TECH SPOTLIGHT

BENCHTOP SEM

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The optical microscope is an indispensable imaging instrument, but the ability to clearly observe fine details at a large depth of field is possible only with the scanning electron microscope. The SEM has ten times the resolving power and 20 to 300 times more depth of field than the optical or light microscope. Commercialized in the 1960s, the SEM has helped researchers explore new frontiers in nature and materials, and more recently has propelled scientists into the world of nanotechnology, where imaging of structures smaller than five nanometers is routine.

In parallel, today's optical microscopes now include advanced compound optics and digital imaging techniques that far surpass the optical microscopes of even a decade ago. However, the magnification range of the most advanced optical microscope still extends only to slightly over 1000X. Furthermore, the depth of field limits the focal area to just a few microns.

This article introduces the NeoScope, a benchtop SEM that can take a specimen prepared for an optical microscope and image it without further preparation. In this way, the microscopist can be sure that the optical microscope and the SEM have examined the specimen in the same condition.

Complementary imaging

Until now, these two specialized areas of imaging overlapped very little, as each had clearly defined areas of application. A sample was either observed under the optical microscope or imaged in the scanning electron microscope. The SEM is a much larger, more expensive instrument than an optical microscope, and to exploit its advanced capabilities an operator typically requires specific training.

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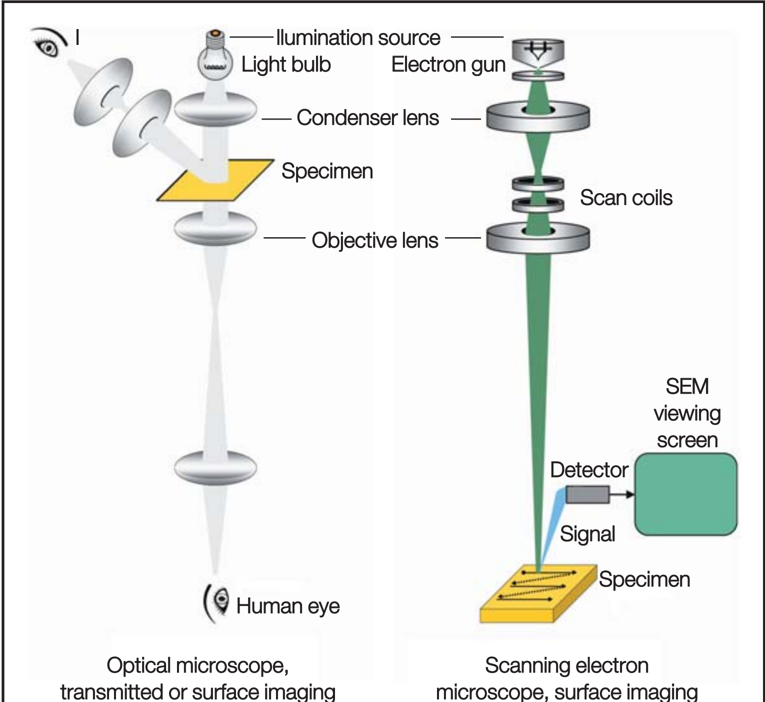
However, the benchtop SEM is easy to learn and allows rapid, detailed imaging at a high depth of field. It also has appeal for the experienced SEM operator, with some of the functionality only a SEM could offer, including choices for settings that can help with pre-screening of biological and composite specimens.

The benchtop scanning electron microscope combines the power of electron optics with the ease of use of a digital light microscope, with about the same footprint as the OM. The benchtop SEM complements optical microscopes by allowing the light microscopist to further investigate the very same samples with much higher depth of field and resolution.

When the scanning electron beam has a very fine spot size, the benchtop SEM reveals intricate details at ultrahigh resolution, yet it is simple enough for any non-SEM user to operate. For the experienced SEM user, such an instrument can fill the void between high-end imaging and digital light microscopy. Its compact size and simplicity, combined with its versatility, make it an ideal pre-screening instrument.

Selectable settings for the NeoScope benchtop SEM include accelerating voltage, vacuum mode, and secondary or backscattered electron imaging. However, it acts as a simple point-and-shoot device with pre-set parameters in recipe format. Automatic settings for focus, contrast, and brightness, enable images with outstanding resolution and large depth of field across the magnification range. Operation is as simple as inserting the sample, pumping the chamber, and selecting the magnification.

Because the SEM's electron beam is stable only under vacuum, the specimen must be observed



This simplified diagram shows the difference between the optical (or light) microscope and the scanning electron microscope.

This is a poppy seed, as seen through an optical microscope (left) and a scanning electron microscope (right).

Limit of Resolving Power	Object Size	Object	Magnification
Human Eye	10 mm	Ant	1X
	1 mm	Tick	1X
Optical Microscope	100 µm	Butterfly Scales Pollen	1X
	10 µm	Red Blood Cells	10X
	1 µm	Bacteria	100X
Scanning Electron Microscope	100 nm	Virus	1,000X
	10 nm	Molecules (Not directly viewable)	10,000X
Transmission Electron Microscope	1 nm	Atoms	100,000X
	0.1 nm	(Atomic Structure of Materials Viewable in TEM)	1,000,000X

in vacuum. The instrument allows a choice of high-vacuum and low-vacuum operation, depending on the nature of the specimen. Liquids cannot be observed in a SEM, but solids of all kinds can be. Hydrous samples such as biological tissues, plants, or insects, or specimens containing oils, or nonconducting samples, can be observed via the low-vacuum setting. All other samples can be observed in high vacuum for the finest surface detail. Furthermore, no special preparation of samples, i.e. coating or drying, is required.

Accelerating voltages

For the novice, it's easy to simply shoot an image of a sample using a pre-stored parameter or recipe file. The accelerating voltage is automatically applied to the electrons emitted from the electron gun to irradiate the specimen. When the specimen is irradiated with an electron beam, signals are generated and sent to the imaging screen.

For the microscopist who wants or needs to experiment with the image quality, three accelerating voltage settings are available. Selectable accelerating voltages of 5, 10, and 15 kV allow the user to see varied levels of surface details as a result of differing penetration depths.

Imaging of electrons

Traditional and more powerful SEMs offer multiple signals and analytical capabilities suited to advanced characterization and observation. The benchtop SEM becomes more useful with a choice of the two most common types of signals.

The most common type of imaging in any kind of SEM is the secondary-electron image. It produces high-quality, high-resolution, high-depth-of-field topographical imaging. In the NeoScope, the secondary electron image quality, with the depth of field possible only in the SEM, allows image capture across the full 10X to 20,000X magnification range, without adjustment or changing lenses. A wide area of view makes it easy to find and correlate the imaging areas from the optical microscope.

Backscattered electron imaging enhances the compositional contrast and is another simple procedure. By producing a signal from deeper layers of the specimen surface, it enables the microscopist to clearly distinguish compositional differences.

The simple user interface is as familiar as the controls on a digital camera. In minutes, the new user can be trained to operate basic imaging functions. The NeoScope eliminates any confusion about placing a sample in the vacuum chamber. Because no coating or drying of the samples is required, operation is very straightforward and, once the sample is loaded on the stage, is automatic. On the other hand, it offers the experienced SEM user more than a novel instrument with simple functions. The JEOL electron optics provide enough flexibility to allow several basic imaging techniques with a few simple controls.

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