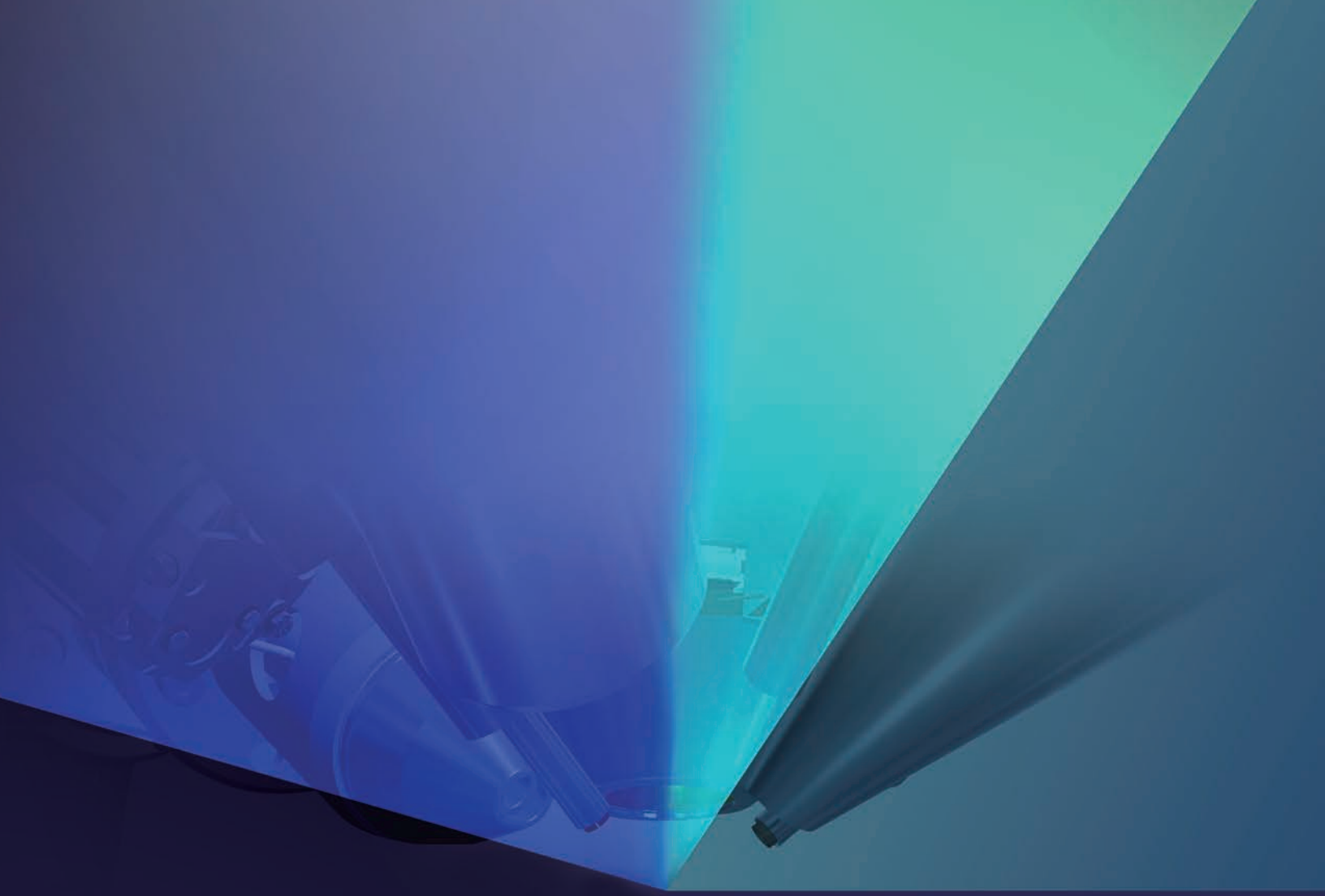


PHI GENESIS

Fully Automated Multi-technique Scanning XPS/HAXPES

PHYSICAL ELECTRONICS
A DIVISION OF ULVAC-PHI

PHI GENESIS

Model 500 for XPS / Model 900 for HAXPES

NO COMPROMISE!!

