

Large-area SEM characterization of wood fibers in a wet environment with Maps Software

Introduction

As materials research continues to advance, environmental SEMs have seen increased use in an ever-growing number of applications. Thanks to their resolution performance and analytical capabilities, combined with the possibility to study materials in their natural state, environmental SEMs are the tool of choice for many applications across a wide variety of industries.

Understanding the development of a material under certain conditions of heating, cooling, pressure variability, or freezing is key when assessing the use of a material for a specific product. However, it is important to be able to characterize large areas of samples of interest to make sure that a specific behavior under certain conditions is repeatable and not only shown in a micron-sized portion of the material.

To meet this need, Thermo Scientific™ Maps™ Software offers the distinctive key ability to automate acquisitions.

Maps Software application for *in situ* experiments

Maps Software is an intuitive automation and correlative workflow software suite for Thermo Scientific SEM, DualBeam™, and TEM platforms. Thanks to the possibility of running multiple samples in a series, or automatically acquiring up to four simultaneous signals, it helps increase system productivity and also offers the chance to take advantage of nights and weekends.

In addition, Maps Software offers a multi-scale, multi-layered visualization environment in which 2D and 3D data and imagery from other modalities (e.g., EDS maps and EBSD) can be imported from any source, easily and accurately correlating layers.

Maps Software is fully integrated in Thermo Scientific workflows, meaning that any user can take advantage of its benefits during any SEM characterization or *in situ* experiment.

Wood fibers in wet environment

The use of Maps Software has shown to be key in obtaining a clear overview of most of the sample of interest while running the same experiment with no need to run the experiment multiple times, focusing each time on different areas. The ability to tile and stitch several images can be extremely beneficial, specifically when topographical changes due to the experiment need to be monitored on a large sample surface.

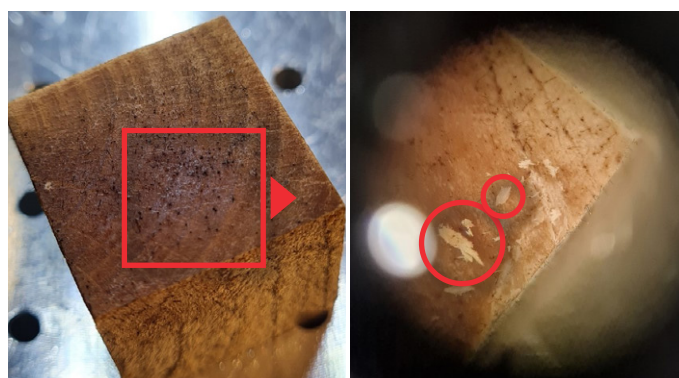


Figure 1. Wood sample. The highlighted fragments in the right image have been selected to be characterized.

The material of interest for this characterization is a block of wet wood (Figure 1) that underwent a compression test. Prior to the experiment, the sample was stored in a plastic bag, which, due to the high humidity and condensation, allowed the growth of black and white mold fibers.

Two small pieces of wood (the two selected pieces are shown in Figure 1, inside red circles) have been carved out of the block using a scalpel and fixed to the Peltier stub using carbon tape.

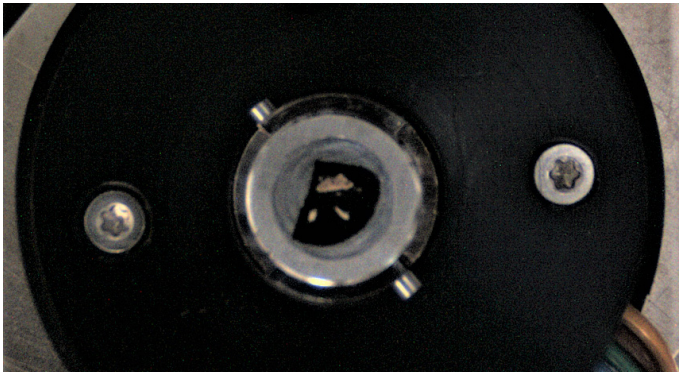


Figure 2. Navigation camera view of the Peltier cooling stage showing the wood fragments at the center of the stage.

