Compact Tabletop Imaging and Analysis Workflows – A Multidimensional Approach

The advent of new technologies and materials with specific properties designed and manifested at the sub-micron scale has ushered in an increased need to equip characterization labs with innovative -- yet compact -- scanning electron microscopy (SEM) and microanalysis (EDS or XRF) setups. The purpose of such a resource is to provide, in most cases, an easy-to-use platform that will serve as an initial step in materials characterization workflow. This SEM/EDS resource will perform full characterization of a specimen, requiring a high level of performance in terms of resolution, complimentary analytical detectors, and software for comprehensive analysis.

Scanning electron microscopes are considered to be one of the most versatile and powerful tools for scientists because of their large depth of field (in comparison to optical microscopes), great spatial resolution (high magnification), and the capacity for chemical composition analysis via several types of spectroscopy. Visualization of specimen topography, microstructure, or establishing the cause of failure is achieved easily through a single image in some cases. Yet, it is often necessary to set up a multidimensional approach to be able to answer questions about material properties that will steer future technological progress.

In such cases SEM provides unparalleled flexibility through the addition of an assortment of electrical, mechanical, and chemical test equipment making the instrument a self-contained 'nano-laboratory.' The JEOL tabletop SEM workflows enable new and more flexible approaches to the analysis of various types of materials, such as semiconductors, powders for additive manufacturing, and polymers, as well as unique approaches to 3D analysis in SEM.

From Macro to Nano – Seamless Navigation and Cross-Referencing

One of the requirements vital to researchers is the ability to connect microstructural defects or features to its micro and nanostructural properties. This could be key to understanding and improving upon the current material design. This new feature, ZEROMAG, enables the user to take a snapshot of the specimen (an optical image) prior to SEM observation, and then maneuver to a region of interest based on this image.

The user can magnify the area to the requisite feature size and observe and chemically analyze the location with the SEM while retaining the optical image tag (see Fig. 1). This is remarkably useful for the observation of multiple specimens or multiple locations on the same specimen.

Figure 1. Linking optical image to SEM imaging and analysis via ZEROMAG function, showing multiple samples in position.

Real-time, Embedded Chemical Analysis with SEM

Neoscope is a tabletop SEM that features a fully embedded and integrated Energy Dispersive X-Ray Spectroscopy (EDS) system that can tag specific locations with chemical analysis and offer real-time compositional data (point analysis or mapping) and spatial distribution of components at the micro and nanometer scale as the multiple samples or locations on the specimen are scanned.

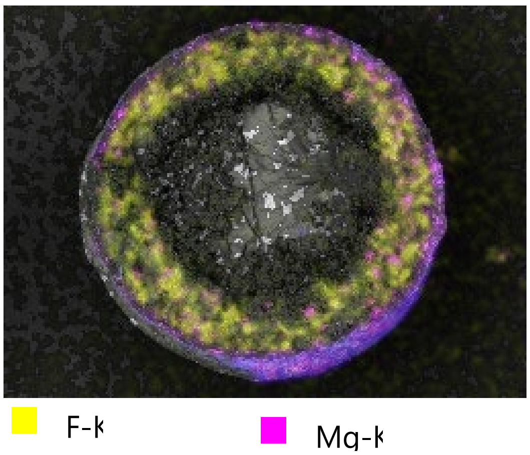
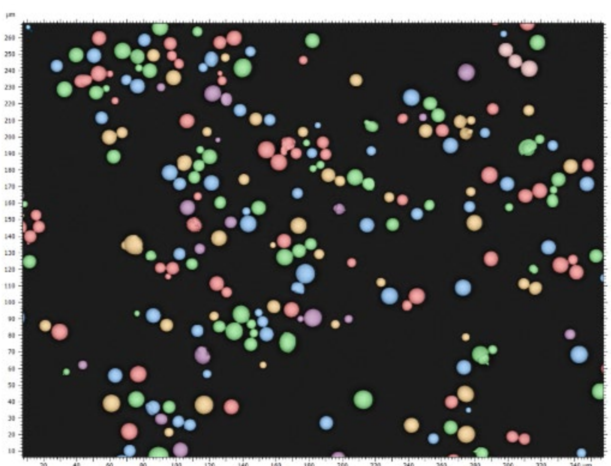