Features

Fully automated
Multi-tech XPS / HAXPES

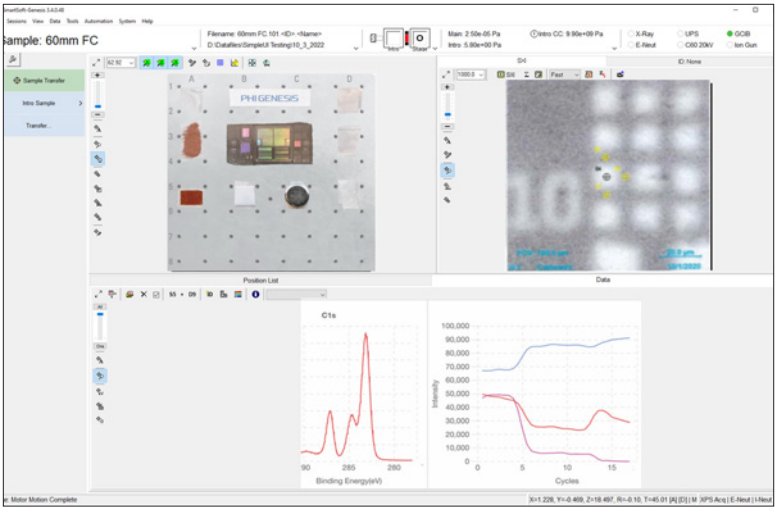
- ✓ Easy Operation & Multi-technique Options
- ✓ Fully Automated with Sample Parking
- ✓ High-Performance Large & Micro Area XPS Analysis
- ✓ High Speed & Non Destructive Depth Profiling
- ✓ Hard X-ray Cr Kα source for HAXPES
- ✓ Comprehensive solution for batteries, semicondutors, organic devices and other applications


ULVAC-PHI, INC.
PHI GENESIS

Ease of Operation

PHI GENESIS provides a new user interface experience that enables intuitive, easy, and fully automated operation of the high-performance instrument.

This interface allows access to all necessary functions to setup routine and advanced multi-technique acquisitions within a single screen, while retaining functions such as navigation using intro photo and 100% accurate positioning from X-ray induced secondary electron images (SXI).

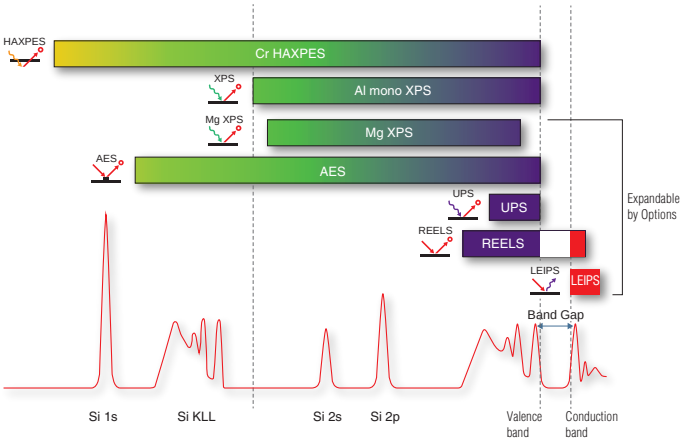


Intuitive UI

PHI GENESIS provides a simple, intuitive and ease-of-use user interface. This allows users to perform simple operations as well as automated analyses including all options.

