Institut Català de Nanociència i Nanotecnologia

EXCELENCIA SEVERO OCHOA

ICN2 Nanofabrication Facility

Overview on Tools & Processes

Nanofabrication Facility Officer:

Dr. Raúl Pérez Rodríguez

Nanofabrication Facility
Overview on Tools & Processes

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Topics of the day

1. Facility overview
2. Systems and processes for:
    1. Thin film deposition
    2. Plasma dry etching
    3. UV Photolithography
    4. Ebeam lithography

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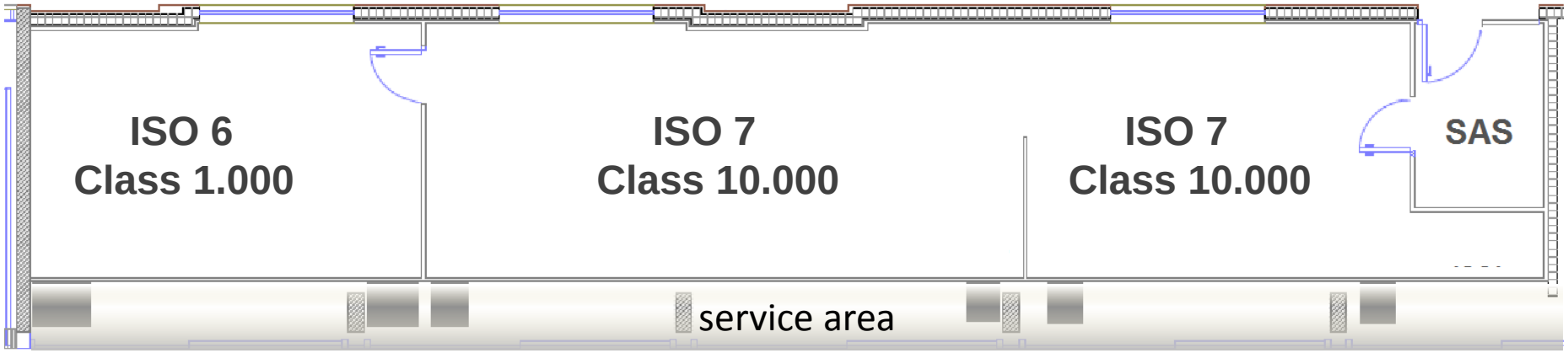
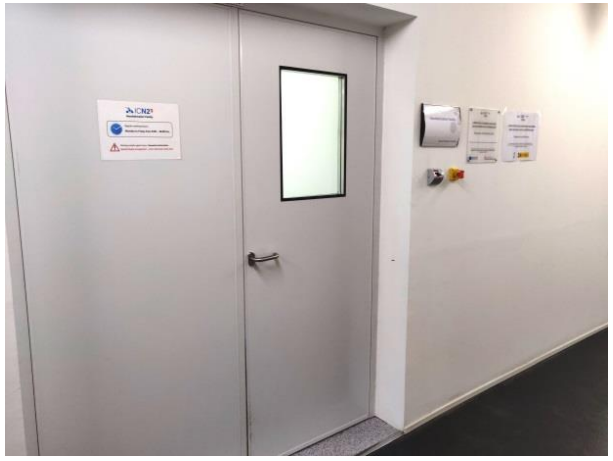
Cleanroom environment

Cleanroom area ~ **100m²**





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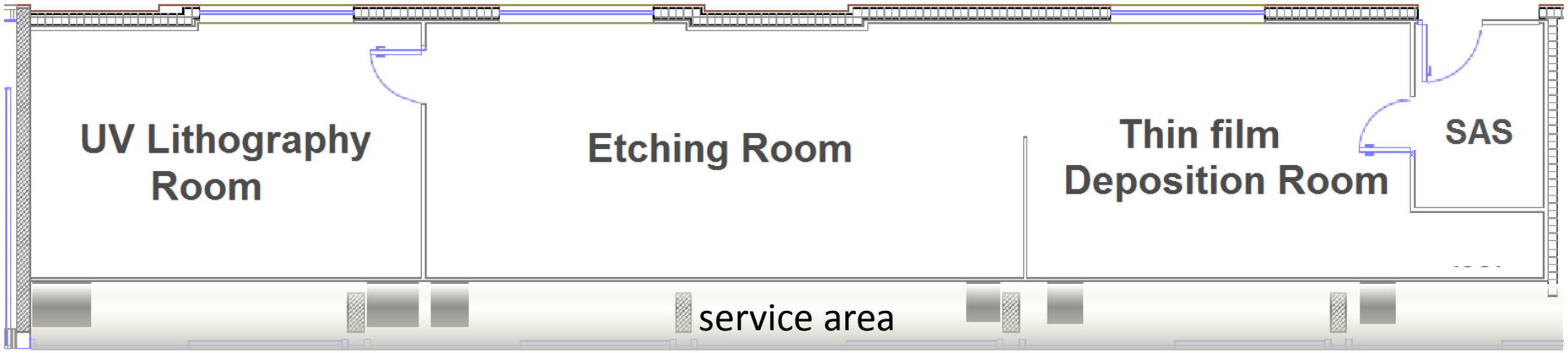
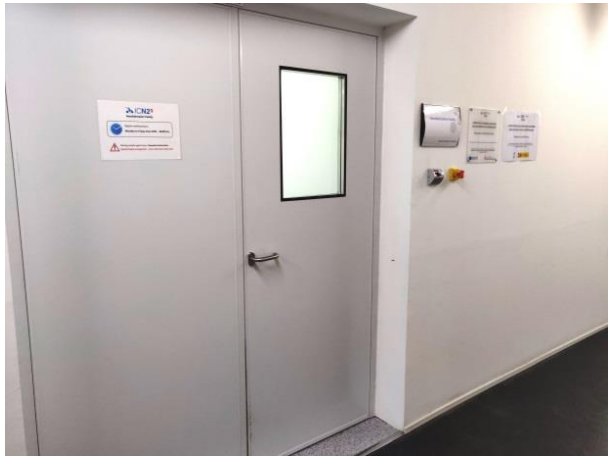
Cleanroom environment

Cleanroom area ~ **100m²**





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Facility installed systems

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Facility installed systems

equipped with:

- Ebeam evaporator
- Ebeam/sputter evaporator
- ALD system

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Thin film deposition

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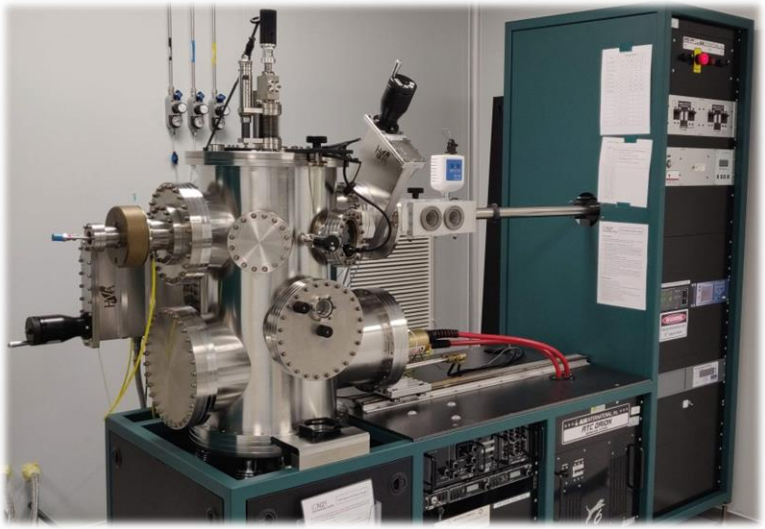
Ebeam evaporator



Manufacturer: AJA International Inc.

