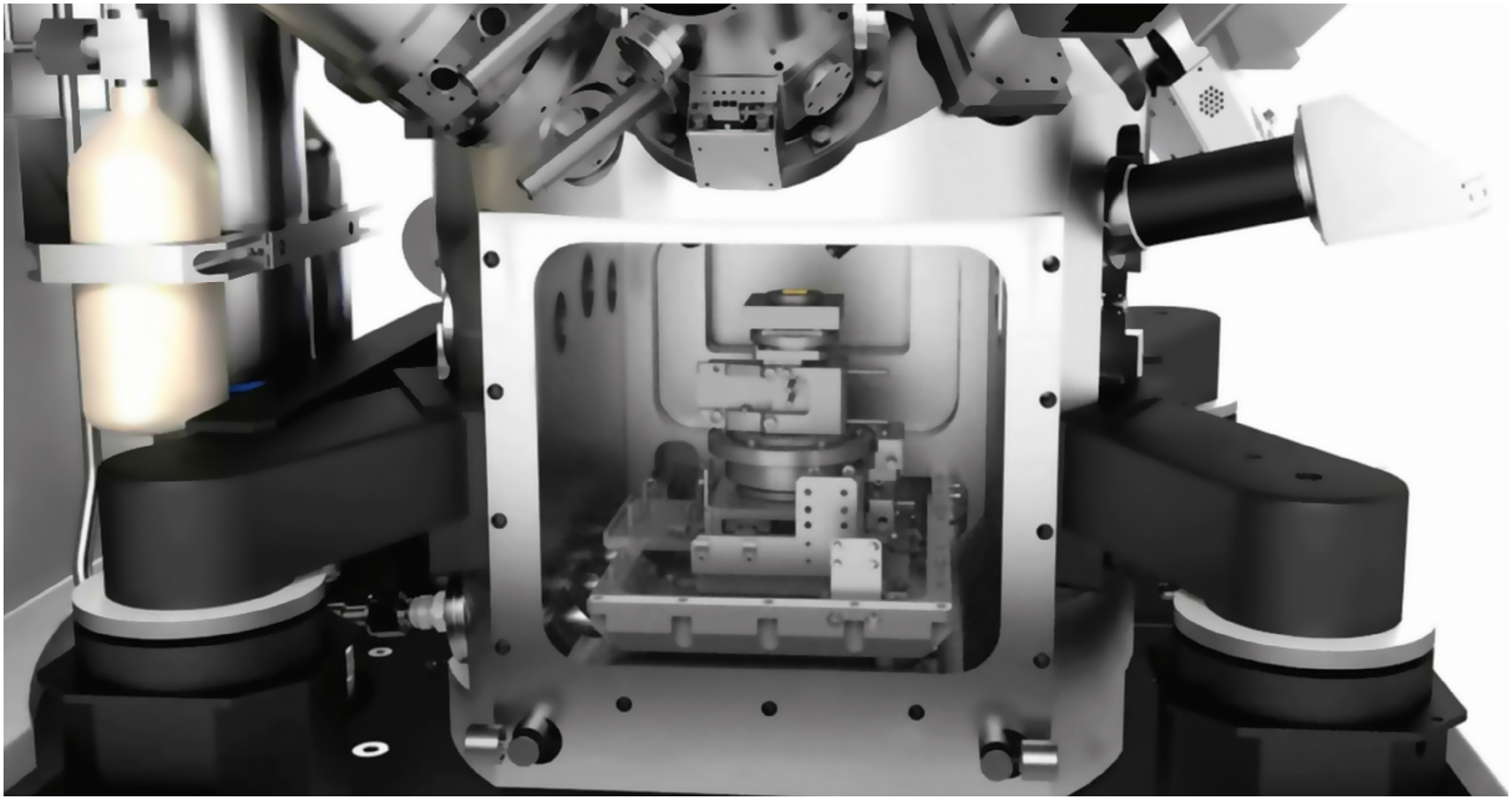


Product Information

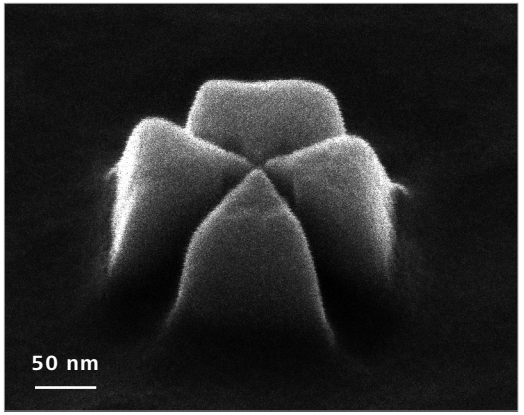
Version 2.0

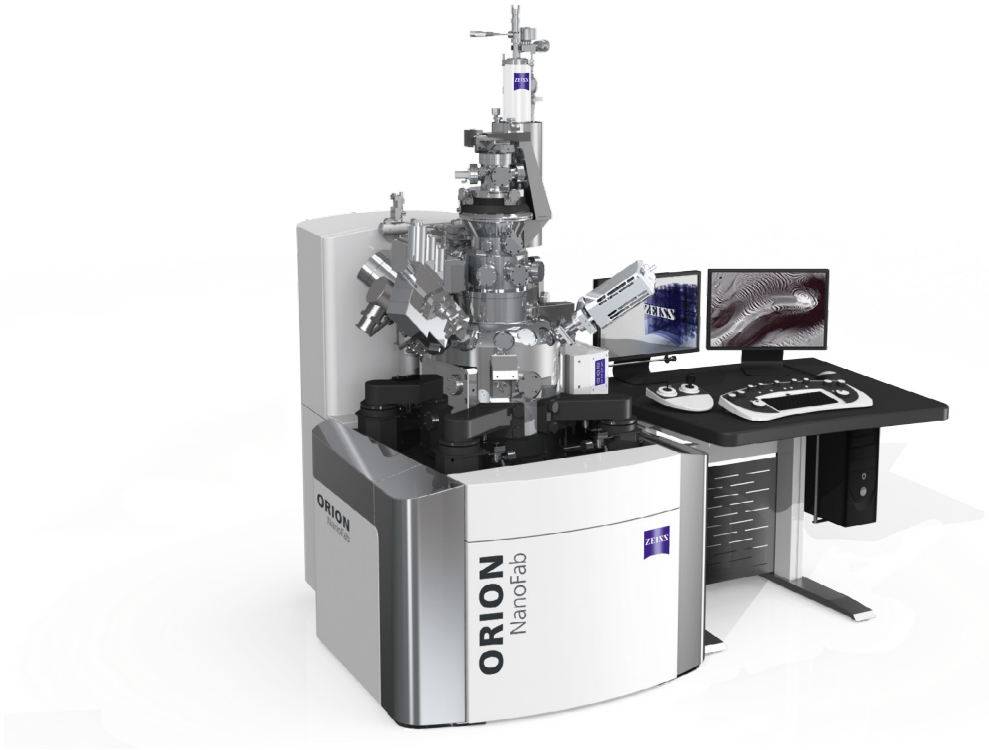
ZEISS ORION NanoFab

Three Ion Beams for Enhanced Flexibility in Sub-10 nm Fabrication

Three Ion Beams for Enhanced Flexibility in Sub-10 nm Fabrication

Fabricate sub-10 nm nanostructures with speed and precision with your ORION NanoFab. Use its neon beam to machine nanostructures at great speed and achieve high throughput. Use the helium beam to create delicate sub-10 nm structures that demand extremely high machining fidelity.
Equip your ORION NanoFab with the optional gallium FIB column and it becomes one of a kind: the only system in the world that covers the complete range of micromachining