DISCOVER NEW HORIZONS IN NANO SCALE IMAGING

ZEISS ORION® PLUS

The revolutionary helium ion microscope for cutting edge imaging applications, providing ultra high resolution coupled with unique material contrast.

ZEISS

We make it visible.

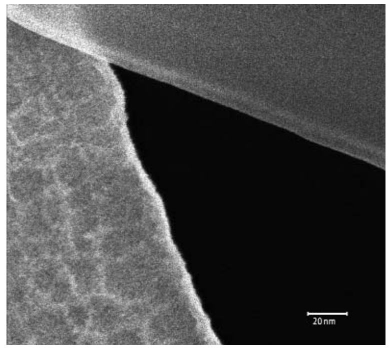
ORION® PLUS

See things you could never see before. Superior to scanning electron microscopes, the ORION® PLUS helium ion microscope delivers ultra-high resolution imaging with strong material contrast.

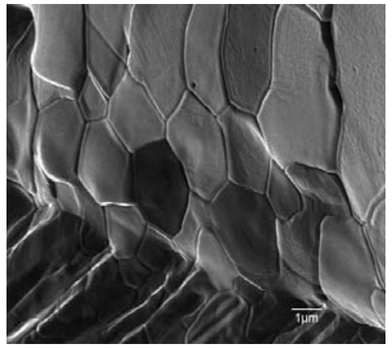
ORION® PLUS

World Record Resolution changes microscopy paradigm.

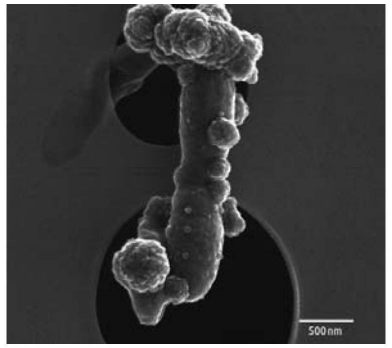
See a new world record resolution for any Scanning Ion/Electron Microscope. This resolution breakthrough of 0.24 nm was achieved on an asbestos sample on a holey carbon film and represents achievable performance of this machine on bulk samples.



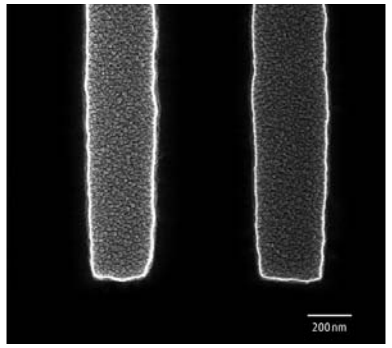
See material contrast like you've never seen before. With a higher, more varied secondary electron yield, your images are sharp, clear and bright.



See low-Z materials, like biological materials, with the resolution and surface information unavailable from a typical SEM.



See Chrome lines on quartz substrate demonstrating the ability to inspect and characterize highly charging samples at highest resolution.

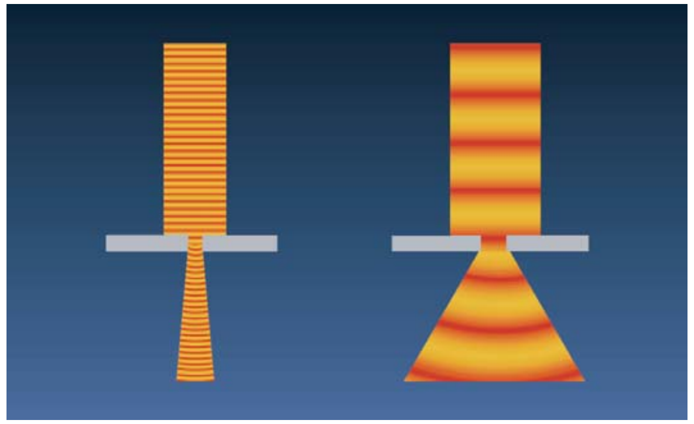


ORION® PLUS – powered by ZEISS ALIS Source Technology

Concept

The ZEISS ORION® PLUS microscope is based on the revolutionary, atomic-sized, ALIS gas field ion source.

