

Hypulse Surface Analysis System

Explore the surface in depth

Understanding the behavior of materials and devices often necessitates characterization of their chemistry below the surface, or at interfaces. As a result, accurate measurements at these locations are often critical across a wide range of industries and applications.

The new Thermo Scientific™ Hypulse™ Surface Analysis System is a fully automated X-ray photoelectron spectroscopy (XPS) system that integrates femtosecond laser ablation with traditional ion beam profiling methods to deliver unique insights for your analysis of thin films, interfaces, coatings, and buried layers.

Enhance your ability to probe below the surface

Ion beam depth profiling has been the standard approach for sub-surface XPS analysis for over 50 years, and the Hypulse System includes a Thermo Scientific™ MAGCIS™ Dual Mode Ion Source for both monatomic and cluster ion depth profiling. To further enhance this capability, the Hypulse System also features a femtosecond laser for material removal. The process of laser ablation is significantly different than ion beam approaches and prevents the chemical damage that can occur with those methods. As a result, laser ablation can increase the accuracy of composition profiles while also shortening experiment times and making it practical to collect much deeper profiles. This means that interfaces that are tens of micrometers below the surface can be readily accessed and measured.

XPS without compromise

The Hypulse System delivers excellent XPS sensitivity and resolution with a high performance X-ray source, efficient electron optics, and fast signal detection. The X-ray spot size, which defines the analysis area, can be varied in five-micrometer steps from 10 μm to 400 μm . This means that the analysis area can be tailored to the feature of interest, maximizing the XPS signal. The Hypulse System also includes our patented dual-beam charge compensation system, which makes the analysis of insulators simple, regardless of whether they are smooth, a powder, or a fiber.

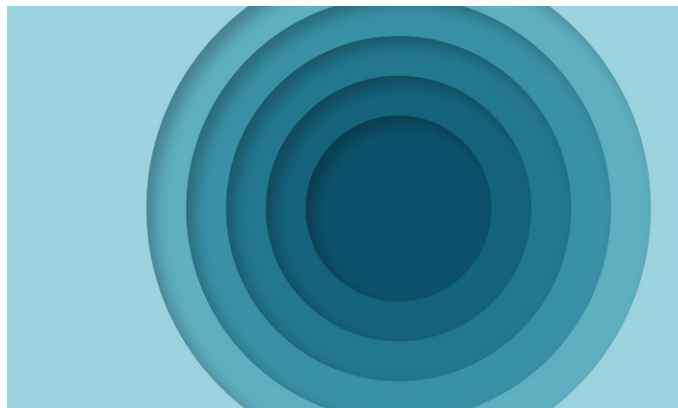
Key features

Unique depth profiling capability. The femtosecond laser ablation system provides controlled material removal without inducing chemical damage to your sample.

Fast, efficient XPS. Quick sample pump-down times, a unique sample viewing system, and high sensitivity for all analysis areas help ensure exceptional data quality, even for highly challenging samples.

Co-incident additional spectroscopy. Optimize the information obtained from features of interest with the inclusion of additional analytical techniques, including ion scattering spectroscopy, reflected electron energy loss spectroscopy, and optional UV photoelectron spectroscopy.

Fully featured software. The latest version of the Advantage Data System is included for data collection and analysis, with the ability to import data into Thermo Scientific™ Maps Software for correlation with electron microscopy images.



Co-incident spectroscopy options

The Hypulse System includes two complementary analysis techniques that can provide further insights into your samples; ion scattering spectroscopy (ISS) and reflected electron energy loss spectroscopy (REELS). An optional UV source can also be added for ultraviolet photoelectron spectroscopy (UPS). Access to this wide range of analytical techniques supports your materials characterization with the insights you need.

Efficient, easy-to-use workflows

The Hypulse System is designed to meet the demands of busy research laboratories and shared-use facilities. The instrumentation and software are engineered to make complex experiments easy to perform, without compromising on performance. The Hypulse System has fully automated system control for all acquisition modes and sample operations, helping to minimize the time from sample loading to results.

Samples

The Hypulse System has a large sample holder with a modular design that can accommodate specimens with an area up to 60 x 60 mm and a thickness ≤ 20 mm. Additional sample plates for powder and fiber samples are also provided.

Optional sample holders are also available to expand your experimental possibilities. A tilting sample holder can be used for angle-dependent XPS studies, such as the investigation of ultra-thin film samples. The vacuum transfer module enables air-sensitive samples to be moved from a glove box to the instrument without exposure to the atmosphere. Special sample holders are also available for the correlative imaging and surface analysis (CISA) workflow, easily allowing the same areas of interest to be analyzed with Thermo Scientific™ scanning electron microscopes.

Software

As with all Thermo Scientific™ surface analysis instruments, the Hypulse System is controlled by the Thermo Scientific™ Avantage Data System, which offers full instrument control along with data acquisition, processing, and reporting. Once the samples are loaded into the instrument, everything is controlled from the Avantage Data System, meaning that it can be run remotely or that collaborators can join an operator at the instrument through desktop sharing or web-conferencing. The Avantage Data System also includes automated routines for instrument calibration using standard samples.

The Avantage Data System is now compatible with Maps Software, which allows data from the Hypulse System to be correlated with electron microscopy imaging. Features of interest can be identified in one instrument and their positions can then be exported to the other instrument for further investigation.



