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Enhancements CD

The scanning electron microscope (SEM) permits the observation and characterization of heterogeneous organic and inorganic materials on a nanometer (nm) to micrometer (μm) scale. The popularity of the SEM stems from its capability of obtaining three-dimensional-like images of the surfaces of a very wide range of materials. SEM images are used in a wide variety of media from scientific journals to popular magazines to the movies. Although the major use of the SEM is to obtain topographic images in the magnification range 10–10,000 \times , the SEM is much more versatile, as we shall now see.

In the SEM, the area to be examined or the microvolume to be analyzed is irradiated with a finely focused electron beam, which may be swept in a raster across the surface of the specimen to form images or may be static to obtain an analysis at one position. The types of signals produced from the interaction of the electron beam with the sample include secondary electrons, back-scattered electrons, characteristic x-rays, and other photons of various energies. These signals are obtained from specific emission regions within the sample and can be used to examine many characteristics of the sample (surface topography, crystallography, composition, etc.).

The imaging signals of greatest interest are the secondary and back-scattered electrons because these vary primarily as a result of differences in surface topography. The secondary electron emission, confined to a very small volume near the beam impact area for certain choices of the beam energy, permits images to be obtained at a resolution approximating that of the focused electron beam. The three-dimensional appearance of the images is due to the large depth of field of the scanning electron microscope as well as to the shadow relief effect of the secondary and back-scattered electron contrast.

In the SEM, characteristic x-rays are also analyzed as a result of electron bombardment. The analysis of the characteristic x-radiation emitted from regions can yield both qualitative identification and quantitative elemental information from regions of a specimen as small as 1 μm in diameter and