

PHI *Quantera II*

Product Description



Overview

The *Quanter II* is a unique scanning XPS microprobe that provides robust large area spectroscopy and unequaled micro-area spectroscopy performance. Capabilities of the *Quanter II* include: x-ray beam induced secondary electron imaging for rapid and confident location of small sample features, large and micro-area spectroscopy, chemical state XPS imaging, high performance sputter depth profiling, automated angle dependent depth profiling, turnkey insulator analysis, and a robotic sample handling platform to automate the analysis of multiple experiments or samples.

The *Quanter II*'s unique x-ray source can produce x-ray beams from less than 7.5 μm to 300 μm in diameter. The focused beam is used to define the dimensions of points, lines, and areas for analysis. This unique approach directs all x-rays to the desired analysis area which maximizes sensitivity, especially for micro-area analyses.

Since the x-ray source is used to define the analysis area, the input lens for the *Quanter II*'s energy analyzer does not need area definition apertures and is designed with one objective, maximum sensitivity. The *Quanter II*'s electrostatic input lens overcomes the limitations of an electromagnetic input lens and provides high sensitivity whether a sample is thin or thick, polymer or steel. This high transmission input lens combined with the focused x-ray source provides the highest sensitivity with the lowest x-ray induced damage potential over a wide range of selected analysis areas.

A floating column sputter ion gun provides high etch rates with accelerating voltages from 200 eV to 5 keV. Whether you are studying thin film structures with thicknesses of microns or nanometers the *Quanter II*'s ion gun provides the capability required to effectively and efficiently perform the experiment.

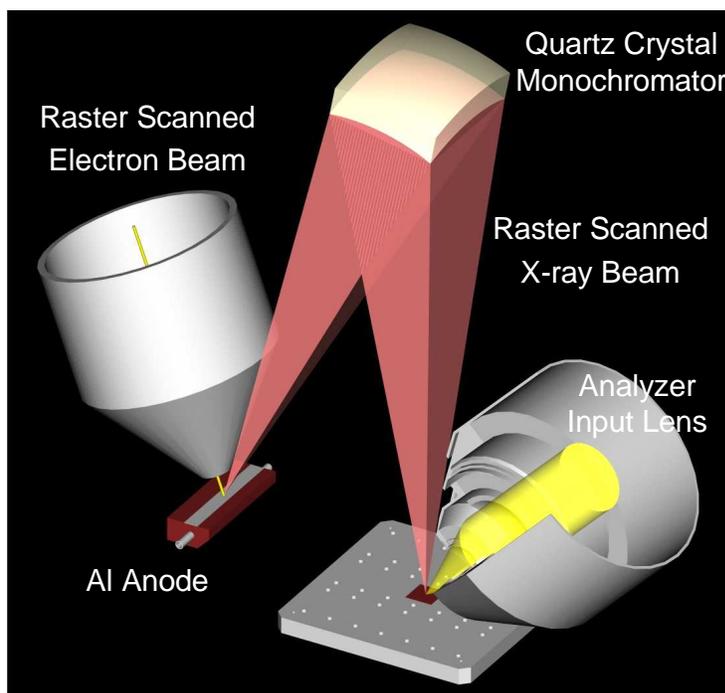
PHI's patented dual beam charge neutralization method eliminates sample-to-sample tuning and the need to mask insulating samples. This turnkey charge neutralization method coupled with robust "Auto-Z" sample alignment, and robotic sample handling provides the ability to characterize three platens full of samples with no operator intervention.

The instrument control software, *SmartSoft-XPS*, provides an easy-to-use task oriented user interface. Every aspect of the instrument is under software control and a powerful queue function facilitates the automation of multiple experiments and the analysis of multiple samples.

PHI *MultiPak* provides a complete array of basic and advanced data processing tools for data interpretation and report generation.

Patented Monochromatic Scanning X-ray Source

The *Quanterra II* is driven by a unique x-ray source that provides a focused monochromatic x-ray beam that can be scanned upon the sample surface. The x-ray source utilizes a focused electron beam that can be electronically raster scanned upon an Al anode for x-ray generation and an ellipsoidally shaped quartz crystal monochromator that refocuses the x-ray beam onto the sample surface. Therefore, when the electron beam is scanned on the anode surface, the refocused x-ray beam is scanned on the sample surface as shown below.



