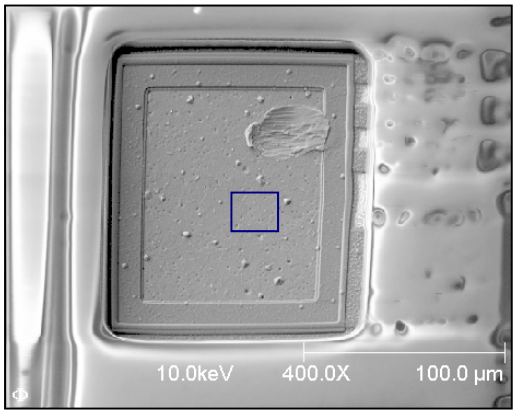
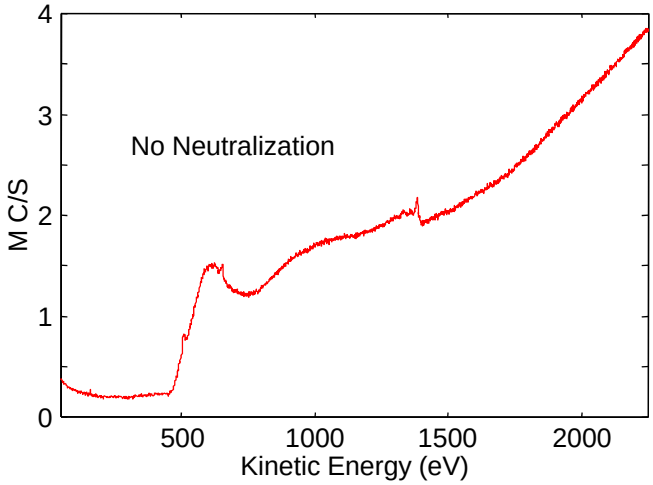
PHYSICAL ELECTRONICS
A DIVISION OF ULVAC-PHI

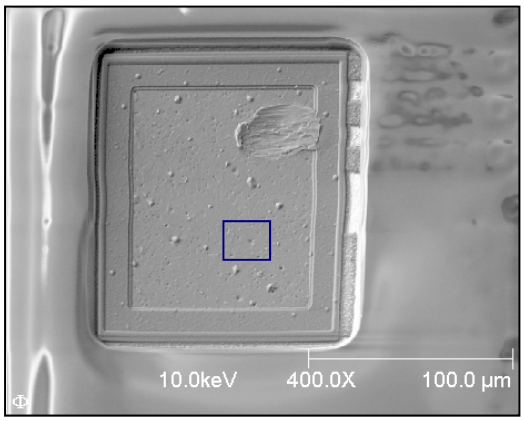
Using Low Energy Ions for Charge Neutralization in PHI Scanning Auger Nanoprobes

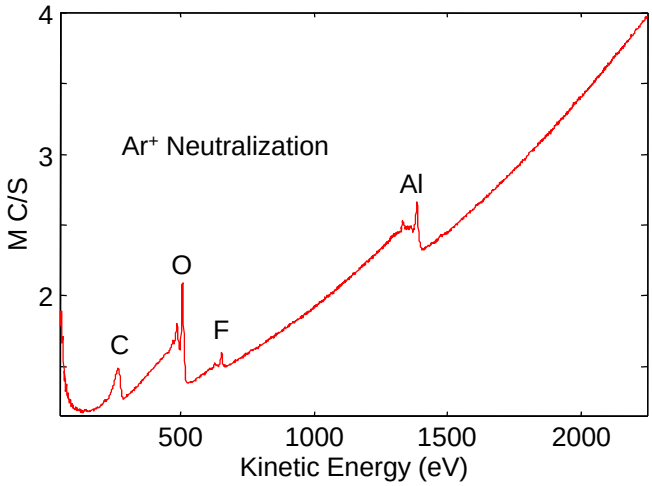
Auger analysis of insulating materials can be impeded by the sample charging to a high negative surface potential. This surface charge severely distorts and shifts secondary electron spectra, which includes the Auger electron peaks, rendering the Auger data meaningless. Such effects can also occur when analyzing conductive materials, such as metal lines or pads, that are embedded in insulating materials. The surrounding insulating material accumulates charge while the sample is imaged at low magnification. Auger and other secondary electrons emitted from the conducting component are perturbed by the surface charge on the surrounding insulating material. Lower energy electrons are more severely perturbed, depending on the extent of the charge on the insulating material. The net consequence is to render at least a portion of the Auger data meaningless.



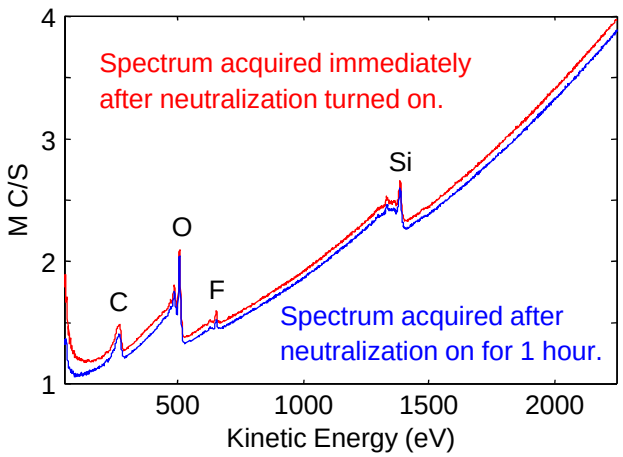


In this example, an Auger spectrum was acquired from an area near the center of an Al bond pad is surrounded by polyimide. The spectrum was adversely modified by the charge on the surrounding polyimide, resulting in a lack of useful information in the Auger spectrum below approximately 1000 eV. Note that the higher energy Al Auger peak occurs at the correct energy, but appears attenuated in intensity.





A low energy argon ion beam may be effective in reducing or eliminating surface charge. In the example shown above, a 70 eV Ar^+ ion beam was used during Auger analysis to eliminate the charge on the polyimide surrounding the bond pad. This made it possible to obtain a normal Auger spectrum from the bond pad. The effectiveness of argon ion neutralization may be affected by changing the ion energy, ion current, and the flood area.



This graph shows two Auger spectra, one taken immediately after the Ar^+ neutralization was turned on, and the other one hour later. These spectra show Al, O, F and C. Al metal typically forms a passivating Al oxide film roughly 4 nm thick. F is a surface contaminant, and may be associated with the Al oxide. C is a surface contaminant adsorbed on the outermost surface of the Al bond pad. The C and F levels are only slightly reduced after one hour of continuous neutralization with 70 eV Ar^+ ions. This shows that minimal sputtering takes place with the low energy ions used for charge neutralization.

This approach to charge neutralization is possible with Physical Electronics Auger systems equipped with the 06-350 floating column ion gun. This ion gun forms ion beams down to a few eV, with useful ion currents. The ion gun will also operate at voltages up to 5 kV for sputter depth profiles at high sputter rates. The ion column has a 5° bend to eliminate neutrals. The gun is fully digitally controlled and offers stored user settings for the ultimate in experimental reproducibility.

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