C6 Scanning Electron Microscopy — Back to Basics

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After attending this presentation, attendees will gain insight into the importance of SEM detector geometries and their impact on data produced by a Scanning Electron Microscopy-Energy Dispersive X-ray Spectrometry (SEM-EDS) system.

This presentation will impact the forensic science community by demonstrating basic SEM-EDS detector geometries and showing how errors in Energy Dispersive X-ray Spectrometry (EDS) spectral acquisition can be avoided.

Scanning Electron Microscopy (SEM) became commercially available around 1965. Many improvements have been made since the early commercial instruments, allowing the SEM to have a presence in many laboratories and classrooms that use and study materials. Adding EDS to the SEM allows the user to quickly obtain the elemental composition of a material. Due to the advances in SEM-EDS hardware and software, very little instruction is typically required to train an individual in the operation of an SEM-EDS system. In fact, SEM-EDS is probably the easiest microscope to use in the laboratory.

Most of the operations for sample chamber evacuation, electron gun alignment, focusing, image contrast and brightness adjustment, and EDS data acquisition have become automated, requiring only the press of a button. Images and EDS spectra, once obtained, can be dropped into word processing, spreadsheet, or presentation software with a simple click and drag of a mouse…or the touch and drag of the “touch screen” that dominates today’s telephones and tablets. Data acquisition using an SEM-EDS system has progressed to the point where the user, or the “human” interface, has become the slowest interface in the SEM-EDS system. Software algorithms have been and are being produced to analyze tremendous amounts of data that can perform iterative queries and produce groups of elements or show associations of elements (phases) during an SEM-EDS analysis that may otherwise be overlooked by the human interface. All of the automation, software, and user interfaces that have been designed to aid the microscopist in his (or her) analysis of a given material are both useful and welcome. The basic geometry of SEM-EDS systems and the electron beam-specimen interactions remain relatively unchanged with the low vacuum capability of modern SEM-EDS systems being but one exception.

SOPs and recipes have put the SEM-EDS within the reach of even the most novice user. These management tools enable laboratories to train individuals and replace individuals quickly so the laboratory remains productive. Unfortunately, no SOP or recipe, no matter how thoroughly written, can guarantee that the data produced is reliable. Fundamental concepts and knowledge of the basic geometry of the SEM-EDS system is essential to ensure the data produced is reliable. A useful approach to understanding the basic detector geometry of any SEM-EDS system is to think of the SEM imaging monitor as a clock face. Locate the EDS detector on the clock face by inspecting the exterior of the microscope chamber and determine where the EDS detector is. Is the EDS detector at 10 o’clock? Is it at 12 o’clock? Locate the secondary electron detector and any other detectors that are part of the SEM-EDS system. Knowing this information will help in assessing any elemental data produced when un-even non-flat specimens, also called “everyday specimens,” are analyzed. The interaction of the primary electron beam with the sample and the line-of-site trajectory of the X-rays produced can affect the quality and reliability of any EDS data produced. Examples of EDS data produced from specimens that are analyzed by SEM-EDS will demonstrate the effects of low vacuum, non-flat specimens resulting in X-ray fluorescence and absorption and general, basic SEM-EDS practices that will aid the SEM-EDS user in the analysis of everyday specimens.

SEM-EDS, Low-Vacuum, Elemental Analysis