Hypulse Surface Analysis System

Technical highlights

Micro-focused, monochromated aluminum K-alpha X-ray source

- Computer-controlled quartz-crystal monochromator
- Software-adjustable spot size
- Spot size range: 10–400 μm
- Motorized, water-cooled anode with 16 positions

Electron optics and analyzer

- Electrostatic objective lens
- Full 180° hemispherical μ -metal shielded analyzer
- Continuously selectable pass energy: 1–400 eV
- 128-channel, signature-corrected, position-sensitive detector
- Automatic energy scale and transmission function calibration

Charge compensation system

- Patented dual-beam electron and ion source
- Beam energy for charge compensation: 0–5 eV

Femtosecond-laser ablation system

- Fully integrated 1,030 nm pulsed femtosecond-laser source
- Class 1 laser system
- Tunable pulse energy up to 1 mJ
- Computer-controlled attenuation optimizes ablation conditions
- Beam imaging module for system calibration and alignment

Ion source

- MAGCIS Dual Mode Ion Source
 - Differentially pumped source with floating drift tube and patented dual gas-injection system
 - Monatomic beam energy: 500–4,000 eV
 - Cluster beam energy: 2,000–8,000 eV
 - Cluster size range: 75–2,000 atoms

Components for additional analytical techniques

- Ion scattering spectroscopy: bipolar analyzer power supply and helium gas ion source
- Reflected electron energy loss spectroscopy: high-voltage upgrade for the electron flood source
- Optional: ultraviolet photoelectron spectroscopy UV source

Sample viewing system

- High-performance system for precise alignment of analysis position
 - Always available optical alignment views:
 - Platter view: Automatically records images of the sample holder in the load-lock that can be used to navigate between the samples mounted on the holder
 - Patented reflex optics view: Live, high-magnification view of the analysis position for the alignment of sample features
 - Height setting view: Another live, high-magnification view of the analysis position, which verifies that the sample is at the correct working distance from the photoelectron transfer lens
 - Sample illumination:
 - Off-axis, for samples with rough surfaces
 - On-axis, for smooth or highly reflective samples
- Integrated XPS SnapMap capability allows XPS images to be used for sample alignment

Software

- Advantage Data System
 - XPS data acquisition, including spectra, SAXPS, line scans, XPS images, and depth profiles
 - Wide range of XPS data processing capabilities
 - Full control of the vacuum system and sample handling
 - Export data to Maps Software and other software packages
 - Calibration and alignment of sources, analyzer, and detector

Sample holders

- Maximum sample dimensions: 60 x 60 x 20 mm
- Standard sample kit
 - Two multi-specimen mounting plates
 - Mounting plate for powder samples
 - Mounting plate for fiber samples
 - Three rotation holders for ion-beam depth profiling
 - Mounting plate for use in combination with a rotation holder
 - Sample carrier base
- Optional sample holders
 - Tilt holder for ARXPS
 - Sample bias holder
 - Vacuum transfer module
 - CISA workflow kit

Stage

- High-precision, automated specimen stage with internal stepper motors; includes a set of standard samples, apertures, and knife edges built into the stage for calibration and alignment
- Calibration samples: copper foil, silver foil, gold foil
- Phosphorescent sample for X-ray spot alignment
- Copper knife edge and TEM grid for X-ray spot size measurement
- Apertures for ion beam alignment and focusing

Vacuum system

- Ni-Fe CNC-machined analysis chamber
- Pumping
 - 260 L/s turbomolecular pump for analysis chamber
 - 260 L/s turbomolecular pump for load-lock chamber
 - 67 L/s turbomolecular pump for differential pumping of MAGCIS Ion Source, flood gun, and UV source (when selected)
 - Rotary vane backing pump or dry backing pump
 - Software-controlled titanium sublimation pump in the analysis chamber
- Gauging
 - Compact, full-range gauge for analysis chamber
 - Compact, full-range gauge for load-lock chamber
 - Pirani gauge for backing pump
- Software-controlled, hardware-interlocked integral bake-out for automated system preparation after service

Installation requirements

Power

- Voltage: 220–240 V
- Frequency: 50 or 60 Hz

Environment

- Room temperature: 15–25°C with maximum change of $\pm 1^\circ\text{C}$
- Heat dissipation
 - Normal operating conditions: 1 kW
 - During bake-out: 2.6 kW
- Humidity: <65%
- Static magnetic fields: <50 μT (500 mG) peak in any direction
- Time-varying magnetic fields: <2 μT (20 mG) peak-to-peak in any direction in the 0.1 Hz to 400 kHz frequency range
- Time-varying electric fields: <3 V/m peak-to-peak in any direction in the 80 to 1,000 MHz frequency range

Dimensions

- System dimensions (W x L x H): 1,250 x 2,000 x 1,724 mm
- Minimum door width required: 1,500 mm

Weight

- The floor should be able to support 1,200 kg

Services

- Water supply of 3 L/min at 4.5 bar with an inlet temperature of 15–20°C
- Compressed air supply with a pressure of 4.5 bar
- Dry nitrogen is used to vent the load-lock and must be supplied at a pressure of 0.5–1 bar
- High-purity argon (>99.998 %) is required for ion etching:
 - Maximum inlet pressure: 10 bar

Instrument

- High-purity helium (>99.998 %) is required for ISS and optional UPS techniques
 - Maximum inlet pressure: 1.5 bar

 Learn more at thermofisher.com/hypulse

thermo scientific