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IT-5-P-3251 Parallel acquisition Auger electron spectroscopy

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Auger electron spectroscopy (AES), a surface analysis technique, has traditionally required the use of Ultra High Vacuum (UHV) conditions on account of its high surface sensitivity and the rapidity with which surface become coated with contaminants under High Vacuum (HV) conditions. Energy Dispersive X-ray Spectroscopy (EDS) has limited resolution due to its large excitation volume. Imaging AES, thus achieves much higher spatial resolution than EDS even when the recently developed Silicon Drift Detector technology is employed. The introduction of techniques that acquire an electron spectrum in parallel will allow a much faster acquisition of AES spectra and thus relax the vacuum conditions required.

Two such parallel acquisition electron energy analyser is the Hyperbolic Field Analyser (HFA) [1] and the Magnetic Electron Energy Spectrometer (MEES) [2]. Figure 1 shows a schematic of the experimental setup used for acquiring Electron Energy Loss (EELS) data and AES data using the MEES analyser. Figure 2 shows an image acquired on an Active Pixel Sensor CMOS detector of an elastic peak using the MEES. The image shows the output of the two dimensional detector when the incident electron beam energy is 900 eV and the magnetic field is 80 Gauss. The x and y axes corresponds to an energy interval of ~700 eV to~1000 eV. The image data can be converted into a spectrum by integrating the image data over specific regions (here between the 2 straight lines from top left to bottom right on Figure 2). The resultant spectrum is shown in Figure 3.

The HFA has been used in an SEM (operating at HV; 10-6mbar) to acquire AES spectra. The samples are cleaned using argon ion bombardment as practiced in surface analysis and then rapidly analysed by AES a few seconds after the ion cleaning is ceased. An example of an AES spectrum from Indium is given in Figure 4. The increase in the carbon Auger signal on the samples can also be monitored over the next minutes as the surface is contaminated. This provides a simple demonstration of how parallel acquisition can monitor rapid changes in surface composition in a way that no other technique can. In this article, we also explore in greater detail the theoretical basis of the MEES and its potential as a device for use in Scanning Electron Microscopes (SEMs) for the high speed inspection of objects on the nanometre scale and show further spectra collected using images acquired with the Active Pixel Sensor.

References

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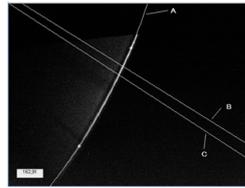
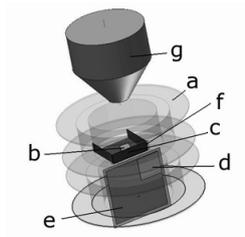


Fig. 1: Schematic representation of the magnetic analyser, MEES. (a) Helmholtz coils shown semi-transparently (b) sample (c) slit (d) sensor (e) board containing electronics for sensor (f) metal plate (g) electron column.

Fig. 2: The locus of the elastic peak is shown as detected by the CMOS sensor. Curve A is the elastic peak and lines B and C mark the limits of integration to create the spectrum in Figure 3.

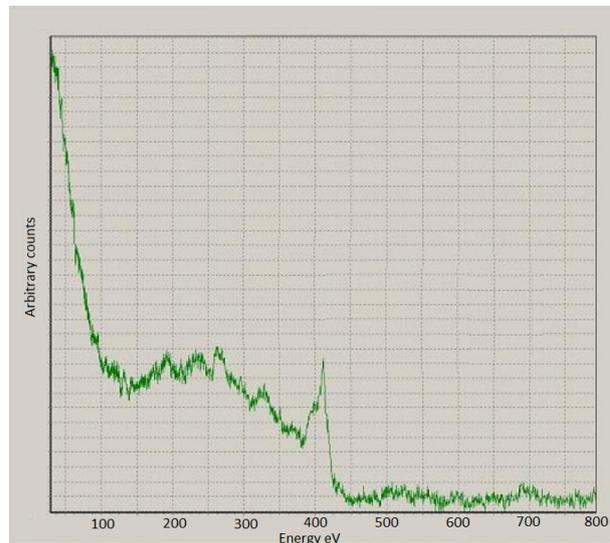
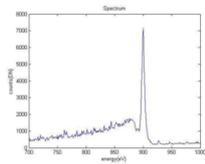


Fig. 3: A spectrum determined from Figure 2 after image processing.

Fig. 4: The Auger spectrum of indium acquired using the HFA in HV vacuum conditions of an ordinary SEM (JEOL 6400F) and shows the In MNN Auger peak taken immediately after ion cleaning. A carbon contamination layer took about 10 minutes to build up after Ar ion cleaning and the acquisition of the AES data.