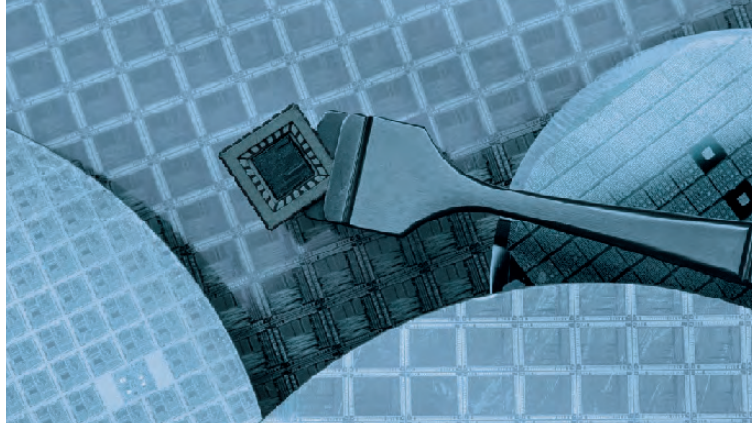
PHI

VersaProbe III

Scanning XPS Microprobe



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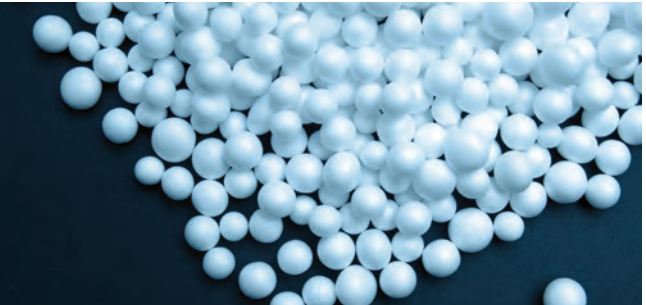


PHI *VersaProbe* III

Scanning XPS Microprobe

X-ray photoelectron spectroscopy (XPS/ESCA) is the most widely used surface analysis technique and has many well established industrial and research applications. XPS provides quantitative elemental and chemical state information from surfaces and thin film structures. XPS is applied to a diverse range of materials applications including: polymers, metals, catalysts, thin films, photovoltaics, batteries, wear coatings, nanomaterials, semiconductor devices, magnetic storage media, display technology, and biomedical devices.

The *VersaProbe* III is the next generation of PHI's highly successful multi-technique XPS product line and provides a two to three-fold increase in sensitivity over the previous generation. Physical Electronics (PHI) is the leading supplier of surface analysis instrumentation and PHI XPS instruments are the only XPS instruments that are equipped with a micro-focused, raster scanned, x-ray beam that provides the unique capabilities associated with a scanning XPS microprobe while maintaining an uncompromised large area spectroscopy capability.

An array of optional excitation sources, ion guns, and sample treatment options are available to support your multi-technique requirements.

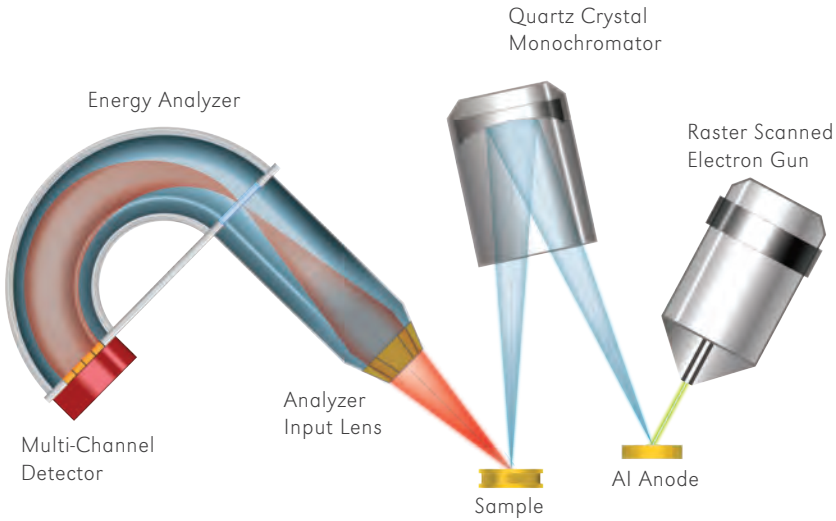
THE SCANNING XPS MICROPROBE ADVANTAGE

Unique Capabilities

PHI's scanning XPS microprobe instrument platform provides secondary electron images (SXI) generated by scanning a focused 10 µm x-ray beam across the sample. These SXI images have a contrast mechanism that is dominated by photoelectron yield (composition), and therefore often reveal features that are not visible optically or related to topography.

