ALD

Process meeting
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ALD theory

ALD: Atomic layer deposition

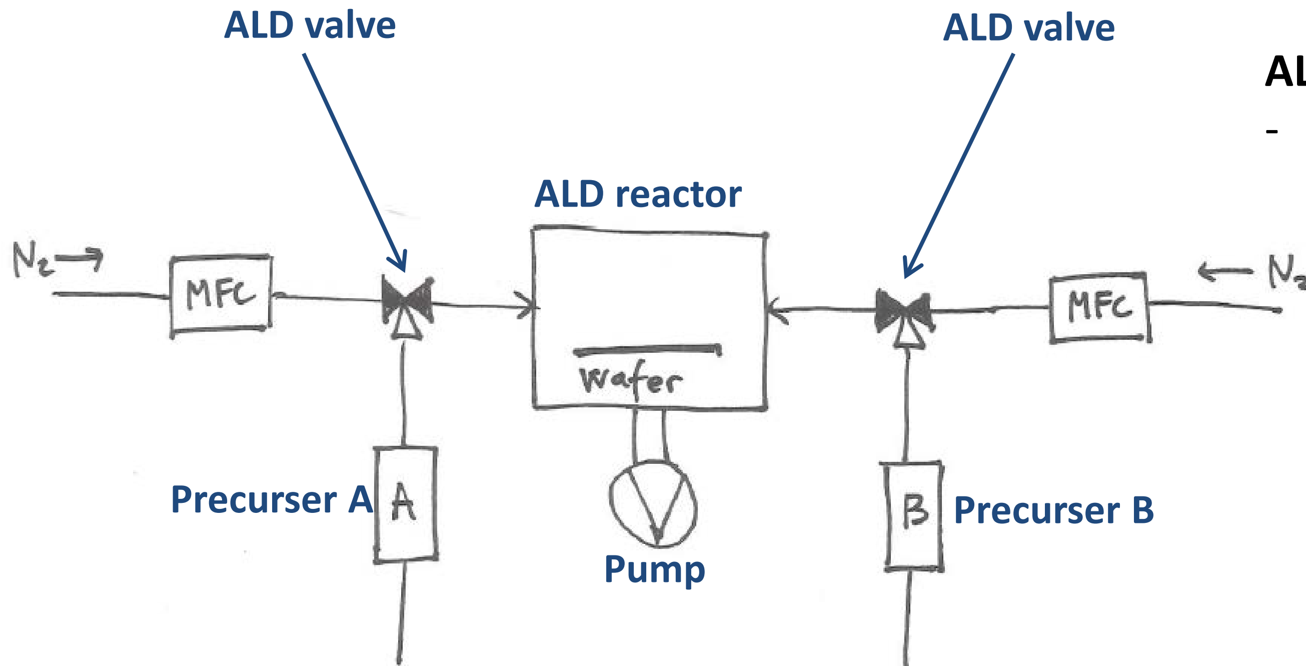
- Thermal ALD
- Plasma assisted ALD

Precursers:

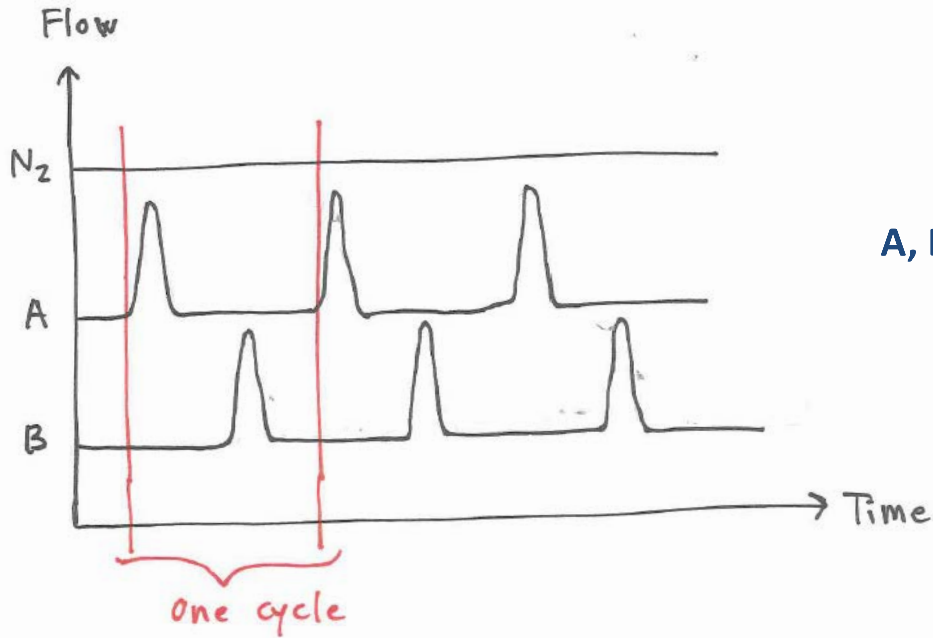
- Gas
- Liquid
- Solid

ALD valves:

- Very short reaction time



ALD theory



A, B: precursers

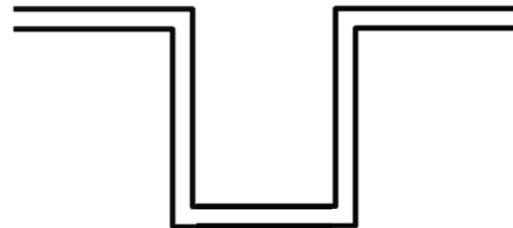
Reaction (one cycle):

A → A*, A is chemisorped on the wafer surface (and everywhere else)

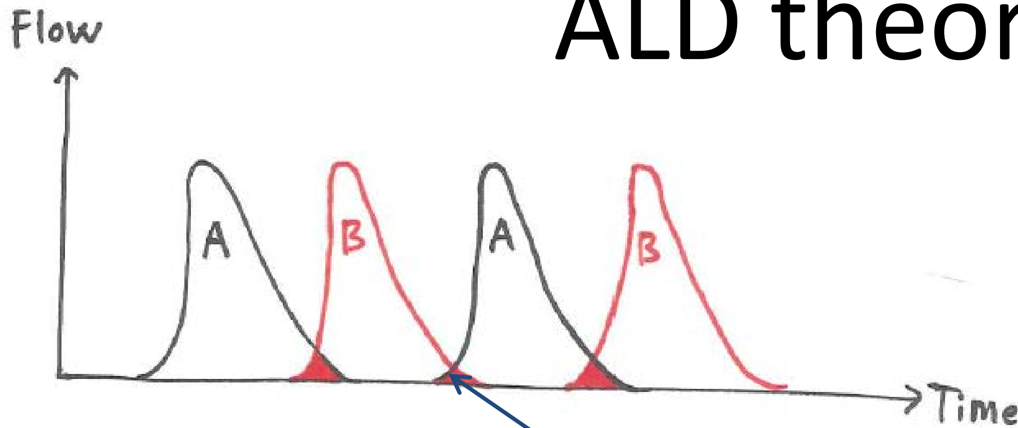
A* + B $\xrightarrow[\text{Temperature}]{\text{Pressure}}$ AB + C, AB react to form one momolayer

More cycles:

Perfect step coverage

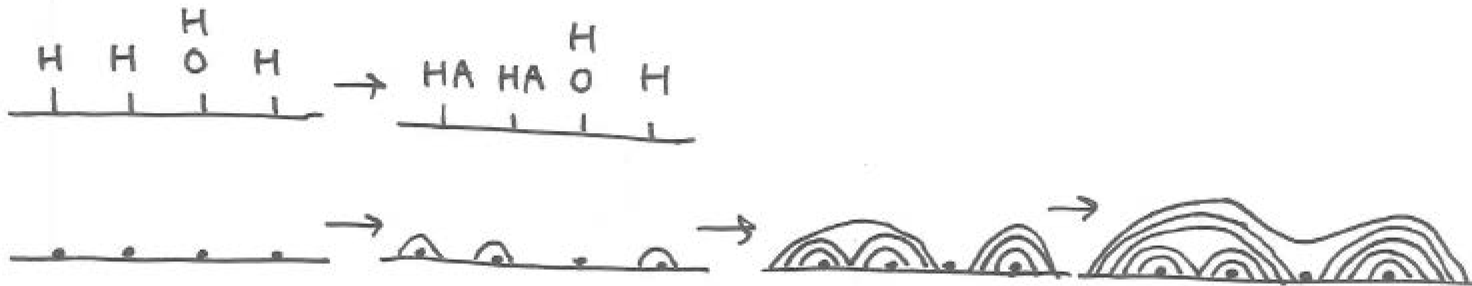


ALD theory



Precurser A and B overlap => CVD process

All reactions have to take place on the surface, otherwise it is not possible to obtain a perfect step coverage