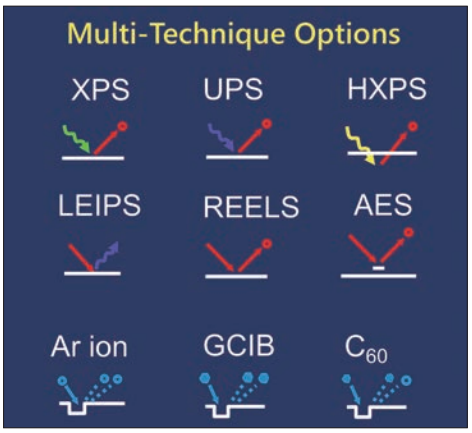
Multi-Technique Options

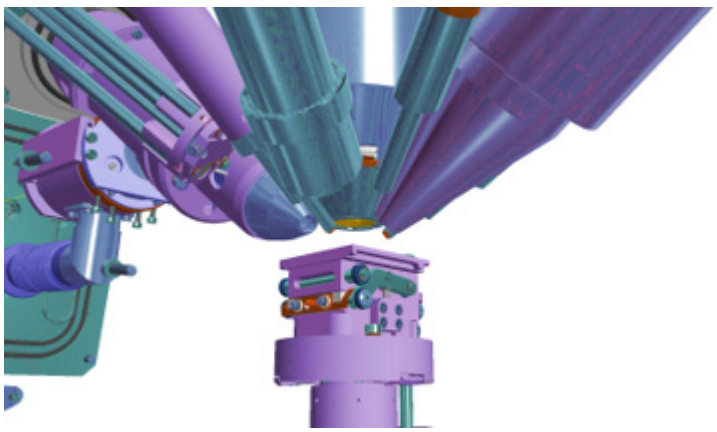
Same area automated analysis using multiple techniques covering full range of energy - from conduction band with LEIPS to core-level excitation with HAXPES, PHI GENESIS offers unprecedented value not found in conventional XPS instruments.

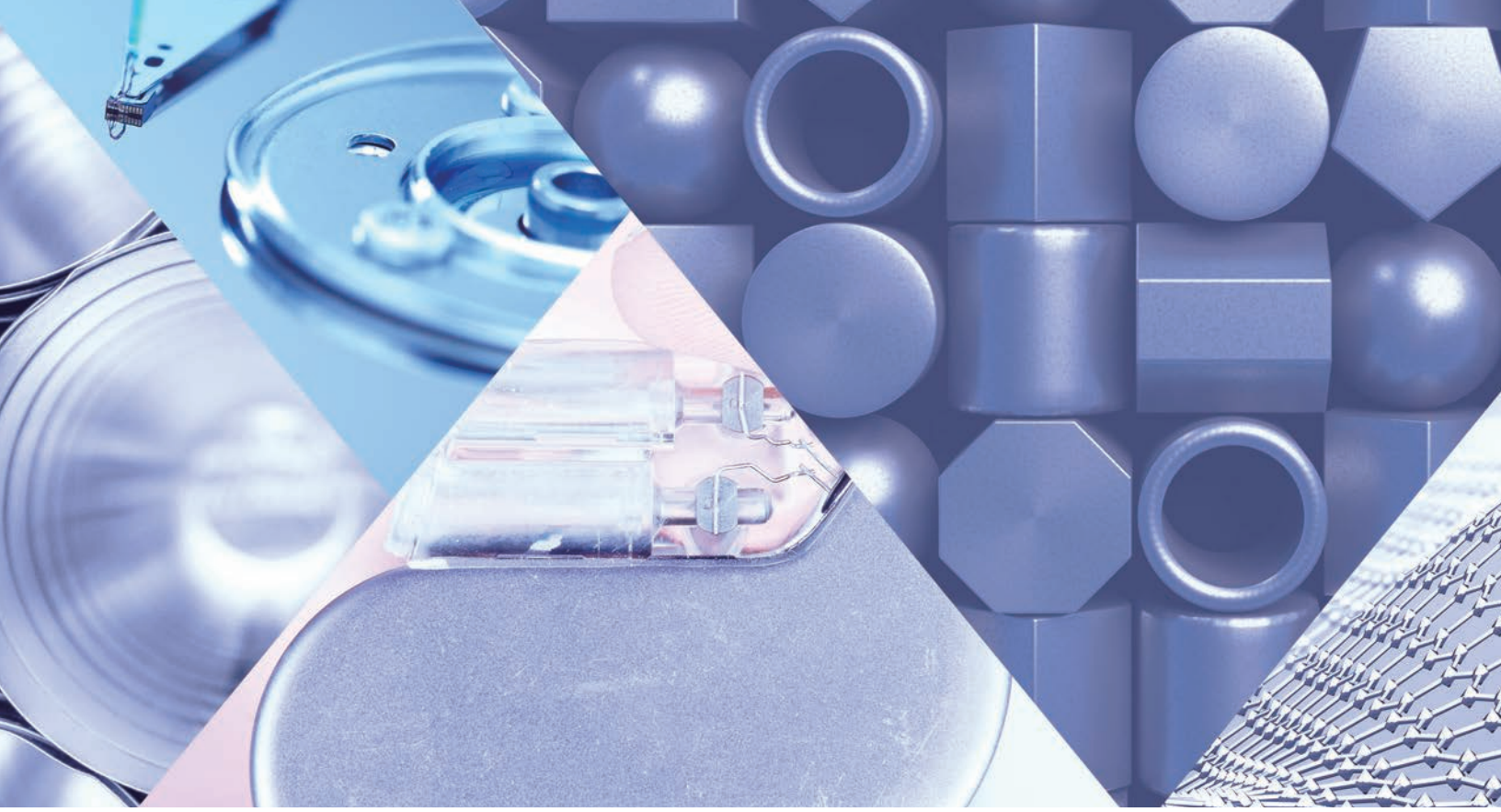


No compromise solution:

The high-performance XPS, HAXPES, UPS, LEIPS, REELS, AES, and a variety of other options meet all surface analysis needs.