Model: ATC-8E Orion

- *10kV HV source* (Telemark)
- *Substrates size*: up to 4” wafers
- *Rotation & tilt holder.*
- *6 material pockets source* (rotary pocket) for deposition of multilayers.
- *Crystal quartz thickness monitor* (INFICON).
- Cryopumped main chamber, up to 1x10-8 mbar
- Turbopumped loadlock chamber, up to 2x10-7 mbar

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Thin film deposition

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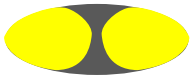
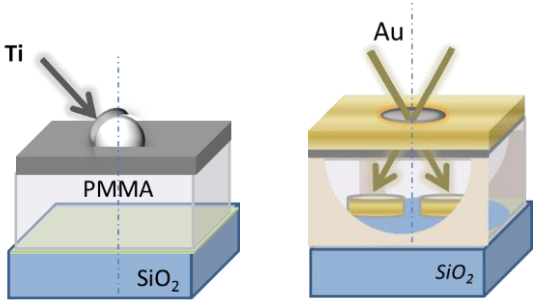
Examples

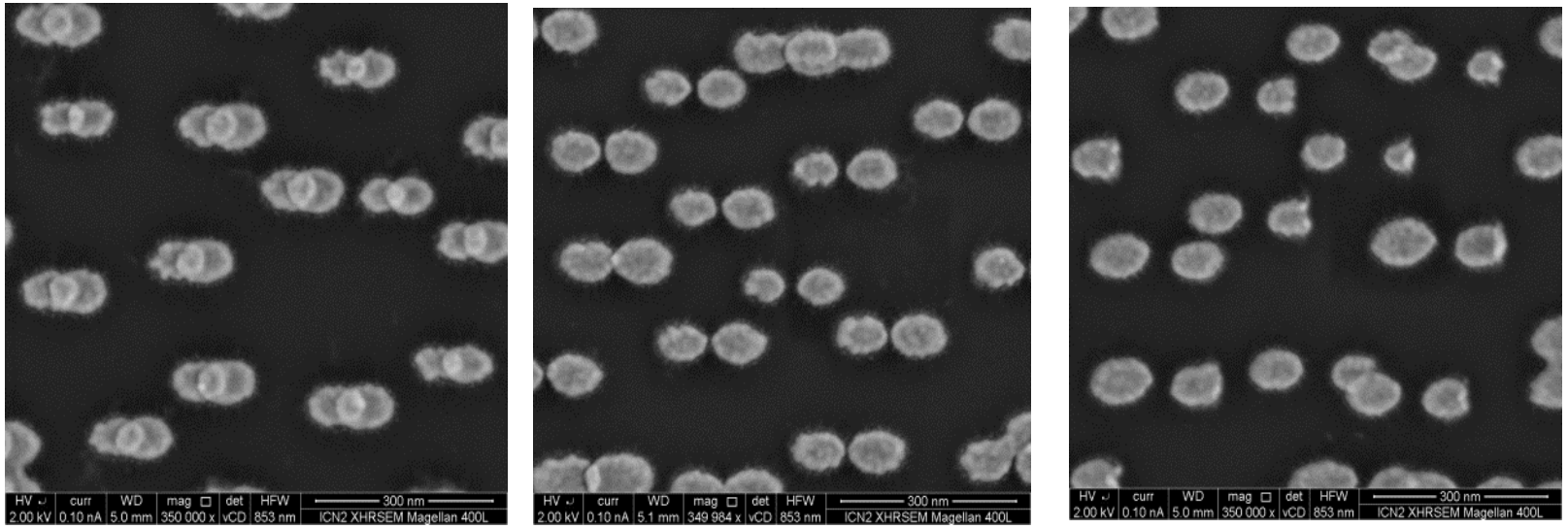
Gold nanogap antennas

- Tilted evaporation of sacrifical layer (elliptical mask)
- Tilted gold evaporation





7.5˚ 10˚ 20 ˚



(courtesy of Carmen Estevez NanoB2A group)

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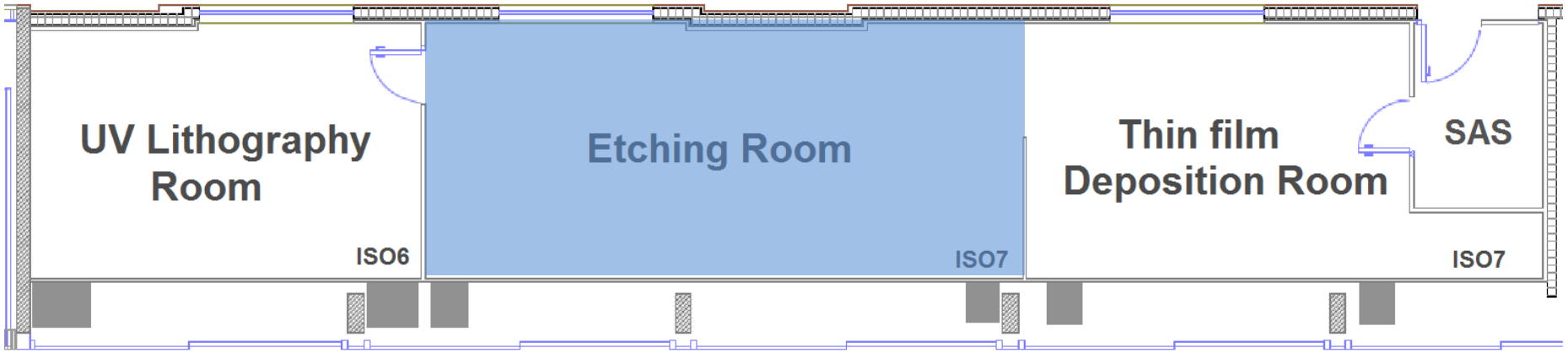
Facility installed systems



equipped with:

- ICP-RIE plasma etching
- O2 Plasma cleaner
- Fumehood (wet etching)

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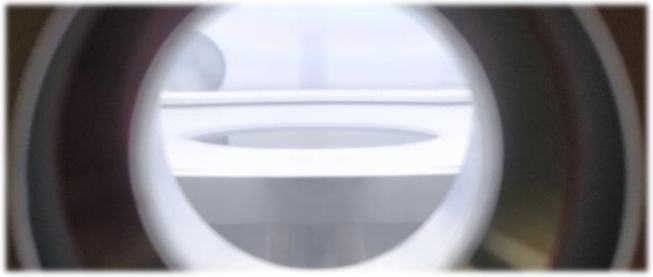
Plasma dry etching

ICP-RIE Plasma etching

Dry etching for pattern transfer.