Thin uniform layers require a very clean sample surface

In practice a 5-10 nm layer is required to have a closed ALD layer

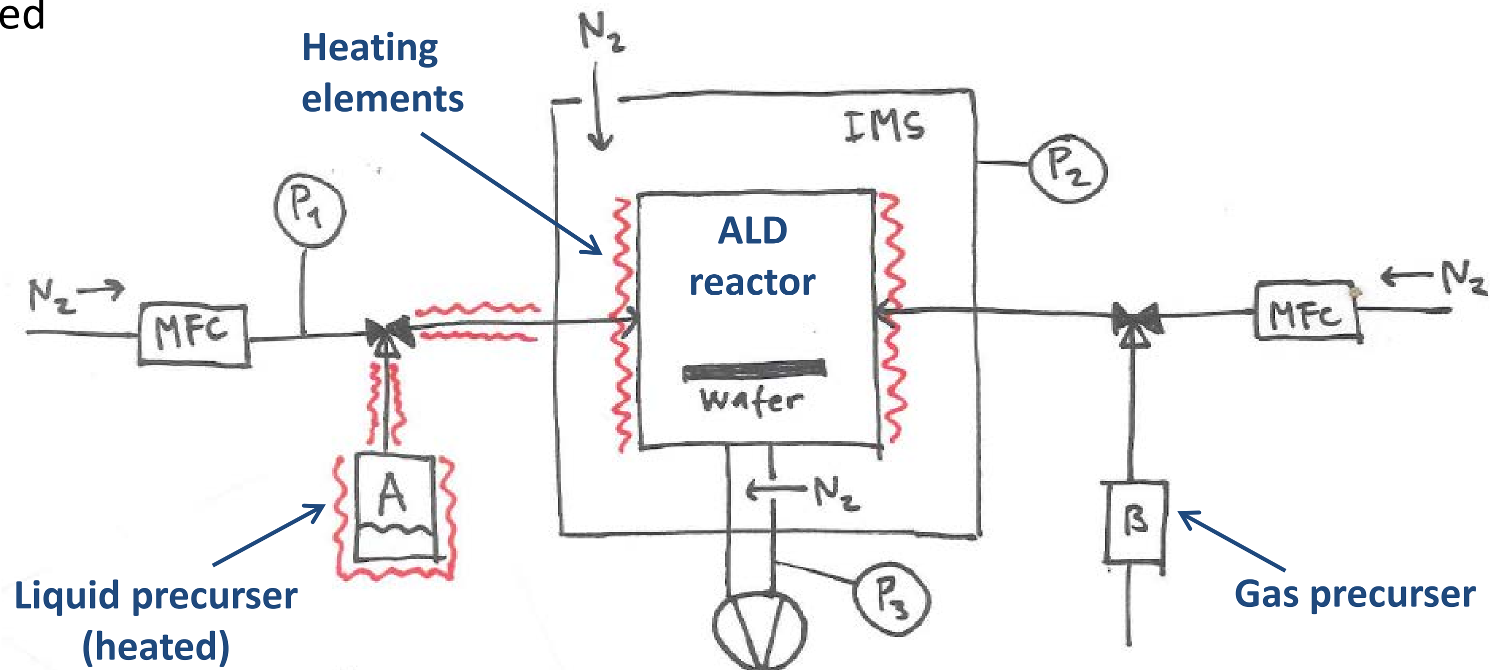
PicoSun ALD

Thermal ALD

IMS: Intermediate space

Heating:
- Increasing temperature from precurser source to ALD reactor
- Wafer heated
- ALD reactor heated (same temperature everywhere)
- IMS not heated

