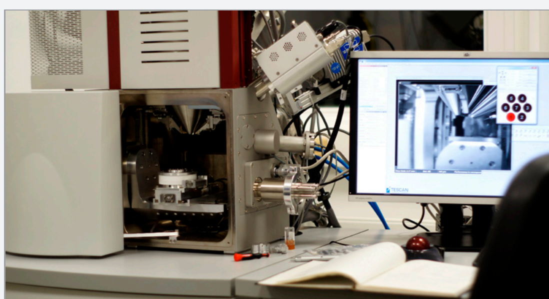
Focused Ion Beam (FIB) combined with Scanning Electron Microscope (SEM)

Instrument description

SEM/FIB is a type of microscope where a focused electron/ion beam is scanned over the sample to generate an image of the surface or to modify it with nanometric resolution (usually better than 10 nm). The image is formed by detecting secondary and backscattered electrons emitted from the impact place of particle beam. The Gas Injection System (GIS) provides a gas inlet for gaseous precursors, thus allowing milling, etching and deposition on the sample surface using advanced surface chemistry. The microscope is equipped with two closed loop nanomanipulators (optionally two more can be installed), which allows measurement of 2-probe or 4-probe current-voltage characteristics. The tool is equipped with Electron Dispersive X-Ray spectroscopy analyser (EDX) for elemental analysis. Applications include positive/negative lithography, sample imaging and modification, electrical measurements and basic chemical and elemental analysis.



Instrument: Tescan Lyra3 XMH

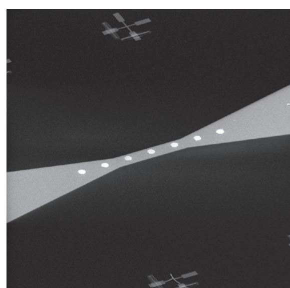
Scanning Electron Microscope combined with independent Focused Ion Beam column, equipped with Gas Injection System Electron Dispersive X-ray spectroscopy analyser and four nanomanipulators

Features:

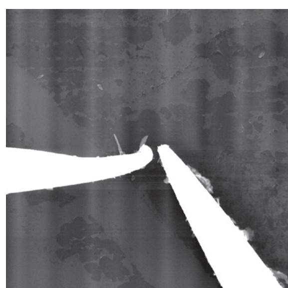
- Scanning Electron Microscope with Schottky autoemission cathode
- Focused Ion Beam column with Ga Liquid-Metal Ion Source with nanometric resolution
- Gas Injection System with inlets for up to 5 precursors for deposition and etching of materials
- two fixed closed loop nanomanipulators, optional: additional two sample stage nanomanipulators for electrical measurements
- Electron Dispersive X-ray spectroscopy for chemical and elemental analysis
- ready for Transmission Electron Microscopy sample preparation
- detectors – secondary (SE), backscattered secondary (BSE), transmitted (TE) electrons, Beam Deceleration technology (BDM), Electron Beam Induced Current (EBIC), In-Beam BSE detector
- electron and ion beam lithography software (milling, etching, deposition)
- integrated controlling software
- active antivibration system

Application

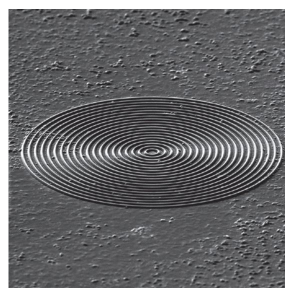
SEM images



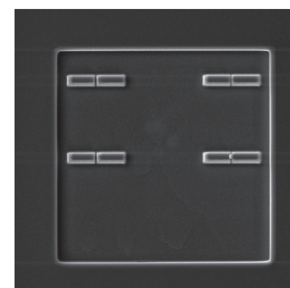
Group of NiFe magnetics disks on Au electrode - EBL, FIB, GIS lithography (view field 55.2 μm, side view)



Nanomanipulators used for electrical contacting of graphene flakes - EBL, nanomanipulators (view field 17.6 μm)

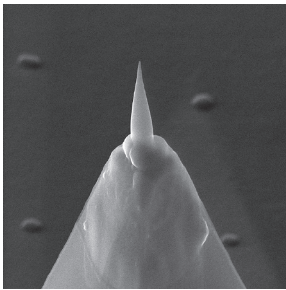


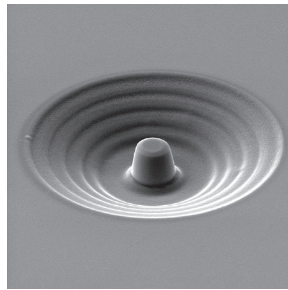
Concentric circles of Pt - GIS deposition, lithography (view field 45 μm, side view)