to nanomachining applications using gallium, neon and helium ion beams integrated into a single instrument.



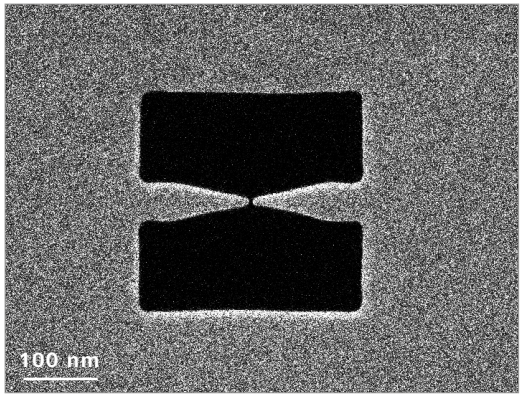


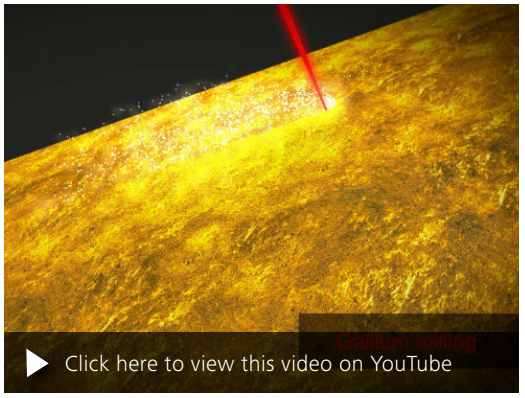
Simpler. More Intelligent. More Integrated.

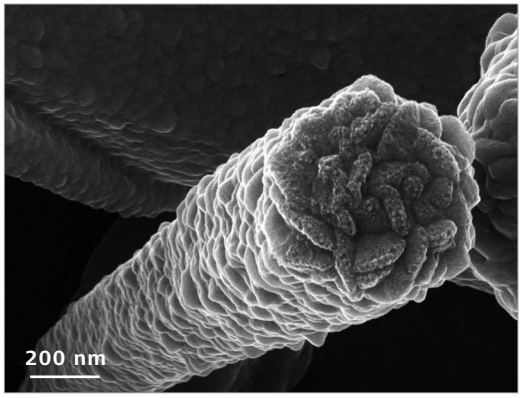
Fast Machining of sub-10 nm Structures
Creating nanostructures with feature sizes smaller than 10 nm is not possible with traditional gallium FIBs. Using neon and helium ion beams in ORION NanoFab, you can make delicate sub-10 nm structures that demand extremely high machining fidelity with speed and ease. Whether your application is material removal using sputtering, gas induced etching or deposition, or lithography, ORION NanoFab excels in sub-10 nm fabrication.

