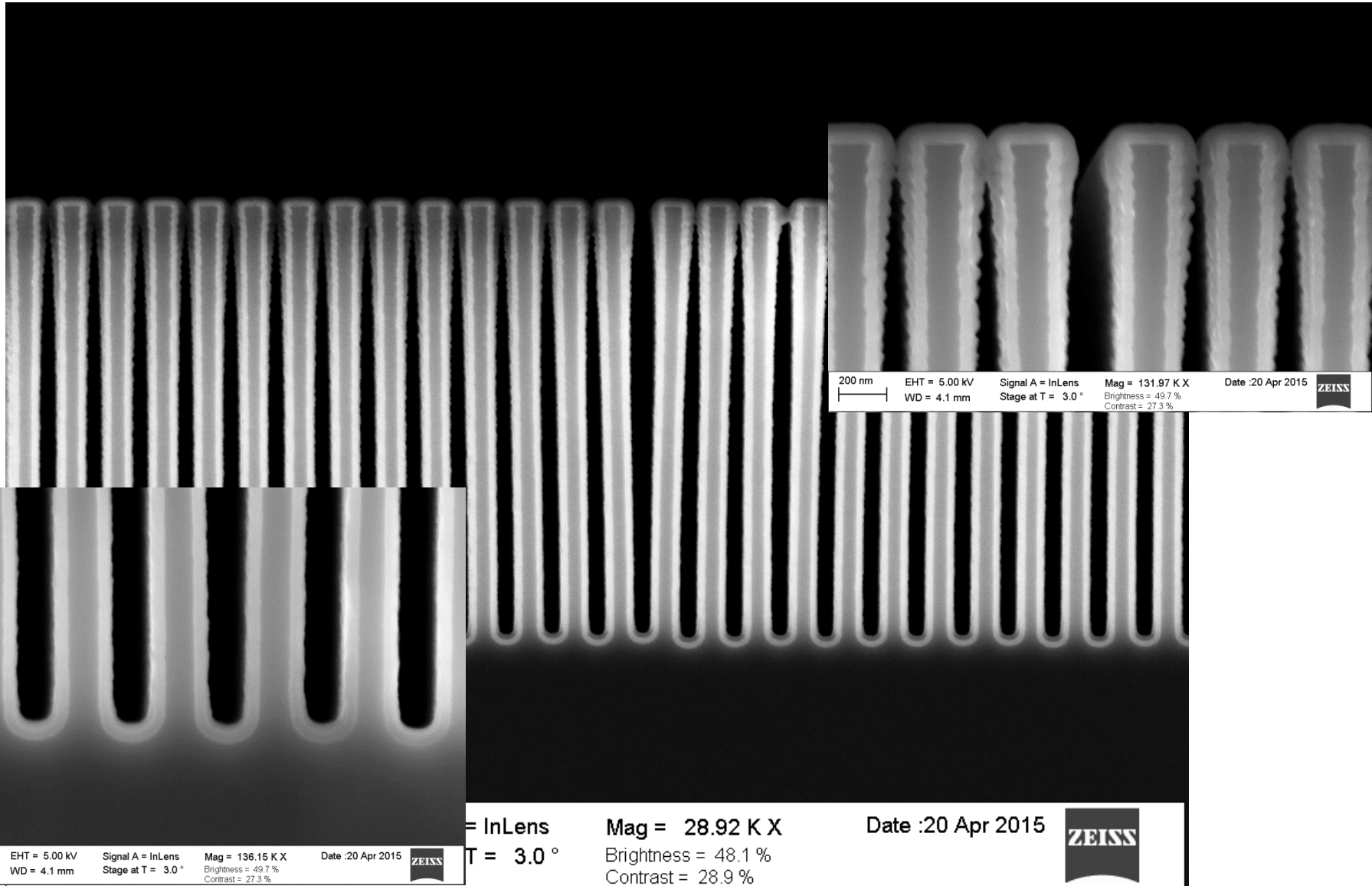
- Highly flexible ALD system, thermal & PE-ALD
- Stacked substrates (pieces – 8" wafers)
- "Work horse" as well as new capabilities
- New chemistries, e.g. for metals and metal nitrides
- Low temperature processes



# PE-ALD test at Oxford Instr: $\text{SiO}_2$ on $\text{Al}_2\text{O}_3$



# PE-ALD test at Oxford Instr: AlN on Al<sub>2</sub>O<sub>3</sub>



# Furnace with reducing atmosphere

## PEO-604 (ATV)

- Multi-purpose process furnace with vacuum capability
- Capacity: 50 x 200 mm wafers
- Process temp: 1100 C, rate < 100 C/min
- Multi-purpose: Easy swap of quartz glass
- Reducing atmosphere:  $\text{H}_2$  /  $\text{N}_2$
- Dry oxidation

Tool accepted in February

Major part of the investment is paid by the **pyrolysis project**  
(Stephan Keller)