Pressure:
- $P_1 > P_2 > P_3$



PicoSun ALD

Heating shield

FMS

N_2

Wafer

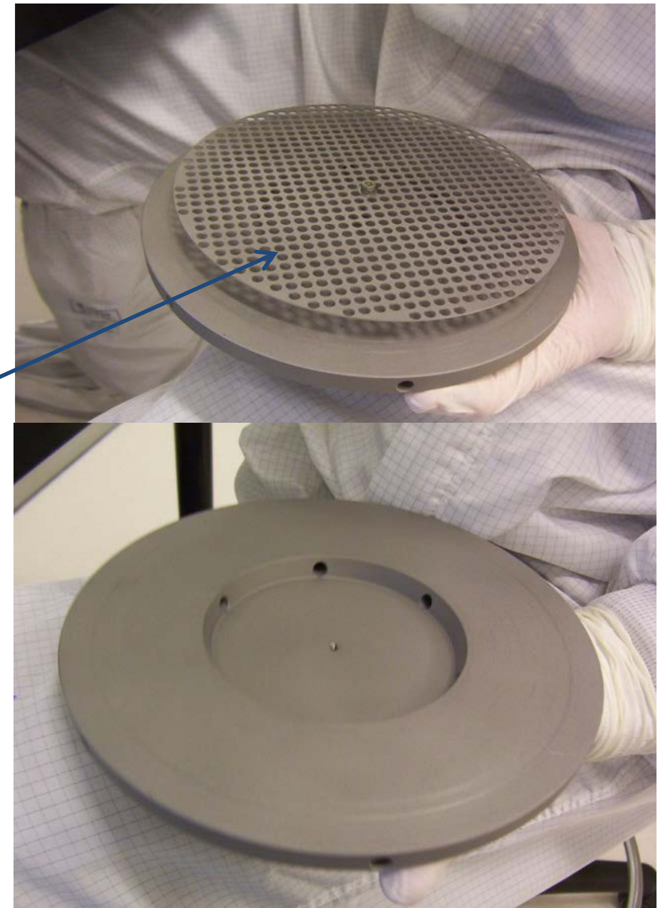
Shower head

N_2

Pump (in basement)