A view of the sample's fragments mounted onto the Peltier cooling stage is shown in Figure 2. At the beginning of the experiment, the chamber was pumped down directly to ESEM mode, and the temperature of the stage was kept at 2°C.

Two different tile sets (Figure 3) were acquired in ESEM mode. For the entire duration of the Maps Software data acquisition (one tile set was acquired in 15 minutes, while the second was acquired in 11 minutes), the relative humidity (RH) was kept at around 100% (700 Pa) to maintain sample humidity and its starting condition. This allowed the effect of the compression test run before the imaging to be monitored.

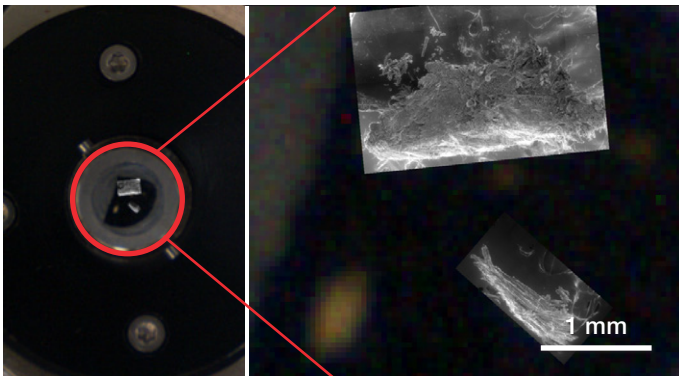


Figure 3. View of Maps Software's user interface showing the presence of two different datasets acquired on each fragment. The image on the right shows the overlay of the navigation camera image and the two acquired tile sets.

Maps Software's dataset allowed inspection of the entire surface of the fragments and was used to navigate the sample to select areas of interest for further higher magnification analyses.

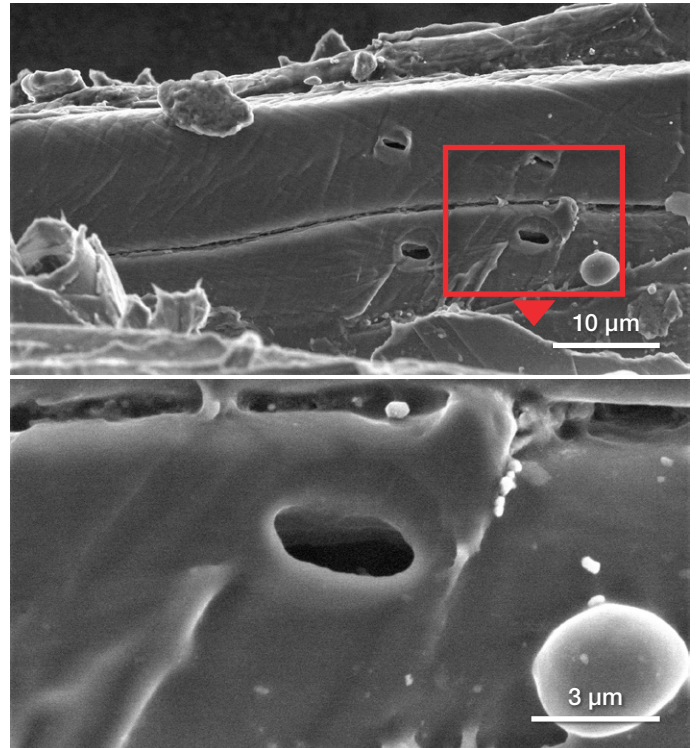


Figure 4. SE images from one of the two fragments, acquired on the fully hydrated sample (pressure 700 Pa, RH around 100%). The bottom image shows the presence of a water droplet.

