17.2.1.6 Photoelectron diffraction (PED)

Diffraction effects have been observed in angle-resolved photoelectron spectroscopy. This diffraction structure is very similar to that of *Low Energy Electron Diffraction* (*LEED*). The term *X-ray Photoelectron Diffraction* (*XPD*) is used for diffraction effects observed in an XPS experiment. Two experimental modes have been developed.

Azimuthal photoelectron diffraction (APD)

The sample is rotated about the surface normal, thus varying the azimuthal angle, and the energy-selected photoelectron intensity from the selected core level is recorded at a fixed polar angle and at fixed photon energy. This technique was developed initially to probe the azimuthal anisotropy of adsorbate systems. The azimuthal profile is very dependent on both the polar angle selected and the photon energy (i.e., the final state). Most APD experiments to date have involved photoelectrons with low kinetic energies so a synchrotron radiation source is usually employed, although it is not essential.

Incident: Fixed energy photons (1-2 keV). Flux: low; Beam diameter 1-3 mm; Angle of incidence: 70-85°.

Detected: photoelectrons from selected core level (less than 100 eV). Angle of exit: Polar angle fixed, azimuthal angle varied (0-360°) by rotating sample about surface normal.

Spectrum: Photoelectron current vs. azimuthal angle.

Normal photoelectron diffraction (NPD)

The energy-selected photoelectron intensity from a selected core level emitted normal to the surface is recorded as the photon energy is swept through a wide range. A synchrotron radiation source is thus essential for this experiment. The other requirement is that the core level selected has a smoothly varying photoionization cross-section over the range of photon energies. The data recorded are very similar to the I-V curves of the LEED experiment (in fact they are a coherent superposition of several LEED beams).

Incident: Variable energy photons (200-1500 eV). Flux: medium to low. Angle of incidence: 44-85°.

Detected: photoelectron from selected core level (0 eV to several hundred eV). Angle of exit: normal to surface.

Spectrum: Photoelectron count rate vs. incident photon energy.