High spatial resolution sample analysis using a Helium Ion Microscope

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Helium ion microscopy provides unique capabilities relative to traditional SEM and gallium based FIB instruments. The ORION^{TM} helium ion microscope has demonstrated a probe size of better than 0.3 nm at working distances sufficiently large to allow other analytical detectors to be employed within the instrument. The very high resolution images from the ORION^{TM} are directly related to the physics of interaction between helium particles and the surface, allowing for high secondary electron yields relative to traditional SEMs and better localization of where the signal is emitted due to the fact that the contribution to the secondary electron signal from the backscattered helium is quite small. Furthermore, the difference in interaction mechanisms between electrons, or gallium ions, relative to helium provides new and useful contrast mechanisms that yield new information about the sample. In addition to the new visual information that the helium ion microscope can provide, it is possible to obtain unique analytical information about the sample using various techniques. One such technique is angle and energy resolved spectroscopy of the backscattered helium.

In order to explore the analytical capabilities of backscattered helium ion spectroscopy with the ORION^{TM} helium microscope, an innovative backscattered helium detector has been constructed to complement its image resolving capabilities. The detector subtends an angle of 0.024 steradians and measures the energy of both the ionized and the neutral helium atoms. Results to date indicate that such a configuration can possibly be used to either identify an unknown element, or if the elemental composition of a thin film is known, it is possible to deduce the thickness of the film. Figure 1 shows the energy spectrum for three different materials in a device cross section. The smallest analyzable region can be significantly smaller than that of a SEM equipped with an X-Ray spectrometer due to the differences in the physics of sample interaction between the helium beam and an electron beam.

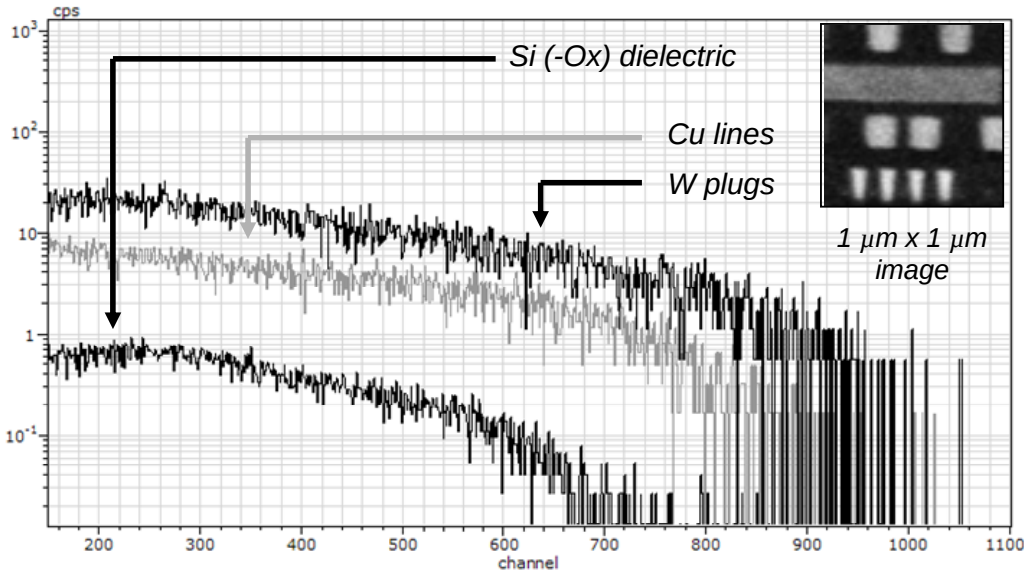

FIG 1. Energy spectra of the backscattered helium from tungsten, copper, and SiOx.