17.2.1.5 Imaging Photoelectron Spectroscopy (SESCA or PESM types)

Two techniques have been reported which permit both the energy analysis (spectroscopy) and spatial analysis (microscopy) of the photoelectrons emitted from a surface. In *Scanning Electron Spectroscopy for Chemical Analysis* (*SESCA*) a thin film or slice of specimen is mounted on a thin aluminium foil. An electron beam is then scanned over the back of the foil producing X-rays which pass through the specimen liberating photoelectrons.
In *Photoelectron Spectromicroscopy* (*PESM*), on the other hand, no scanning or focusing elements are involved. The whole surface is irradiated from the front and the electron emission mapped by a divergent axially symmetric magnetic field. Both X-ray and ultraviolet radiation can be used in PESM.

Scanning electron spectroscopy for chemical analysis (SESCA)

The electron gun provides a primary electron beam of high energy ($\approx$ 10 keV) and current ($<$ 3×10^{-5} A) which is focused on a spot ($<$ 0.5 μm diameter) and scanned across the aluminium foil by electrostatic deflection. The emitted photoelectrons are collected and energy analyzed by a high resolution double pass cylindrical mirror analyzer. The lateral resolution is limited by the foil thickness (about 2 μm) to approximately 15 μm.

Incident: fixed energy electrons (0.1-10 keV). Beam diameter: less than 0.5×10^{-6} m. Angle of incidence: electron beam is scanned across aluminium foil.

Detected: photoelectrons, 0 eV to within a few eV of the X-ray photon energy. Angle of exit: normal to surface.

Spectrum: Photoelectron current vs. photoelectron energy (binding energy).

Photoelectron spectromicroscopy (PESM)

The whole surface is irradiated with either ultraviolet radiation, soft X-ray radiation, slow metastable atoms or fast atoms. As the emitted photoelectrons travel along the divergent magnetic field lines the conservation of angular momentum (or, more precisely, the conservation of orbital moment) causes the transverse component of the electron's linear momentum to become axial so that when the electron is energy analyzed all the electron's momentum is in the forward (axial) direction. Retarding field energy analysis can be performed with a retarding grid and trochoidal energy analysis with a crossed electric field. The electrons are detected by an electron multiplier or phosphor screen. The lateral resolution is determined by the electron energy and the magnetic field strength and can reach 0.1 μm. With soft X-rays as image generators *elemental mapping* can be performed and with ultraviolet radiation molecular information maps can be produced by analysis of the valence photoelectron spectrum, (i.e., *molecular or chemical mapping*).

Incident: Fixed energy photons, 4 eV - 10 keV. Flux: high to low; Beam diameter: 1-5 mm; Angle of incidence: from grazing to 80° (not critical); Magnetic field strength: 1-7 tesla.

Detected: photoelectrons, 0 eV to within a few eV of incident photon energy. Angle of exit: almost all angles of exit are collected and collimated by magnetic field.

Spectrum: Photoelectron current vs photoelectron energy. Angle-integrated photoelectron spectrum.