

## Scanning the Industry

### Seeing at Atomic Resolution is Believing: Welcome the Helium Ion Microscope

By Phaedra E. McGuinness, Managing Editor

The world of SEM is recognizing an emerging sister technology—helium ion microscopy (HIM). Bill Ward, inventor and president of ALIS Corporation (Peabody, Mass., USA; [www.aliscorporation.com](http://www.aliscorporation.com)), has created the world's first helium ion microscope. It has the potential to rival traditional SEMs and TEMs with a projected .25 nm resolution.

By swapping electrons for helium ions as the imaging particle, ALIS hopes to circumvent the physics barriers of present-day microscope technologies. According to Ward, "Helium ions give better contrast than electrons and helium beams can be focused to a much smaller probe size. Also, electrons have a much larger interaction volume (IV). Since ions are more dense, they are less likely to scatter near the surface, potentially providing better spatial resolution."

Ward has targeted the ultra-high resolution segment of the semiconductor industry, with a secondary interest in the materials science and nanotechnology markets, to meet the high demand for microscopes in these fields. He adds, "The ability to see the surface detail is crucial for those studying contamination, failure analysis, and defect review. The use of helium ions may allow the microscopist greater chemical contrast, and therefore a new potential for surface imaging."

Mass plays an important role in studying materials. "As an example, both carbon and electrons are light; therefore, the interaction volume is very large, Ward adds. "People working with carbon nanotubes have a difficult time looking at them with EMs; however, carbon looks opaque under a helium microscope, so observing carbon nanotubes is easy."

According to Ward, physicists in the EM community have known for years that a helium ion microscope could offer potential capabilities an EM could not. A practical, high-brightness helium ion source was the missing component, and that is what he has been working on for a decade. "We perfected the method of taking a helium beam from one atom and using it as the ion source for the system. We can install a sharp point that has a single atom on top within the scope, then remove that sharpness, and put a point back on it again and again. It's the re-sharpening at will that made the helium ion source reliable and commercially viable."

The product is the first scanning *transmission* ion microscope, according to Clarke Fenner, V.P. of Business Development at ALIS. He adds, "We predict users will see surface information invisible to the electrons. Ions have a wavelength 80 times shorter than electrons, so there is virtually no diffraction effect, which is a resolution-limiting factor in electron microscopes."

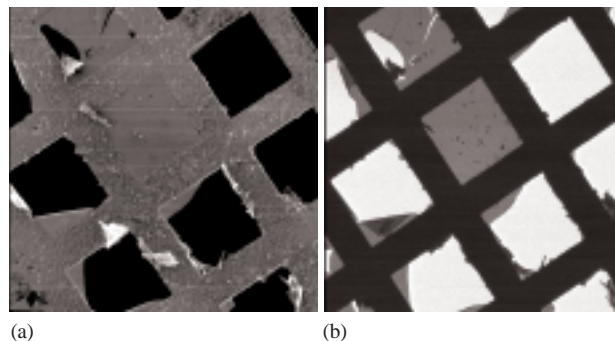


FIG. 1 (a) This image was taken with a scanning helium microscope in the secondary electron mode. (b) This image was taken with a helium scanning transmission microscope in the ion stopping detection mode. The sample is a 10 nm film of carbon stretched over a TIM grid. Some of the carbon windows are broken. Note how opaque the thin carbon windows are in (a) and how transmissive they appear in (b).

Mike Phaneuf of Fibics Incorporated (Ottawa, Canada), a potential end user, has seen the alpha prototype and agrees the innovation could have a significant impact on how microscopy is performed. "There are a lot of exciting applications one can imagine performing at the nanometer or sub-nanometer scale with a helium beam at medium energy ranges of 5-100 kv. There are functions we have not dreamed of that this machine may be able to tap into." He believes one advantage of the HIM is that it is based on stable, well-researched physics and a technology that has existed for more than 40 years. "The virtual source size is down to the point where the resulting resolution is impressive—an order of magnitude better than the virtual electron source size. For spatial resolution the HIM is a contender, and for analytical applications it will be a nice complement to the SEM with capabilities such as nanometer scale Rutherford backscattering analysis," he says.

The 1930s saw the first electron microscope, a TEM. The SEM and the STM followed in the 1950s and 1960s, respectively. "The ion energy is coming from a space the size of an atom and since we do not know of any energy sources smaller than an atom, this may be the last step in microscopy," adds Ward. Manufacturers and end users of SEMs and TEMs will surely weigh in on this developing technology in the future.

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