PHYSICAL ELECTRONICS
A DIVISION OF ULVAC-PHI

Advantages of the TRIFT Analyzer for Imaging and Spectroscopy in the PHI nanoTOF

Introduction: Physical Electronics introduced its unique triple focusing time-of-flight mass spectrometer, the TRIFT, in 1992 with performance that surpassed previous Poschenrieder and reflectron mass spectrometer technologies. The TRIFT's unique design provides superior imaging of the rough surfaces that are often encountered in real world surface analysis, excellent mass resolution for detailed mass spectrometry, and superior detection limits for trace element detection.

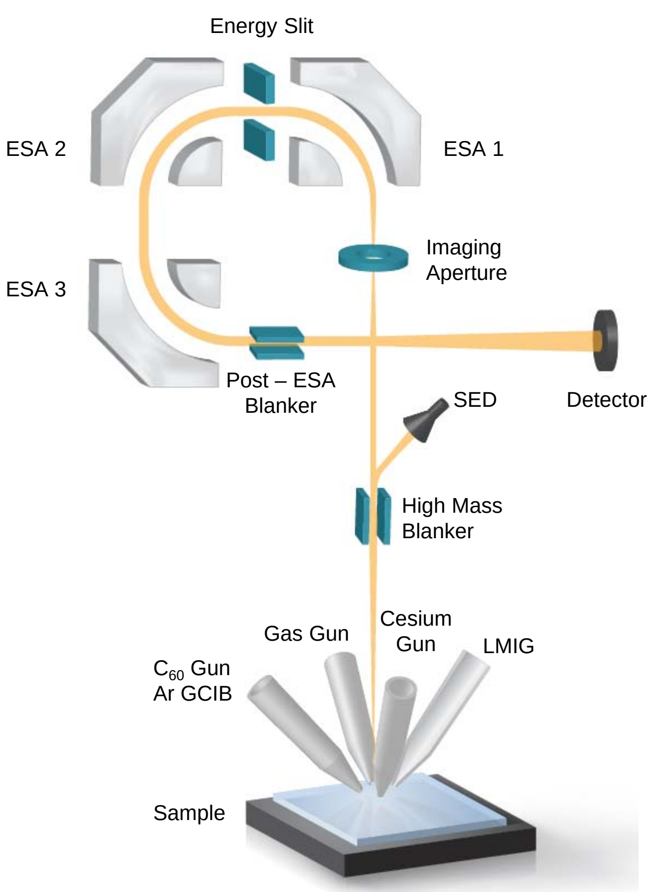

Figure 1. Schematic diagram of the TRIFT analyzer.

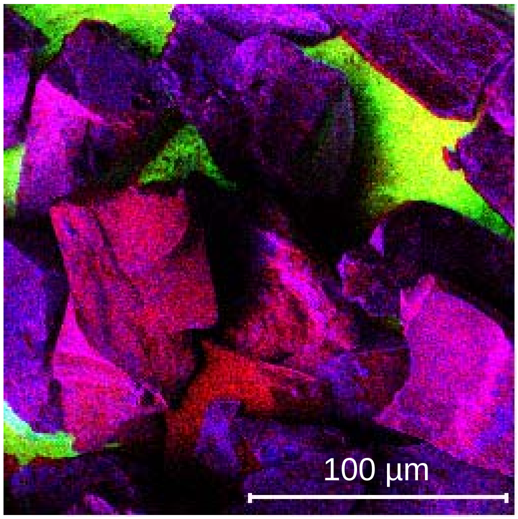

Figure 2. TOF-SIMS images of multifaceted mineral particles dispersed on indium foil demonstrate the effectiveness of the TRIFT analyzer for imaging rough surfaces. ***Oxygen*** *is shown in red,* ***indium*** *in green, and* ***sulphur*** *blue.*

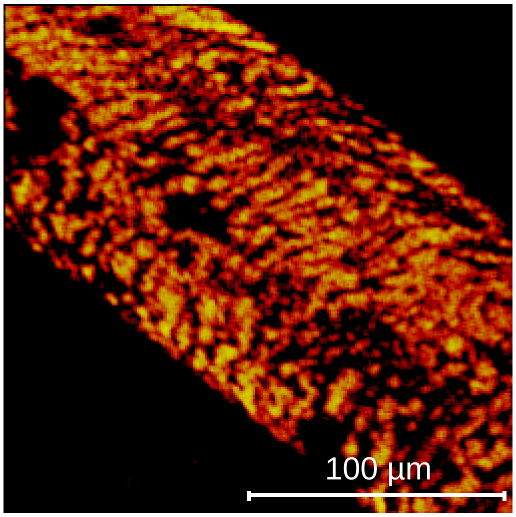

Figure 3. TOF-SIMS image of fatty acid molecular ions at m/z 341 across the entire diameter of a human hair demonstrate the large depth of field of the TRIFT analyzer.