Image of the atoms at the end of the source tip emitting helium ions. Since each atom can be individually seen, the virtual source size must be much smaller.



The helium ion beam has a DeBroglie wavelength that is approximately 300 times smaller than an electron beam resulting in much less diffraction.

The "Trimer"

The secret to the amazing resolving power of the helium ion beam starts with the source tip. 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 gas flowing over it. A high voltage is applied to the needle to produce an extremely high electric field at its apex. The helium gas is attracted to the energized tip where it is 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.

The Column

This ALIS source is mated with an advanced electrostatic ion column that focuses the beam with sub-nanometer precision. Much like a SEM, the beam is rastered across the sample pixel by pixel.

Imaging

The number of detected secondary electrons is used to determine the gray level of that particular pixel. Since the number of detected secondary electrons varies with material composition and shape, the images provide excellent topographic and compositional information.

Diffraction

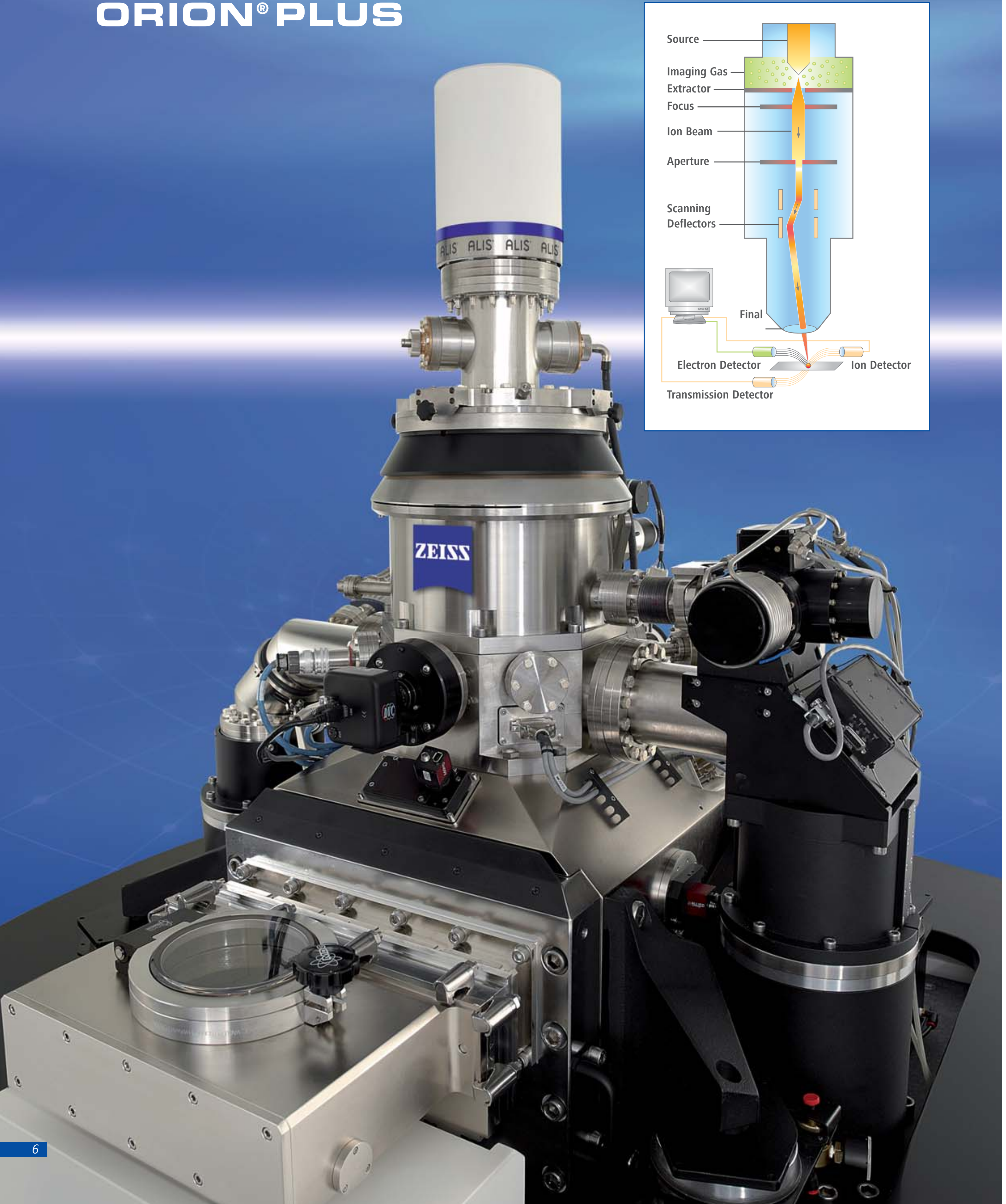
Helium ions are about 8000 times heavier than electrons. Because of this, a helium ion beam exhibits very little diffraction when passed through an aperture or across an edge. Diffraction is a significant problem for a SEM where the diffraction effect limits its ultimate spot size. Since the helium ion beam is not affected by diffraction, it can be focused to a much finer spot size, enabling sub-nanometer resolution.