Figure 2: *EDS Map - Pharma API for Drug Delivery*

Particle and Fiber Analysis

SEM is well suited to perform particle and fiber analysis by providing a high-resolution view of the sample's surface morphology and details on sizes and shapes. Integrated Energy Dispersive X-ray Spectroscopy (EDS) further allows the SEM to classify particles by their chemical type. To streamline this process, automation workflows are available for fast throughput and unattended operation. This enhances existing inspection capabilities in areas like automotive cleanliness, additive manufacturing, pharma, and energy.



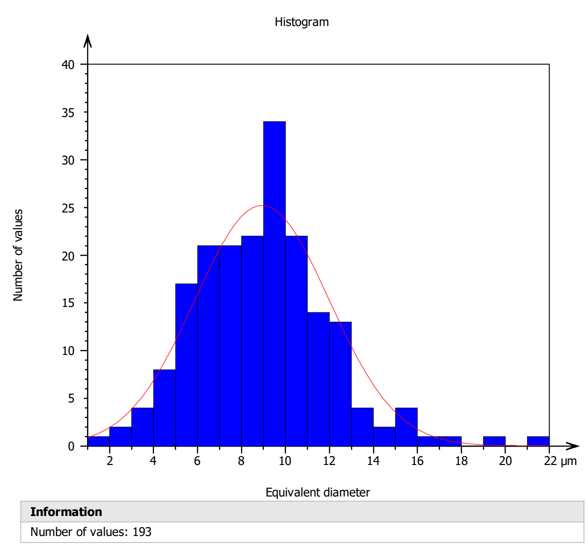


Figure 3: *Particle Morphology for Additive Manufacturing*

3D Analysis of Surfaces

Long depth of field related to SEM imaging has conventionally appealed to the researchers because of the fundamental ability to generate a more three-dimensional representation of the specimen surface in contrast to optical microscopy. There has been a concerted effort recently to take this capability even further, with various software and hardware solutions that provide not only qualitative but also a quantitative representation of the 3D nature of specimen surfaces.

The proposed solutions range from simple composites of two or more stereo pair images (easily acquired through tilt series) to the actual redesign of detectors to obtain several images synchronously and merge those images to create a LIVE 3D representation of the specimen surface (Fig. 2) that can be easily tilted, rotated, and manipulated by the user.

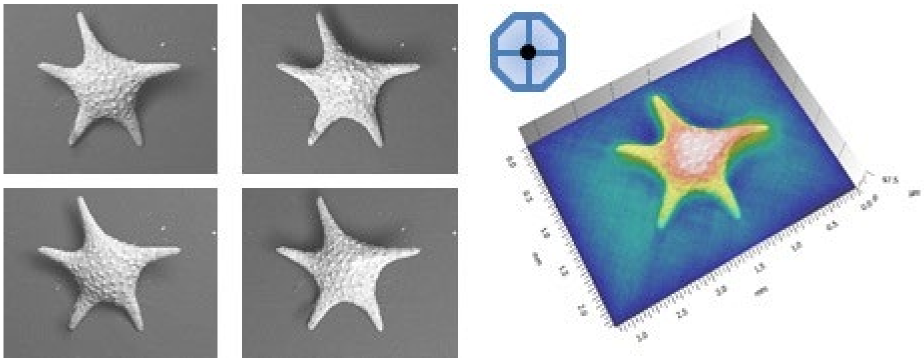


Figure 4: *Live 3D surface morphology of star-shaped beach sand during SEM observation using a multi-segmented backscatter detector*

Additional Workflow Components - Sample Preparation

SEM analysis integrity always relies on suitable sample preparation, which is an integral part of an efficient tabletop workflow. A compact Smart Coater makes it easy to quickly and consistently coat non-conductive specimens with either a metal or carbon coating layer prior to imaging. A tabletop broad ion beam specimen preparation device, the Cross-section Polisher (CP), prepares pristine cross-sections of any type of material. CP users can utilize cryogenic and air isolated transfer mechanisms for preparation of temperature and environment sensitive materials. Moreover, users can easily coat their samples with metal or carbon in the CP prior to SEM analysis.

