PHYSICAL ELECTRONICS
A DIVISION OF ULVAC-PHI

PHI TRIFT V

nanoTOF

Time-of-Flight SIMS

PHI TRIFT V
nanoTOF

Time-of-Flight Secondary Ion Mass Spectrometer

Time-of-Flight SIMS has emerged as an important elemental, chemical, and molecular imaging technique for many areas of advanced technology and research because of its unique combination of sensitivity, spatial resolution and molecular specificity.

Parallel Detection of all Elements from Hydrogen to Uranium

Detection and Identification of Molecules from Exact Mass and Characteristic Fragments

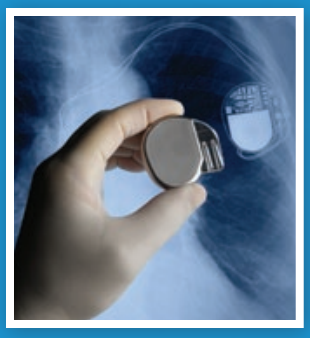
Elemental and Molecular Imaging with Spatial Resolution down to 70 nm

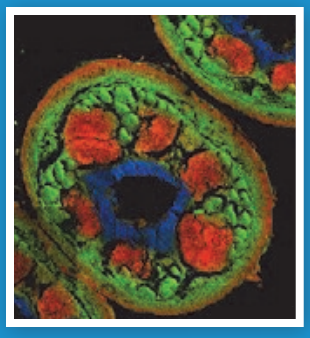
Parts-per-Million Level Elemental Sensitivity

Depth Profiling and 3D Imaging of both Elements and Molecules

The PHI TRIFT V *nanoTOF* Provides Unique Insights into Materials Development, Failure Analysis and Basic Medical Research

PHI's patented TRIFT mass spectrometer provides superior sensitivity and the unique ability to image highly topographic surfaces. The *nanoTOF* can be configured with a wide variety of options to optimize performance for organic materials, inorganic materials, or both, depending on customer requirements.





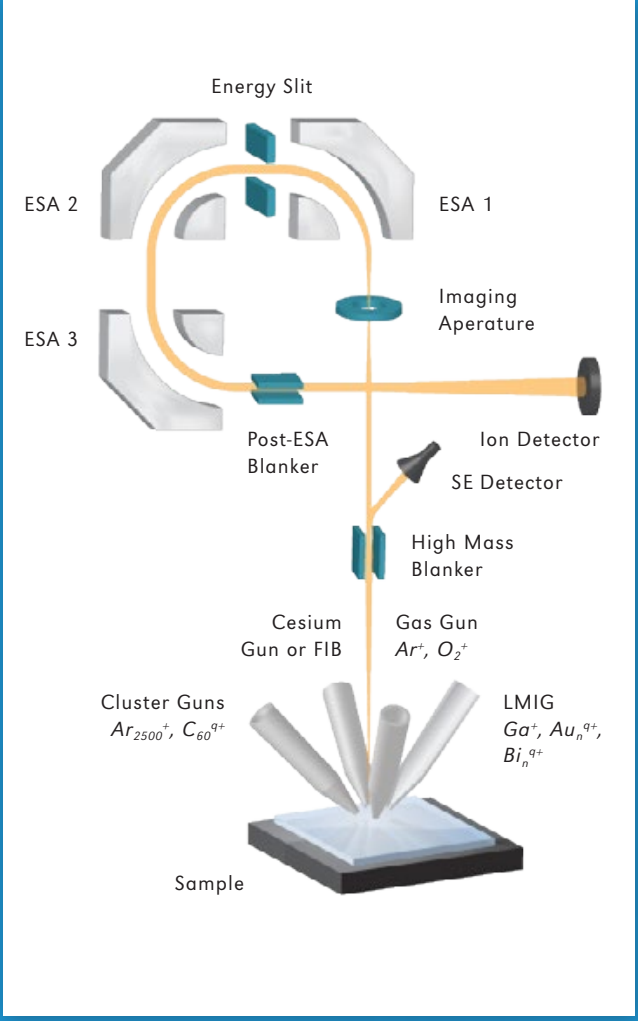

APPLICATIONS

Nanotechnology
Energy Conversion
Batteries
Organic Electronics
Polymer Blends
Thin film Coatings
Medical Research
Pharmaceuticals
Paints
Adhesives
Semiconductors
Magnetic Media
Medical Devices
Catalysts
Ceramics

Superior TRIFT Analyzer Performance

TRIPLE FOCUSING TIME-OF-FLIGHT (TRIFT)MASS ANALYZER

The *nanoTOF* is based on PHI's patented TRIFT mass spectrometer which consists of three 90° sector electrostatic analyzers (ESA). The triple ESA design efficiently eliminates metastable ions and produces spectra with very low background and excellent detection limits. The TRIFT analyzer has a larger angular acceptance, larger energy bandpass and a larger depth-of-field than other analyzer designs.



