Imaging with Long Depth of Field

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.
angle. The image was captured with the beam impinging 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.

Global Solution Provider
The Nano Technology Systems Division of Carl Zeiss SMT provides its customers with complete solutions featuring the latest leading-edge EM technology. The company’s extensive know-how, meticulously acquired over 60 years in the field of e-beam technology, has brought many pioneering innovations to the market. Our global applications and service network ensure fast, reliable and high quality support sharply focused on customer requirements. Combined with dedicated upgrade strategies, this will protect your investment for its entire lifetime. The core technology embedded in our innovative products enables us to provide solutions which add value to our customers’ businesses.

Customer feedback is always welcomed and gathered by collecting valuable information at trade shows, in workshops, in user meetings and upon instrument installation. The Division’s business services also include outstanding support from sales consultancy to technical service options even when the warranty has expired.