Manufacturer: Oxford Instruments
Model: PlasmaPro Cobra 100

- Substrate size: up to 8”
- ICP Power: up to 3kW
- RIE Power: up to 600W
- He backside substrate cooling
- Table temperature: -10C - 60C
- Low pressure strike
- 8 gases line:
  O_2, Ar, He, N_2, CHF_3, SF_6, C_4F_8, CF_4



- Laser endpoint detector

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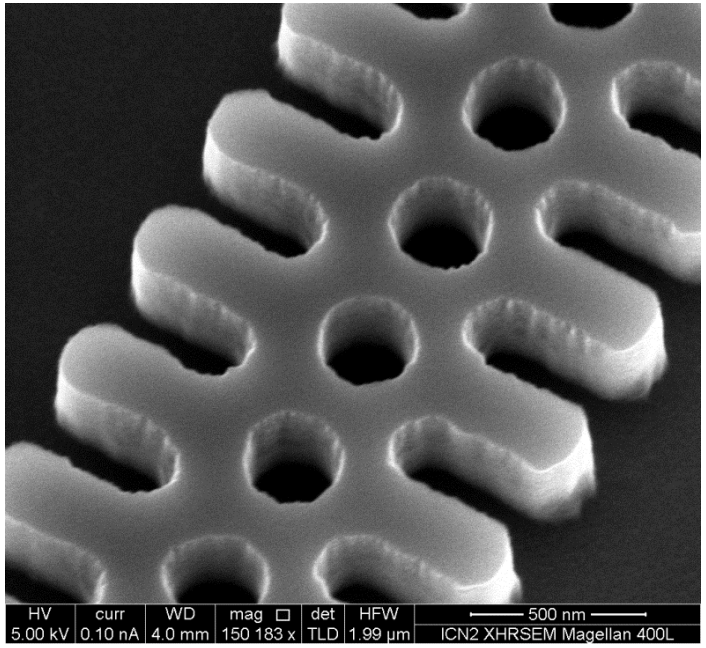
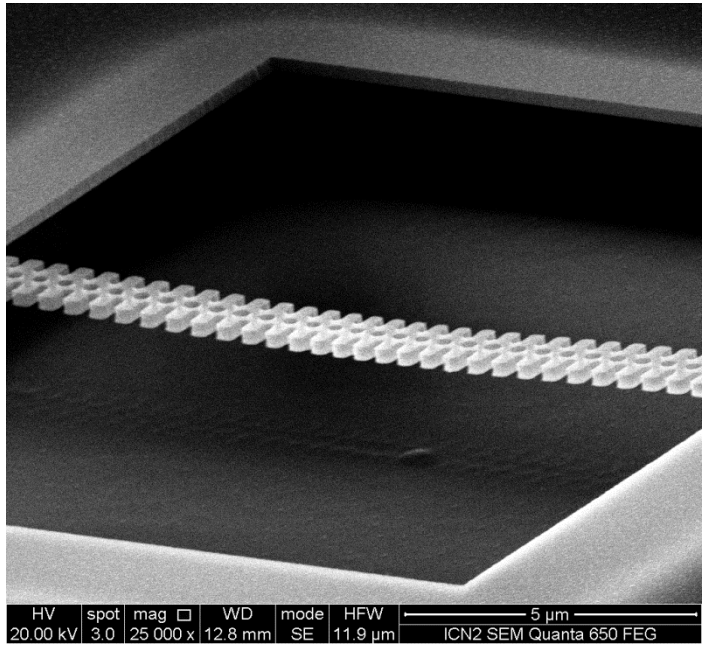
Plasma dry etching

Recipes

Si etching

Gas	Flow	Pressure	HF power	ICP Power	Time	Etched depth
C_4F_8/SF_6	30/10sccm	25mTorr	35W	1200W	1min	300nm





courtesy of Maria G., Guillermo A. and Marianna S. from P2N group

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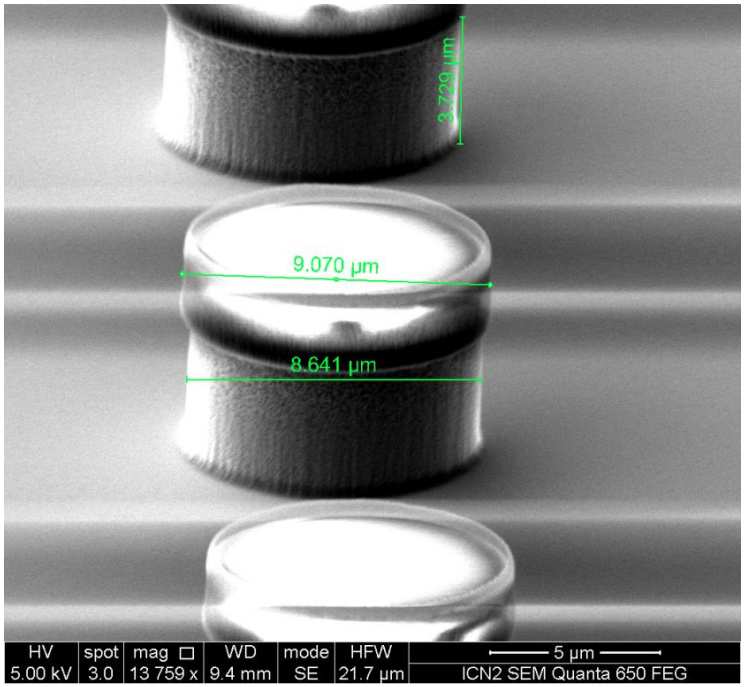
EXCELENCIA SEVERO OCHOA

Plasma dry etching

Recipes

Si etching

Gas	Flow	Pressure	HF power	ICP Power	Time	Etched depth
C_4F_8/SF_6	60/35sccm	8mTorr	40W	1500W	10min	3,8um