Uniform imaging sensitivity on curved or rough surfaces due to the large solid angle of collection

Superior depth-of-field in images due to large energy acceptance window

Low spectral background and highest abundance sensitivity due to the ability to reject metastable ions

High mass sensitivity for organic and medical applications

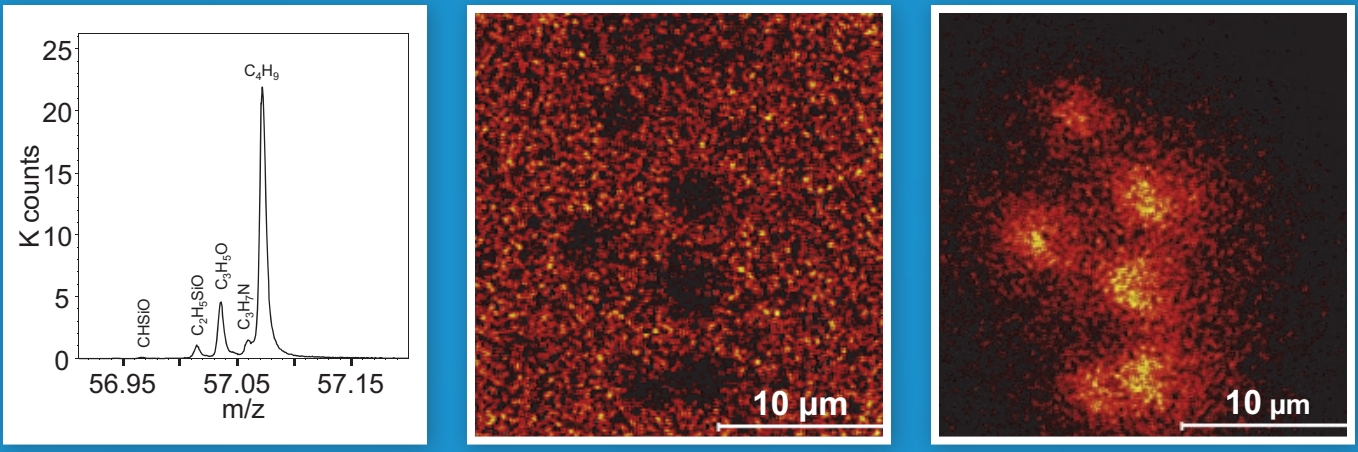
Turnkey insulator analysis enabled by patented dual beam charge compensation technology

HR² Imaging

OPTIMIZED MOLECULAR IMAGING

The new PHI liquid metal ion gun (LMIG) can achieve ion beam diameters of less than 500 nm while in the high mass resolution mode with beam currents that are much higher than was previously achievable. One no longer has to choose between high spatial resolution or high mass resolution modes; they both can be achieved in a single, fast analysis with the *nanoTOF*'s new HR² imaging mode.

HR² = High Mass Resolution with High Spatial Resolution



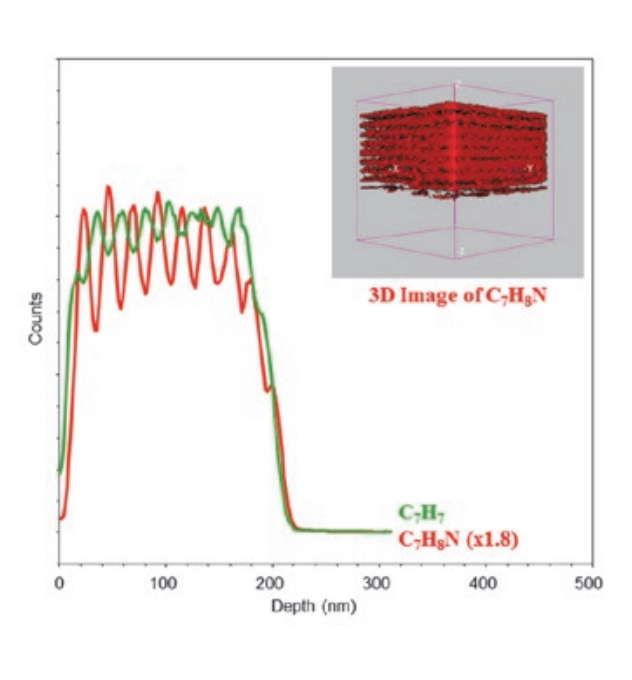
C_3H_5O+ C_4H_9+

HR² imaging is demonstrated above in the images of micro organic droplets. In a single analysis, peaks for multiple molecular fragments were observed at m/z 57 with high mass resolution and identified by measurement of their exact mass. The distribution of each species was visualized with a spatial resolution of less than 400 nm. The single measurement that contains all this information was acquired in only six minutes due to the high ion beam current available in the *nanoTOF*'s HR² imaging mode.