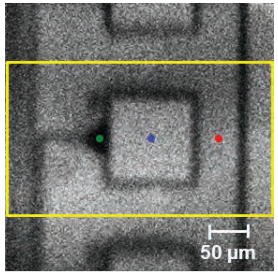
SXI images provide a high degree of confidence in locating small features for analysis.

The micro-focused x-ray beam defines the analysis area pattern for large area spectroscopy, micro area spectroscopy, chemical state imaging and depth profiling.

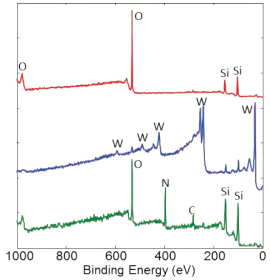


PHI's patented scanning XPS microprobe technology delivers a micro-focused, raster scanned, monochromatic x-ray beam to the sample surface providing unique and powerful capabilities to our users.

THE SCANNING XPS MICROPROBE ADVANTAGE



SXI image of a patterned device structure.

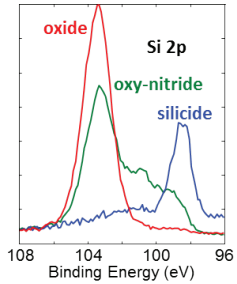


Spectra from three selected locations on the SXI obtained using a sub 10 µm x-ray beam.

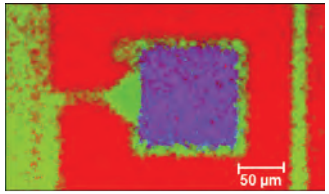
Microprobe Workflow

A typical analysis begins by collecting an SXI image that is quickly generated using a sub 10 µm diameter raster scanned x-ray beam. Regions for spectral analysis or imaging are selected from the SXI image with a point-and-click user interface. The resulting spectra are used to guide the next steps which may include: obtaining high energy resolution spectra for chemical state analysis, chemical state images, or compositional sputter depth profiles.

Si Basis Spectra

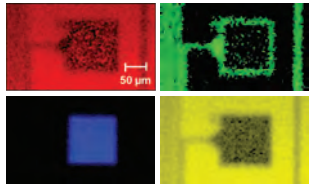


Si Chemical Images



oxide (red), oxy-nitride (green), silicide (blue)

Si chemical state images were created using linear least squares fitting with 128 channel basis spectra that were extracted from the elemental Si 2p image data set.



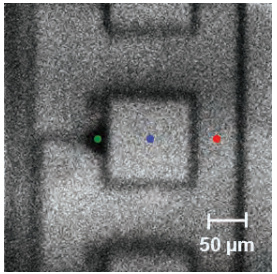
Elemental Images

Elemental images obtained with a sub 10 µm x-ray beam.

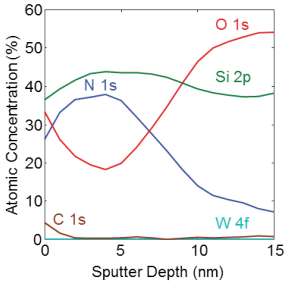
THE SCANNING XPS MICROPROBE ADVANTAGE

Multi-Point Depth Profiling

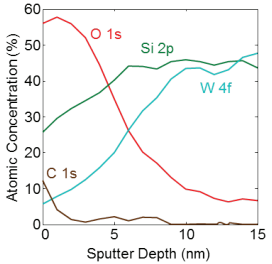
A unique and powerful capability enabled by PHI's scanning XPS microprobe technology is the ability to obtain a multi-point sputter depth profile data set using analysis points defined on an SXI image. In one measurement, with one sputter crater, depth profiles from multiple locations can be obtained as shown in the example on this page. The ability to obtain comparative depth profiles from neighboring sample features or on and off of a defect in a single measurement is a powerful tool for PHI XPS users.



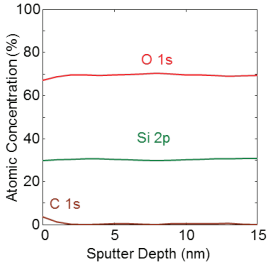
SXI of a patterned device structure showing analysis locations for a multi-point sputter depth profile.



Depth profile of the green (oxy-nitride) point obtained using a sub 10 µm x-ray beam.

