

## **PHI 5600 LS XPS System**

### **Brief Description:**

Monoenergetic x-rays are focused onto the surface of a material and excite surface atoms. Core and valence shell photoelectrons with energies characteristic of elements in the top 100 angstroms are ejected and energy analyzed to obtain qualitative and quantitative information on surface composition. The kinetic energy of the electron emitted provides information about the functional group and the oxidation state of the surface species.

### **Type of Information Obtained:**

Qualitative and quantitative analysis of elements and functional groups present at surfaces.  
Oxidation states of surface atoms depth distribution of topmost surface species  
Surface chemical reaction products following exposure to reactants, plasmas, temperatures, and specialized environments.

All elements except hydrogen and helium can be detected. Detection limits are element-specific and are typically ~0.01-0.1 atom percent. It should be recognized that low-concentration bulk components (ppm) that migrate to a surface may be easily detected if the surface concentration exceeds our detection limit in the outermost 100 angstroms. The XPS experiment is performed in ultrahigh vacuum, so samples should be vacuum-compatible. Solids, films, powders, and fibers can be analyzed. Thin samples up to 8 inches in diameter can be studied intact. Proper handling of the sample before analysis is critical, because contamination must be avoided (fingerprints can completely mask the surface of interest).

### **Examples of Uses:**

- Studies of surface modifications and treatments
- Locus-of-Failure identification in multi-layer films
- Determination of fiber finish compositions
- Identification of thin film coatings and surface contaminants
- Catalyst oxidation state and poisoning studies
- Surface coatings of pigments
- Surface compositions of polymers and polymeric coatings

The system is composed of seven major subsystems: the vacuum system and associated electronics; the integrated console; the x-ray generator; the analyzer-detector and associated electronics; the computer electronics; the sample manipulation system electronics and sample processing hardware; and the sputtering system.

The vacuum system is all UHV construction with a 220-liter per second ion pump and a titanium sublimation pump. The sample introduction system allows a sample platen to be introduced into the vacuum system. A mechanical and turbo molecular pump provides

introduction system pumping. Valve sequencing and pumping can be controlled manually or with the automated Auto Valve Control.

The system has two x-ray sources: a standard dual anode and an aluminum monochromator. A closed cycle heat exchanger deionizer unit provides x-ray source cooling. It has a flow rate indicator which is interlocked with the x-ray source electronics so that if the coolant flow stops, the x-ray source turns off.

Electron energy analysis is provided by a 180° spherical capacitor analyzer. The analyzer is composed of two concentric hemispheres, which are surrounded by a magnetic shield. The electrons are detected by a multi-channel detector (a 16-position channel plate detector).

Instrument control, data acquisition and data reduction are provided by Windows 10 PC. The acquisition and data massage software provide automation of all sample positioning and analysis parameters. Operator-defined settings allow the operator to recall frequently used analysis settings. The operator can perform data analysis and reduction while data acquisition is occurring. Further, the system can operate in an automated mode to improve the system efficiency. Advanced data reduction can also be done through use of the optional CasaXPS software package.

The large sample manipulator (a base multi-sample platen) can position a single sample up to eight inches in diameter, up to one inch thick, and up to five pounds in weight; up to 100 smaller samples; or a combination of intermediate sized samples. For angle resolved XPS, the LS system has a specially designed platen that permits data acquisition of photoelectron take-off angles from 10° to 90°. Computer control of sample positioning (stage movement along x, y, and z axis as well as tilt and rotation under automated control) on all platens allows the operator to select and program up to 100 analysis positions. A continuous zoom binocular microscope, color camera and monitor are used to align the sample and locate specific regions for analysis.

A variable intensity, flange-mounted light source is used to illuminate the sample during sample alignment. The analysis area is selected by an externally adjustable five-position aperture (Variable; 0.8 x 2 mm to 75 µm ) and by computer-controlled analyzer lens voltages.

A sputter ion gun is provided and used for the removal of surface contamination and for XPS composition depth profiling capability.

The LS system has been under service contract during its entire lifetime including yearly preventative maintenance visits. All manuals that came with the instrument are in possession.

### **Complete Specifications:**

**Data Acquisition Modes** ..... survey, multiplex, depth profile, angle resolved

#### **Analysis Area**

Analysis Area..... Variable; 0.8 x 2 mm to 75 µm diameter

Resolution..... 0.48 - 1.40 eV

#### **Sample Dimensions, Stage**

Maximum Sample Width..... 8 in (20.32 cm)

Maximum Sample Height..... 1 in (25 mm)

Maximum Sample Weight..... 5 lbs (2.3 kg)

Stage..... 5-axis computer controlled

#### **Precision Energy Analyzer**

Type ..... Spherical Capacitor Analyzer (SCA)

Lens..... Omni-Focus™ III

Detector..... Multi-Channel Detector

#### **Analyzer Electronics**

Energy

Scan Range..... 0 to 4800 eV

Resolution..... 0.025 eV minimum step size

Pass Energy (Fixed Analyzer Transmission Mode)

Range ..... 0 to 200 eV

#### **Monochromatic X-Ray Source**

Energy Range..... Variable; 4 kV to 15 kV

Anode Material ..... Al

Power ..... 300 W in continuous operation

#### **Dual Anode X-Ray Source**

Energy Range..... Variable; 4 kV to 15 kV  
Anode Material ..... Side 1 – Mg, Side 2 – Al  
Power ..... maximum 400 W during single  
anode operation

**Ion Gun**

Source Type..... Electron Impact  
Beam Voltage..... Variable, up to 5 kV  
Maximum Beam Current ..... 5  $\mu$ A  
Beam Current Density..... 600  $\mu$ A/cm<sup>2</sup>  
at 5.0 cm from gun  
Beam Diameter ..... Variable, 800  $\mu$ m to 200  $\mu$ m at 5.0  
cm from gun  
Raster ..... Independent x and y rastering,  
maximum 10mm by  
10mm centered on static beam position  
Gas ..... Argon  
Differential Pumping .....  $< 7 \times 10^{-8}$   
Torr in test chamber while sputtering with turbo molecular pump

**Vacuum System**

Base Pressure.....  $\leq 5 \times 10^{-10}$  Torr