Winning the Hospitality Claim using Scanning Electron Microscopy (SEM) with Energy Dispersive Spectroscopy (EDS)

Scanning electron microscope (SEM) uses a focused beam of electrons to generate a variety of signals from the surface of a sample. Using special detectors, those signals can be captured and used to characterize the nature of object being analyzed. If one considers the electron gun to be analogous with the sun, and the detectors analogous to your eyes, the physics is similar. The electron beam travels from the gun—similarly to light traveling from the sun—and strikes the surface of the object being analyzed. The detector—in reality, the eye is merely a special detector designed to receive light—then captures the electrons or other emissions from the beam/surface interaction and converts that to an image of the surface.

There are two major advantages of using an SEM over an optical microscope: depth of field and resolution. Due to the physics of how the electron beam interacts with the object being analyzed, the depth of field within an SEM is orders of magnitude higher that an optical microscope. Depth of field is how much of a three-dimensional object can be in focus at the same time. In any type of microscopy, as magnification goes up, the depth of field goes down, but an SEM will allow one to observe clearly the entire object of interest at a much higher magnification than optically. Also, the size of the electron beam is much smaller than the wavelength of visible light, so the electron microscope can resolve images several orders of magnitude higher than an optical microscope. Whereas an optical microscope loses its usefulness somewhere around 150 times magnification, an SEM can resolve surface features as high as 50,000 times magnification.

In addition to imaging, SEM's typically have another detector attached to the sample chamber, called an energy dispersive spectrometer. Energy dispersive spectroscopy (EDS) is an analytical technique that detects the x-rays generated by the electron beam/sample interaction and converts that data into information about the elements present in the surface of the sample.

Why is this important? What benefits does it provide the analyst? Why do we use these high-powered, expensive tools? These are important questions.

As an engineer or scientist hired to determine why something broke, allegedly malfunctioned, deteriorated, or just didn't do what it was supposed to do, we use all the tools at our disposal to gather as much information as possible. An SEM/EDS system is just another tool in the toolbox, albeit an extremely powerful one.

For instance, a claimant purchases a pizza from a local pizzeria and takes it home for dinner. The claimant alleges that he found metal particles in his pizza and after feeling ill, went to the emergency room. X-rays revealed a small piece of metal in the digestive tract and removed it. The claimant's attorney demanded significant reparations be made to his client. The particles retained by the claimant were analyzed using SEM/EDS and it was determined that the small metal particles were pieces of galvanized sheet steel that had been snipped off or drilled out of the sheet. In addition, the EDS analysis revealed that the surface was zinc, with an iron core, consistent with galvanized steel. By examining the particles at high magnification, the analyst was able to determine that these particles were not from any source within the pizzeria. Further investigation revealed that the claimant was an HVAC contractor and that while installing heating systems, he often drilled or snipped galvanized sheet steel. The particles in question most likely fell onto the pizza from his clothing. The claim was denied.

SEM's, equipped with EDS systems, are powerful tools that failure analysts and engineers use to determine "why." Be it a broken bolt on a railing that caused a fall or the rusting of the window, the particles found in food or the ruptured water line, these tools allow the analyst to "see" the microscopic evidence of what really happened.