DTU Nanolab

Techforum 2019 #2
Agenda

• DTU Nanolab and smaller points
• Lab shutdown
• Light rail
• New equipment
DTU Nanolab
National Centre for Nano Fabrication and Characterization

Scope:
• top down, scalable, cleanroom based nanofabrication technology
• E-beam+ based characterization

What:
• around 105 staff
• Ph.D. school
• Education and teaching (under DTU Fysik umbrella)
• No changes concerning operation and access to the facilities
Softmatter microscopy lab – basement 307

- Investigate the possibility of a softmatter lab in the basement of building 307
- Should include sample prep and microscopes
- Many outstanding issues before decision is made
Room 905 Vibrations

In general VC-F should be achieved.

VC curves and ISO guidelines for people in buildings.
Raith eLine Plus EBL system

Contact: Anna Elsukova (annaels@dtu.dk)

- Smallest beam size in the world of a professional EBL system (< 1.6 nm)
- Sub-5 nm linewidth in EBL resist demonstrated
- Automated large-area applications — from mm² up to 4 inch.

Goal: convert to **Organic Ice Resist Lithography** instrument

Cryo-conditions

Condensation  →  Exposure  →  Warming up

Cryo-conditions

Room temperature
Decommissioning of Stack D "Student furnaces"

- Manual load, boat on tube bottom

- APOX oven, LM: 5.009
  - Not used for past 2 years

- III-V oven LM: 10.009
  - Exclusively used for VCSEL oxidation
  - VCSEL oxidation transferred to C2
Physimeca move – making space for new sputter tool
UPS we did it again

- UPS: Uninterruptible Power Supply
- Supports all safety related systems
- 45 min capacity without external power
- Two old systems merged into one new
- Work in basement ongoing
- Cleanroom closed twice
- Saturday 22 June 09:00-13:00
- Monday 1 July 07:00-19:00
- Many process gases closed 28 June to 2 July
- Much equipment down 2 July (exhaust errors)
Fan Filter Unit (FFU) update

- Several units ordered
- Mockups in basement
- New impeller in existing FFU box: 3 dBA less noise
- Awaiting test equipment
- Timeline still unknown
- 6 months notice for cleanroom shutdown
LIGHTRAIL FIELD CANCELLING SYSTEM
Field cancelling setup
First field cancellation results – can dampen ca. 60 times

No applied field
Field cancellation off

Applied field > 1200 nT p-p
Field cancellation off

Applied field > 1200 nT p-p
Field cancellation on
Measured field: 20 nT p-p
Long-term test – no applied tram field

- No tram field
- Only normal fields, 200 nT p-p
- SC24 field cancellation system on
- Up to 450 nT peaks
- One user's samples damaged
- Old cancelling system is now used
No applied tram field – field cancellation on and off

- Field cancellation disturbs normal beam operation
Field cancelling - Conclusions so far

• Simulated tram field: 1200 nT p-p
• Actual tram field strength might be higher
• The Spicer SC-24 can dampen 1200 nT p-p to ca. 20 nT p-p (60 times)
• Signal drift and spikes when field cancelling is on
• Powerful Helmholtz counter fields might disturb e-beam writer
• Further investigations necessary
• New cancellation system not in normal operation
NEW EQUIPMENT
HF vapour phase etch

- Sacrificial oxide etching
- Heated chuck
- Electrostatic/mechanical clamping
- Up to 150 mm wafers, optional 200 mm

Market survey:
- Idonus (CH)
- AMMT (DE)
High Vacuum RTP-system for sidewall smoothening

ANNEALSYS: AS-Premium – start-up/acceptance on going

**Purpose/specs:**
Sidewall smoothening after DRIE nano etching
- high vacuum ($10^{-6}$ mbar base press)
- ultra-clean (load-lock)
- cold-wall chamber technology
- up to 1200 °C (max 10 min)

**Configuration:**
- turbo/dry scroll pumps (chamber + load-lock)
- 4 process gas lines
- water-cooled stainless steel chamber
- up to 1200 °C (max rate 100 °C/s)
Twin-Pegasus

Pegasus 3
DRIE (Si) – 6”
High-throughput
Cassette-Cassette
"Workhorse"

- Start testing Si etching
(150 mm)