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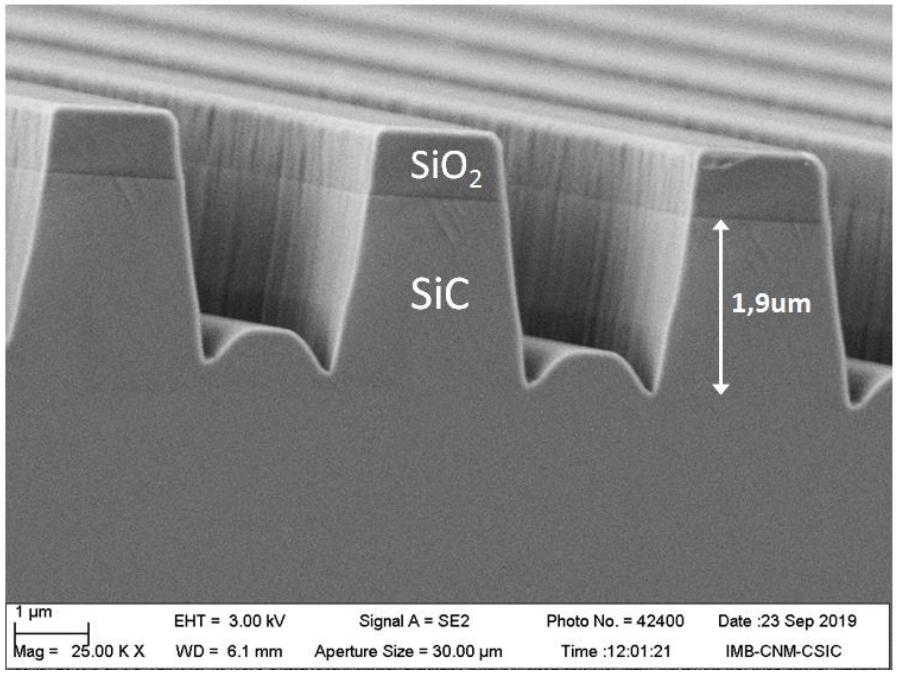
Plasma dry etching

Recipes

SiC etching

Gas	Flow	Pressure	HF power	ICP Power	Time	Etched depth
SF_6	60sccm	8mTorr	60W	1250W	8min	1,9um



courtesy of Philippe Godignon from IMB-CNM

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EXCELENCIA SEVERO OCHOA

Plasma dry etching

Recipes

SiN etching

Gas	Flow	Pressure	HF power	ICP Power	Time	Etched depth
CF_4/O_2	50/10sccm	8mTorr	50W	500W	2min	310nm

Au etching

Gas	Flow	Pressure	HF power	ICP Power	Time	Etched depth
Ar	60sccm	6mTorr	30W	300W	2min	60nm

Graphene etching

Gas	Flow	Pressure	HF power	ICP Power	Time	Etched depth
O_2/Ar	40/20sccm	80mTorr	20W	0W	2min	--nm

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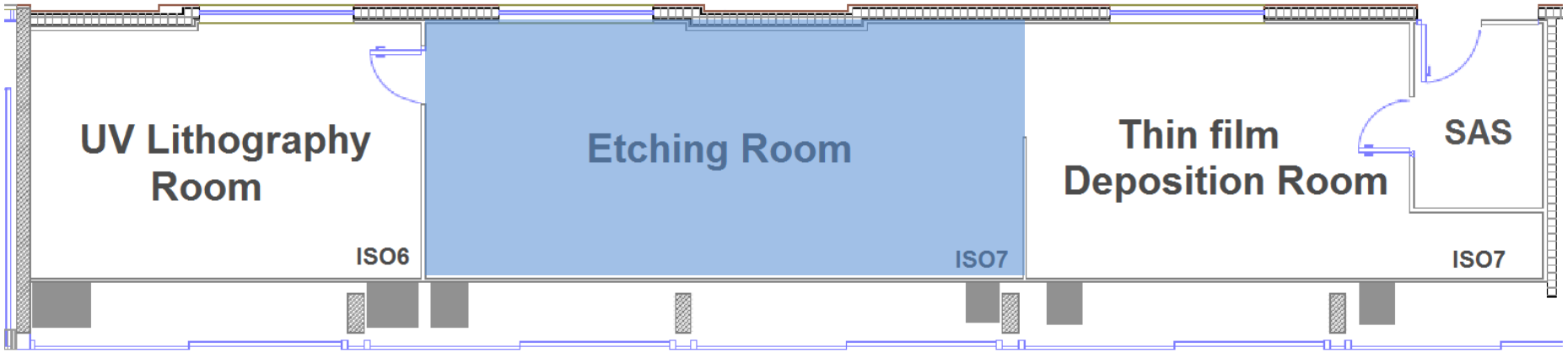
Facility installed systems



equipped with:

- ICP-RIE plasma etching
- O2 Plasma cleaner
- Fumehood (wet etching)

Characterization equipment:

- Stylus Profilometer (KLA-Tencor)
- 3D Optical Profiler (Filmetrics)

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EXCELENCIA SEVERO OCHOA

Facility installed systems

equipped with:

- Direct Write Laser Lithography
- UV Mask Aligner
- Fumehood 1 (Spinner + 3 Hotplates)
- Fumehood 2 (Vacc. Dess. + Sonicator)
- Optical Microscope (x10, x50)
- Oven (300C)
- Fridge

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UV photolithography

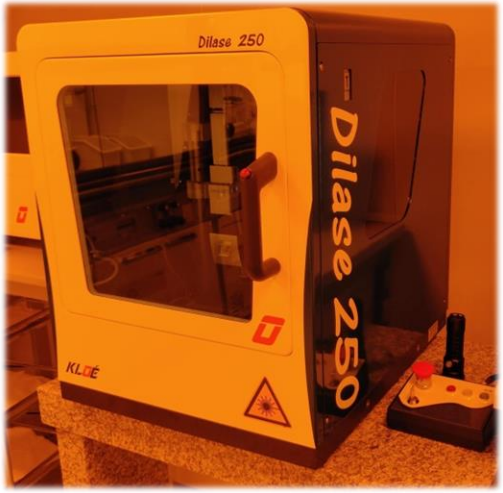
UV Exposure

Mask aligner

Manufacturer: KLOE
Model: KUB 3

- Substrates: from small pieces to 4”
- Mask Size: 5”x”5”
- UV LED source: 365nm
- Resolution: 2um
- Alignment accuracy: 3um

Direct Write Laser



Manufacturer: KLOE
Model: Dilase 250

- Substrates: from small pieces to 4”
- UV source: 375nm
- Laser spot size: 1um
- Writing speed: up to 100mm/s
- Alignment accuracy: 1um