Long Source Lifetime

The helium ion source has a very long lifetime due to the fact that the source tip is always kept at a positive potential. The only things attracted to the tip are electrons, which do not cause any ill effects. Positively charged ions are repelled from the tip and other gasses will be ionized before they have a chance to strike the source tip. For this reason, the source lifetime for the helium ion source is well over 1000 hours.

ORION® PLUS

ORION® PLUS



ORION® PLUS – Surface Interaction and Contrast

Beam Scattering

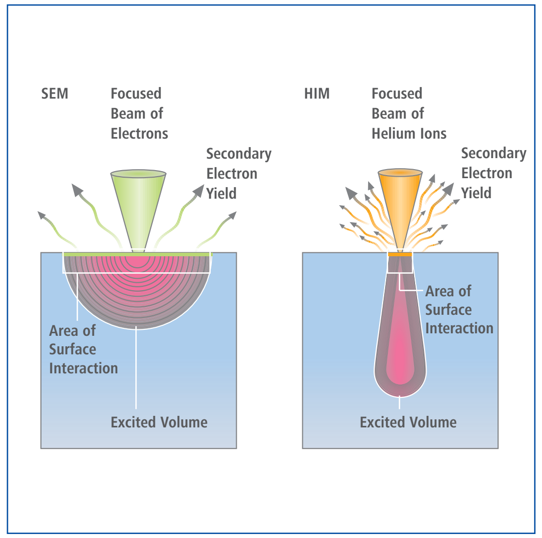
Imaging with charged particle beams – either electron or helium ion beams – is subject to a beam scattering effect. When the beam's primary particles strike the sample surface, they interact with the surrounding material, causing the emission of secondary electrons from an area that is somewhat larger than the size of the beam itself. The larger the area of surface interaction, the lower is the ultimate imaging resolution. Conversely, the smaller the area of surface interaction, the higher will be the ultimate image resolution.

In the case of a SEM, the beam's electrons are scattered rapidly in the sample, resulting in secondary electrons being emitted from an area many times larger than the beam itself. Fortunately, when the helium ion beam strikes 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.

Material Contrast

Although the area of surface interaction for the helium ion beam is relatively small – compared to a typical SEM, the total number of secondary electrons produced is greater. This larger secondary electron yield, and the large difference in yield between different materials, provides higher contrast imaging, making it easier to differentiate between materials with the helium ion microscope.

In addition, the helium ion microscope can collect backscattered helium ions, much like in Rutherford Backscattered Spectroscopy. With proper selection and positioning of the detector, the total backscattered ion yield is directly proportional to the mass of the sample atoms. Using this imaging mode, it is possible to easily differentiate between sample materials.