Three Beams in One Instrument
Seamlessly switch between gallium, neon and helium beams with ORION NanoFab. Use optional gallium FIB to remove material in the micron range. Take advantage of the neon beam for precision nanomachining of 10-100 nm features. Use the helium beam to fabricate delicate sub-10 nm structures that demand extremely high machining fidelity. Avoid deposit contamination using neon and helium ion beams.

High Resolution Imaging
Take advantage of the high resolution performance of your ORION NanoFab: with imaging resolution of 0.5 nm, ORION NanoFab generates high resolution images of your sample in the same instrument that you used for fabrication. ORION NanoFab especially excels in imaging non-conductive samples due to charge compensation technology. Gain new insight from images with a 5 to 10 times greater depth of field compared to images acquired with FE-SEMs, and with higher surface sensitivity.







Your Insight into the Technology Behind It

Gas Field Ion Source Technology
Takes Material Removal to a New Level

A finely sharpened needle is made even sharper through a proprietary process. Individual atoms are stripped away from the source until an atomic pyramid is created with just three atoms at the very end of the source tip – a configuration called the trimer. This repeatable process can be accomplished *in-situ*. Once the trimer is formed, the tip is maintained under high vacuum and cryogenic temperatures with helium or neon gas flowing over it. Applying a high voltage to the needle produces an extremely high electric field at its apex. The helium or neon atoms are attracted to the energized tip where they are ionized. With ionization happening in the vicinity of a single atom, the resulting ion beam appears to be emanating from a region that is less than an angstrom in size. This produces an extremely bright beam that can be focused to an extraordinarily small probe size.

Advanced Column
for Ultra-accurate Beam Focus

This GFIS source is combined with an advanced electrostatic ion column that focuses the beam with sub-nanometer precision. Much like an SEM, the beam is rastered across the sample pixel by pixel for imaging. For nanofabrication, the beam can be controlled to execute an user selected pattern with prescribed dosages.

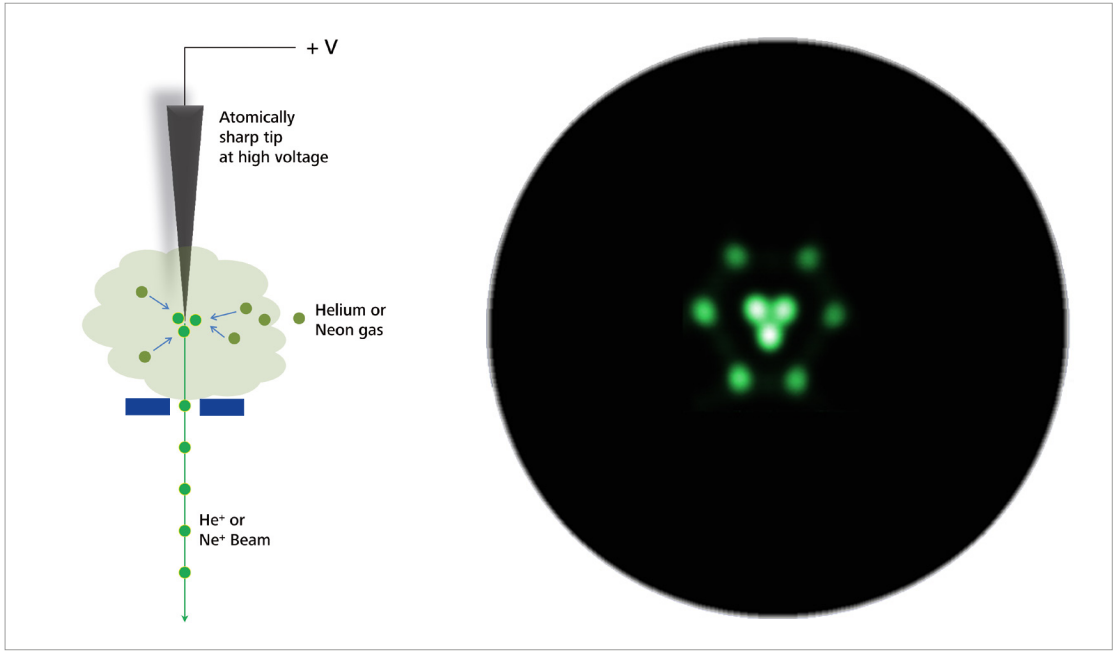
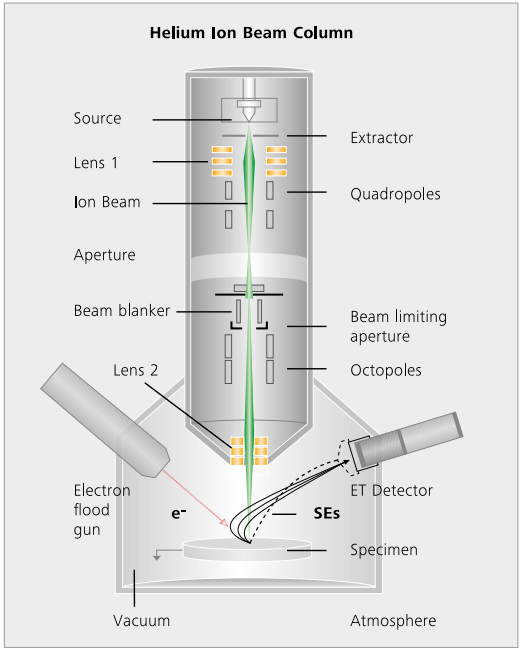