Pegasus 4
DRIE (Dielectrics) – 6”
Reconfigure (Dielectrics)
High-throughput
Cassette-Cassette
"Workhorse"

Almost ready:
- plasma tested
- gas manifold for H₂/He
- CF₄ & H₂ addition (install)

CPX Platform
Twin vacuum cassette cluster (Brooks handler)
Pegasus 2: DRIE of silicon

- **Nano-etching** of silicon
  - exploring better control & cleanliness (Henri Jansen/Vy Nguyen)

- **Oxygen inhibitor** based (not fluorocarbon based)
  - mixed/switched SF$_6$/O$_2$ based plasma
  - inhibitor: SiO$_x$F$_x$ $\gg$ CF$_x$ (CF deposits at all surfaces (“dirty”))

- 6” set-up (TDESC) – permanent

- **Contact Henri / Vy** for info/assistance
PVD multi-chamber tool: Dual-Sputter system from Lesker

**OCTOS robotic cluster tool including new functionalities:**

- **2 x PVD75** sputter systems
- **Separation:** Metal oxides / Metal nitrides
- **Module A:** 6 x 3” magnetrons, DC/RF/pulsed DC/HiPIMS
- **Module B:** 1 x 4” + 2 x 3” magnetrons: DC/RF/pulsed DC/HiPIMS
- Distribution chamber (Genmark robot)
- Cassette station (10 wafer cassette)

**Status:**

expected FAT: Medio July
Thermofisher Nexsa

- Raman spectroscopy (option!)
- Very similar to our K-Alpha: Easy transition to Nexsa
- Optional techniques and acquisition:
  - ARXPS and ARUPS
  - ISS
  - REELS
  - Raman spectroscopy

Kratos Axis Supra

- Large hemispherical analyzer with high energy resolution
- 3 station cassette holder in load lock to enable degassing during analysis
- Optional techniques and acquisition:
  - ARXPS and ARUPS
  - ISS
  - AES, SAM and ‘SEM’
  - Ag Lα X-ray source
  - Surface Science Station

Phi Versaprobe III

- Microfocused X-ray beam down to 10 µm -> imaging with SE electrons that enables extremely precise (in X and Y) analysis on specific areas (alignment with SE’s)
- Optional techniques and acquisition:
  - ARXPS and ARUPS
  - ISS
  - AES, SAM and SEM
  - Low Energy Invers Photoelectron Spectroscopy
  - REELS
  - C₆₀ ion source for profiling polymer films
Choices of optional techniques

- **UPS (Ultraviolet Photoelectron Spectroscopy):** Provides information on the valence band electrons.  
  - **Pricetag:** Light

- **ISS (Ion Scattering Spectroscopy):** Provides elemental composition information from the top atomic layers.  
  - **Pricetag:** Light

- **REELS (Reflected Electron Energy Loss Spectroscopy):** Provides information on electronic structure and can measure the presence of hydrogen.  
  - **Pricetag:** Light

- **ARXPS (Angular Resolved X-ray Photoelectron Spectroscopy):** Provides information on electronic bands.  
  - **Pricetag:** Medium

- **AES (Auger Electron Spectroscopy):** Provides elemental and chemical information with high lateral resolution  
  - **Pricetag:** Heavy

- **Raman:** Molecular bonding and structural information  
  - **Pricetag:** Heavy
Tool package training (TPT) - Status

**Introduction course**
3 hrs self-study (videos/documents + test) + practical session

**Lithography**
lecture videos (self-study) + questions/exercises (2hrs) + practical session

**Mask design**
ca. 1 day self-study (CleWin & L-Edit), based on exercises

**SEM training**
3 hrs lecture + practical sessions

**Dry etch training**
3 hrs self-study (videos) + questions/exercises (1.5 hrs) + practical session

**Thin film 1 (non-vacuum techniques)**
2 hrs lecture, launched after Easter  
Next: 19 June

**Thin film 2 (vacuum techniques)**
3 hrs lecture + practical training, launched after Easter  
Next: 26 June
Take home messages

• Planned shutdown 22 June & 1(+2) July
• Relocation of Physimeca
• Feed-back/suggestions on surface analysis (XPS etc.) (jmli@dtu.dk)