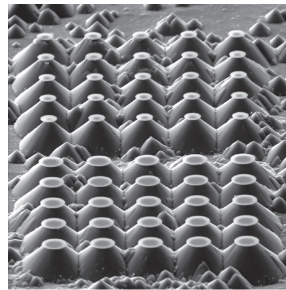


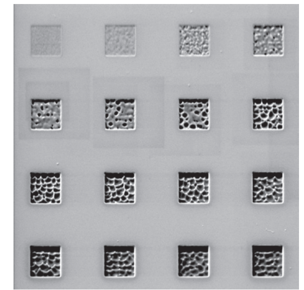
Plasmonic antennas emitting in IR - FIB ion milling; (view field 15 μm)

SEM images


SPM tip sharpening - combination of FIB ion milling and GIS tip growth (view field 5 μm, side view)


3D concetric circle stairs - FIB milling, ion lithography (view field 12 μm, side view)


Deposition of Pt islands (GIS) used for selective etching of SiO_2 substrate (view field 18 μm, side view)

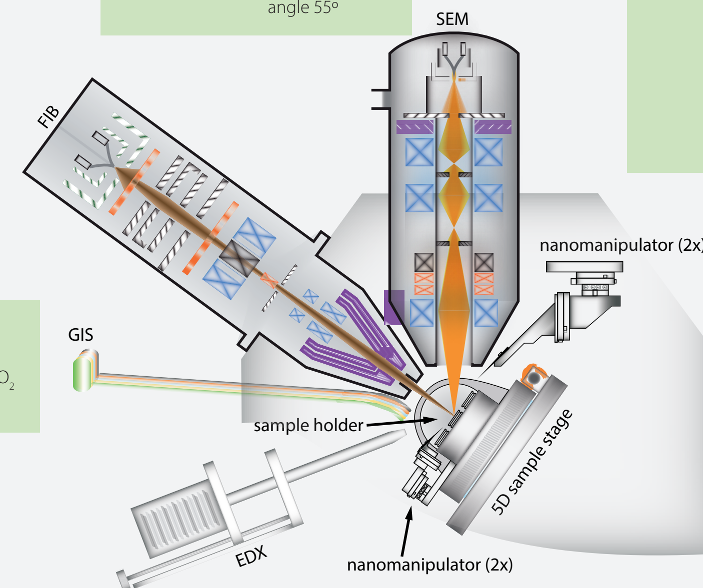

Milling etching rate calibration of NiFe layer - FIB, etching rate (view field 19.6 μm)

Technical specification

General info:
chamber vacuum: <5x10^{-4} Pa
stage range: 130 mm x 130 mm x 100 mm,
planar rotation 360º,
tilt -30º to 90º,
compucentric
sample size: up to 6" wafer size
plasma and cryo decontaminators
active antivibrating system

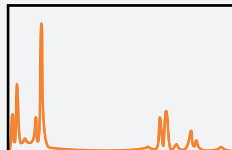
Focused Ion Beam (FIB):
Orsay Physics - Canion Gallium LMIS
Accelerating voltage: 500 V to 30 kV
Probe current: 1 pA - 40 nA
View field: > 1 x 1 mm^2 at WD 9 mm
Magnification: 150 x - 1,000,000 x
Resolution: 5 nm at 30 kV
coincidence point: SEM WD 9 mm,
FIB WD 12 mm,
angle 55º

Scanning Electron Microscope (SEM):
Tescan Lyra3 - FEG
Accelerating voltage: 200 V to 30 kV (50 V in BD mode)
Probe current: 2 pA - 200 nA
View field: > 6 x 6 mm^2 at WD 9 mm
Magnification: 1x - 1,000,000 x
Detectors (Resolution):
Secondary Electron detector (Everhart-Thornley YAG crystal, 1.2 nm at 30 kV)
+ Beam Deceleration mode (1.8 nm at 3 kV),
Backscattered SE detector (Everhart-Thornley YAG crystal, 2.0 nm at 30 kV),
In-Beam BSE detector (Everhart-Thornley YAG crystal, 2.0 nm at 15 kV),
Transmitted Electron detector (0.9 nm at 30 kV)
Electron Beam Induced Current detector (pA meter)



Gas Injection System (GIS):
e-beam, i-beam lithography
deposition precursors: Pt, W, SiO_2
etching precursors: H_2O, XeF_2

Nanomanipulators:
SmartAct SLC-1730-S/SA 7D12
chamber mounted:
range: 21 mm x 21 mm x 21 mm
3D, closed loop
resolution 5 nm, repeatibility ±25 nm
stage mounted:
range: 12 mm x 12 mm x 12 mm
2x3D + rotation,
resolution 1 nm, repeatibility ±25 nm



Electron Dispersive X-ray spectroscopy (EDX):
Bruker Quantax 200
elements detection: from B (5) to Am (95)
energy resolution: ≤ 129 eV
active area: 10 mm^2

Contact

Core Facility: Nanofabrication and Nanocharacterisation

Section: Nanolithography infrastructure/
Probe Microscopy & Nanomanipulation

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