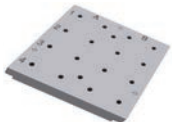




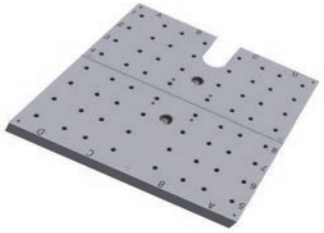
High Throughput Large Area Analysis

- Automated transfer of samples from intro to analysis chamber
- Three sample holders can be used at the same time
- 80 x 80 mm large sample holder is available for high throughput
- Can analyze a variety of sample types – powders, rough textures, insulators, large or oddly shaped samples.

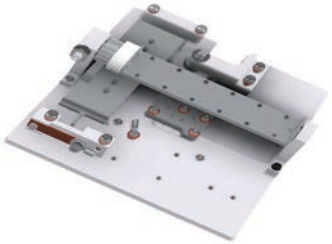
[Standard holder 40 mm x 40 mm]

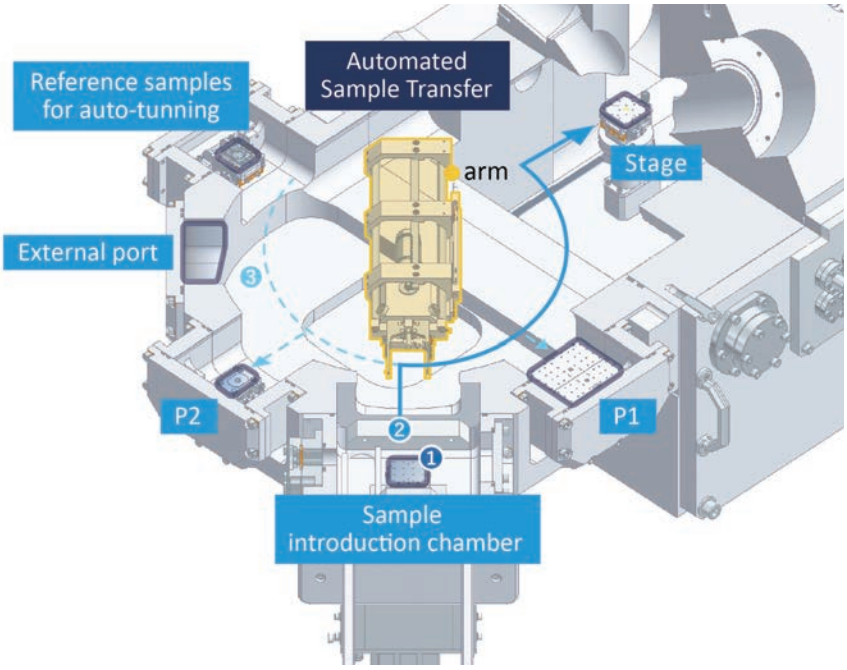


[Extended plate 80 mm x 80 mm]

