S.O.S. IN ENVIRONMENTAL CHEMISTRY
JIWAJI UNIVERSITY, GWALIOR

X-ray photoelectron spectroscopy

Kai M. Siegbahn Obtained Nobel Prize For his work on XPS

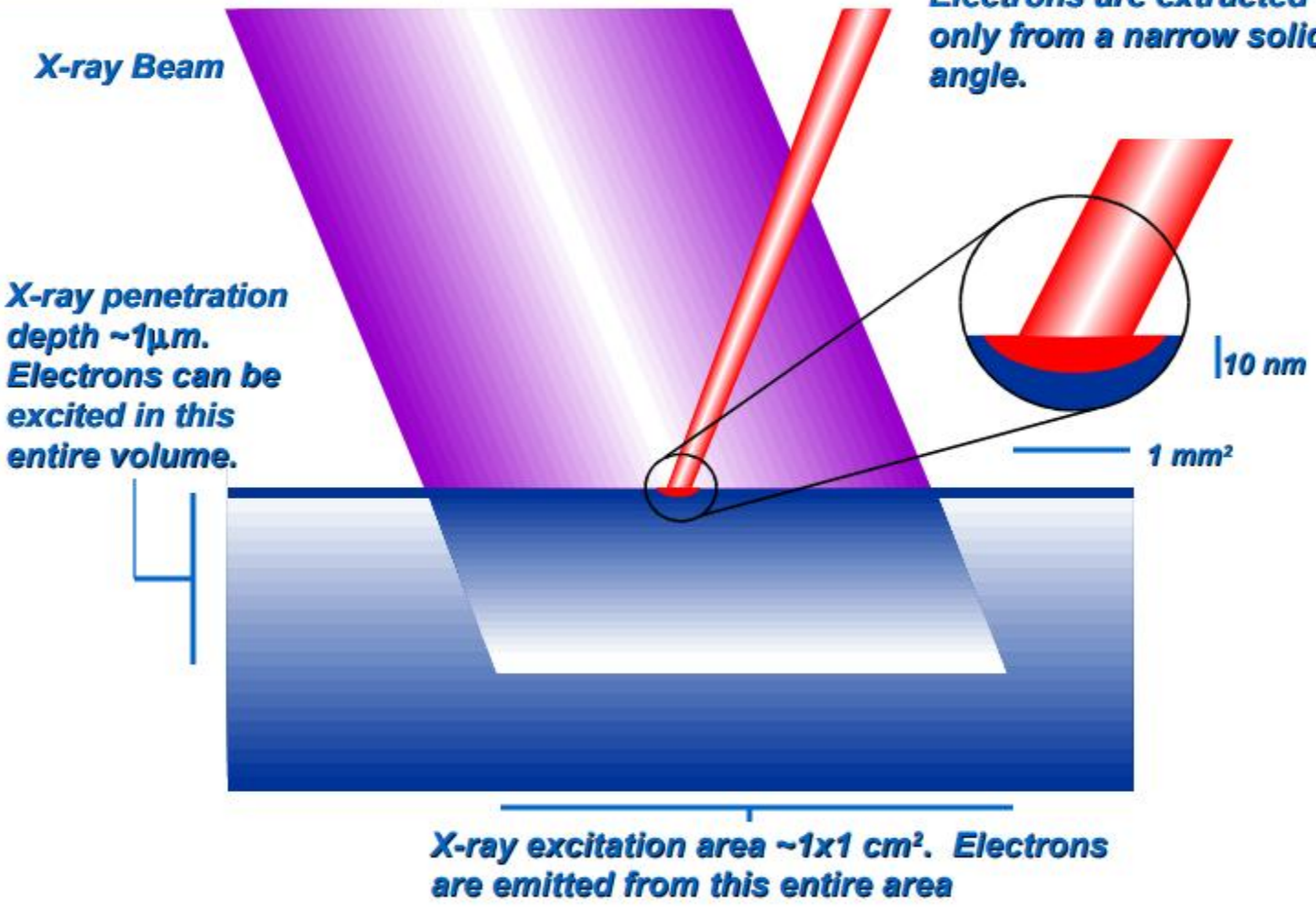
Introduction

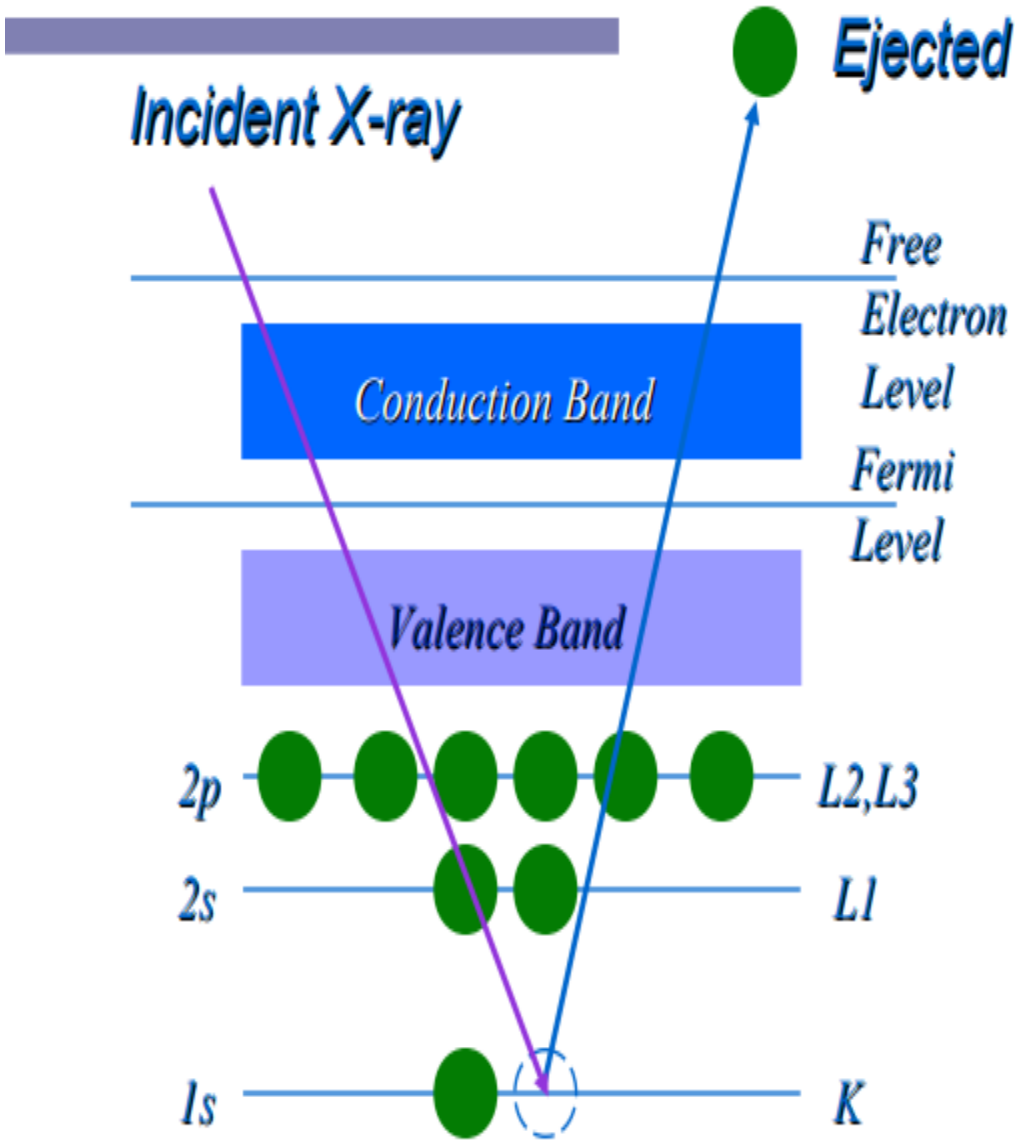
X-ray Photoelectron Spectroscopy (XPS), also known as Electron Spectroscopy for Chemical Analysis (ESCA) is a widely used technique to investigate the chemical composition of surfaces.

X-ray Photoelectron spectroscopy, based on the photoelectric effect,1,2 was developed in the mid-1960's by Kai Siegbahn and his research group at the University of Uppsala, Sweden