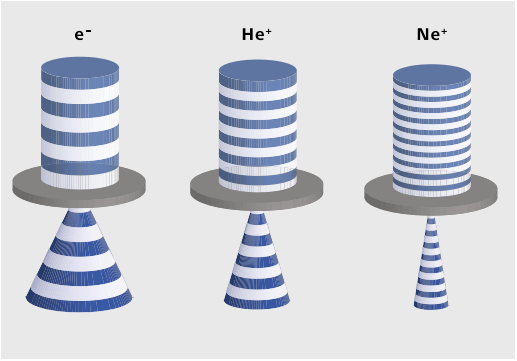
Image of the atoms at the end of the source tip emitting helium ions.



Your Insight into the Technology Behind It

Minimize Diffraction

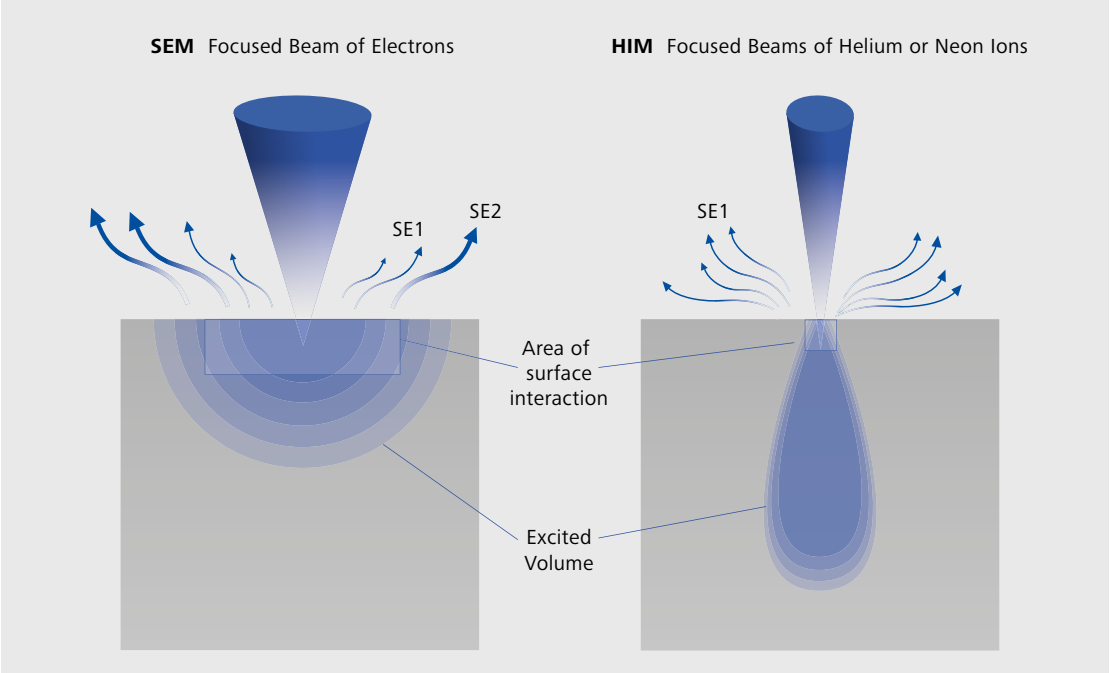
Helium ions are about 7,000 times heavier than electrons and neon ions are 40,000 times heavier than electrons. Because of this, a helium or neon beam exhibits very little diffraction when passed through an aperture or across an edge. Diffraction is a significant problem for an SEM where the diffraction effect limits its ultimate spot size. Since the helium or neon ion beam is not affected by diffraction, it can be focused to a very small spot size.



The helium and neon ions have a DeBroglie wavelength that is much smaller than an electron beam resulting in much less diffraction.

Localized Beam-sample Interaction for Higher Resolution Images

When an electron beam strikes a surface, it is subjected to a beam scattering effect caused by interaction with the surrounding material. This results in the emission of secondary electrons from an area that is somewhat larger than the size of the beam itself. The smaller the area of surface interaction, the higher the ultimate image resolution will be. When the helium or neon ion beams strike the sample with its larger and heavier particles, the particles do not scatter near the surface. This translates into a smaller area of surface interaction and much higher resolution images for the helium ion microscope.