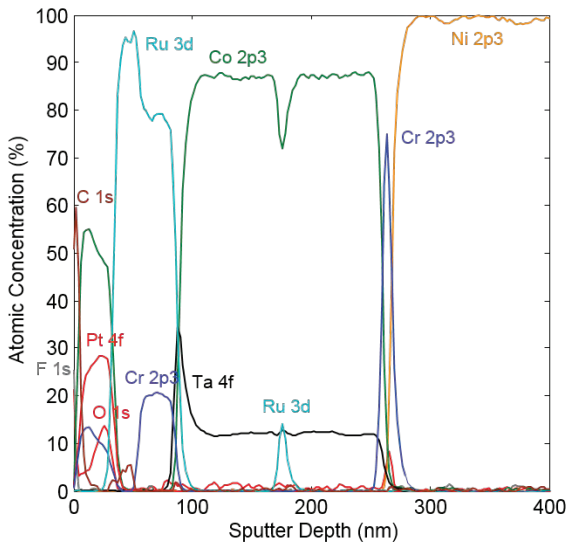


Depth profile of the blue (silicide) point obtained using a sub 10 µm x-ray beam.



Depth profile of the red (oxide) point obtained using a sub 10 µm x-ray beam.

THIN FILM ANALYSIS



2 keV Ar^+ sputter depth profile of a multi-layer coating on a computer hard disk performed using Zalar rotation to enhance layer definition.

Inorganic Thin Film Analysis

- Floating column ion gun enables efficient low voltage depth profiling
- Bend in ion column to stop neutrals
- Compucentric Zalar rotation
- Robust dual beam charge neutralization
- Micro-area depth profiling
- Multi-point depth profiling

Optimized Configuration

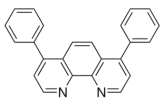
A focused x-ray beam, high sensitivity spectrometer, high performance floating column argon ion gun, turnkey dual beam charge neutralization, compucentric Zalar™ rotation, and advanced data reduction algorithms provide the highest performance XPS depth profiling capability available. The standard monatomic argon ion gun is capable of generating 5 eV to 5 keV Ar ion beams and is ideally suited for most inorganic depth profiling applications.

Ar_{2500} CLUSTER SOURCE ION GUN OPTION

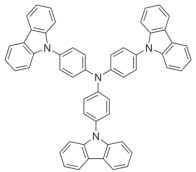
Organic Depth Profiling

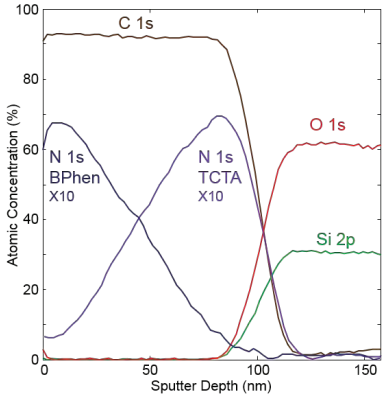
It is well known that monatomic Ar ion guns used for inorganic thin film analysis typically cause severe chemical damage when sputtering most polymer and organic materials. PHI has led the way in developing and applying cluster source ion guns for the successful thin film analysis of polymer and organic materials. Our optional 20 kV Ar_{2500} gas cluster ion gun and optional C_{60} ion guns have proven performance for depth profiling many polymer and organic films while minimizing the potential for chemical damage.

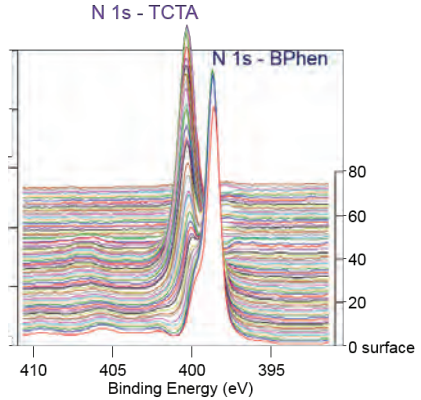
BPhen



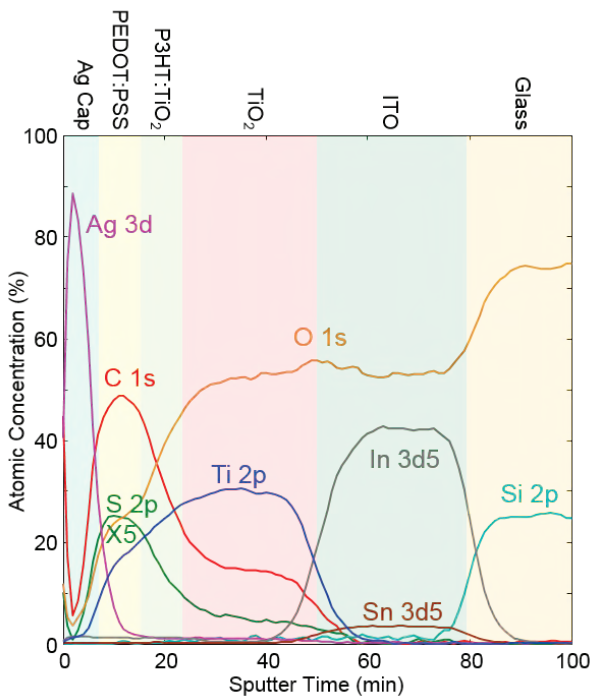
TCTA







10 kV Ar_{2500} gas cluster ion beam sputter depth profile of a graded OLED test structure showing the ability to preserve and observe the two organic species that make up the test structure. The montage plot of N 1s spectra, on the right, shows the spectra that were used to create chemical state plots for N with the linear least squares fitting algorithm in PHI MultiPak.