- * US Patent 5,315,113
- * US Patent 5,444,242
- * JP Patent 3752252B2
- * JP Patent P3754696B2
- * EP Patent 0590308B1
- * EP Patent 0669635B1
- * EP Patent 12202080B1

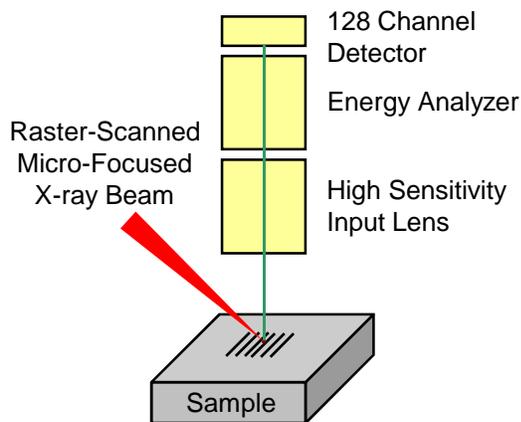
The diameter of the x-ray beam is user selectable from less than 7.5 μm to 300 μm in diameter. The focused x-ray beam can be used to define single or multiple analysis points, areas, lines, and maps. This unique x-ray source directs all the x-rays to the selected analysis area, which maximizes sensitivity and minimizes the potential for x-ray beam damage.

This unique x-ray source also provides a high performance large area analysis capability. Operating in a mode analogous to a rotating anode, a 100 W - 100 μm diameter x-ray beam is scanned 1.4 mm in the non-dispersive direction of the x-ray monochromator at high speed, providing a large rectangular analysis area with both high sensitivity and high energy resolution. The width of the rectangular area is user adjustable from 0.1 to 0.5 mm.

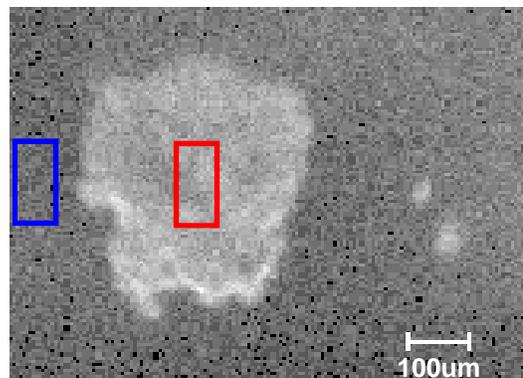
Unique Scanning X-ray Imaging (SXI™)

The *Quantera II* provides x-ray excited secondary electron imaging of the sample surface in a manner analogous to how an SEM generates a secondary electron image. This unique feature utilizes the scanned x-ray beam to generate secondary electrons that are collected by the *Quantera's* energy analyzer to provide images with topographical or surface chemical contrast information in a few seconds. X-ray excited secondary electron images can be acquired from insulating or conducting samples without coating or masking the sample. The use of the same hardware for secondary electron imaging and XPS measurements ensures that spectroscopic information is coming from areas selected on secondary electron images. This unique capability facilitates the rapid and confident location of small sample features for analysis.

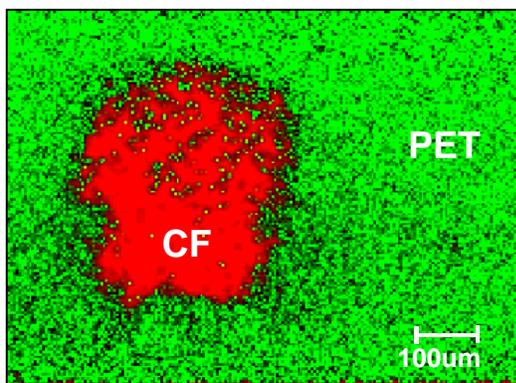
Quantera II Scanning XPS Microprobe



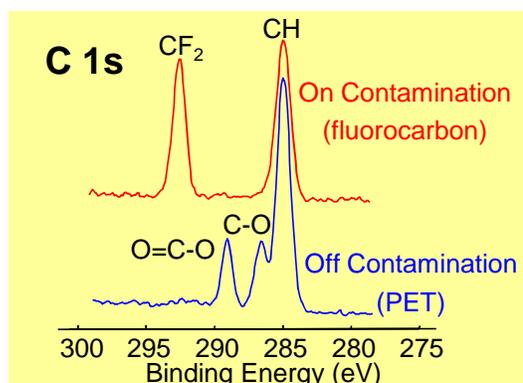
Secondary Electron Imaging of Contamination on a Polymer Film



C 1s Chemical State Maps



Micro-Area Spectroscopy



Uncompromised X-ray Photoelectron Spectroscopy

The *Quanterra II*'s spectrometer and unique x-ray source provide a full-featured XPS analysis capability including: large area spectroscopy, micro-area spectroscopy, sputter depth profiling, mapping, line scans, and angle dependent depth profiling. This patented XPS microprobe instrument platform provides the same ultimate spatial resolution for spectroscopy and imaging. Detailed spectroscopy, depth profiling, imaging, and angle dependent measurements are available at all x-ray spot sizes. The versatile and high sensitivity spectrometer consists of an electrostatic input lens, a 180° spherical capacitor energy analyzer (SCA), and a 128 channel multi-channel detector (MCD).