Cluster Source Ion Guns

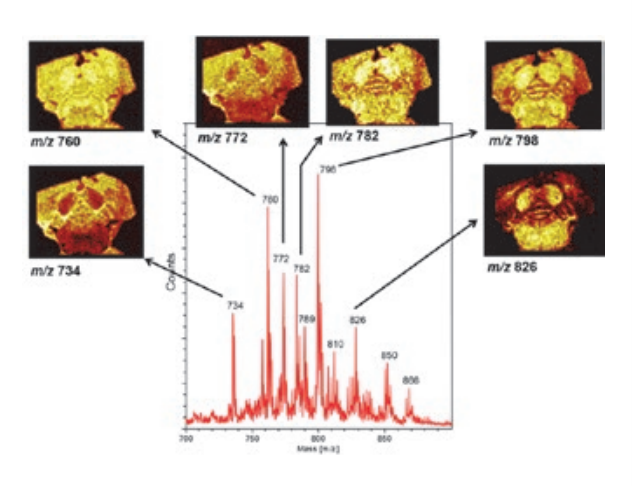
INNOVATIVE PERFORMANCE

PHI was the first surface analysis manufacturer to offer C_{60}^{+} and Ar gas cluster ion beam sputtering. The 20 kV C_{60} ion gun provides the unique ability to depth profile most organic materials and inorganic materials and provide the highest sensitivity for organic spectroscopy. The 20 kV Ar_{2500}^{+} gas cluster ion beam provides the most versatile capability for depth profiling organic films.



MULTIPLE CLUSTER ION GUN OPTIONS

20 kV Ar_{2500}^{+} gas cluster ion beam for molecular depth profiling organic films. Shown here is a depth profile of a multi-layer polystyrene and poly (2-vinylpyridine) block copolymer film obtained by sputtering with a 5 kV Ar_{2500}^{+} gas cluster ion beam.



20 kV C_{60} ion gun for imaging and spectroscopy when the highest sensitivity for organic species is required. Shown here is the detection and imaging of specific lipids in a mouse brain specimen.

FIB-TOF 3D Chemical Imaging

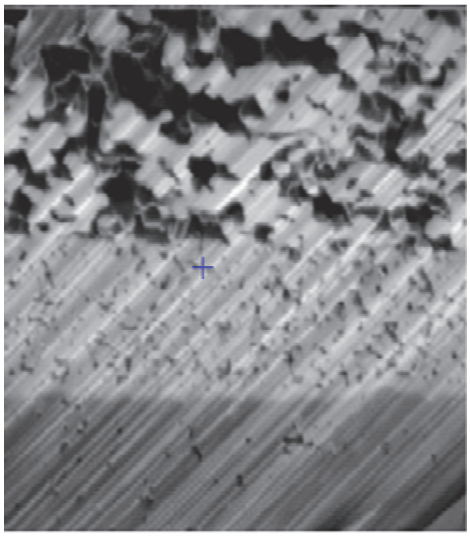
FIB-TOF TOMOGRAPHY

3D FIB-TOF tomography with the PHI *nanoTOF* provides characterization and imaging of complex matrix chemistries that would not be possible by traditional sputter depth profile analysis. Due to the large angular acceptance and depth-of-field provided by the TRIFT spectrometer, accurate 3D images are acquired with high quality mass spectra available throughout the analysis volume.

TOF-SIMS imaging of FIB sectioned specimens

High mass resolution spectra at every pixel

3D imaging software with multi-element overlay capability

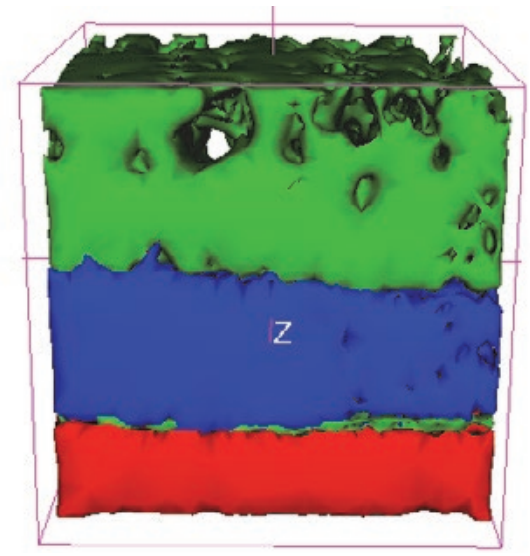


SED Image of FIB Cut

Cathode

Electrolyte I

Electrolyte II



Overlay of Sr^+, Ce^+, Zr^+ 3D Images

3D FIB-TOF images of a solid oxide fuel cell with a 50 x 50 x 10 µm analysis volume show the ability to observe compositional information and physical structures such as voids.

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PHI TRIFT V *nanoTOF* Capabilities

STANDARD CONFIGURATION

TRIFT mass analyzer
30 kV LMIG with Bi, Au, or Ga emitter
Dual beam charge neutralization
5 axis sample stage
In-situ optical viewing
Secondary electron detector
WinCadence instrument control and data reduction software package
Analysis chamber with four primary ion gun ports
350 l/s turbo molecular pump
Integrated bakeout facilities

OPTIONAL ACCESSORIES

20 kV C_{60} pulsed ion gun
20 kV Ar_{2500}^{+} gas cluster ion gun
2 kV Cs ion gun
5 kV gas gun (Ar/O_2)
Oxygen flood module
30 kV Ga FIB gun
Hot/Cold sample stage module
Flash cooling for sample intro chamber
High temperature sample stage module
Sample transfer vessel
Intro chamber glove box
Voltage cycling sample stage module
Sample preparation chamber

Physical Electronics

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