Imaging with Long Depth of Field

Application Note

Author: Larry Scipioni
Date: November 2008

Application

Imaging non-planar objects such as MEMS devices, cellular material, nanoparticles or nanowires, or tilted surfaces.

ORION® PLUS Capabilities

Provision of a long depth of field with high spatial resolution, even at very high magnification.

Background

It is often necessary to do microscopic analysis on non-planar objects. It is common, for example, to image large particles or conglomerates on a substrate, where one wishes to learn about the particles and their interaction with the substrate. It may be desired to analyze elongated shapes such as nanowires or carbon nanotubes, particularly those which are not lying parallel to their supporting substrate. Sometimes a planar surface such a cross section needs to be investigated with the face of interest at an angle to the incoming beam, such as with FIB exposed cross sections.

Challenge

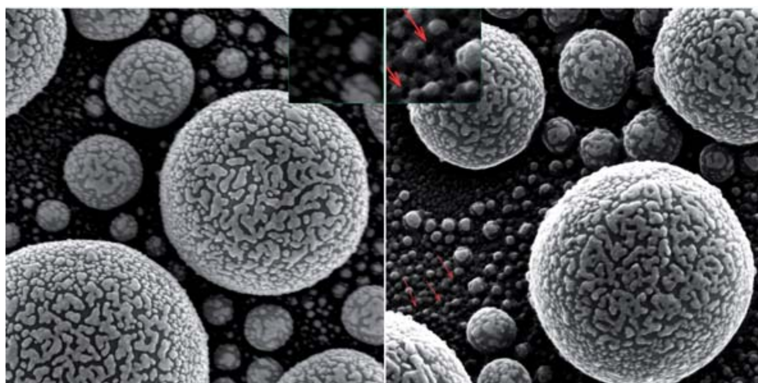
In examples such as those above, the beam cannot be in perfect focus at all heights. This leads the microscopist to have to choose which plane to image sharply. This is not acceptable in cases where information from all regions of the sample is necessary to interpret the situation accurately.

ORION® PLUS Solution

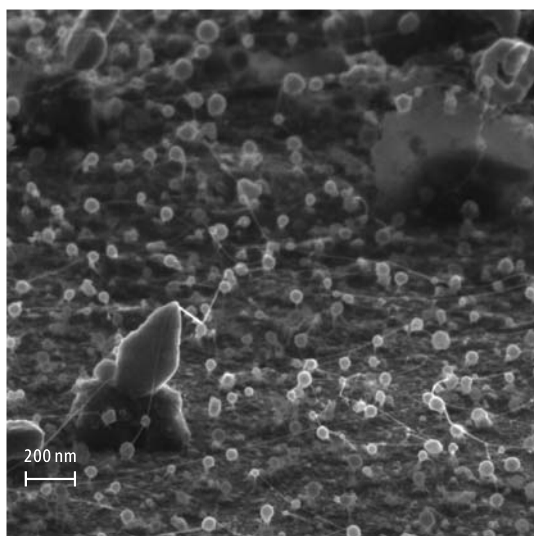
The ion optical column in the helium ion microscope is run at a smaller demagnification than a typical SEM. This is possible because the ion source is extremely small. Thus the depth of field, being inversely proportional to the convergence angle, can be five to ten times longer in the ORION® PLUS. This allows foreground and background objects to be in good focus simultaneously. An example of this is seen in the image montage below. Here we compare the imaging of gold nano-islands on tin spheres on a carbon substrate. The SEM image has good focus for the tops of the spheres, but the edges – and even more so the substrate – are blurred. The ORION® PLUS image appears in focus at all heights allowing all the information to be captured at once. In fact, it is possible to see the many small pinholes that exist in the carbon substrate. A few of these are highlighted by the arrows in the image and the distinct advantage revealed more clearly in the comparative magnified insets.
An additional example of this depth of field benefit is the ability to look at highly slanted surfaces, as is seen in the second image below. In this sample it was discovered that single-walled carbon nanotubes grew suspended above the substrate by the network of catalyst particles. It was of interest, then, to view the sample at a very high tilt

We make it visible.

angle. The image was captured with the beam impingent 70 degrees from normal, yet one can observe the nanotubes from the foreground deep into the background, contacting just the very top of each catalyst particle. This type of sample information is ascertained much more readily due to the long depth of field provided by the ORION® PLUS image.



Comparison of SEM image (left) to ORION® PLUS image (right).
The field of view in each frame is approximately 2 µm.
Images courtesy of Dr. Andras Vladar, NIST (Gaithersburg, MD).



Carbon nanotubes suspended on catalyst particles.
Sample courtesy of Dr. Harvey Rutt, University of Southampton (UK).

Maximum Information – Maximum Insight

More than 160 years of experience in optics has laid the foundation for pioneering electron and ion beam microscopes from Carl Zeiss. Superior integration of imaging and analytical capabilities provides information beyond resolution, unlocking the best kept secrets of your sample.

With a broad technology portfolio Carl Zeiss provides instruments both tailored to your requirements and adaptable to your evolving needs. With our highly versatile application solutions we endeavor to be your partner of choice.

Superbly equipped, regional demo centers provide you with access to our applications expertise developed in collaboration with world-class partners in industry and academia. Global customer support is provided by the Carl Zeiss Group together with an extensive network of authorized dealers.

Our mission at all times: Maximum Information – Maximum Insight.

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, 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 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

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 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

www.zeiss.com/nts

We make it visible.

Due to a policy of continuous development, we reserve the right to change specifications without notice. Version 01-11 © by Carl Zeiss NTS, Oberkochen