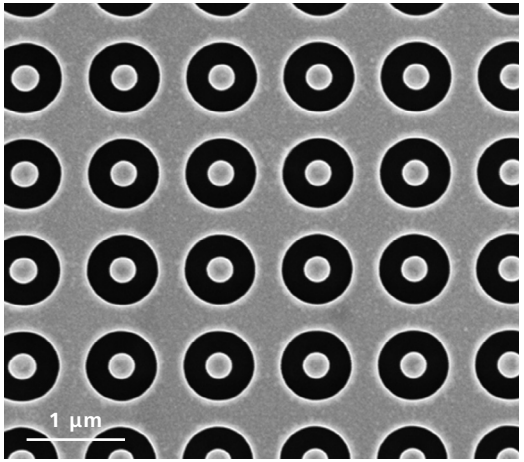
Expand Your Possibilities

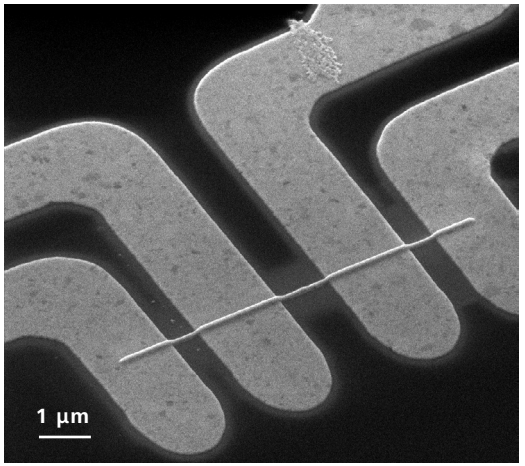
Nanopatterning with Three Ion Beams

ORION NanoFab has multiple patterning and data visualization tools. Select between a patterning tool that comes directly with your ZEN user interface or decide for the optional advanced nanopatterning module NPVE. A dedicated 16 bit scan generator for each column features dual signal acquisiton and supports real-time patterning and visualization. Completely control the beam by a GUI that allows you to create a range of fully editable shapes including rectangles, trapezoids, polygons, lines, polylines, ellipses and spots.

Fabricate Ultra-fine Structures with Gas Injection System

Extend the nanofabrication capabilities of your ORION NanoFab with the optional gas injection system. By combining a targeted delivery of chemically active species with a sub-nm ion probe you will be able to deposit and etch ultra-fine structures. Thanks to a higher secondary electron yield, the helium and neon beams provide faster etching and deposition rates as well as higher purity films compared to gallium beam deposits.

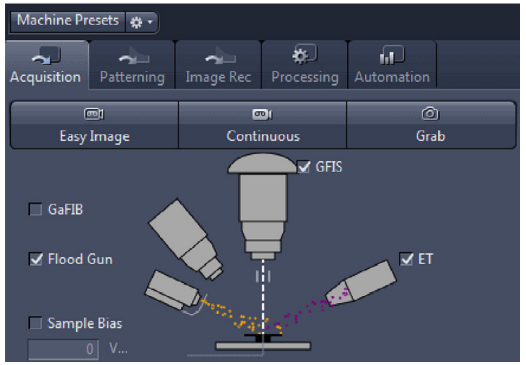




Expand Your Possibilities

Gain Your Results Simply and Quickly

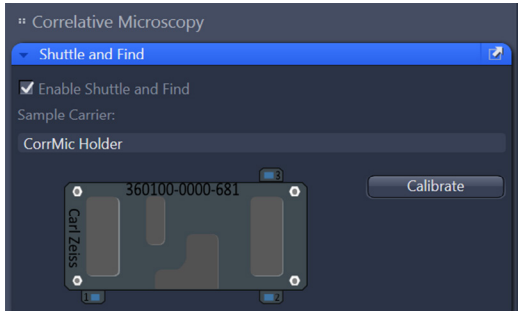
Profit from the ZEN imaging software user interface. Correlate sample maps between different imaging modalities. This user friendly software supports patterning, system presets and wizards that guide you to form the ion source. Easily manage your experiments and create reports. Achieve true correlative workflows between light-, electron- and ion microscopes by using the Shuttle & Find software module.



Profit from ZEN imaging software: set up your instrument quickly by using preset functions.

Correlate Your Data with ZEISS Shuttle & Find

The Shuttle & Find software module allows an easy-to-use, productive workflow to overlay data from your light, electron and ion microscopes. Combine the optical contrast methods of your light microscope with the high resolution and excellent surface sensitivity of your ion microscope. Discover information about the function and structure of your sample.



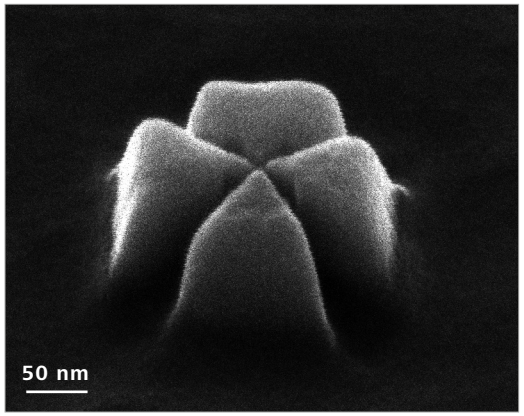
Register the fiducials on your correlative sample carrier with Shuttle & Find.