The input lens uses electrostatic lens elements that maintain high sensitivity on thin or thick samples, polymers and metals. Because the *Quanterra II* uses its x-ray source to define analysis area size, the use of apertures in the input lens to define the analysis area is not required. This aperture-free lens design provides significantly higher sensitivity than aperture based input lenses and consistent XPS quantification for all analysis areas.

The 128 channel detector provides high dynamic range and further enhances spectrometer sensitivity. The MCD can be operated in both the scanned and unscanned (snapshot) detection modes. The scanned mode is the standard spectroscopy mode. In the scanned mode each data point is measured by each detector channel. This eliminates any detector signature and allows user selectable data point density. The unscanned mode is used for maps and lines scans and provides a 128 channel spectrum at each pixel that can be used to provide quantitative and chemical state information. Depth profiles can be obtained using either detection mode. The snapshot mode reduces data collection time and provides 128 channel spectra at each depth. The scanned mode allows the user to independently define the energy range, pass energy, and number of data points (up to 4000) for each spectral region.

Patented Charge Neutralization Capability

The *Quanterra II* is equipped with PHI's patented* dual beam charge neutralization system that utilizes both a cold cathode electron flood source (~ 1 eV) and a very low energy ion source (≤ 8 eV) to provide turnkey charge neutralization of all sample types. This unique capability eliminates sample to sample tuning of the neutralizer apparatus, eliminates the need for masking insulating samples, and makes it possible to automatically analyze multiple types of insulating samples with no operator intervention.

* JP Patent 3616714, US Patent 5,990,476 , EP Patent 0848247B1

High Performance, Sputter Depth Profiling

Features of the *Quantero II* that contribute to its powerful sputter depth profiling capability include: a high performance floating column argon ion gun, the focused x-ray source, 128 channel MCD, *Compucentric Zalar™* rotation, and dual beam charge neutralization. Dual beam charge neutralization can be effectively used to minimize or eliminate peak shifting when sputtering through layers with different electrical properties. This makes the spectra from depth profiles far more useful for chemical interpretation. For routine thin film analysis applications the ion gun can be operated between 1 and 5 KeV with high etch rates. For ultra thin films the ion gun's floating column can be used to generate a high current low energy ion beam (200 – 500 eV). Low energy ion beams minimize sample damage and enhance interface definition. The ion gun is also equipped with a neutral filter to further enhance interface definition and minimize the sputtering of adjacent areas. The ion gun is completely software controlled. The use of software settings to define operating conditions improves day-to-day repeatability of etch rates and makes it possible to program etch rate changes during a depth profile analysis.

High Performance Angle Dependent Analysis (ADXPS)

A dedicated sample holder is provided to facilitate automatic angle dependent XPS profiling with an angular range of 5° to 90° (photoelectron take-off angle). *SmartSoft-XPS*, the instrument control software, provides eucentric tilt compensation to ensure the same location is analyzed at each angle. Multiple samples can be attached to the ADXPS sample holder and accessed in a queue for unattended multiple sample ADXPS analysis. Two software selectable angular acceptance modes are available $\pm 20^\circ$ and $\pm 4^\circ$. PHI *MultiPak* contains spectral manipulation tools for chemical state analysis including curve-fitting and linear least squares fitting of ADXPS data files. *MultiPak* also contains an ultra thin film analysis tool to extract a stratification model of the measured thin film structure.

Sample Handling

The *Quantero II* accepts up to three 75 x 75 mm sample platens that can be loaded with samples for automated analysis. The maximum sample size is 100 mm in diameter and up to 25 mm thick. The vacuum processing required to introduce a sample platen is under software control and in-vacuum movement of sample platens is performed by a robotic arm. The robotic arm can access the sample introduction chamber, sample stage, and the two in-vacuum parking positions. Up to three platens may be loaded into the analysis chamber for automated analysis. A high resolution digital optical image of the sample platen is obtained in the sample introduction chamber and it is possible to zoom in anywhere on the platen using *SmartSoft-XPS*. The sample platen image can be used for navigation and defining analysis locations.

The five axis sample stage is motorized and software driven. The entire 75 x 75 mm sample platen can be accessed using X and Y translations. Rotation is *Compucentric* (eucentric) allowing the orientation of a sample to be easily changed if necessary. In the central region of the sample platens, *Compucentric Zalar* rotation can be used to minimize sputtering artifacts associated with sputtering at a fixed angle and improve layer (interface) definition.