TRIFT ANALYZER: As shown in figures two and three, the TRIFT analyzer provides a large solid angle of collection and a large depth of field that make it possible to image rough, textured, and curved surfaces. TRIFT images therefore provide a more complete and accurate picture of the chemical distribution on the sample's surface. An extension of this capability is the ability to analyze the sidewalls of patterned structures including the face of a FIB cut, which enables 3D tomography imaging of complex structures.

The TRIFT analyzer has a 240 eV kinetic energy band pass to provide a large depth of field in the normal mode of analysis. The large solid angle of collection is provided by the design of the TRIFT's optics.

The triple ESA design of the TRIFT analyzer provides an inherent capability to eliminate the products of metastable secondary ion decay because it is a bandpass filter. Secondary ions with a kinetic energy below the full acceleration potential (3keV) do not reach the detector. The rejection of metastable decay products occurs without diminishing the intensity of stable secondary ion species produced at the sample surface (figure 4). In a reflectron analyzer, low energy metastable decay products are detected, as shown in figure 5, unless an aperture is placed in front of the detector, which has the undesired consequence of reducing transmission.

Summary: The TRIFT analyzer enables several important capabilities for PHI nanoTOF users including:

1. The ability to more accurately image rough, textured, and curved surfaces.
2. The ability to characterize sidewalls of patterned structures, including FIB cuts that can be used to create 3D images of complex structures by tomography.
3. Superior trace level detection due to the inherent ability of the TRIFT analyzer to eliminate peak interferences from metastable decay products with no reduction in transmission.

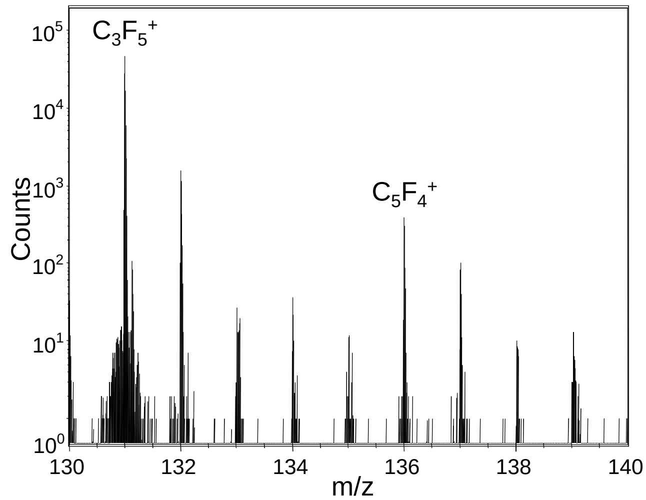

Figure 4. TRIFT based spectrum of PTFE showing the ability to observe small peaks without interference from metastable peaks and the inherent low background provided by the TRIFT analyzer.

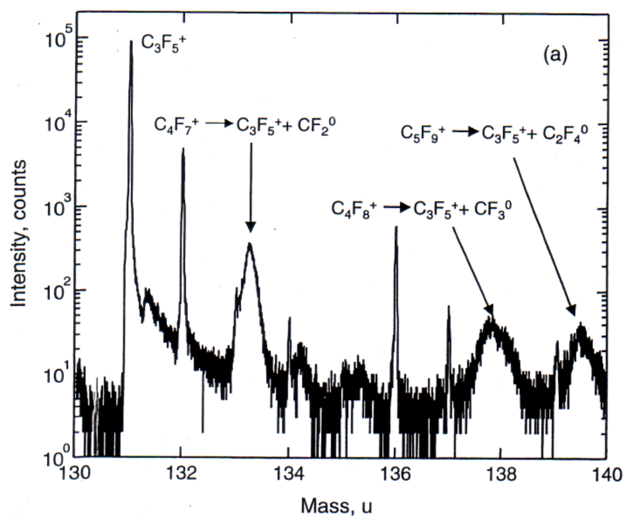

Figure 5. Reflectron based ION-TOF IV mass spectrum of PTFE from a VAMAS Interlaboratory Study. I.S. Gilmore, M.P. Seah, F.M. Green, *Surf. Int. Anal.* 37 (2005) p. 666.

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