02: Surface analysis: an introduction to XPS

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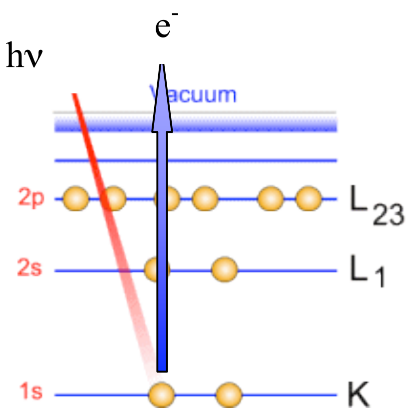
X-ray Photoelectron Spectroscopy known as XPS or ESCA (Electron Spectroscopy for Chemical Analysis) has been developed from the Fifties by Professor K. Siegbahn. The Physics Nobel Prize awarded his work in 1981. The most interesting thing with this technique is its ability to measure binding energy variations resulting from their chemical environment. For the past 20 years, this type of spectrometry emerged as a key tool in surface analysis, mainly because of two major features :

1. Quantitative analysis
2. Information on the chemical nature and state of the detected elements.

By absorbing a photon, an atom gains an energy amount equal to hn. It then releases an electron to regain its original stable energy state. The released electron retains all the energy from the striking photon. It can then escape from the atom, and even further from matter and kinetic energy keeps it moving.



For example, by usual X-ray sources, magnesium and aluminium emit at 1253.6 and 1486.6 eV respectively. The relative high level of the incident energy causes the matter to release an electron from an atom internal shell.

Consequently, there will be some atoms lacking electrons in the internal shells from which photoelectrons have been released. To recover from this ionised state the atom can emit another photon (fluorescence) or undergo an Auger transition. The principle of the conservation of energy allows us to write the energy balance equation, valid for the absorption of a photon carrying an energy of hν

$$h\nu = E_{\text{Kinetic}} + E_{\text{Binding}} + \varnothing_{\text{Work function}}$$

The course : The aim of this course is to provide an intensive introduction to the principles of the electron spectroscopic techniques of X-ray photoelectron spectroscopy. After theorical aspects, laboratory demonstrations will be performed. The lecturers will study 2 different kinds of surfaces, a silicon wafer and a stainless steel surface in order to identify elements and chemical bonds. Finally a model to describe oxide surfaces will be proposed to calculate oxide thicknesses.