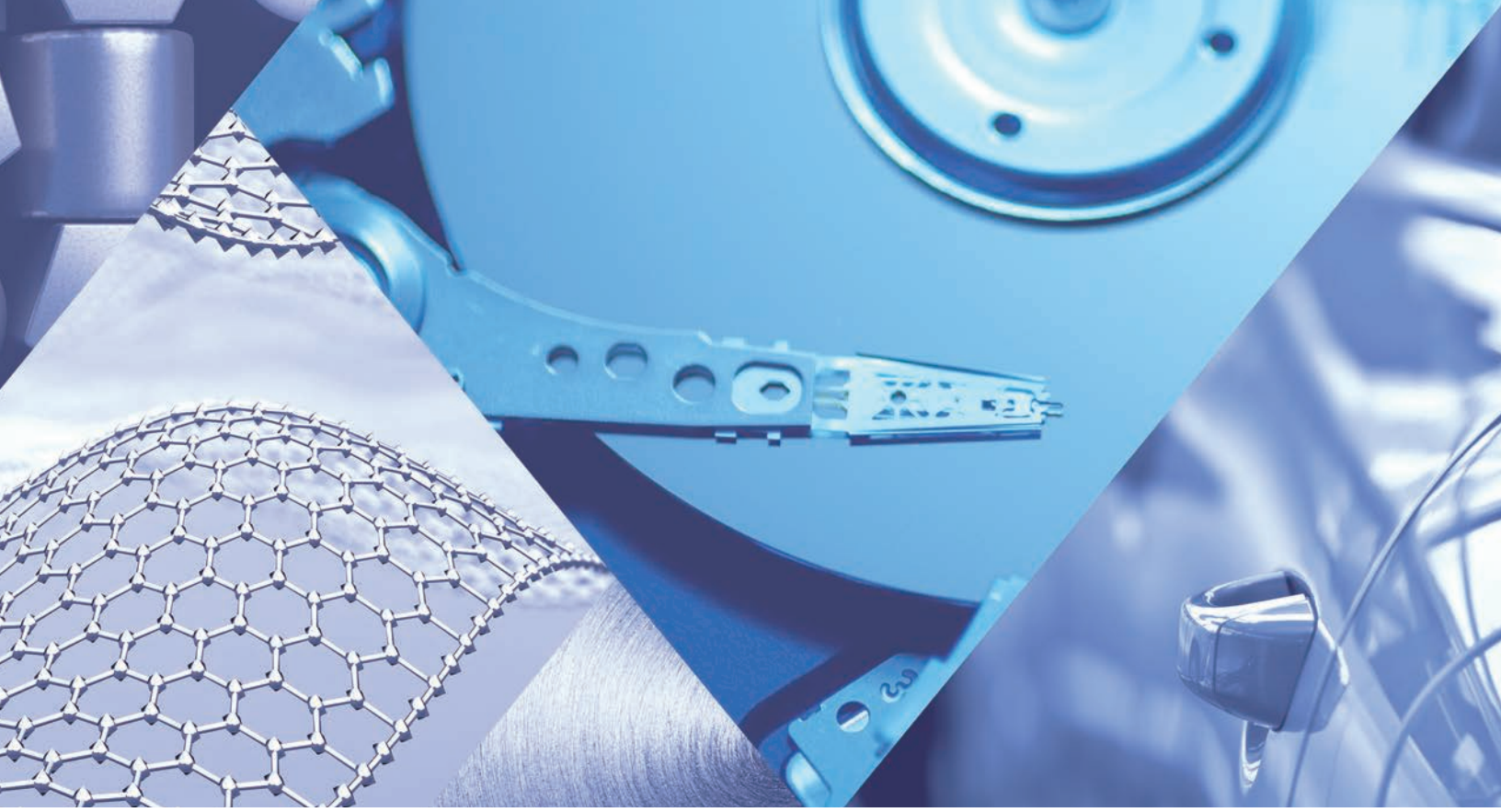


[Dedicated tilt holder]



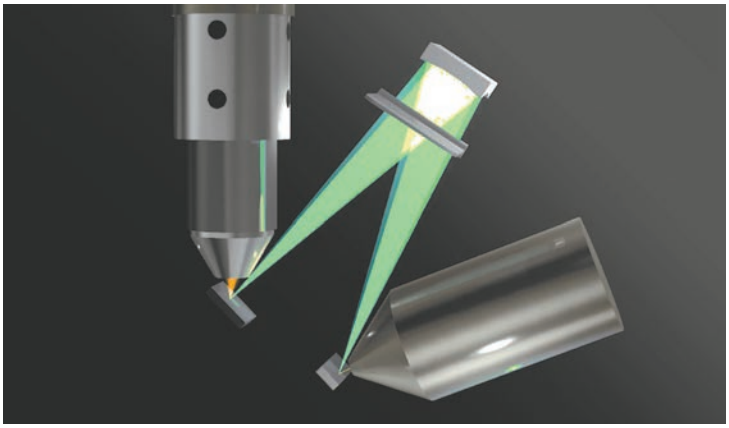


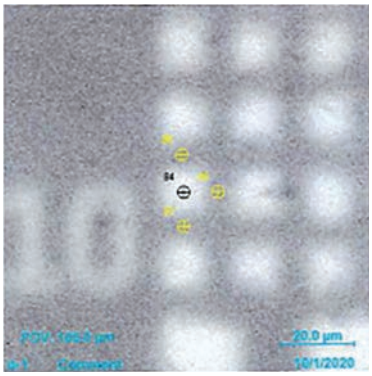
Fully automated multi-sample transfer platform