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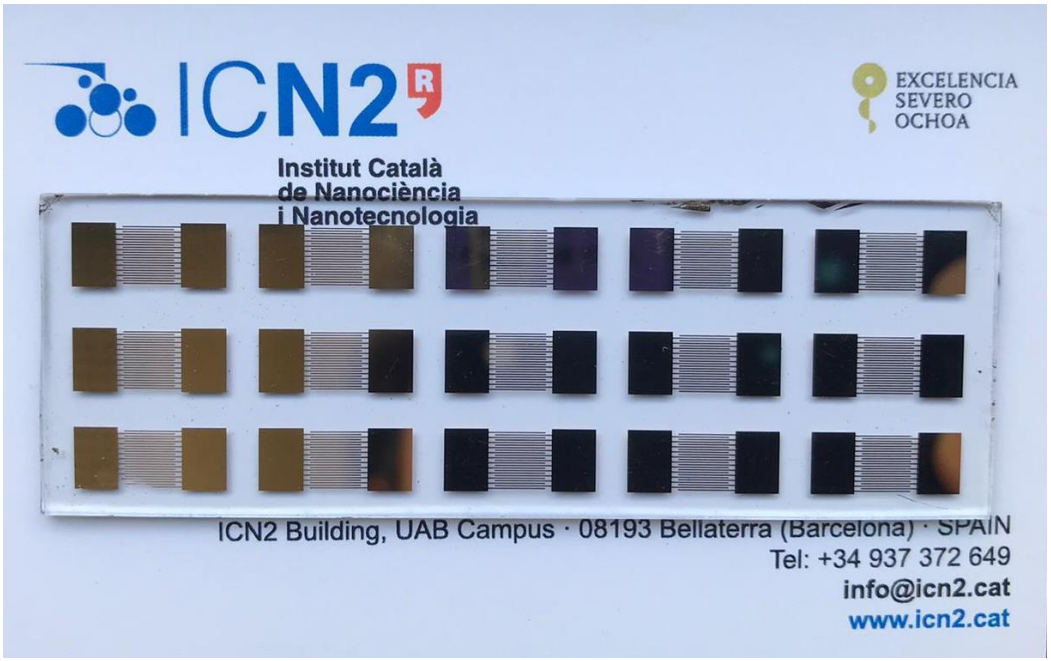
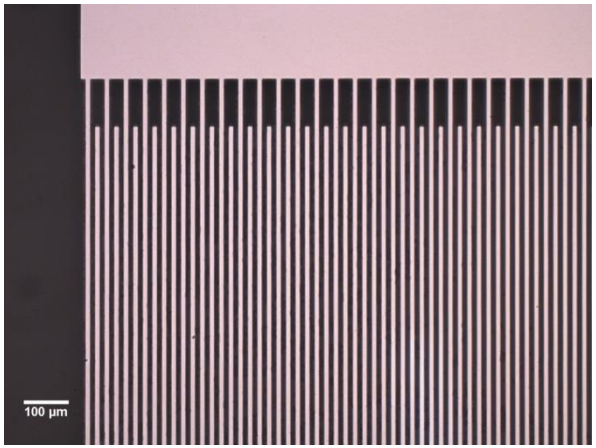
UV photolithography

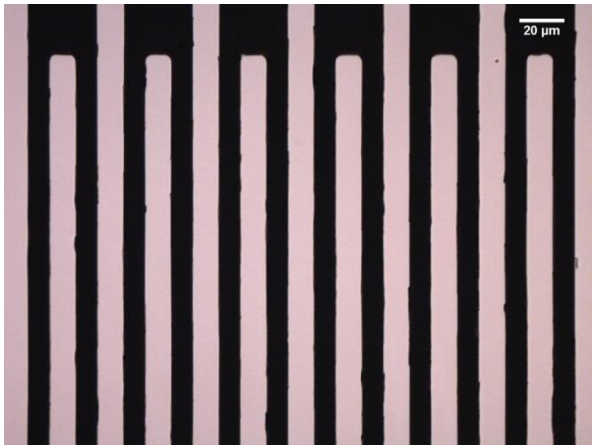
Examples

AZ5214 thin positive/negative resist – liftoff applications



15um- Au electrodes on glass
(courtesy of Peng Xiao from P2N group)

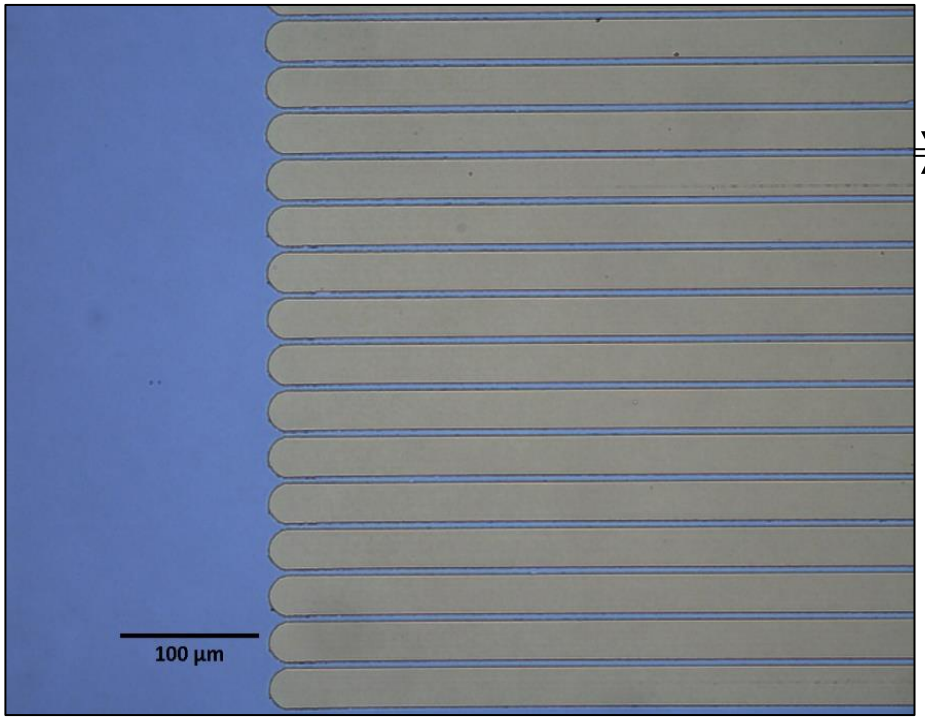




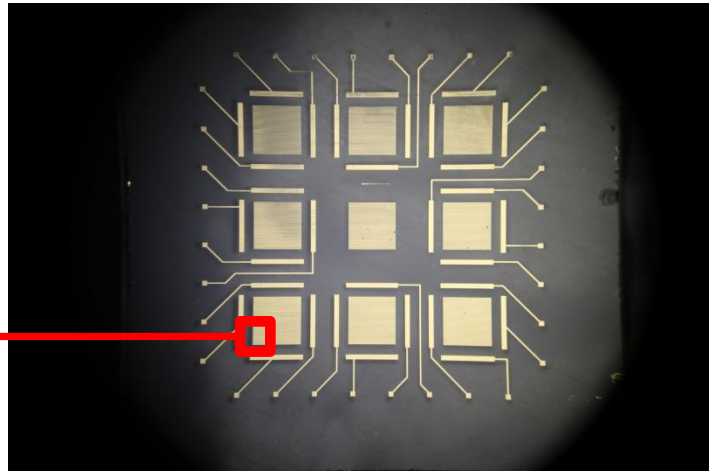
UV photolithography

Examples

Gratings *(Ti/Au)* are fabricated on topological insulator (TI) samples for field-enhancement of THz radiation:



3 µm gaps

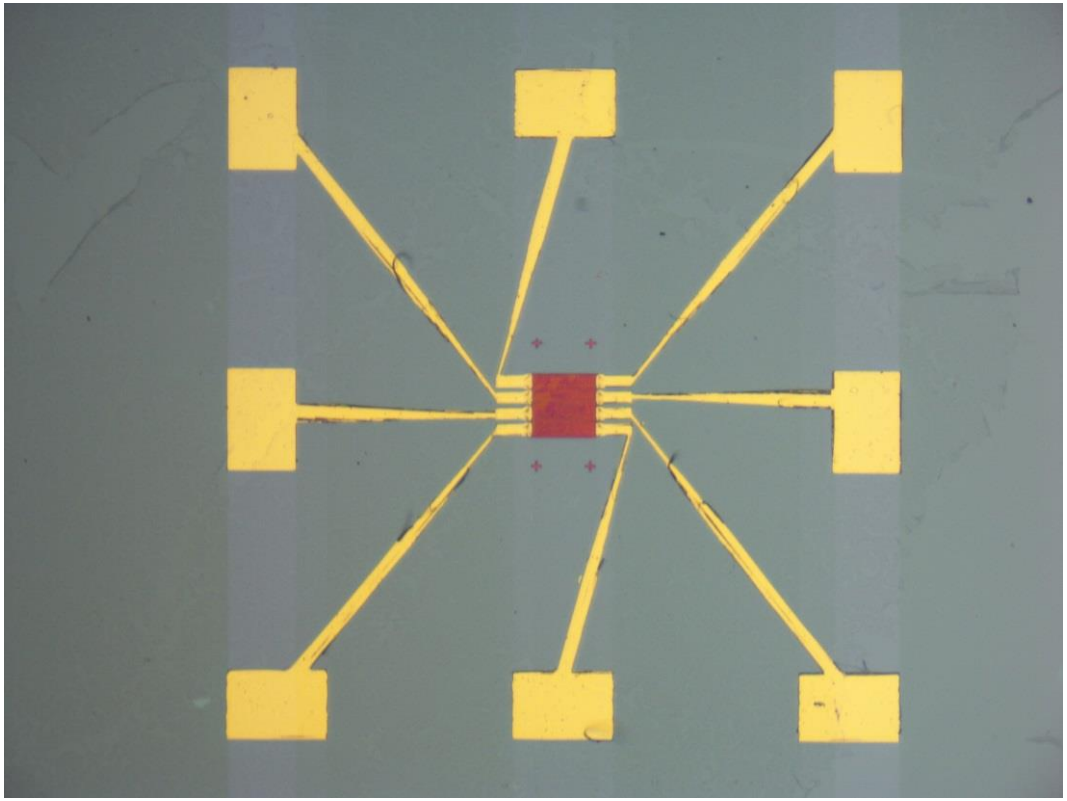


(courtesy of David Saleta from UDNS group)

UV photolithography

Examples

Au electrodes aligned on silicon with graphene and EBL previous pattern



(courtesy of Nicolau Molina from AMS group)

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UV photolithography

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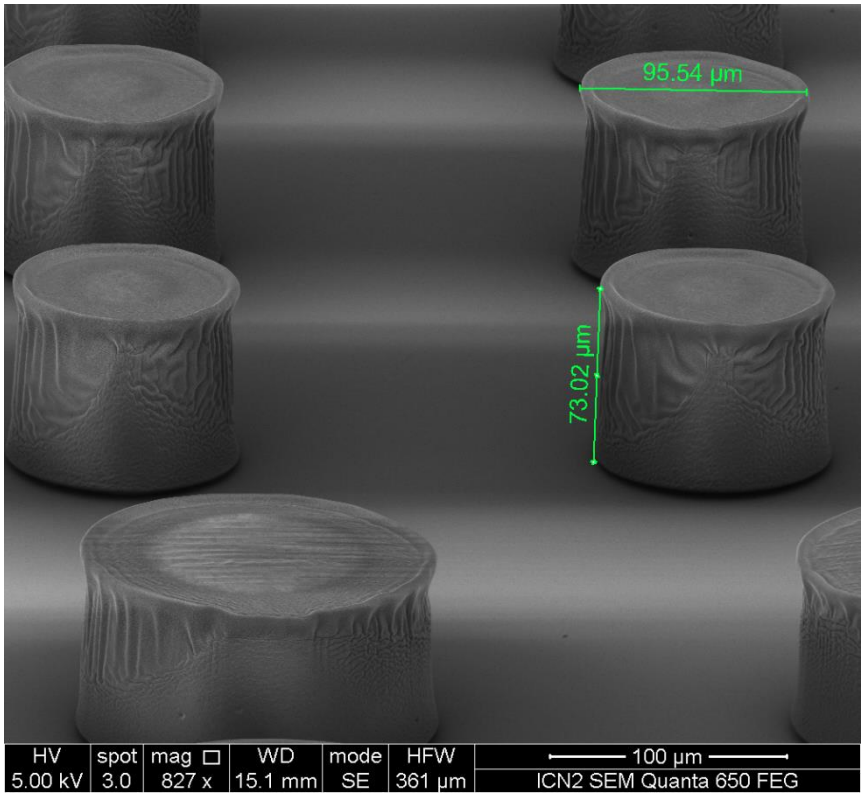
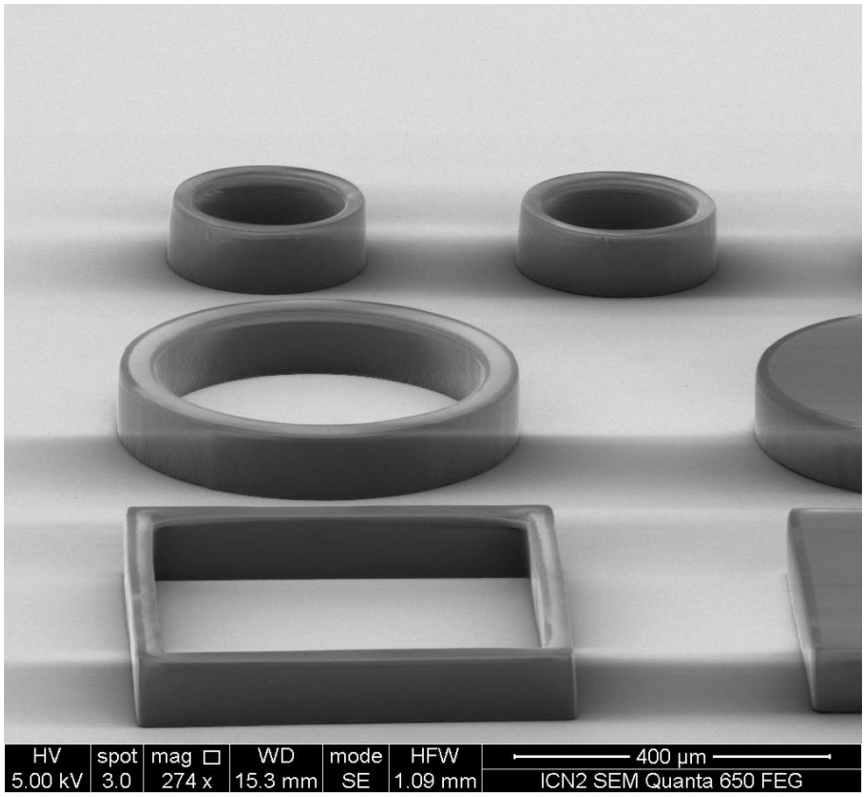
Examples

