X-ray Photoelectron Spectroscopy (XPS) or Electron Spectroscopy for Chemical Analysis (ESCA)

SCIENCE ET SURFACE
Filiale de SERMA TECHNOLOGIES

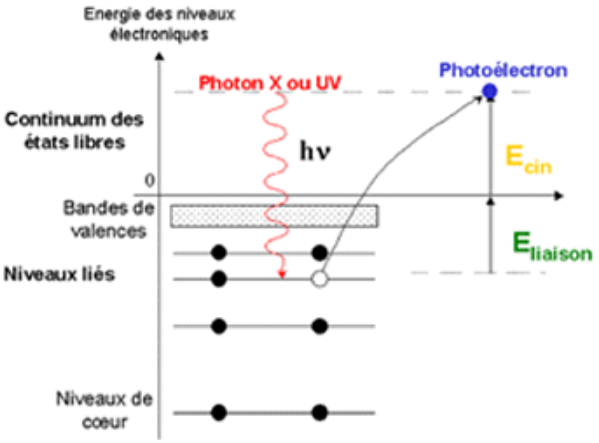
SPECIFICATIONS

- Qualitative **elemental analysis**: all elements can be detected except H and He
- Average detection level : **0.1 - 0.5 atomic%**
- **Quantitative** analysis: precision 2-5%, accuracy 20 %
- **Surface analysis** : analysis depth < 100 Å (about 30 to 50 Å)
- **Chemical analysis** : type of bonds, oxide/metal rate...
- Spot size (for our device): 10 µm to 200 µm
- **Non destructive**... except in case of **concentration profiles**
- **Conductive and insulating samples**
- **Quantitative depth profiling**
- **Quantitative chemical imaging**
- Analysis under **ultrahigh vacuum** (10^{-9} - 10^{-10} torr)

PRINCIPLE

The surface of the sample is bombarded by a monochromatic X-ray beam. X-ray photons are absorbed by the material, the energy transferred, Ex, is partly used to excite core levels electrons: : $\mathbf{E_x = E_l + E_c}$, *(E_l binding energy and E_c kinetic energy of the excited electron).*

The detection consists of a kinetic energy filtering of emitted electrons. The **XPS spectrum** is described by a **succession of peaks which correspond to a given El** (for example, C 1s peak = excitation of carbon 1s level electrons), that's why it is possible to perform **elemental analyses.**



There are few interferences between peaks of the different elements. Even when a peak can correspond to several elements, there is, in general, a way to satisfy doubts by studying the whole elemental spectrum: presence/absence of peaks, relative intensity of characteristic peaks of the suspected elements, study of the Auger peaks, ... The signal under each peak of element A is proportional to the number of A atoms, so this **analysis** can be **quantitative**. Finally, the signal intensity as a function of sample thickness t is damped by exp(-t/**λ**) with **λ**, the mean free path of electrons in material: the deepest you go in the sample, the less the ejected electrons have a probability to be detected, i.e., the weakest is their contribution to total signal.

Thus 70 % of detected signal comes from the first l Å, and beyond 3**λ**, the contribution is negligible. λ being about 10 to 20 Å, the thickness analyzed is about 30 to 50 Å, that's why XPS is a **surface analysis** technique.