Tailored Precisely to Your Applications

Typical Applications	Task	ZEISS ORION NanoFab Provides
DNA Sequencing/Nanopores	Make sub-10 nm pores in multilayered thin films for molecular detection and sequencing.	ORION NanoFab offers material removal at a very fine rate allowing you to make nanopores in films in a single step.
Photonics/Plasmonics	Create smaller structures with fidelity reaching sub-10 nm without gallium contamination of the sample.	ORION NanoFab offers fabrication of structures that are too small to be made with gallium based traditional FIB systems.
Lithography	Electron beam lithography suffers from “proximity effect” as the patterns become dense and small.	ORION NanoFab offers lithography without any proximity effect.
Graphene	Make nanoribbons with sub-10 nm width in sensitive material.	ORION NanoFab enables precision cutting of delicate samples such as graphene.
Ion Beam Induced Deposition	Deposit high quality conductive and insulating material.	ORION NanoFab enables the deposition of material without gallium implantation and the consequential changes to physical properties.
Oil and Gas: Shale Rock Imaging	Identify pores with a diameter <5nm.	ORION Nanofab provides high resolution images of insulating rock-core samples.

ZEISS ORION NanoFab at Work

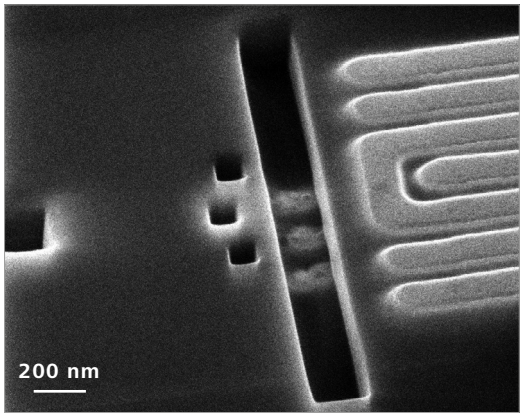
Plasmonic Structure Fabrication



A plasmonic antenna fabricated in 3 steps in a gold film using gallium, neon and helium ion beams.

ORION NanoFab is ideal to make sub-10 nm structures by sputtering. Much smaller structures with better accuracy can be made than what is possible using a gallium FIB.

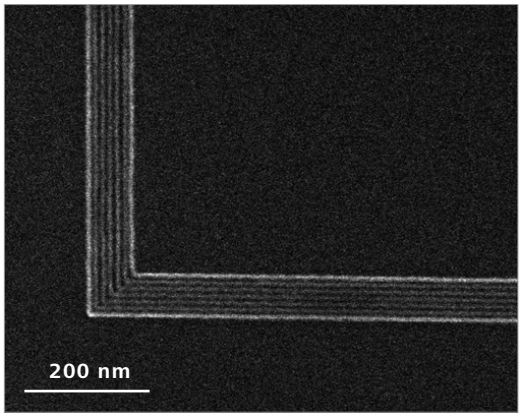
Circuit Analysis



Rectangular hole milled through approximately 300 nm of dielectric to expose buried copper lines in a semiconductor chip. Fabrication: neon, imaging: helium.

ORION NanoFab is ideal for making cuts and conductive connections in semiconductor circuit analysis applications.

Lithography

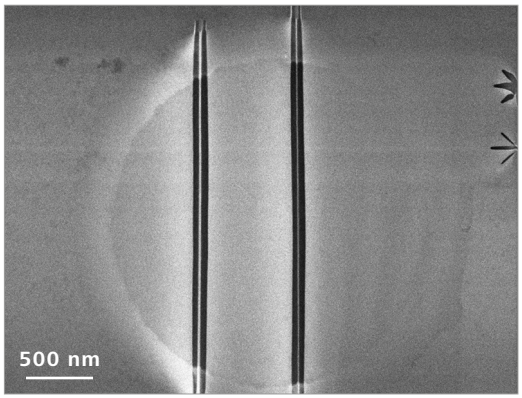


6 nm nested lines in HSQ fabricated by helium ion lithography. Courtesy of: HP Labs

ORION NanoFab is ideal for lithography as photo-resist can be exposed without proximity effects using helium and neon beams resulting in smaller and more uniform features than what is possible using electron beam lithography.