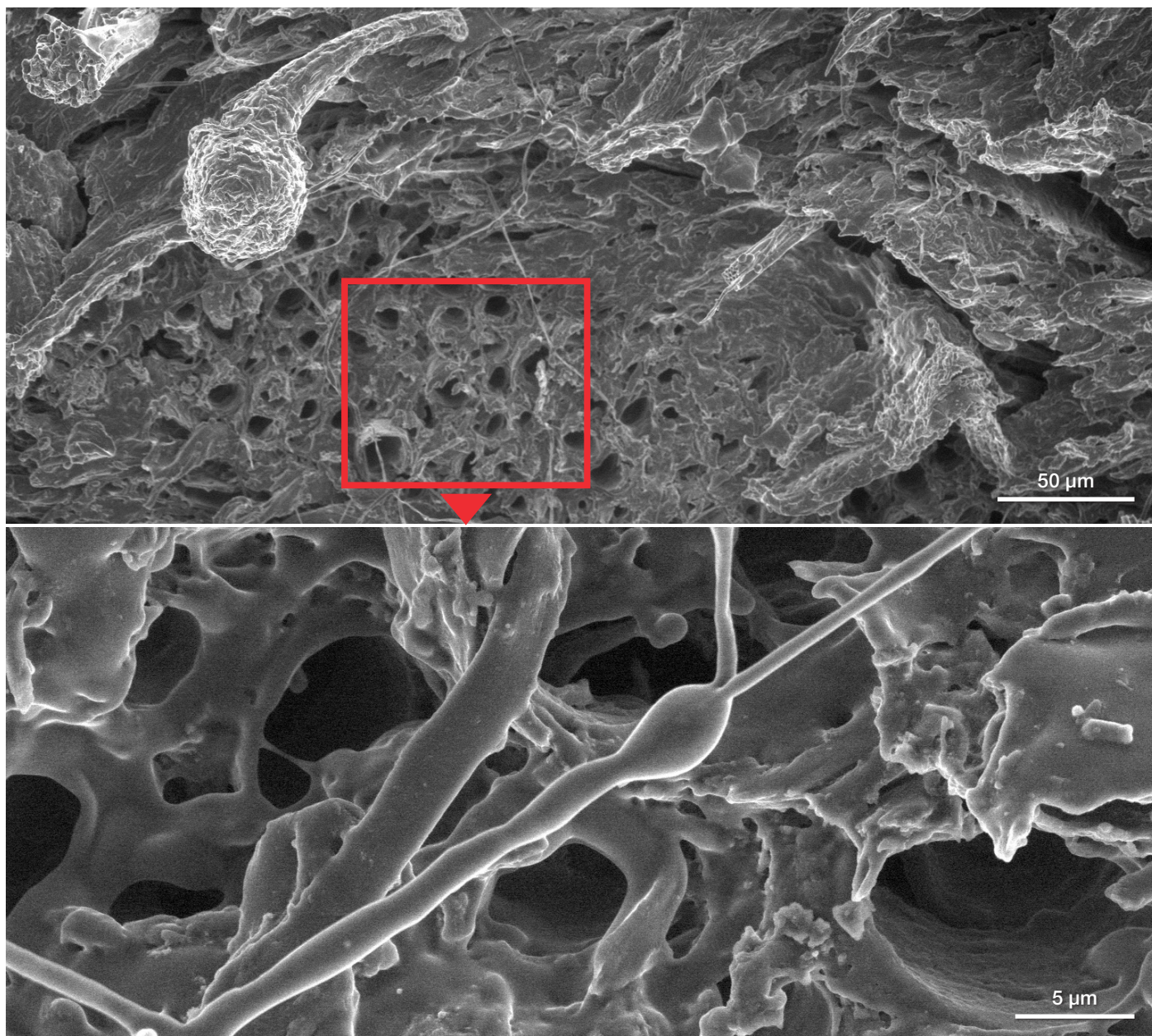


Figure 5. SE images from the second fragment, acquired on the fully hydrated sample (pressure 700 Pa, RH around 100%). The bottom image highlights a water-coated mycelium.

Further higher magnification imaging was conducted while maintaining the system at 2°C and with an RH of 100%. Both characterized fragments show the effect of the hydration, as water droplets are visible in Figure 4, and water-coated mycelium is visible on the second fragment (Figure 5).

Conclusion

This application note shows how Maps Software, running on an environmental SEM, was used to acquire a large-area tile set of a hydrated sample. The results show that, even in these conditions, stable imaging is possible. The tile set can effectively be used for sample navigation as well as for offline review of how the sample's surface and features changed during the duration of the *in situ* experiment.

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