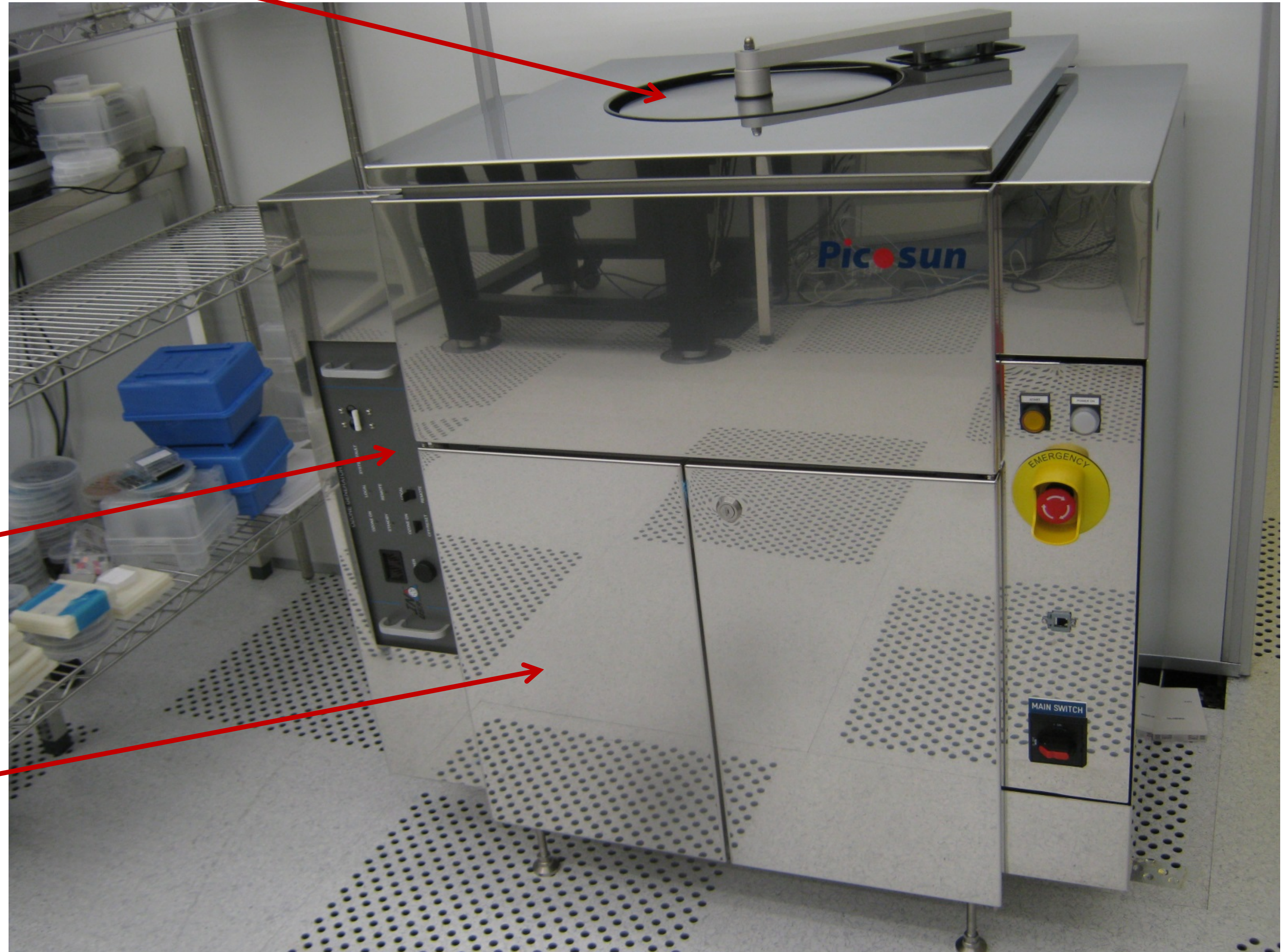
N_2

Precurser



Picosun ALD

Lid for sample loading



Ozone generator

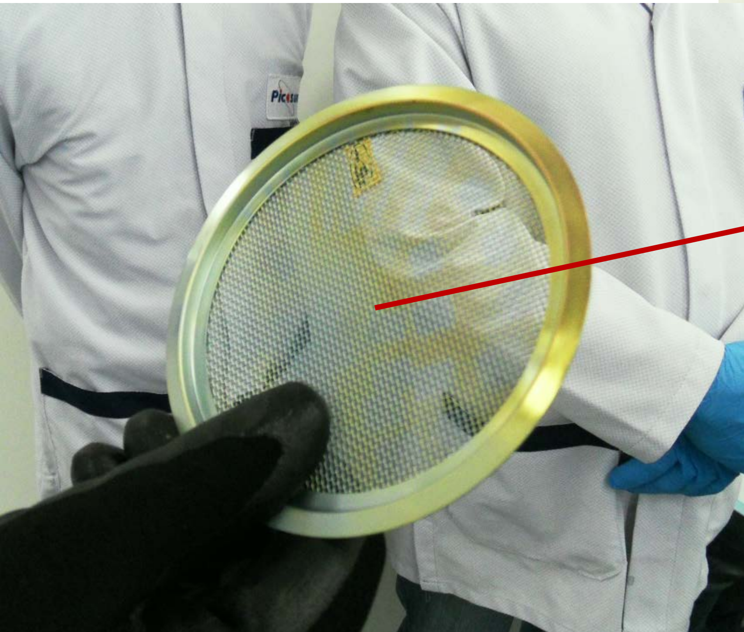
Cabinet with liquid and solid precursers

Picosun ALD

Wafer

Lid for sample loading

Grid for small samples



Picosun ALD

Sample holder for batch processing

Picosun ALD

ALD reaction chamber

Not necessary to cool down the chamber after processing

Picosun ALD

Cabinet with liquid and solid precursers

Close manual valves when precurser are not in use

Precursers

Picosun ALD

Ozone destroyer

After burner

Particle trap

Picosun ALD

ALD reactions:

- TMA + H_2O -> Al_2O_3
- $TiCl_4$ + H_2O -> TiO_2
- $MeCpPtMe_3$ + O_2 -> Pt

Precusers:

- TMA
- $TiCl_4$
- $MeCpPtMe_3$
- H_2O (water)
- O_2 (oxygen)
- O_3 (ozone)

$MeCpPtMe_3$ precurser:

- Price: 150 €/gram
- 0.5 gram used for 1 run (50 nm Pt)
- Not all users will be allowed to deposit Pt

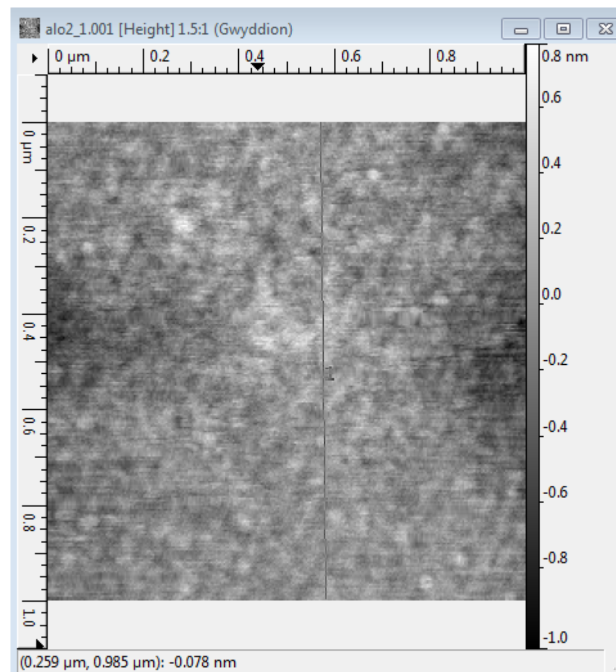
Acceptance test

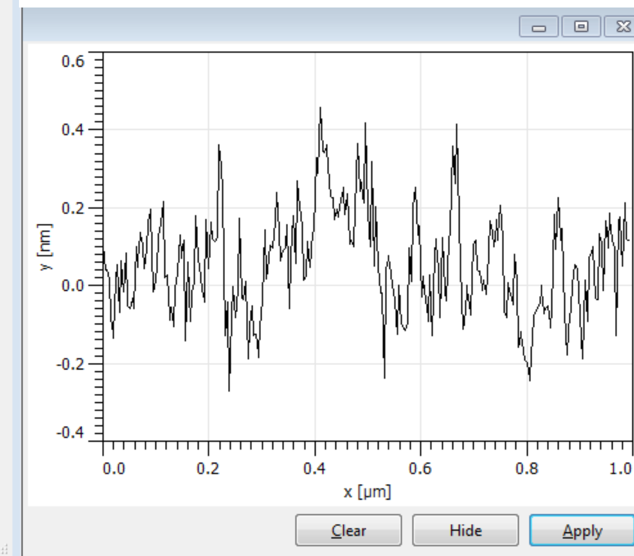
Factory acceptance test (FAT):

- Functional test
- Al_2O_3 on planar Si surface:
  - 20 nm Al_2O_3 grown in 2 hours
  - Thickness and uniformity within 5%
  - Wetting confirmed by AFM measurement

FAT results:

- 50 nm Al_2O_3 grown in 2 hours
- Thickness and non-unformity for 6” wafer: 0.6 %





Acceptance test

Al_2O_3 process

One cycle:
- TMA pulse: 0.1 s, 150 sccm
- N_2 purge: 3 s
- H_2O pulse: 0.1 s, 200 sccm
- N_2 purge: 4 s

