

ELECTRON YIELD DETECTOR

The detector consists of an aluminized Mylar entrance window, a collecting grid of Ni mesh and a back plane with an opening where the sample is attached so as to seal the opening. The Ni mesh will always produce a Ni edge; therefore, replace the Ni mesh with an aluminized Mylar collecting grid when measuring Ni. The front window and sample are electrically connected to be at the same potential. The center grid is either ± 45 volts depending upon whether electrons or positive ions are to be collected on the grid. The switch on top indicates whether the grid is collecting electrons (-) or positive ions (+). The output should go directly to a Keithley amplifier; typically at 10^8 gain. The other BNC connector marked Batt allows connection of an external battery or controllable DC supply. Note that the detector body can be rotated to the appropriate angle so that e-yield, fluorescent, and normal absorption mode signals may all be collected simultaneously, if desired.

Normally, a very small flow of He or H₂ is maintained through the detector. As shown by Erbil et al. (1) and Elam et al. (2) the presence of the gas results in considerable gain since the energy to create an ion pair is ~ 30 eV, hence a typical x-ray photon will be converted into $\sim 10^2$ electrons. Although other gases may be used, He or H₂ in the detector will minimize the absorption of x-rays within the e-yield detector and thereby minimize the observed intensity of x-ray diffraction spikes from crystalline samples. The principle of operation of the detector is based upon the photoelectric effect whereby x-ray absorption in the sample produces photoelectrons plus Auger electrons plus lower energy in-elastically scattered electrons. Most of the e-yield signal arises from ionization in the detector gas caused by the Auger electrons, e. g. the KLL electrons for the K absorption edge, which are emitted from the surface of the sample. Elam et al. (2) have estimated the escape depth of the electrons to be

$$d = 0.011/\rho E^{3/2}$$

where d is in Å, ρ is the density and E is the appropriate electron energy in eV, thus the e-yield signal arises from within a few hundred Å of the surface.

It is important that the sample be electrically connected to the sample plane or a charge will build up on the sample and cause random discharge glitches. Bulk metal samples or conducting samples may simply be taped

over the sample opening. Non-conducting bulk samples may be placed upon Ni mesh which is fastened over the sample opening. Powders may be rubbed onto or moistened onto thin Al foil which is then taped over the sample opening. It is not necessary to prepare uniform absorbers, any adhering particles will suffice. Note that a Duco smear is not a good sample since the electrons will not emerge through the Duco surface. Volatile or gas phase samples (3) may be introduced into the gas stream at a low concentration, ~ 1000 ppm. The sensitivity is approximately 1 ppm. The usual problem is too much sample gas in the He. For gas samples tape a piece of aluminized Mylar or thin Al over the sample opening.

The advantages of the e-yield technique arise from 1) the high signal level due to the gas gain, 2) the 2π solid angle of collection (4π for gaseous samples), and 3) the fact that thickness effects are absent since the sample is always in the thin limit because the incident x-ray absorption length is much greater than the electron escape depth (4). Figure 1 illustrates the importance of the thickness effect where the spectra of bulk sulfur measured simultaneously in e-yield and fluorescence are compared (5). The small feature due to a surface impurity emphasizes the major disadvantage of the technique--it is sensitive to the surface. For example, e-yield spectra of metals (tin) which form thick surface oxide layers will have the oxide phase in the data.

REFERENCES

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