SU-8 thick negative resist - mainly used as master to make PDMS molds





(courtesy of Nikolaos Kehagias from P2N group)

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Systems outside the facility

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E-beam lithography room

Room -1024

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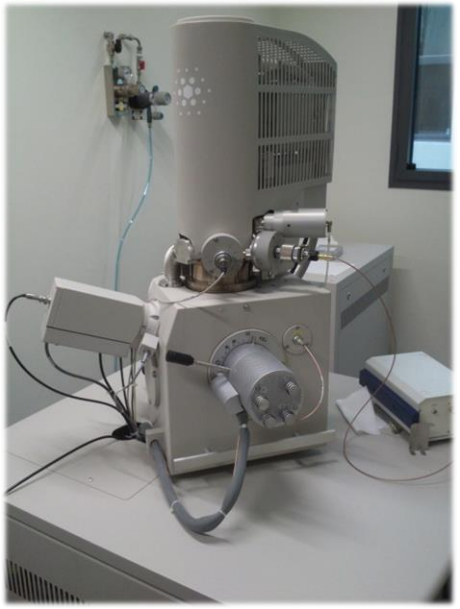
Systems outside the facility

Ebeam Lithography System

SEM based ebeam lithography patterning.



Manufacturer: Raith GmbH.

Model: Elphy Quantum (Inspect F50 FEI SEM based)

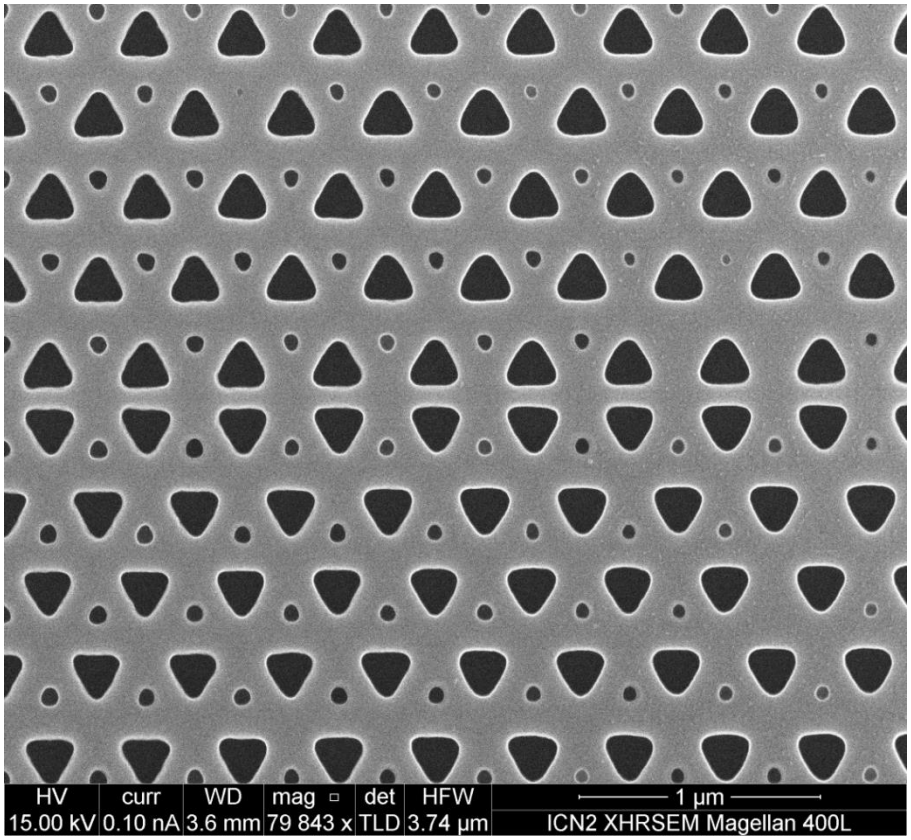
- *High stability* FE tip.
- *HV range*: 500V to 30kV
- *Current*: 0.6pA to 100nA.
- *6MHz Dual DAC* to adress x-y beam deflection
- *Writefield Sizes:* from 25x25μm to 1x1mm.
- High speed beam blanker (50MHz)
- Multiuser software management

Ebeam lithography

Examples

Topological structure fabricated on silicon: A photonic crystal where inversion symmetry of the periodic structure is broken.

All the fabrication steps done at ICN2, the electron beam lithography and etching.



(courtesy of David Garcia from P2N group)

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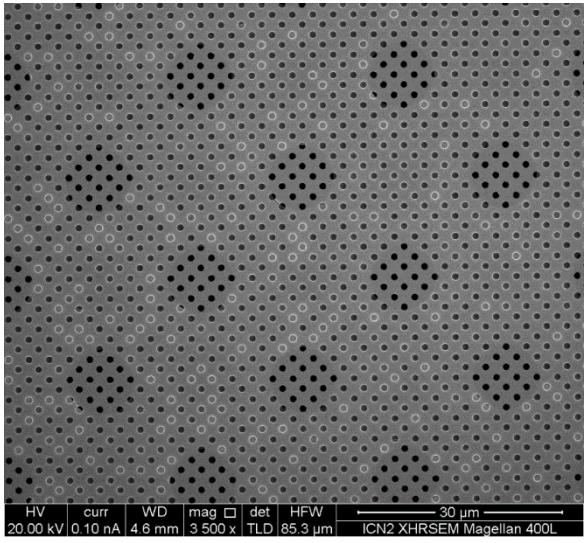
Ebeam lithography