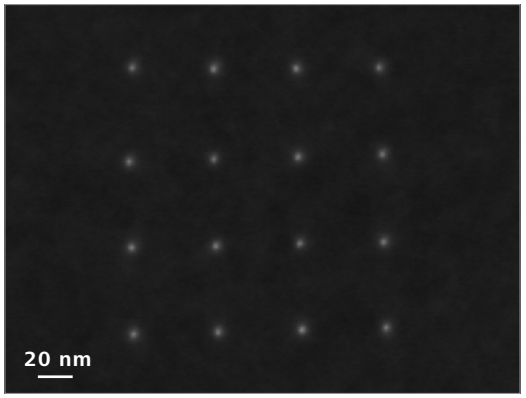
ZEISS ORION NanoFab at Work

Graphene



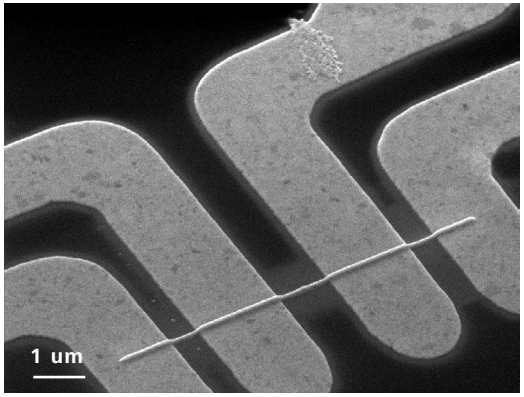
20 nm (left) and 10 nm (right) suspended nano-ribbons in graphene created by ion milling. Fabrication and imaging: helium. Courtesy of D. Pickard, National University of Singapore.

DNA Sequencing Devices/Nanopores

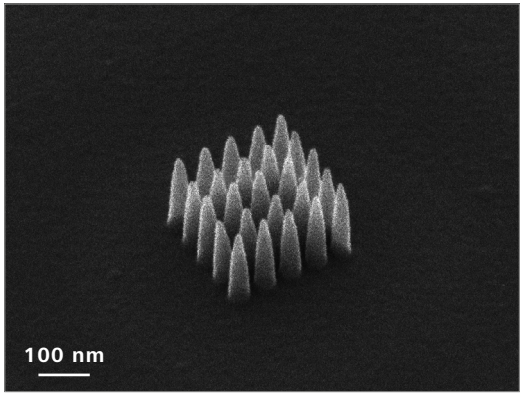


Scanning transmission electron micrograph of an array of 4 nm diameter nanopores drilled through a 30 nm silicon nitride membrane. Pores were drilled in about 1 second each. Fabrication: helium, imaging: electron. Courtesy of A. Hall, JSNN.

Ion Beam Induced Deposition

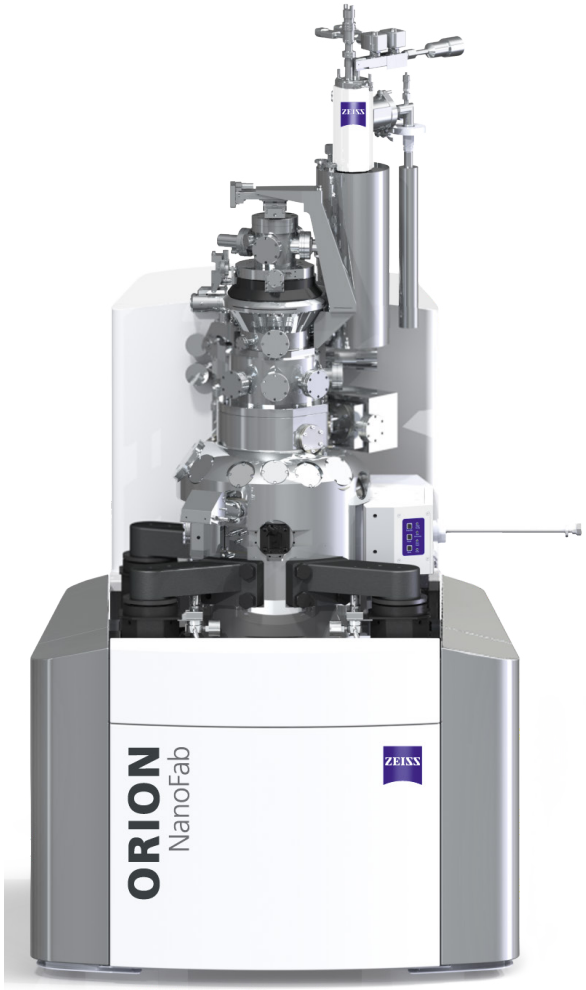


100 nm wide tungsten wire deposited on a test structure. Fabrication: neon, imaging: helium.



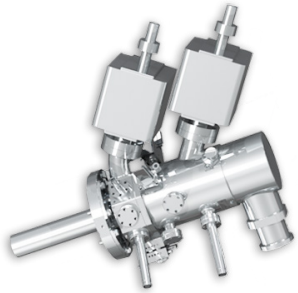
Array of platinum nano-pillars (pillars: 35 nm diameter, tight array pitch: 50 nm), example of the helium ion beam deposition capability. Fabrication and imaging: helium.

Your Flexible Choice of Components



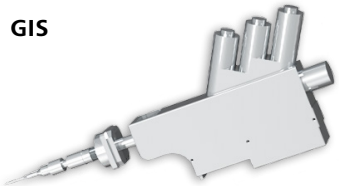
Options

Ga FIB column



State of the art gallium column for high rate ion milling with a resolution of 3 nm @30 kV, 1 pA beam current.