20 kV C_{60} sputter depth profile of an inverted organic photovoltaic device that contains metal layers, organic layers, oxide layers and a mixed matrix layer with an organic and TiO_2 nanorods. Compucentric Zalar rotation was used to enhance layer definition.

C_{60} CLUSTER SOURCE ION GUN OPTION

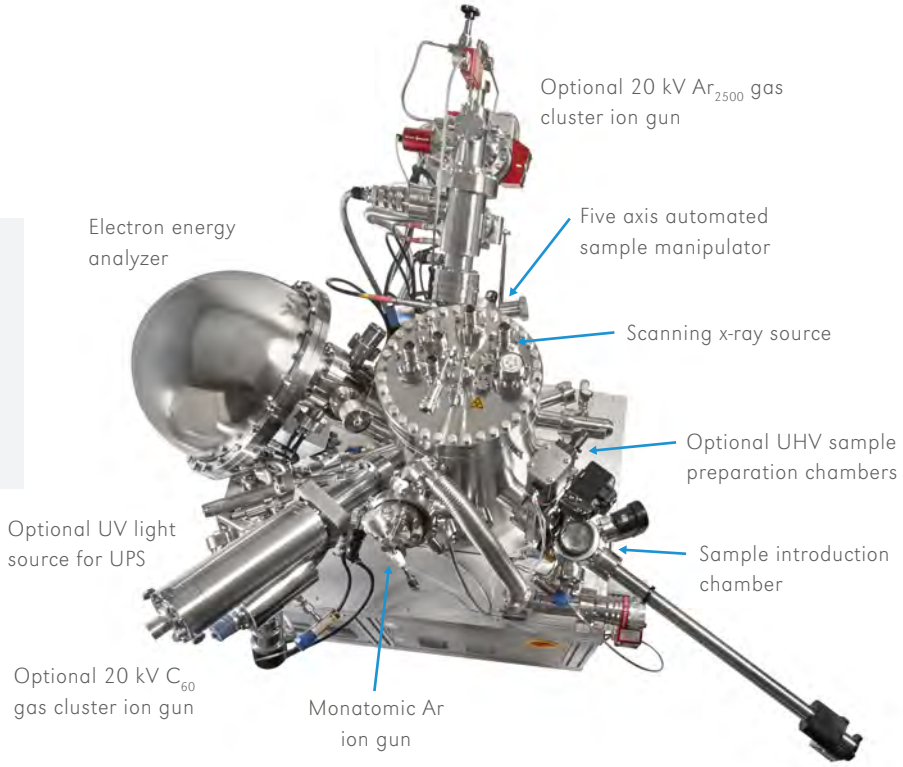
Inorganic depth profiling

With the introduction of cluster source ion guns for organic and polymer thin film depth profiling, interest has grown in applying these ion guns to inorganic structures that sustain chemical damage with monatomic Ar ion beam sputtering. Our experience has shown that some metalloids, oxides, and thin film structures that contain both organic and inorganic materials sustain less chemical damage and differential sputtering artifacts when depth profiled using a 20 kV C_{60} cluster source ion gun.

VERSATILE TEST CHAMBER CONFIGURATION

Integrated Optional Accessories

The *VersaProbe* III test chamber is designed to accept multiple photon and ion sources that are focused on a common analysis point on the sample and are all controlled from the *SmartSoft* user interface.



CAPABILITIES

Standard Features

- Scanned, micro-focused, monochromatic x-ray beam
- X-ray beam induced secondary electron imaging
- Dual beam charge neutralization
- 128 data channel detection
- Large area XPS
- Micro area XPS
- Chemical state imaging
- Multi-point sputter depth profiling
- Floating column monatomic Ar ion gun
- Compucentric Zalar rotation
- Angle dependent XPS
- Five axis automated sample manipulator
- 25 mm and 60 mm diameter sample holders

Optional Accessories

- 10 kV C_{60} ion gun
- 20 kV C_{60} ion gun
- 20 kV Ar_{2500} gas cluster ion gun
- 100 nm Scanning AES
- UV light source for UPS
- Dual anode, achromatic x-ray source
- Hot / Cold sample manipulator
- Custom sample preparation chambers

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