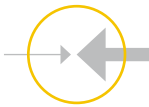
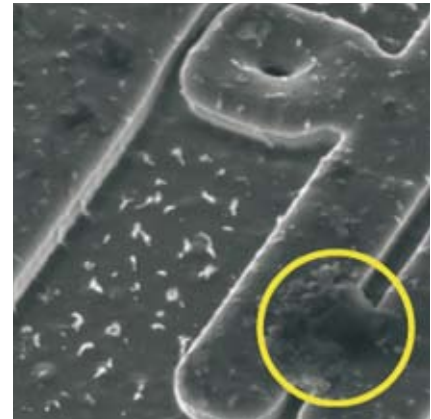
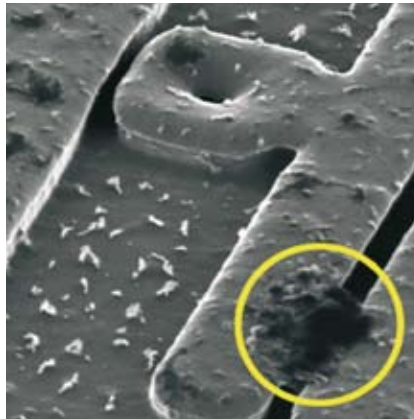


An Eagle Eye for the Nano World

The new helium-ion microscope generates particularly high-resolution images.



ORION™ had to pass its first test right when it was delivered. Because the doors in Building E at the Manfred von Ardenne Ring were not wide or high enough, it was forced to take the more tedious route through the window. Thanks to the active support of dedicated employees, a crane and many wooden pallets, it was possible to nonetheless complete this difficult procedure with the heavy instrument. This new type of microscope that goes by the brand name **ORION** has resided in its rightful place at the Carl Zeiss Innovation Center in Dresden since the end of October.



Display of a defect on a semiconductor structure with helium-ion technology: the **ORION™** helium-ion microscope (left) stands out, in particular, as a result of its brilliant contrast which scanning electron microscopes (right) cannot achieve with their very high resolution.

Behind the stellar name is a pioneering technology that generates helium-ion images from the nano world, in which the dimensions of a billionth of a meter are the measure of all things. The development of this new microscope can be traced to the patented work of ALIS in Peabody, Massachusetts, under the management of Bill Ward. This start-up company was acquired by Carl Zeiss SMT during the summer of 2006 and has now been fully integrated. "With **ORION**, we have launched a truly revolutionary product," says proud inventor Ward, Chief Technologist of Carl Zeiss SMT in the USA that is now also headquartered in Peabody to the north of Boston. The helium-ion microscope at the Technopark Nord in Saxony's capital is the only one of its kind in Europe. Together with a microscope based on cross beam technology (CrossBeam 1540 EsB) that uses electron and ion beams for imaging and material processing of the smallest particles and

structures, it is the heart of the Innovation Center that will advance the development of future chip generations as part of the joint Nanoanalysis project. In addition to Carl Zeiss SMT, the project sponsored by the German Federal Ministry of Education and Research (BMBF) with a total of 12 million euros also includes semiconductor manufacturers AMD and Qimonda.

Increasingly complex structures in ever smaller dimensions. Imaging procedures have repeatedly provided the foundation for new insights into the natural sciences. Images, whose resolution and contrast set standards, can be generated with an intensive beam of single helium ions. The most important element for the microscope is a durable source for the helium ions in which a sharp tungsten needle is placed in a high vacuum at very low temperatures. The applied high voltage generates an extremely thick electrical field around the nee-

dle tip, whose strength is sufficient to ionize the helium atoms flying by. During this process, an electron is released via the tunnel effect on the tip so that positively charged helium ions are created which are accelerated away from the needle. The ion beam is then guided through a column with a series of focusing, adjusting and probing elements before it is bundled on an almost unimaginably small surface with a diameter of only 0.75 nanometers. Here, the beam scans the probe pixel by pixel, similar to a scanning electron microscope. "The gray scale value of each single image element is determined by the number of secondary electrons detected," explains Ward. The potential of the new method can be estimated based on the dispersion pattern created when the helium ions scatter while penetrating the specimen: its cross section is clearly smaller than with an electron beam and ensures the high resolution. In this regard, *ORION* is clearly superior to a scanning electron microscope.

"The size of the specimen is approximately one square centimeter where we can examine up to six of the objects at the same time. The largely automated change takes less than 10 minutes, the processes thus permits very good throughput," emphasizes Dr. Heiko Stegmann, head of the Carl Zeiss team at the Innovation Center in Dresden. Together with partners from the chip industry, the group of scientists is working on the 3D characterization of semiconductor structures and new materials for chip fabrication. "As a manufacturer of innovative microprocessors,

we are faced with the challenge of producing increasingly more complex structures in ever smaller dimensions with maximum yield," says Dr. Udo Nothelfer, Vice President of AMD Fab 36, explaining the commitment of the three partners. "With the structural dimensions that we have now achieved, the current storage cells can only be seen under an electron microscope," confirms Frank Prein, President of Qimonda Dresden GmbH and Global Head of Technology at Qimonda AG.

Biological specimens and semiconductors. The new cutting-edge tool is not only available to the project partners but all interested companies and institutes in greater Dresden. All of the approximately 250 employees of the Silicon Saxony Network, which includes the technical university in Dresden and the Fraunhofer Center for Nanoelectronic Technologies (CNT), for example, can ask and receive answers to nanotechnology application questions. Furthermore, biological specimens from the natural science and medical institutes at the University of Tübingen (NMI) are currently being examined in Dresden.

Strategic Alliances. The use of the new precision instrument from Carl Zeiss is not limited to leading micro-electronic companies in Europe. There is also enormous interest from across the Atlantic. Systems have already been installed at key customers such as the National Institute for Standards and Technology in Gaithersburg, Maryland. Harvard University in Cambridge, Massachusetts, also relies on technology from Carl Zeiss



Extremely heavy, leading-edge instrument: the ORION™ helium-ion microscope

for its Center for Nanoscale Systems (CNS). Harvard has ordered eight electron and ion microscopes from Carl Zeiss SMT, including an *ORION*. "This order, which also means a long-term strategic partnership for our company, is a great honor and accolade," says Dirk Stenkamp, Member of the Board at Carl Zeiss SMT. Hopefully the "scientific heavyweights" will also fit through the doors at the CNS.

Klaus Jopp