Material	Z	M(amu)	SE yield
Aluminum	13	27.0	5.31
Silicon	14	28.1	3.38
Titanium	22	47.9	4.65
Iron	26	55.8	4.55
Nickel	28	58.7	5.14
Copper	29	63.4	4.23
Indium	49	114.8	5.69
Tungsten	74	183.8	3.69
Rhenium	75	186.2	3.61
Platinum	78	195.1	8.85
Gold	79	197.0	5.17
Lead	82	207.2	5.57

ORION® PLUS – Unique Features

Since the ORION® was introduced, a number of new features have been developed that have further enhanced the image quality from the Helium Ion Microscope. The main ones are:

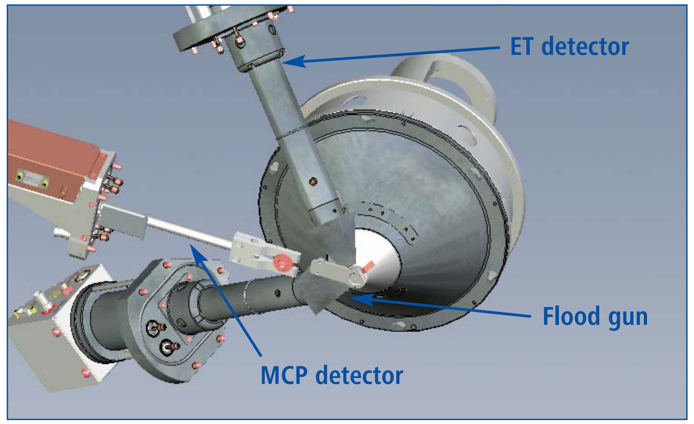
“Accelerating Voltage” – the tip geometry has been modified to increase the accelerating voltage of the helium ions resulting in improved resolution.

"Clear View" – a sample and chamber cleaning strategy which uses a combination of plasma cleaning and heating elements, effectively removing hydrocarbons from the sample and the environment and preventing re-deposition in the sample area. This results in images with increased surface detail and is ideal for semiconductor samples. This also reduces the need for external sample cleaners.

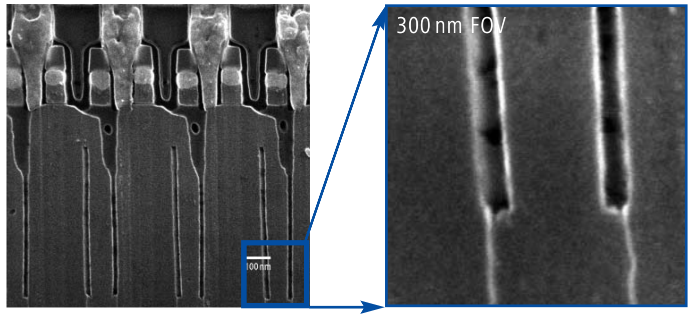
"Signal Boost" – enhances secondary electron collection at short working distances resulting inimproved signal to noise.

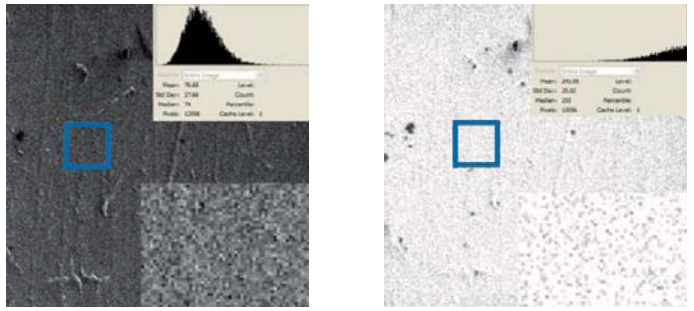
"Quiet Mode" Imaging – an improved LN2 cooling strategy minimizes noise contribution and allows higher sample throughput and improved ease-of-use. An additional benefit of this is the lower source temperature which results in an increase in brightness.

“Ease of Use” – software enhancements for increased ease of use.



Inside schematic of the ORION® PLUS work chamber showing the electron (ET) and ion (MCP) detectors, as well as the charge neutralizing flood gun. These features provide the different imaging modes and sample type flexibility that are designed into the microscope.





4x improvement in signal collection at 4mm working distance.

ORION® PLUS – Applications

Insulating Samples

The image at the right is of collagen fibrils from the knee joint of a mouse. The sample is insulating and high resolution imaging in SEMs is difficult without coating the sample. In the ORION® PLUS, charge compensation is performed with an electron flood gun which neutralizes the positive charge induced by the helium ion beam. The ORION® PLUS image clearly shows the bands which are 61 nm apart.

