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CASE STUDY

National Institute for Criminalistics and Criminology

Phenom Desktop SEM for forensic diatomology

How the technology is helping criminal investigations

In the NICC Microtraces and Entomology Laboratory, Luc Bourguignon finds and studies trace materials of biological origin, such as human and animal hair, insects, plants, diatoms, etc. The results of the institute's analyses are used in criminal investigations and trials.

Almost all analyses in the Microtraces and Entomology Laboratory involve microscopy. The laboratory has many microscopes of various kinds. Most are light microscopes, and there are also several larger, conventional scanning electron microscopes (SEMs) located in the gunshot residue laboratory of the Institute for Criminalistics and Criminology. The Microtraces and Entomology Laboratory clearly needed higher magnification SEM images but found it difficult to justify the expense of a full-sized instrument, as well as the facilities and personnel it would require. Access to existing SEMs in other labs was limited and the operators of those instruments, since they were not experts in diatoms and forensic botany, were not always able to deliver the needed results.

Challenges in forensic botany research

"Traces" of plant or animal material are, by definition, small, but they are often critical in establishing a suspect's presence at a crime scene. In particular, diatoms and forensic botany often require higher resolution/magnification than is available from light microscopes, which are generally limited to magnifications around 1,000x and are able to resolve features a little less than a micrometer in size.

Luc Bourguignon explains, "For forensic botany, the challenge is to identify or compare plants based on very small fragments of larger organisms. Diatoms are unicellular algae. The smallest are only 2 to 3 micrometers in size. Due to their presence in most waters and their great chemical resistance, they are used to prove contact with water, for example, to provide support to the hypothesis of a drowning. With light microscopy, it is barely possible to even observe such small entities, let alone identify them. When the sample is not perfectly clean, which it never is, a diatom fragment can easily be mistaken for a mineral particle. These two factors can lead to false negative results."

Phenom Desktop SEM

As Bourguignon recalls, "When practical desktop SEMs began to appear we were immediately interested. We have had our Phenom Desktop SEM now for about 4 years." As part of their decision process they evaluated four desktop SEMs. Ultimately, they selected the Thermo Scientific™ Phenom Desktop SEM based primarily on four factors:

Imaging performance - The higher resolution and the higher magnifications of the Phenom Desktop SEM are a great improvement over light microscopy. It also has a much larger depth of focus. This is especially important for samples like diatoms that are very three dimensional. The whole diatom can be sharply focused. According to Bourguignon: "Identification of samples and comparisons are now much easier. Features that were difficult or impossible to see in the light microscope are immediately visible on the Phenom Desktop SEM."

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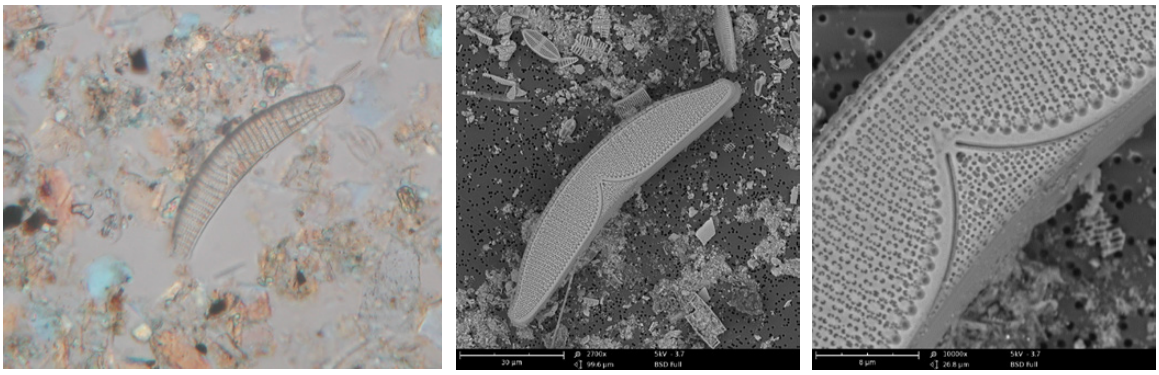

Figure 1. Comparing a light microscope image (left) at approximately 2,000x with Phenom Desktop SEM images (middle) at 2,700x and (right) 10,000x of a *Epithemia cfr. turgida* diatom. Even at similar magnifications the SEM image (middle) is much better than the light image (left). The high magnification SEM image (right) shows just how much more detail (resolution) is available on the Phenom Desktop SEM. Increasing the magnification of the light image would only show a larger, but more blurry, image since light microscopes lack the resolving power of SEMs.

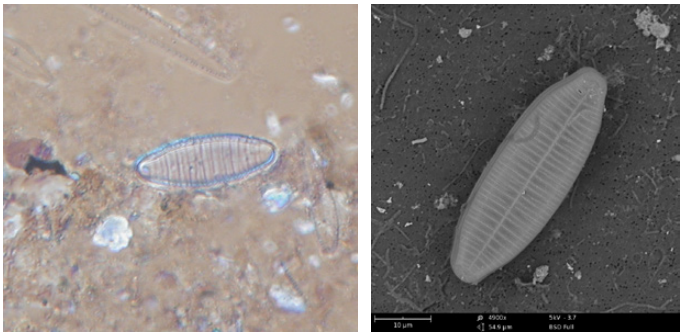

Figure 2. Another comparison of a light microscope image (left) zoomed in at approximately 2,000x and a SEM image (right) magnified at 4,900x of a *Diatoma vulgaris* diatom.

No sample preparation - The low charge sample holder of the Phenom Desktop SEM eliminates the need to coat insulating samples with a conductive coating that avoids charging artifacts. In forensic applications, it is important to preserve the specimen in its original state. Eliminating the coating also makes it easier to compare light microscope and SEM images, which is done frequently with larger specimens like hair. It also saves the time that would be required to apply the coating and otherwise prepare the sample.

Speed – "We look at a lot of samples. When we use a light microscope, we compare slides between each other, and so we tend to change the slides very often. We typically look at something for a few seconds and then go on to the next sample, so that was a capability we wanted to keep with an SEM. When we compared different systems, the Phenom Desktop SEM was clearly ahead of all the others on this - about 30 seconds per sample," Bourguignon explains.

Ease of use – "We needed a system that would be easy to use and not require specialized training or a dedicated operator. Our Phenom Desktop SEM is used mostly by two people, but it is available to anyone with minimal training. We keep a 'reminding procedure' available for anyone in the lab. We also let students and people from other labs use the instrument. A PhD researcher from the toxicology lab worked on it for a while, and some other students performed their theses with it."

Bourguignon summarizes his experience with the Phenom Desktop SEM: "We are microscopists, and thanks to the very short time needed to get the images, we can now use SEM with the comfort and speed of a light microscope, but at higher magnifications. This allows us to see more things than before, which expands our possibilities to help our customers. I would recommend the Phenom instruments to everyone! It is one of the most important tools in our lab now. The Phenom Desktop SEM changed my practice of forensic diatomology."

NICC

The National Institute for Criminalistics and Criminology (NICC), located in Brussels, comprises several separate laboratories, each specializing in their own forensic field: ballistics, drugs, toxicology, textiles, DNA, arson, glass, paints and more.

Find out more at **thermofisher.com/phenom**

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