

Helium Ion Microscopy – Geologic Applications

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The Zeiss Helium Ion Microscope (HIM) offers unprecedented capabilities for the imaging both inorganic and organic geological samples. The HIM functions similar to FE-SEM, using a focused beam of He⁺ ions that produce high contrast secondary electron emission originating mostly from the surface interactions. Spherical and chromatic aberrations of the ion optical column are insignificant and the spot size of the scanned beam is not limited by diffraction aberration. The net effect is that HIM can provide many advantages over all modes of SEM. These include

- Higher resolution. Features as small as 0.35 nm can be resolved. Imaging is restricted to the surface, eliminating ghosting from sub-surface features.
- Higher depth of field. Estimated 5X greater than FE-SEM. Ultra-high resolution can be obtained without the need of smooth surfaces eliminating the need for microtoming or ion milling.
- Charge neutralization is achieved using a electron gun, eliminating the need for conductive surface coatings that can obscure fine structures and produce artifacts.
- Material contrast differs from electron interaction, allowing for features to be imaged that are difficult to be seen in SEM.

We have applied HIM to a variety of geologic samples including organic-rich source rocks and sandstone and carbonate reservoir rocks. In shales, we have imaged the development and preservation of porosity in organic matter and were able to characterize the manner in which gas is stored and transported. We have also applied HIM to bacteria recovered from the deep subsurface and to microbially induced corrosion of steel. In all cases, HIM proved to be superior to SEM.

HIM of highly porous organic matter in a gas shale.