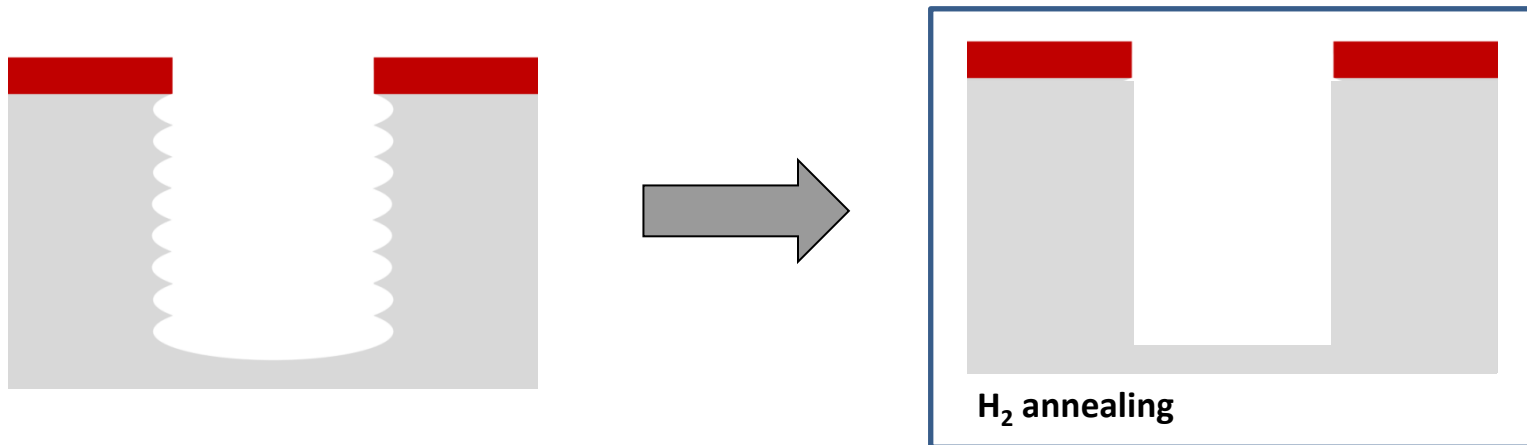


Initial pyrolysis tests went well – batch processing is now possible (SU-8)

# Furnace with reducing atmosphere

Hydrogen annealing for removal of DRIE-scallops:

3-weeks project /Mikkel Mar, Pernille Larsen, (Henri Jansen)



Enhanced surface mobility of Si-atoms by hydrogen annealing

Expect to release the PEO-604 after the 3-weeks period

## PECVD-4 – replacement of PECVD-1/2

- SiO / SiN / SiON / BPSG / (~~Ge-doped~~)
- Including stress-tuning capability
- Refurbished SPTS system (2011)

Installation under preparation

- expect most installation work to be finalized end of August



## AOE – multiple problems

- Intermittant network failure (DOS & WIN 2000 system – comm. problem)
- Recipes ending straight away (broken insulation to TDESC HV-line)
- Wafers being dropped intermittantly (guide pin in TDESC wafer lift)
- Carousel mapping failure (new lift motor and gear box )
- Various mechanical issues fixed (transfer arm re-adjusted)

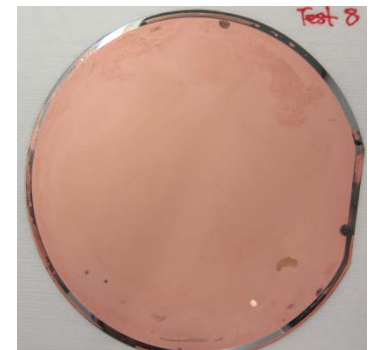
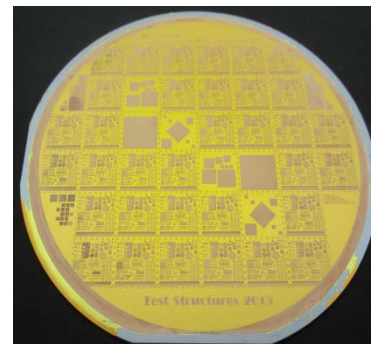
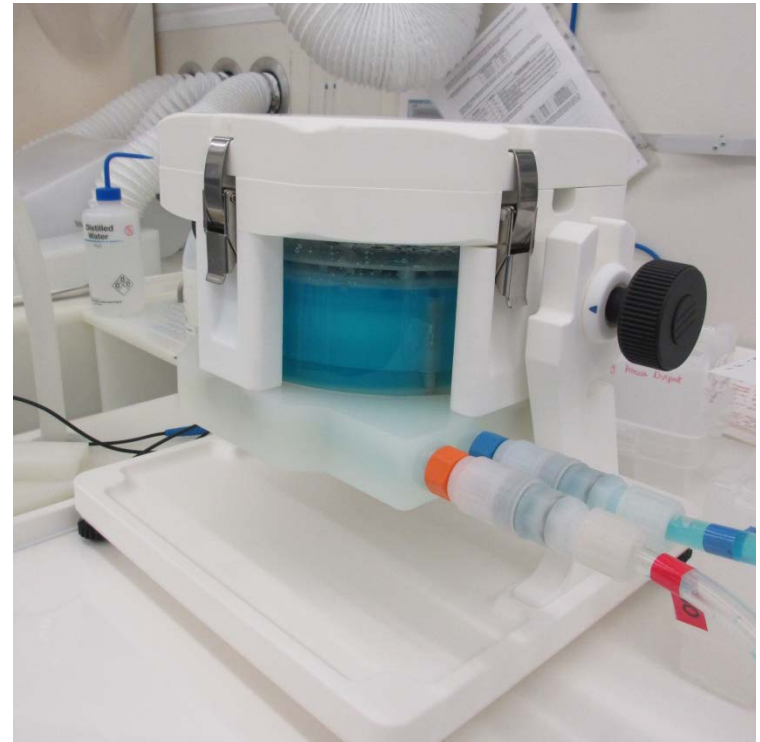
# New copper electroplater

## Electroplating-Cu from Silicet

- Acidic sulfate bath
- DC, pulse and pulse reverse plating
- Can run 4" and 6" wafers
- First test runs have yielded copper foils, coils and other tests structures which are being characterized
- Installation not completed yet

## Current status

- Manual needs to be written
- Completion of installation
- Control software to be finished
- Expected release: Sep/Oct 2015





**wrap up**