Number of cycles: ~500
Time: ~2 hours
Temperature: 300 °C

Result: 50 nm Al_2O_3

Longer purge time for high aspect ratio structures

Acceptance test

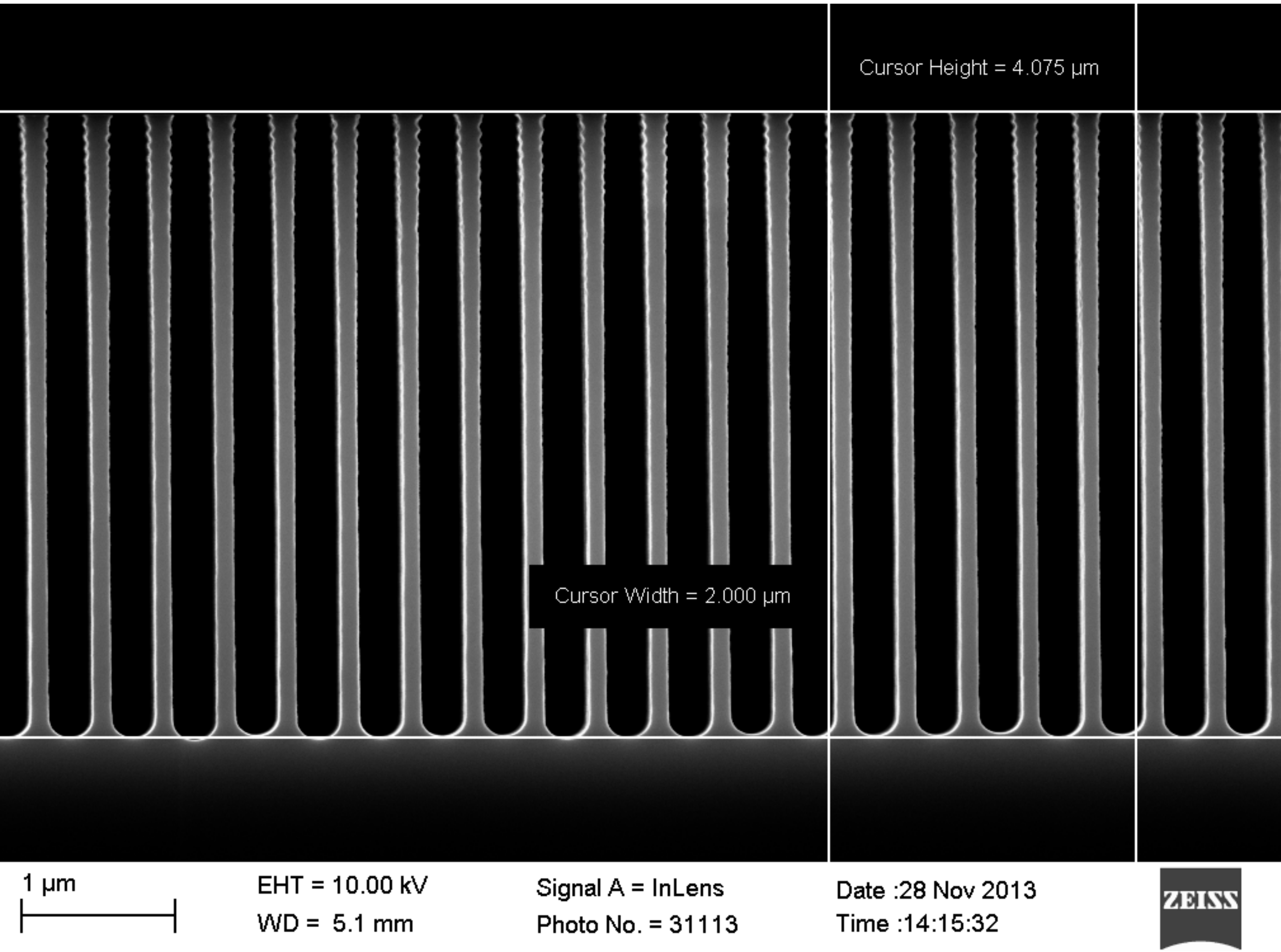
Site acceptance test (SAT):

- Functional test
- Al_2O_3 on planar Si surface:
  - 20 nm Al_2O_3 grown in 2 hours
  - Thickness and uniformity within 5%
  - Wetting confirmed by AFM measurement
- TiO_2 on planar Si surface:
  - 20 nm TiO_2 grown in 2 hours
  - Thickness and uniformity within 5%
  - Wetting confirmed by AFM measurement
- TiO_2 in trenches:
  - Trench dimensions: 200 nm width, 4 µm depth
  - 20 nm TiO_2 grown in 2 hours
  - Thickness and uniformity within 5%