Low-Z Materials

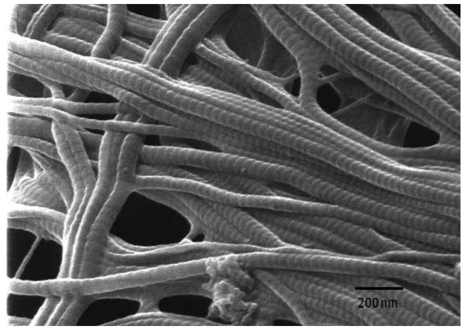
Many low-Z materials are challenging to image in a conventional SEM as the electrons tend to pass right through the substrate and fail to provide much useful imaging information. The more massive helium ions have greater stopping power in low-Z materials and provide copious amounts of useful secondary electrons for high contrast images such as the ones seen at right of carbon nanotubes.

Biological Materials

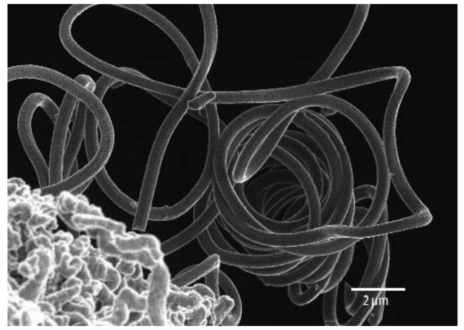
The ability to image samples prone to damage as well as bring out subtle changes in contrast make the ORION® PLUS an ideal tool for imaging biological samples. The image on the right shows Philipodia from Chinese Hamster Ovary cells highlighting the ORION® PLUS' ability to preserve the structural integrity of delicate frameworks while creating a high contrast image.

Superior Material Contrast

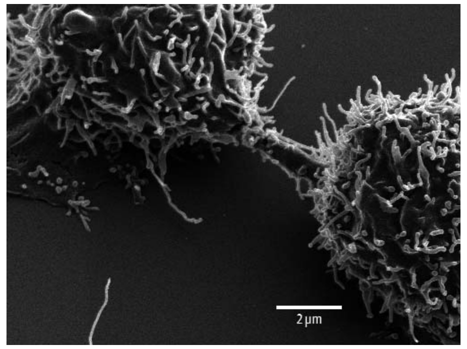
The helium ion ORION® PLUS microscope has unsurpassed material contrast. The image on the right of a flash memory cell shows clear differentiation between the various layers highlighting the surface sensitivity of the ORION® PLUS at a high magnification.



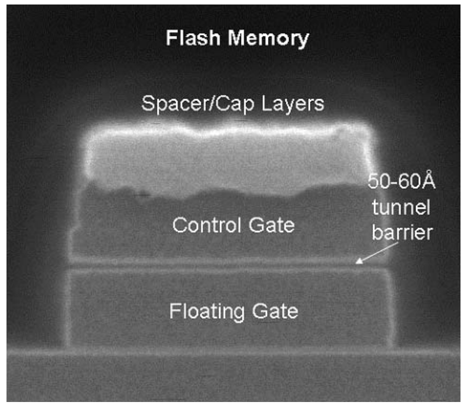
Collagen fibers from the knee joint of a mouse. The banding in the fibers is clearly seen. The charge neutralizing flood gun available in the ORION® PLUS allows for stable imaging. Imaging in collaboration with Dr. Claus Burkhardt, NMI (Stuttgart, Germany)



Sample courtesy of Dr. Brendan Griffin, University of Western Australia.



Sample courtesy of NMI.

