**X-Ray Photoelectron Spectroscopy (XPS) Technique Description**

XPS (also referred to as Electron Spectroscopy for Chemical Analysis or ESCA) is an analytical technique where x-rays are used to bombard a specimen and the energies of emitted electrons are analyzed. Typical x-ray sources are $MgK_\alpha$ at 1253.6 eV and $AlK_\alpha$ at 1486.6 eV. Analysis with an ultraviolet source at 21.2 eV can also be made to provide high count rates for the low energy region which contains valence band information.

X-rays penetrate the specimen surface to a depth of a few micrometers but only the electrons near the surface can be emitted without losing energy due to collisions with other atoms. The kinetic energy (KE) of the electrons is measured and the binding energy (BE) of the electrons can be determined with a simple relationship:

$$h\nu = KE + BE + \varphi$$

where $h\nu$ is the x-ray energy and $\varphi$ is the spectrometer work function (usually only a few eV).

An energy spectrum is obtained with a scan over the kinetic energy range from 0 eV to the incident x-ray energy. The energy spectrum is different for each element and permits elemental identification of the species present in the top 1-2 nm. The detection limit is approximately 0.1% atomic. XPS is more sensitive for higher atomic number elements.

The energy resolution of the spectrometer is sufficient to resolve differences in binding energy for different chemical bonds. For example, it is possible to separate C-C from C-O and O-C=O. The area under the peak for each bond represents the percentage of that bond that is present.

Since the XPS electrons originate mostly from the first few monolayers, sample cleanliness and handling are crucial to obtain useful results. Samples should be stored in glass or Fluroware containers and not in plastic bags.

This technique has been used to analyze a very wide range of materials. The limitations are that it must be a solid and vacuum compatible. Powders can be mounted with sticky tape and liquids can be dried on a substrate such as silicon.