PHI 5600 XPS X-ray photoelectron Spectrometer

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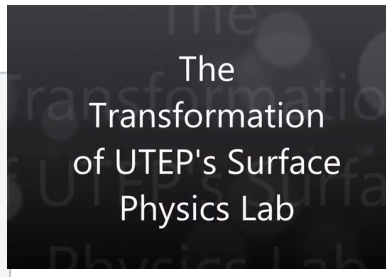
Curriculum vitae, Spanish writings, Nuclear and Surface Physics Group, Nuclear Physics Research, XPS Research



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PHI 5600 XPS X-ray Photoelectron Spectrometer

To see an introductory video click here.

To see the list of active and pending jobs, or to request an XPS/Auger/UPS study, click here.

Basic Theory

The XPS system enables quantitative element analysis at surfaces of solid materials by spectroscopy of emitted photo electrons, and gives information on the chemical states by analysis of peak-shifts or peak-shape changes.

The operating principle of XPS is the photoelectric effect: emission of an electron from an element due to collision between a photon ad an atomic electron. For this to occur the photon energy must exceeds a critical value, the ejected electron escapes with a kinetic energy equal to the difference between the incident energy of the photon and the energy required to remove the electron from its orbital into space (its original binding energy minus the work function). Knowing the phton energy and the kinetic energy of the emitted electron allows to calculate the binding energy, which can be used to identify the emitting atom.

The XPS 5600 operates by striking the sample with a high energy photon (an X-ray from a Mg or Al based source) and measuring the kinetic energy of all of the ejected electrons. The binding energies of these electrons are then calculated and from these a distribution of atomic species is determined. **The lightest element that XPS can detect is lithium**. Even though the X-ray photons can penetrate deeply into the material, scattering limits only electrons from the **top 5-10 nm to be ejected without attenuation of their kinetic energy**. Thus, XPS is considered a surface sensitive technique.

In addition to determining the atomic composition of the surface, XPS can also provide semi-quantitative information (expressed in units of **atomic percent**) by dividing the peak areas of each element by sensitivity factor, which is simply the probability of a particular element to emit an electron when struck by a photon. The sensitivity of XPS is element-dependent, with larger elements (which have larger sensitivity factors) being more sensitive than smaller elements.

XPS 5600 Characteristics

- excitation by Al-Ka (1586.6 eV) or Mg-Ka (1253,6 eV) X-rays, monochromatized Al-Ka, or He-UV-radiation
- electron analysis with a 150 mm diameter hemisperical energy analyzer with 16-channel multi-channelplate detector, pass energy from 2.9 to 175 eV, best energy resolution at Ag3d = 0.8 eV
- local analysis (best in the region of 100 µm) by a special lens-system, automatic map- and line-scan-analysis by a scanning system up to 2 mm * 2 mm, typical analysis region of 800 µm diameter
- sample holder 1 and 2 inch, computer-controlled sample tilt for automatic angle-resolved measurements
- sputtering with a SPECS IQ 12-38 ion gun typically by noble gas ions (e.g. Ar+) for surface cleaning and depth profiling, 2 mm * 2 mm scan region, 1 ... 4 nm / min sputtering rate
- low energy electron flood gun for charge compensation

- UHV vacuum system with a combination of Ti ion getter and an Ti sublimation pump, base pressure 10^{-8} Pa (10^{-10} Torr), fast load lock pumped with a turbomolecular pump, sample transfer between XPS and AES (and with glove box) without air exposure ($p < 10^{-5}$ Pa) possible
- UHV-coupling with 2 preparation chambers (heating, evaporation, scraping, sputter deposition)
- OmniFocus III small area lens
- 10-360 spherical capacitor analyzer
- Includes monochromator and OMNI III lens and MCD detector and scanning AES option.
- XPS sensitivity: Magnesium anode specified performance obtained with single Mg anode operating at 400 W (26.7 mA and 15 kV) on a sample of clean silver.
- Analysis area: Selected by an externally fixed 1-position aperture and by a computer-controlled analyzer (150 um analysis area)
- Environmental requirements:
    - Magnetic fields: less than 0.3 uT (3 mG) peak-to-peak, alternating field, less than 1G static field
    - Heat dissipation: 3,000 W under typical operating conditions, 10,000 W additional during system breakout
    - Utility requirements: 200-240 VAC, 1 phase, 50-60 Hz, 50 A (to be hardwired to separate 60 A branch circuit by customer)
    - Dry nitrogen: 0.279 kg/cm^2 (4 psi) max
    - Compressed air: 5.6 to 7.0 kg/cm^2 at 0.17 m^3/hr (80 to 100 psig at 0.1 CFM), pressure-regulated for vibration-isolated console and automatic valve control options only
- Samples must be solid and ultra high vacuum compatible (should not have a low sublimation pressure or be excessively oily, etc.).
- Maximum sample dimensions are roughly 2 cm in diameter and 1 cm in height.
- List of accepted wafer materials: alumina, BK7, Borofloat (Schott), ceramic, copper, Corning 1737, Foturan (Schott), fused silica, gallium arsenide, gallium phosphide, germanium, glass (Hoya), glass-ceramic, indium phosphide, lithium niobate, other, Pyrex (Corning 7740), quartz (fused silica), quartz (single crystal), sapphire, silicon, silicon carbide, silicon germanium, silicon on insulator, silicon on sapphire, titanium.

More Information

- Perkin-Elmer Handbook of XPS
- Safety Notices
- System Power and Emergency Off
- Calibration (see Page 14 of Handbook)
- Cooling System
- Hemispherical Energy Analyzer
- Monochromator
- X-ray Source
- Ion pump
- Mounting Samples
- Bake-Out
- Data Acquisition
- Using CASA XPS for data analysis
- Preventing Maintenance

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