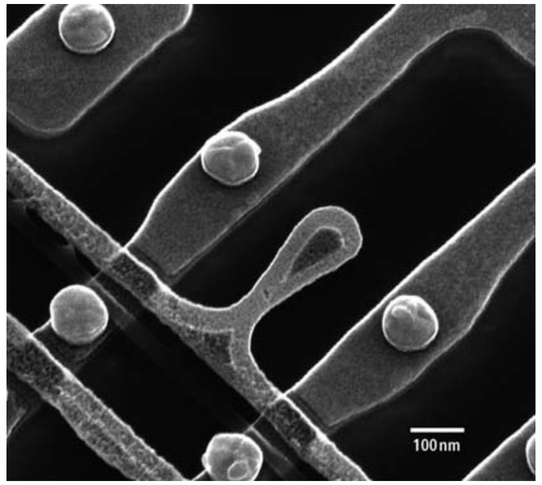


Sample courtesy of Chipworks.

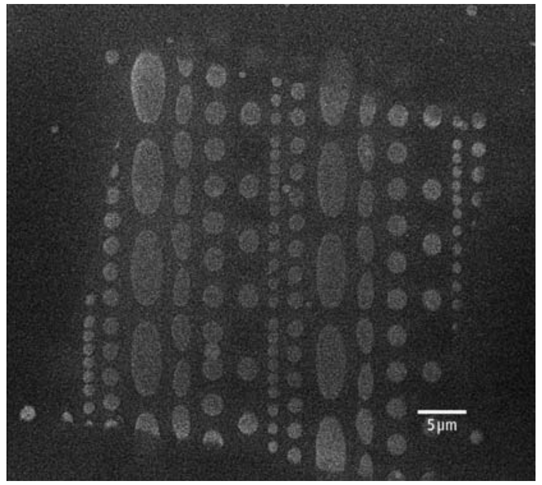
ORION® PLUS – Applications

Semiconductor Applications

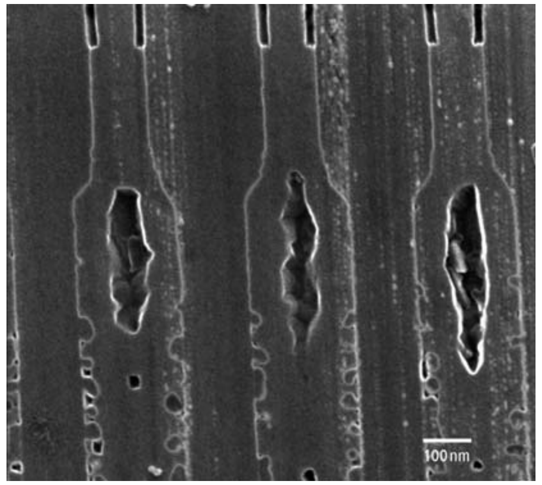
The ORION® PLUS provides unique contrast mechanisms which make it the tool of choice for semiconductor applications. In addition to fine surface detail, the ORION® PLUS can image dopant profile without any additional sample preparation. Further, the strong material contrast shows interface layers a few nm thick in stunning detail.



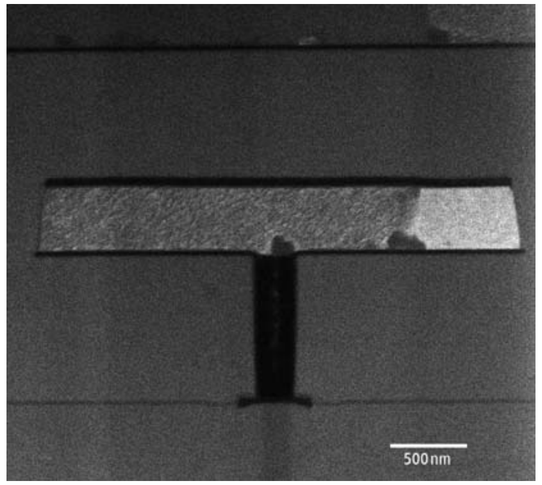
Deprocessed 65 nm CMOS SRAM device at the contact level highlighting the material contrast, surface sensitivity, and topographic detail obtained in the ORION® PLUS.



Patterned NBPT self assembled monolayer on gold. An ebeam stencil mask converted the terminal group of the exposed from a nitrate group to an amine. This alteration is invisible to the SEM but is captured clearly in ORION® PLUS.
Sample courtesy of University of Bielefeld (Germany)



The articulation of the dielectric barrier (high performance insulator) seen lining this DRAM trench attests to the strength of ORION® PLUS when spotlighting contrast between materials.
Sample courtesy of Infineon.