SAT not completed yet

Acceptance test

Si sample with trenches for FAT

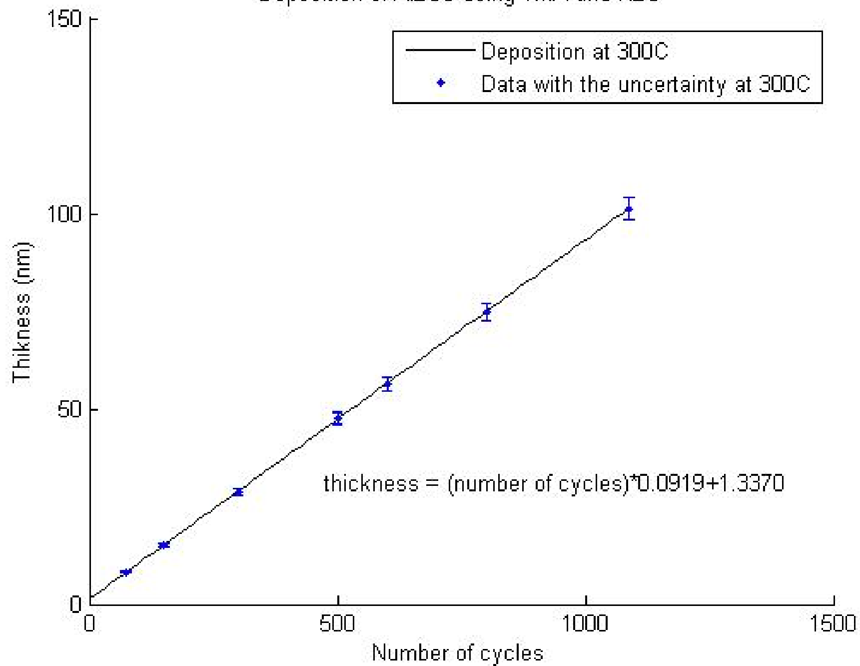


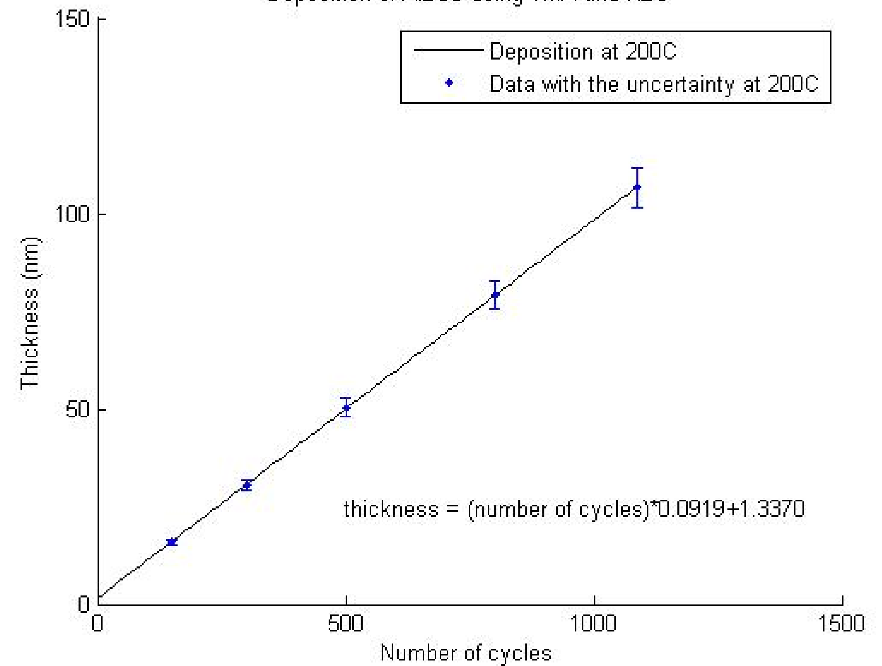
DRIE Pegasus etch:

”polySOI-10” recipe

70 cycles (08 min 45 s)

Al_2O_3 results





Al_2O_3 results