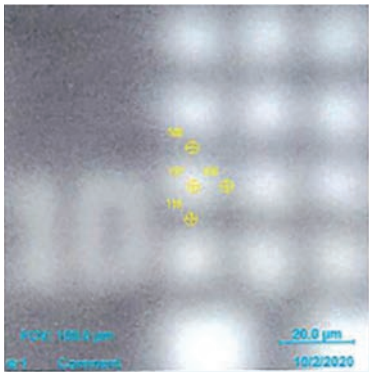
Superior Micro Area Spectroscopy
≤ 5 µm X-ray spot

In PHI GENESIS, a micro-focused scanning X-ray source is used for intuitive SEM-like navigation using X-ray induced secondary electron images (SXIs). Multi-point small areas can be defined from SXI images with 100% certainty for spectra, depth profiles, and maps.





5 µm SXI



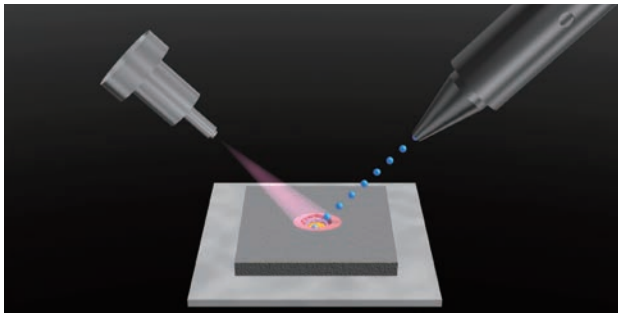
10 µm SXI

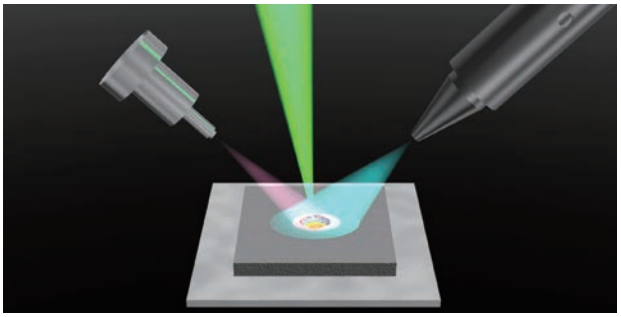
Improved Scanning X-ray Image(SXI)

The unsurpassed 5 µm small spot X-ray beam opens new opportunities for micro-XPS applications.

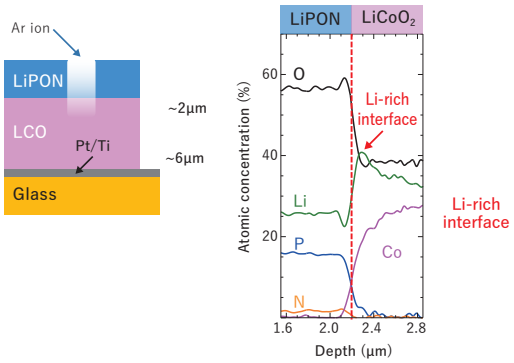
High-Throughput Depth Profiling

PHI GENESIS enables high throughput depth profiling. The micro-focused X-ray source, highly sensitive detector, high-performance Argon ion gun, and high-efficiency dual beam neutralization enable fully automated depth profiling, including multi-point analysis within a single crater.

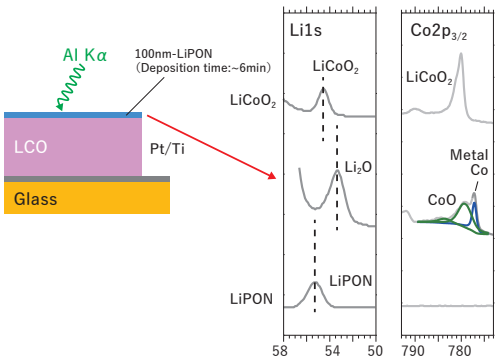




High performance depth profiling



A depth profile of a thin film All-solid-state battery. Depth profiling to a depth below 2.0 μm clearly shows the existence of the Li-rich interface.



