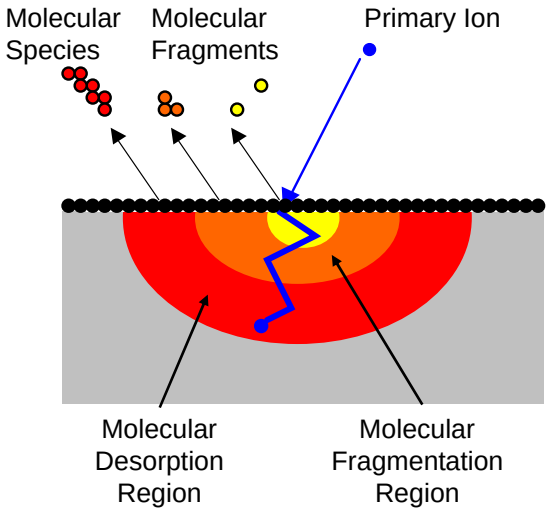
PHYSICAL ELECTRONICS
A DIVISION OF ULVAC-PHI

Time-of-Flight Secondary Ion Mass Spectrometry

Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) is an analytical technique that uses a primary ion beam to probe the surface of a solid material.



The secondary ions which desorb from the sample surface are analyzed and their mass is determined with high accuracy. As a result, elemental and molecular chemical information can be obtained on both insulating and conducting materials. TOF-SIMS allows spectroscopy for characterization of chemical composition, imaging for mapping the surface distribution of species, and depth profiling.

In the spectroscopy and imaging modes, only the outermost 1-2 monolayers of the sample surface are analyzed. To ensure the maintenance of these "static" conditions, a primary ion dose of less than 10^{12} ions/cm^2 is employed. Below this "static limit," roughly less than one in one-thousand surface atoms or molecules are struck by a primary ion. The actual desorption of material from the surface is caused by a "collision cascade," which is initiated by the primary ion inside the sample surface. The emitted secondary ions are extracted into the TOF analyzer by applying a potential between the sample surface and the mass analyzer. Secondary ions are generated by a pulsed primary ion source (very short pulses of <1 ns).

Secondary ions then travel through a field-free analyzer with different velocities, depending on their mass-to-charge ratio (ke=1/2mv^2). For each primary ion pulse, a full mass spectrum is obtained by measuring the arrival times of the secondary ions at the detector and performing a simple time-to-mass conversion. Chemical images are generated by collecting a mass spectrum at every pixel (256 x 256) as the primary ion beam is rastered across the sample surface.

TOF-SIMS is also capable of shallow depth profiling. A low-energy ion gun is operated in the DC mode for sputtering with high depth resolution. For data acquisition, the same or a different ion gun is operated in the pulsed mode. Depth profiling by TOF-SIMS allows monitoring of all species of interest simultaneously, and with high mass resolution.

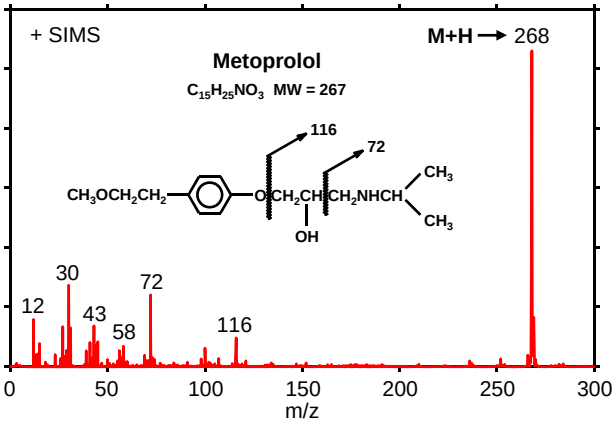


Figure 1. ***Spectroscopy:*** *mass spectrum of Metoprolol showing molecular and fragment species.*

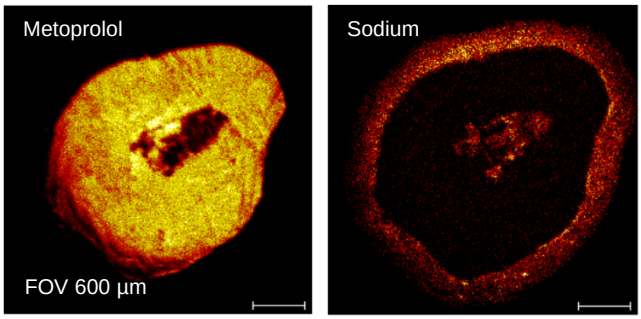


Figure 2. ***Elemental and Molecular imaging:*** *Images of a cross-sectioned drug pellet for the molecular ion of the drug and an atomic species.*

TOF-SIMS Features

- Surface Sensitivity: uppermost 20Å
- Detection limits: ppm – ppb range
- Spatial resolution: < 120 nm (determined by diameter of primary ion beam)
- Elemental and Molecular Chemical Information: practical mass range < 10,000 Da

Sample Specifications

- Sample Type: solid materials including conductors, semi-conductors and insulators
- Typical Sample Size: < 2 cm in diameter and < 10 mm thick
- Typical Analysis Area: less than 600 x 600 μm^2

Typical Applications

- Polymer / Organic Coatings: on plastics, glass, metals, and paper
- Surface Contamination: additives, mold release agents, surfactants, defects
- Delamination
- Surface Modification Chemistry
- Trace Impurities
- Catalyst Surface Characterization
- Bio-materials Characterization
- Thin Film Depth Profiling

To learn more about TOF-SIMS or to discuss your specific analytical needs please contact our sales or technical staff at one of the regional support centers listed below.

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