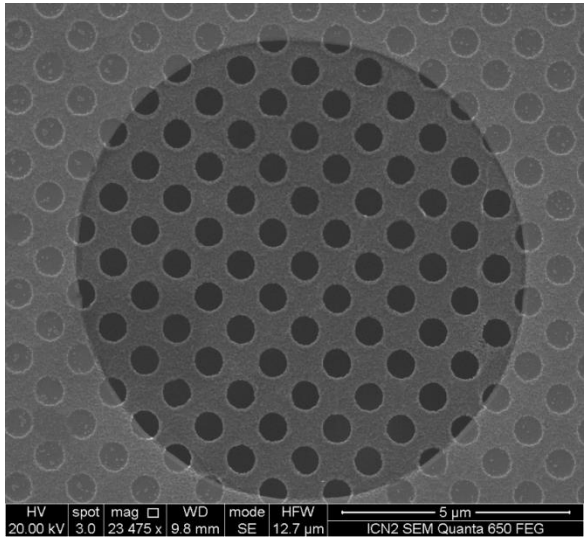
Examples

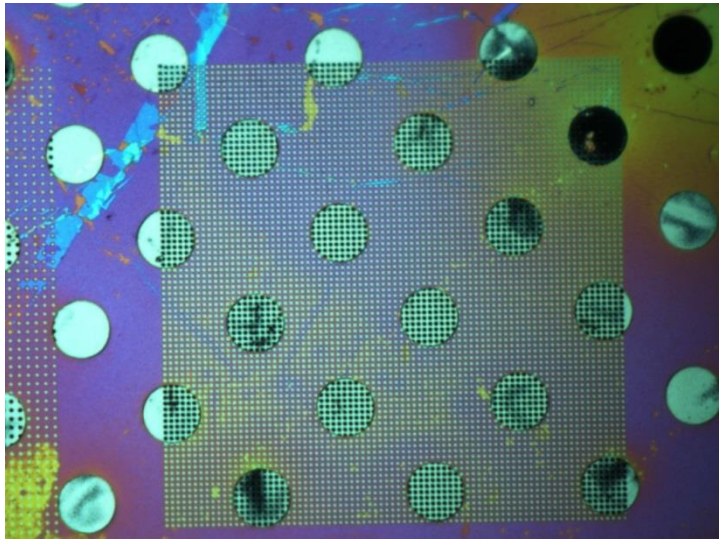
Free-standing Polycrystalline MoS2 holy membrane: EBL+RIE+Water-assisted transfer tech.

Study the thermal conductivity of free-standing polycrystalline MoS2 holey membrane.

All the fabrication steps done at ICN2, the electron beam lithography and etching.







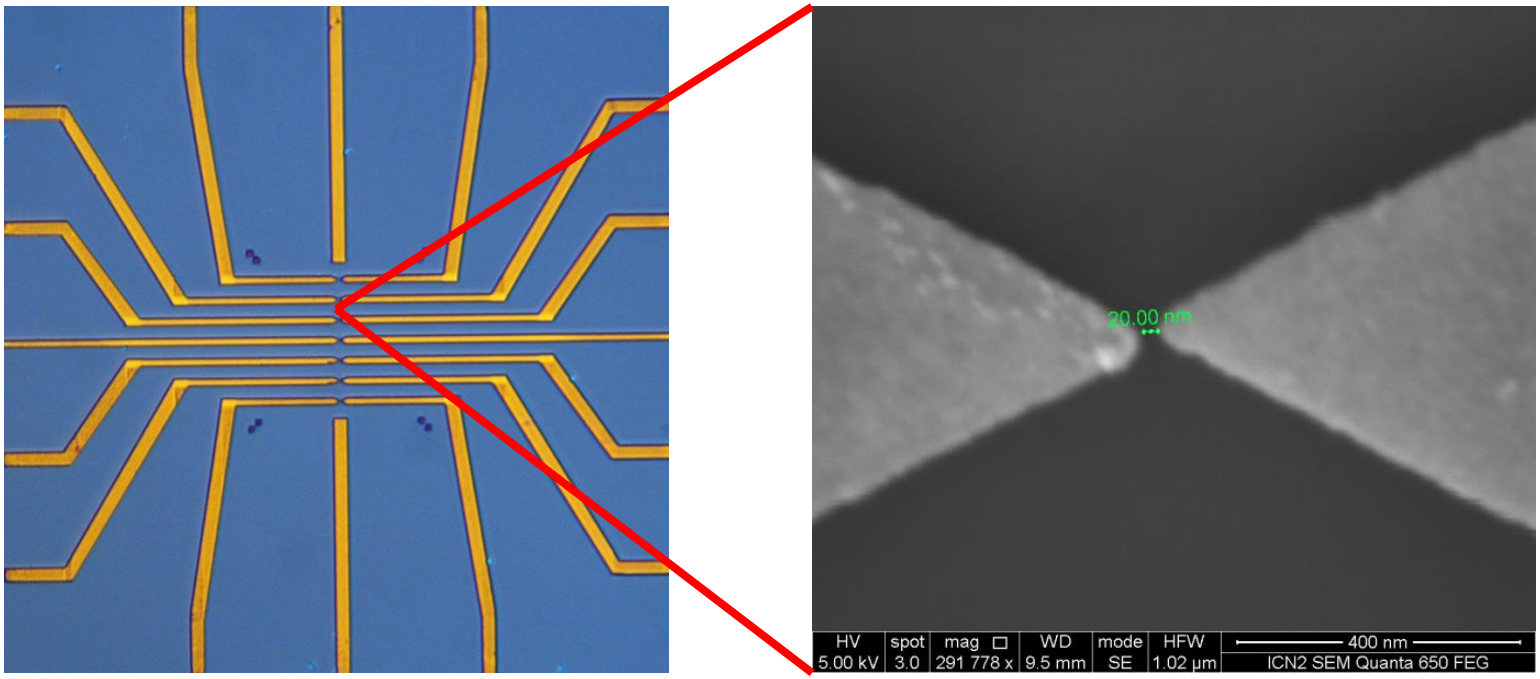
(courtesy of Peng Xiao from P2N group)

Ebeam lithography

Examples

Graphene nanoribbon (GNR)-based Field Effect Transistors (FET). The distance between drain-source electrodes is controlled down to 20 nm via either arrows (left figure) or parallel finger-electrodes in order to contact single-GNR.

All the fabrication steps done at ICN2, the electron beam lithography and metallization.



(courtesy of Jose Ramón García from AMS group)

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Research support facilities

MOLECULAR SPECTROSCOPY AND OPTICAL MICROSCOPY FACILITY

NANOFABRICATION FACILITY

www.icn2.cat/en/nanofabrication-facility-overview

PHOTOEMISSION SPECTROSCOPY (XPS&UPS) FACILITY

BIOLAB FACILITY

X-RAY DIFFRACTION FACILITY