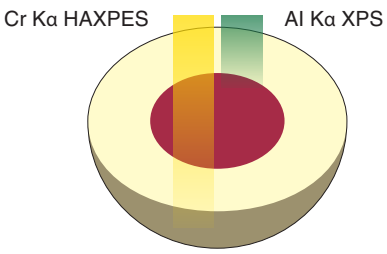
At the initial stage of LiPON film deposition, it was suggested that oxygen was incorporated from the $LiCoO_2$ layer to the LiPON layer, to stimulate Co reduction from oxide to metal at the Li-rich interface of $LoCoO_2$ layer.

Non-Destructive Depth Profiling

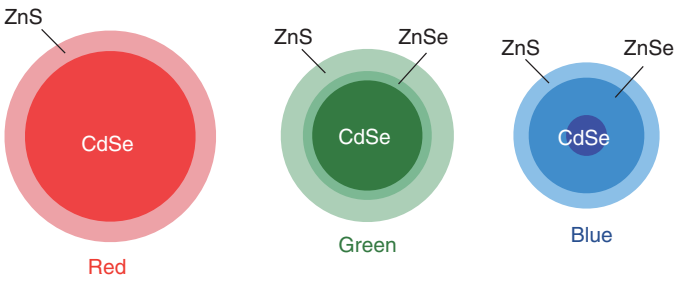
Using a high-energy hard X-ray source, it is possible to obtain information from a deeper depth compared to conventional soft X-ray XPS.
This enables a detailed and unperturbed chemical state analysis of buried interfaces without sputtering.

No-sputter depth probing

Quantum Dots(QDs) with a diameter of approximately 10 to 50 nm are used in a next-generation transparent luminescent materials.
By combining information from same-area analysis using XPS (Al Kα X-rays) and HAXPES (Cr Kα X-rays),
it is possible to perform detailed depth-resolved structure analysis of QDs.
The combination of XPS and HAXPES allows depth-resolved, quantitative and chemical analysis of nanoparticles, eliminating possible ion beam-induced damage.



Information Depth



Cross-sectional view of QDs

List of Application Area

Advanced functional materials used in all-solid-state batteries, semiconductors, photovoltaics, catalysts, etc. are complex multi-component materials, and their research and development relies on high-throughput quantitative chemical structure-to-property optimization.
ULVAC-PHI offers new surface analysis instrument that offers unsurpassed high performance and high degree of flexibility and automation to meet the requirements of all customers - the “PHI GENESIS” scanning X-ray photoelectron spectrometer (XPS).

The Application Areas include:
- semiconductors, batteries, organic devices, catalysts, quantum dots, nanoparticles, bio- and life-science materials, polymers, ceramics, metals, and others solid materials and devices.

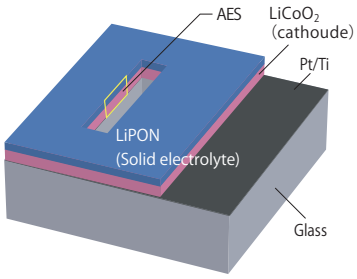
Wide Variety of the PHI GENESIS Options for Research Needs

Battery

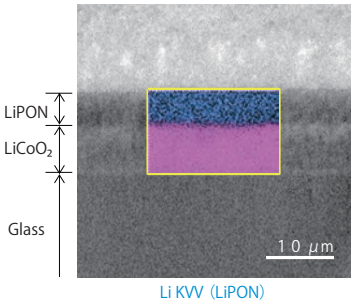
AES | Transfer Vessel

“pA-AES Lithium chemical map from LiPON/$LiCoO_2$ cross-section”
Li-based materials, such as LiPON, are sensitive to electron beam irradiation.
The high-sensitivity analyzer available on the PHI GENESIS enables fast acquisition of AES chemical maps at low beam current (300 pA).