GIS



Single needle gas injection system (GIS) with up to three simultaneous precursors (W, Pt, PMCPS, TEOS, Water, XeF_2)

Technical Specifications

Product Name	Description
ORION NanoFab	Scanning ion microscope
	Gas Field Ion Source (GFIS) and column including helium and optional neon source gas operation
	Advanced Nanopatterning
	ET secondary electron detector
	Electron flood gun for charge compensation
	5 axis motorized stage
	Advanced workflow based user interface on 64 bit Windows 7® operating system
	Powervar Security Plus uninterruptible power supply
GFIS Column	Field of view: 800 µm – 100 nm @ 8 mm working distance
Helium Ion Beam	Resolution: 0.5 nm @30kV
	Beam energy: 10 – 30 kV
	Beam current: 0.1 to 100 pA*
Neon Ion Beam	Resolution: 1.9 nm @ 25kV
	Beam energy: 10 – 25 kV
	Beam current: 0.1 to 50 pA
Chamber	Internal dimensions: 280 × 280 × 260 mm (L × W × H)
	Plasma cleaner
	80 mm loadlock
	Customizable access door
	6 line of sight ports for options
	Time to transport sample: 3 minutes
Sample Stage	Motorized 5 axis eucentric stage
	x, y, z, r are all piezo driven
	Order of stage stracking (bottom to top): tilt, y, x, rotate, z
	Stage travel: x = 48 mm, y = 48 mm, z = 8 mm
	Rotation: 0 - 360°
	Tilt: 0 – 54°
	Coincidence point for gallium FIB option is nominally at 8 mm helium/neon beam working distance

Technical Specifications

Product Name	Description
Detector	Everhart Thornley Secondary Electron Detector
Source Cooling	Liquid nitrogen, on-board Dewar with computer controlled autofill
Vacuum System	Fully automatic, pneumatic column isolation valve
	Two 450 L/sec Mag-Lev turbomolecular pumps backed by oil-free and particle-free roughing pumps
	One 40 L/sec ion pump
	Ionization gauge for high vacuum measurement
	Pirani / Magnetron gauge for measurement of pressure in sample chamber
Camera	Camera for viewing sample position
Scan and Acquisition System	Image size: up to 2 k × 2 k pixels
	Dwell time: 100 ns – 100 ms
	64 k × 64 k DAC for beam positioning
	Auxiliary inputs for detectors
	External input for third party scan control
Charge Compensation	Low energy electron flood gun
	Line by line or frame by frame multiplexing
User Interface and Software	Advanced workflow based user interface on 64 bit Windows 7® operating system
	ZEN User Interface on 64 bit Windows 7® operating system
	Inbuilt Nanopatterning Capabilities
	Optional: Shuttle and Find for Correlative Workflows
	System Presets and Source Forming Wizards
	Region of analysis and image analysis functions including FFT, CFT (contrast transfer function), and Power Spectrum Function

Technical Specifications

Options	Description
Gallium FIB	Gallium Focused Ion Beam with Liquid Metal Ion Source (LMIS)
	Resolution: 3 nm @ 30 kV, 1 pA
	Beam energy: 1 – 30 kV
	Beam current: 1 pA – 100 nA
	Source life: 2000 µAh
Gas Injection System	Single needle gas injection system (GIS) with a choice of 3 precursor gases out of 6 (Pt, W, PMCPS (siloxane), TEOS, XeF_2, and water)
Nanopatterning and Visualization Engine (optional)	Dual Signal acquisition modules
	Nanopatterning and Visualization Engine Software
	Recipe builder
	Grayscale bitmap NanoPatterning
	Deflection lists
	Array builder
	Real time image processing & FFT
	Automated drift correction

Count on Service in the True Sense of the Word

Because the ZEISS microscope system is one of your most important tools, we make sure it is always ready to perform. What's more, we'll see to it that you are employing all the options that get the best from your microscope. You can choose from a range of service products, each delivered by highly qualified ZEISS specialists who will support you long beyond the purchase of your system. Our aim is to enable you to experience those special moments that inspire your work.

Repair. Maintain. Optimize.
Attain maximum uptime with your microscope. A ZEISS Protect Service Agreement lets you budget for operating costs, all the while reducing costly downtime and achieving the best results through the improved performance of your system. Choose from service agreements designed to give you a range of options and control levels. We'll work with you to select the service program that addresses your system needs and usage requirements, in line with your organization's standard practices.

Our service on-demand also brings you distinct advantages. ZEISS service staff will analyze issues at hand and resolve them – whether using remote maintenance software or working on site.

Enhance Your Microscope System.
Your ZEISS microscope system is designed for a variety of updates: open interfaces allow you to maintain a high technological level at all times. As a result you'll work more efficiently now, while extending the productive lifetime of your microscope as new update possibilities come on stream.

Profit from the optimized performance of your microscope system with services from ZEISS – now and for years to come.

>> www.zeiss.com/microservice

Carl Zeiss Microscopy GmbH
07745 Jena, Germany
microscopy@zeiss.com
www.zeiss.com/orion-nanofab