A

B (top), D (bottom)

C

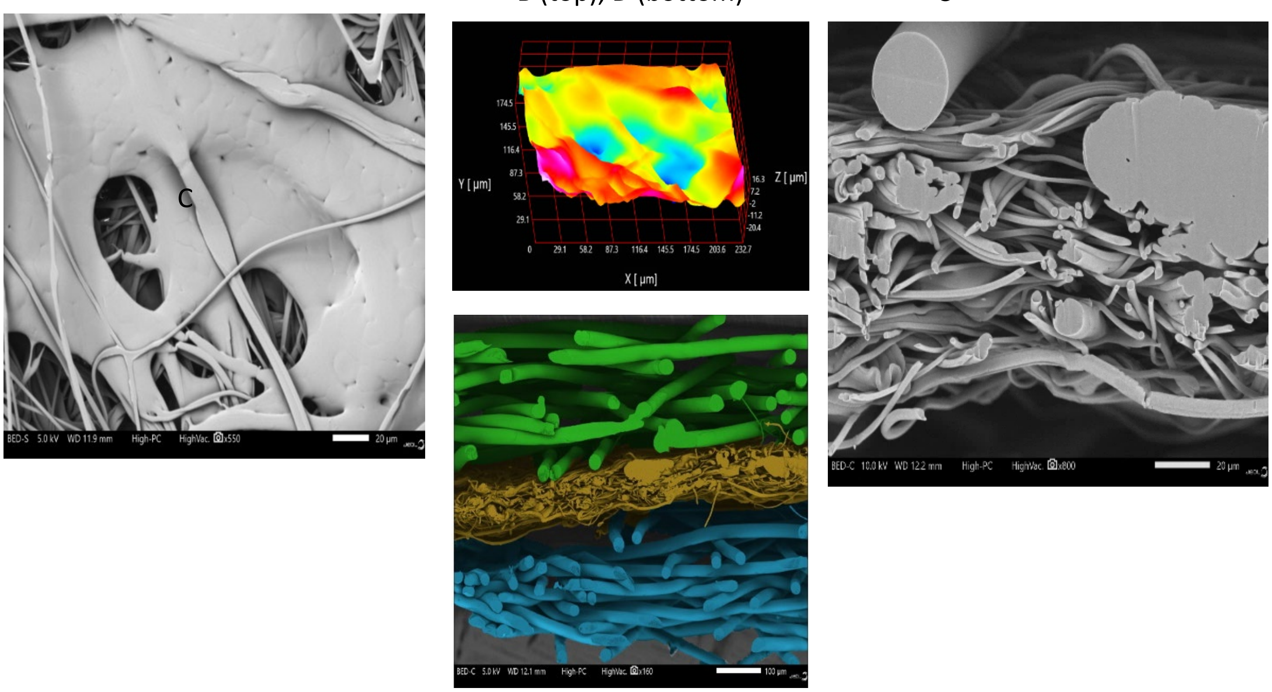


Figure 5: *Paper face mask. A) High vacuum image (Au coated), B) 3D color image, C) SEM image of cross section, D) Cross section colorized to show outer layers and middle of sample.*

Conclusion

The tabletop workflow solutions from JEOL allow researchers to setup a compact and user-friendly lab environment without compromising data integrity. This technology seamlessly guides the user from sample preparation to imaging, microanalysis and reporting.

jeolusa.com