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Introduction to the Capabilities and Applications of the World's Largest Chamber Scanning Electron Microscope

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The Y-12 National Security Complex in Oak Ridge, TN has recently purchased a new large chamber scanning electron microscope (LC-SEM), manufactured by VisiTec, that has the largest chamber in the world at eight cubic meters. The instrument can examine specimens measuring up to 1-m in diameter by 1-m tall and weighing as much as 300-kg. This microscope provides high resolution images at magnifications from 10x to 200,000x, while using a mobile column that moves in conjunction with the sample on a six-axis positioning system. Now large parts such as diesel engines, automobile wheels, and turbine blades can be examined without having to destroy the part by cutting a small section for the conventional SEM.

Not only can this new instrument examine the physical characteristics of large parts, it can also evaluate the chemical properties of the material. Unlike most conventional SEM's that only have one or two associated analytical tools, the new LC-SEM is unique in that it has a variety of analytical tools designed for nondestructive evaluation. The LC-SEM is equipped with a Backscatter Detector, Energy Dispersive X-ray Spectrometry (EDS), Electron Backscatter Diffraction (EBSD), and Fourier Transform Infrared Spectrometry (FT-IR). The LC-SEM will soon be equipped with Secondary Ion Mass Spectrometry (SIMS), which will essentially enable the characterization of every element from hydrogen to uranium. The LC-SEM is also equipped with a Focused Ion Beam (FIB) for ion milling, surface preparation, and 3-D reconstruction for defect modeling. The instrument's variable-pressure option adds yet another degree of freedom and enables researchers to perform critical surface characterization studies on both conductive and non-conductive surfaces, such as steels and ceramics.

This LC-SEM is a one-stop examination and analytical tool for almost any sample, ranging in size from a grain of sand to a diesel engine. A cracked sample can be fully examined with only one instrument, without cutting the sample and introducing new anomalies to the microstructure. In minutes the researcher has a high resolution topographical image, an elemental compositional image, spectrometry analysis of the elemental composition, and a 3-D reconstruction showing the depth and shape of the crack.

This microscope is ideal for the examination of large pieces that are difficult to section, or for parts that have defects that are too large to isolate in a conventional SEM sample size. One-of-a-kind prototypes and expensive items, due to costly material or detailed machining, are easily examined in the LC-SEM without the fear of destroying the unique samples. Prehistoric bones and fossils, as well as artifacts from ancient civilizations can be further examined without losing a valuable part of the past.

The capabilities of this microscope provide countless opportunities in a variety of applications. The Y-12 LC-SEM Team has been working with numerous customers and projects, and they are finding new applications and opening new possibilities with each passing week.

Fig. 1. The LC-SEM operator works at the control station while a V-6 engine block sits in the chamber ready to be examined.

Fig. 2. A V-6 engine block in the LC-SEM with the column and backscatter detector positioned above.

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