Sample：All-solid-state battery
(Cross section was prepared by FIB)

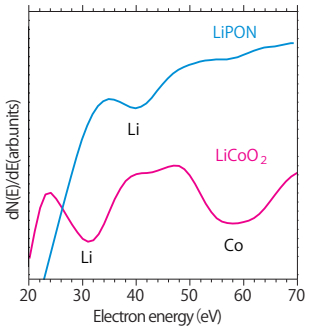


Li Chemical Map
(Overlay on SEM)



Li KVV (LiPON)
Li KVV ($LiCoO_2$)

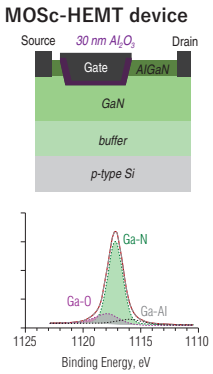
Li KVV Spectra

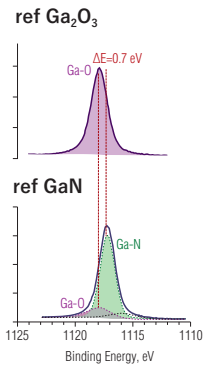


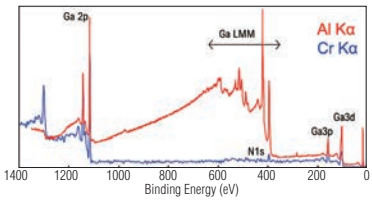
Semiconductors

HAXPES

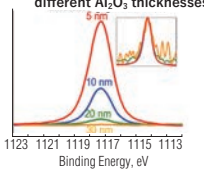
Semiconductor devices generally consist of complex thin films containing many elements, and their development often requires non-destructive analysis of chemical states at interfaces.
HAXPES is necessary to acquire information from buried interfaces such as GaN under gate oxide film.







HAXPES Ga 2p3/2 peak intensity for different Al_2O_3 thicknesses



Al_2O_3Thickness, nm

nominal	*HAXPES*
5 nm	4.5
10 nm	8.2
20 nm	18.9
30 nm	27.8

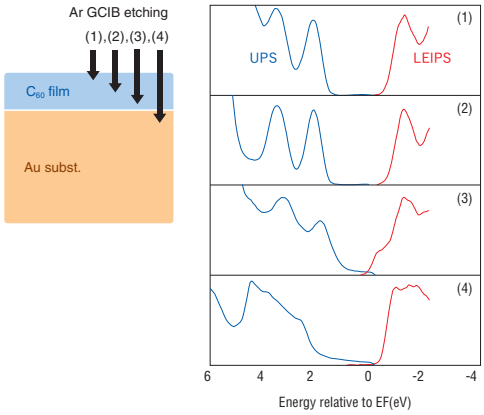
Organic Devices

UPS LEIPS GCIB

The evolution of the energy band diagram using UPS/LEIPS and Ar-GCIB

(1) C_{60} film surface
(2) C_{60} film after surface cleaning.
(3) C_{60} film /Au interface
(4) Au surface

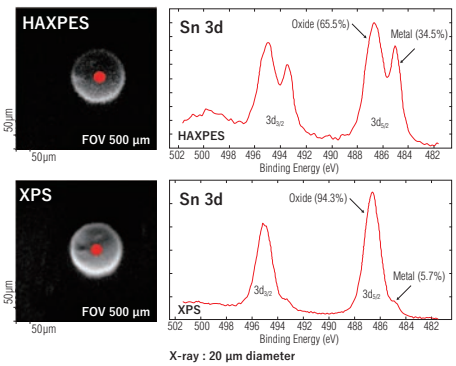
Energy diagram of organic layers as a function of depth can be determined by combination of UPS/ LEIPS and Ar-GCIB depth profiling.



Micro Electronics

HAXPES

Micro-spot solder-ball analysis:
The HAXPES data shows a higher percentage of metallic Sn than the XPS data. This is consistent with the formation of surface oxides on the solder ball.



X-ray : 20 μm diameter

Optional Accessories

HAXPES • UPS • LEIPS • SAM • REELS • Dual anode X-ray sources (Mg/Mg, Mg/Al, Mg/Zr) • Dual source ion gun for Ar Monomer/Ar-GCIB • Ar-GCIB cluster size measurement tool • 20 kV C_{60} cluster ion gun • Narrow acceptance angle aperture • Sample heating and cooling • 4-contact voltage application • Transfer vessel • Dedicated intro pumping • High magnification sample observation microscope (Live view) • Sample positioning system (SPS)

PHYSICAL ELECTRONICS
A DIVISION OF ULVAC-PHI

Physical Electronics - USA
Phone: 952-828-6100
Email: sales@phi.com
Web: www.phi.com

ULVAC - PHI Inc. - Japan
Phone: 81-467-85-4220
Email: webmasterjp@phi.com
Web: www.ulvac-phi.co.jp