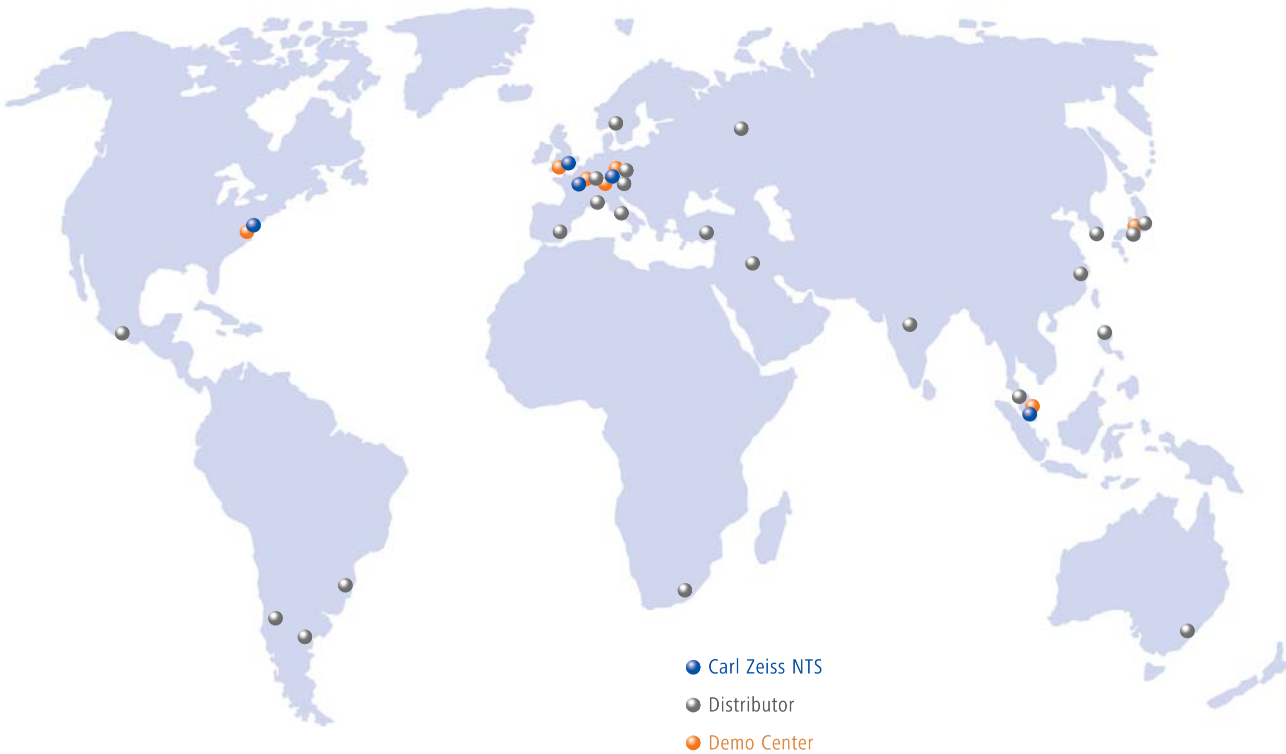


Transmission mode imaging of an IC device on the ORION® PLUS shows the aluminum metal line with its Titanium-Tungsten liners and Tungsten via. The image reveals the aluminum grain structure as well as Micro-structure defects in the core of the Tungsten plug.
Sample courtesy of Fraunhofer Institute, Halle.