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Four sample platens are provided with the *Quantero II* along with a hardware kit of assorted screws, clips, and sample masks:

Model 750 platen	2 each	A 75 mm square sample platen with multiple tapped holes for mounting screws, capable of mounting multiple small samples or a large sample up to 100 mm in diameter.
Model 760 platen	1 each	Identical to the Model 750 sample platen except for the inclusion of a Faraday cup at the center of the platen
Model 755 platen	1 each	A 75 x 16 mm raised sample platen, for angle dependent studies, capable of mounting multiple samples or five of the supplied sample masks.

UHV Test Chamber

The *Quantero II*'s test chamber provides a true Ultra-High Vacuum (UHV) environment to prevent vacuum related contamination of the surface being measured. A 480 l/s differential ion pump and a 1,000 l/s titanium sublimation pump are used to maintain a UHV environment in the test chamber. The sample introduction chamber, differential ion gun pumping, and test chamber roughing are accomplished using a 210 l/s turbomolecular pump.

User Interface and Data Station

The user interface for the *Quantera II* is provided by two software packages that reside on a Hewlett-Packard® personal computer that uses an Intel Pentium® processor and a Windows® operating system. *SmartSoft-XPS*, the instrument control software, provides a task oriented user interface and software control of all instrument functions. Data reduction is accomplished via a seamless interface to *MultiPak*, PHI's advanced data manipulation software. The Windows operating system and an integrated LAN port provide the tools required to connect the *Quantera II* to a local computer network.

PHI *Quantera II* Optional Accessories

Optional Sample Positioning Station

The Sample Positioning Station (SPS) provides a high magnification optical imaging interface for sample navigation. The SPS is located on the operators table and consists of a high quality 350X optical microscope, light source, color CCD camera and a precision microscope table with position encoders to record the location of captured optical images. The spatial resolution of the SPS imaging system is approximately 2 μm . Once images are captured, the sample platen is inserted into the *Quantera II* and the selected sample feature can be relocated with a positioning accuracy of less than 20 μm .

Optional C₆₀ Sputter Ion Gun

An optional 10 keV or 20 keV C₆₀ sputter ion gun can be mounted on an optional auxiliary chamber to provide surface cleaning capabilities for removing contamination from polymer samples. This unique feature also allows sputter depth profiling of many polymer thin films with minimal chemical damage. C₆₀ powder is evaporated and injected into an electron impact ionizer. The C₆₀ ion beam is accelerated through an extraction lens which focuses the beam at a Wien filter aperture for mass separation. An isolation valve is included to allow source maintenance without breaking vacuum in the analytical chamber. The ion gun column has a 1 degree bend at the blanking plate for eliminating neutral particles to preserve sample chemistry, enhance depth resolution, and minimize sputtering of adjacent areas.

Optional 20 kV Ar₂₅₀₀⁺ Gas Cluster Ion Gun

The optional Ar gas cluster ion gun is mounted on an optional auxiliary chamber to provide sputter depth profiling for a wide range of polymer and organic thin films. This unique ion gun also provides the ability to remove organic surface contaminants from inorganic and organic materials. A high pressure and high purity Ar gas flow is introduced into the ion gun to form a giant Ar cluster by rapid adiabatic expansion and injected into an electron impact ionizer. The Ar gas cluster ion beam (GCIB) is accelerated through the extraction lens which focuses the beam into a Wien filter where smaller clusters and mono-atomic Ar are removed. An isolation valve is integrated into the ion optics to allow source maintenance without breaking vacuum in the analytical chamber. The ion gun column has a 4 degree bend to eliminate neutral particles from the ion beam and to preserve sample chemistry, enhance depth resolution, and minimize sputtering of adjacent areas. The dedicated differential pumping system is configured with turbo pumps, mechanical oil rotary pumps, and a water chiller. When the GCIB option is selected, the ion pump on the main chamber will be replaced with a large turbo pump and an oil lubricated rotary pump.

Optional Auxiliary Chamber and Transfer Rod

The optional auxiliary chamber provides a sample transfer point for moving sample platens from the analysis chamber to an external experimental station or sample treatment chamber. The sample transfer rod provides the ability to transfer a 25 mm diameter sample mount from the auxiliary chamber into a custom sample treatment chamber.

Optional Hot/Cold Sample Stage and Hot/Cold Sample Introduction

The Hot/Cold option allows the central area of the 75 x 75 mm hot/cold sample platen to be temperature controlled in the introduction chamber to a nominal temperature range of -150° C to +250° C and on the sample stage to a nominal temperature range of -120° C to +250° C. The Hot/Cold apparatus uses liquid nitrogen cooling and resistive heating to provide the specified temperature ranges. All five axis of sample stage motion are maintained when heating or cooling.