X-ray Photoelectron Spectroscopy

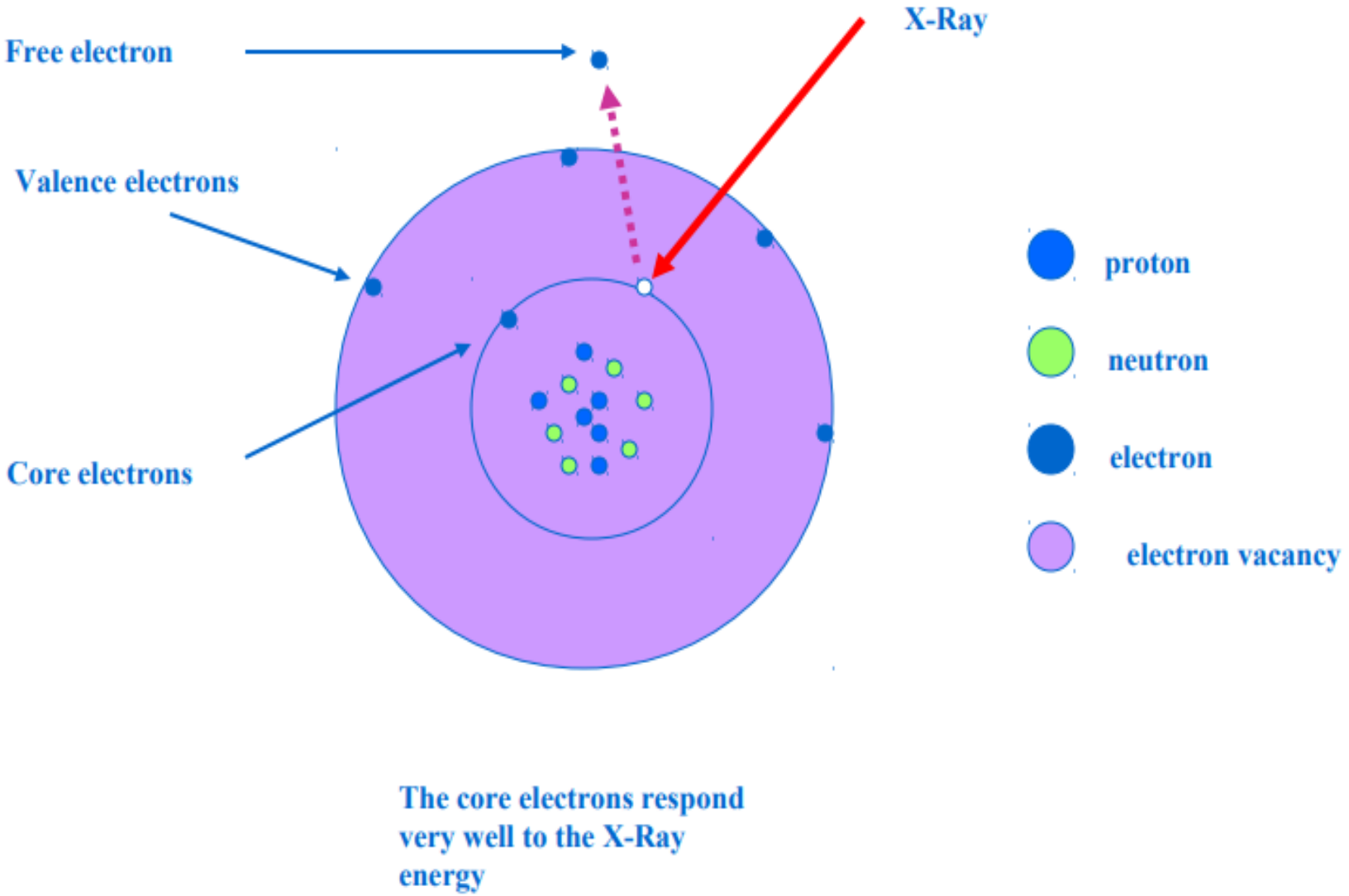
Small Area Detection





XPS spectral lines are identified by the shell from which the electron was ejected (1s, 2s, 2p, etc.). The ejected photoelectron has kinetic energy: $KE=hv-BE-\Phi$ Following this process, the atom will release energy by the emission of an Auger Electron

- A monoenergetic x-ray beam emits photoelectrons from the from the surface of the sample.
- The x-ray photons The penetration about a micrometer of the sample
- The XPS spectrum contains information only about the top 10 - 100 Å of the sample.
- Ultrahigh vacuum environment to eliminate excessive surface contamination.
- Cylindrical Mirror Analyzer (CMA) measures the KE of emitted e-s.
- The spectrum plotted by the computer from the analyzer signal.
- The binding energies can be determined from the peak positions and the elements present in the sample identified.



The core electrons respond very well to the X-Ray energy

COMPONENTS OF XPS:

- A source of X-rays
- An ultra high vacuum (UHV)
- An electron energy analyzer
- magnetic field shielding
- An electron detector system
- A set of stage manipulators

How Does XPS Technology Work?

• A monoenergetic x-ray beam emits photoelectrons from the surface of the sample.

•The penetration about a micrometer of the sample

• The XPS spectrum contains information only about the top 10 - 100 Å of the sample.

•Ultrahigh vacuum environment to eliminate excessive surface contamination.

•Cylindrical Mirror Analyzer (CMA) measures the KE of emitted e-s.

•The spectrum plotted by the computer from the analyzer signal.

•The binding energies can be determined from the peak positions and the elements present in the sample identified.

Use of XPS Technology

• Elements and the quantity of those elements that are present within the top 1-12 nm of the sample surface.

• Detects all elements with an atomic number (Z) of 3 (lithium) and above. It cannot detect hydrogen (Z = 1) or helium (Z = 2) because the diameter of these orbitals is so small, reducing the catch probability to almost zero.

• Chemical state analysis of the surface of polymers readily reveals the presence or absence of the chemical states of carbon known as: carbide (C 2-), hydrocarbon (C-C), alcohol (C-OH), ketone (C=O), organic ester (COOR), carbonate (CO_3), fluoro-hydrocarbon (CF_2 -CH_2), trifluorocarbon (CF_3).

•Is routinely used to analyze:

➢ Inorganic compounds.

➢Metal alloys.

➢Semiconductors.

➢Polymers.

➢Catalysts, glasses, ceramics, paints, papers, inks, woods, plant parts, make-up, teeth, bones, medical implants, bio-materials, viscous oils, glues, ion modified materials and many others.

•Organic chemicals are not routinely analyzed by XPS because they are readily degraded by either the energy of the X-rays or the heat from non-monochromatic X-ray sources.

Thank you