Technical Data

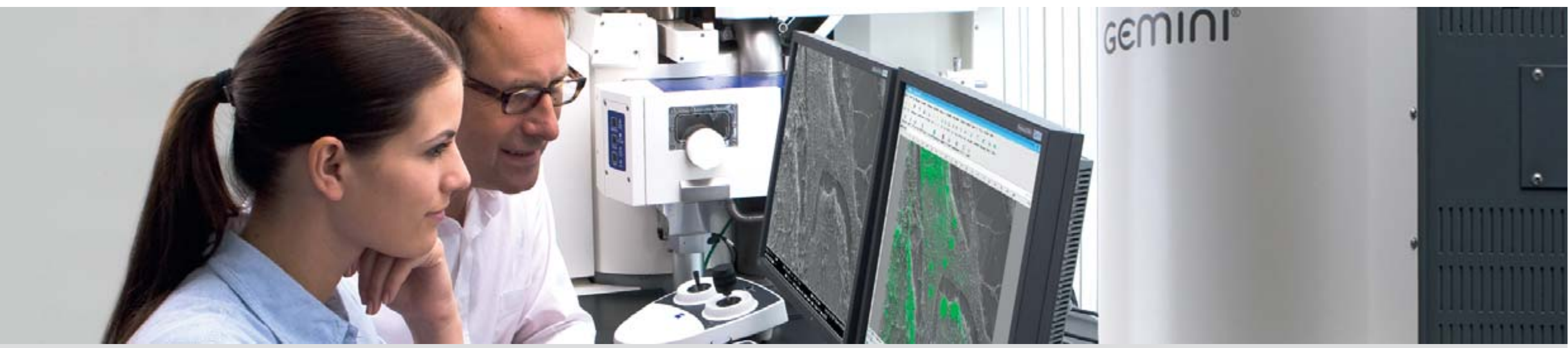
ORION® PLUS Essential Specifications	
Resolution (Probe Size)	≤ 0.35 nm
Accelerating Voltage	10 kV – 35 kV ± 5 kV
Magnification	100 x – 1,000,000 x
Field of View	1 mm – 100 nm
Probe Current	Range: 1 fA – 100 pA
Ion Source	ALIS Gas Field Ion Source
Process Chamber	Volume 400 mm^3 Base Vacuum 8×10^{-7} Torr Customizable port plate Loadlock: Integrated Plasma Cleaner
Image Detectors	Everhart-Thornley Microchannel Plate Solid-state energy resolving backscattered Helium detector
Sample Stage	5-axis motorized stage, 50 mm travel in X and Y, 12 mm Z, 360°, 0° to 45°tilt
Vacuum System	300 L/sec Mag-Lev turbomolecular pumps backed with oil and particle free roughing pumps
Video Cameras	Two video monitoring cameras – Source View and Chamber View
User Interface	Intel® Quad Core Processor 4GB DDR3 memory Two 160GB hard drives Two 20" flat screen displays

Global Sales and Service Network



Would you like to have a product demonstration? Are you looking for application support? Please do not hesitate to contact us for an appointment to visit one of our superbly equipped demo centers. You can find us in the following locations: Germany (Dresden and Oberkochen), USA (Peabody), France (Nanterre), UK (Cambridge), Japan (Yokohama) and in Singapore. We look forward to seeing you! You can find an overview with contact details online at www.zeiss.com/democenter

For more information please visit us at www.zeiss.com/nts



Carl Zeiss NTS GmbH
Carl-Zeiss-Str. 56
73447 Oberkochen,
Germany
Tel. +49 73 64 / 20 44 88
Fax +49 73 64 / 20 43 43
info@nts.zeiss.com

Carl Zeiss NTS Ltd.
511 Coldhams Lane
Cambridge CB1 3JS,
UK
Tel. +44 12 23 41 41 66
Fax +44 12 23 41 27 76
info-uk@nts.zeiss.com

Carl Zeiss NTS, LLC
One Corporation Way
Peabody, MA 01960,
USA
Tel. +1 978 / 826 1500
Fax +1 978 / 532 5696
info-usa@nts.zeiss.com

Carl Zeiss NTS S.a.s.
Zone d'Activité des Peupliers
27, rue des Peupliers - Bâtiment A
92000 Nanterre,
France
Tel. +33 1 41 39 92 10
Fax +33 1 41 39 92 29
info-fr@nts.zeiss.com

Carl Zeiss NTS Pte. Ltd.
50 Kaki Bukit Place #04-01
Singapore 415926
Singapore
Tel. +65 65 67 / 30 11
Fax +65 65 67 / 51 31
info.sea@nts.zeiss.com