

## **Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS)**

### **Available at Technical Research Centre @ IACS**

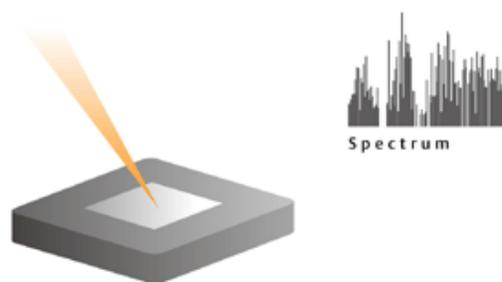
Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) is a very sensitive surface analytical technique, well established for many industrial and research applications. The technique provides detailed elemental and molecular information about the surface, thin layers, interfaces of the sample, and gives a full three-dimensional analysis. The use is widespread, including semiconductors, polymers, paint, coatings, glass, paper, metals, ceramics, biomaterials, pharmaceuticals and organic tissue.

For a TOF-SIMS analysis, a solid surface is bombarded by primary ions of some keV energy. The primary ion energy is transferred to target atoms via atomic collisions and a so-called collision cascade is generated. Part of the energy is transported back to the surface allowing surface atoms and molecular compounds to overcome the surface binding energy. SIMS is a very surface sensitive technique because the emitted particles originate from the uppermost one or two monolayers.

TOF mass spectrometry is based on the fact that ions with the same energy but different masses travel with different velocities. The accelerated ions then travel over a drift path to the detector. The lighter ions fly with a higher velocity and arrive at the detector before the heavier ions. Measuring the flight time for each ion allows the determination of its mass.

### ***Surface Spectrometry***

The aim of a static SIMS investigation is the analysis of the original, non-modified surface composition. As SIMS in principle is a destructive technique this means that the contribution of those secondary ions to the spectrum originating from already bombarded surface areas to the spectrum must be negligible. This quasi non-destructive surface analysis can be achieved by the application of very low primary ion dose densities. Surface spectroscopy provides detailed elemental and molecular information from the outer monolayers.

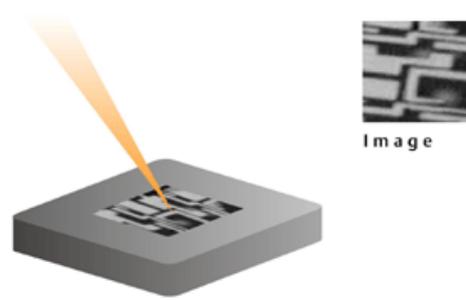


1. High sensitivity in the ppm/ppb range
2. High mass resolution and accuracy even on insulating samples

## Surface (2D) Imaging

By rastering a fine-focussed ion beam over the surface, like an electron beam in an electron microprobe, mass resolved secondary ion images (chemical maps) can be obtained simultaneously.

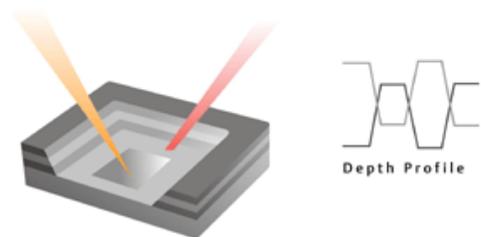
1. High lateral resolution (<60 nm)
2. Fast image acquisition (up to 50 kHz pixel frequency)
3. Field of view from  $\mu\text{m}^2$  to  $\text{cm}^2$



## Depth Profiling

For Depth Profiling two ion beams operate in the Dual Beam Mode. While the first beam is sputtering a crater, the second beam is progressively analysing the crater bottom.

1. Depth resolution better than 1 nm
2. High mass resolution
3. Sputter speed of up to 10  $\mu\text{m}/\text{h}$
4. Ideally suited for insulators



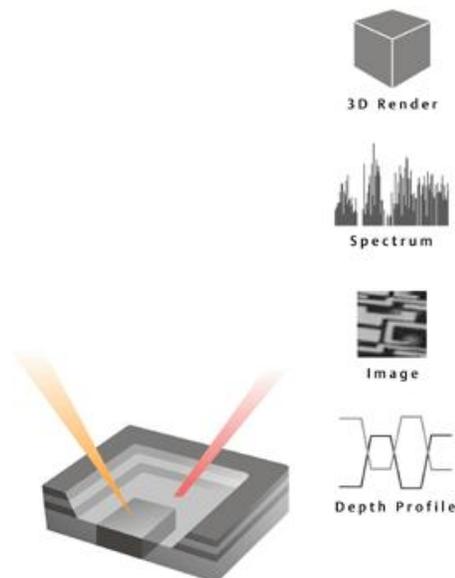
## 3D Analysis

The visualization of 3D sample structures is possible by combining spectral, imaging and depth information. 3D Analysis is ideal for the investigation of complex and unknown structures or defects. In particular the composition, shape and position of features and defects can be visualised.

Applications include:

Manufactured structures: TFT displays...

Defect Analysis: buried particles...



Material Science: grain boundaries, diffusion...

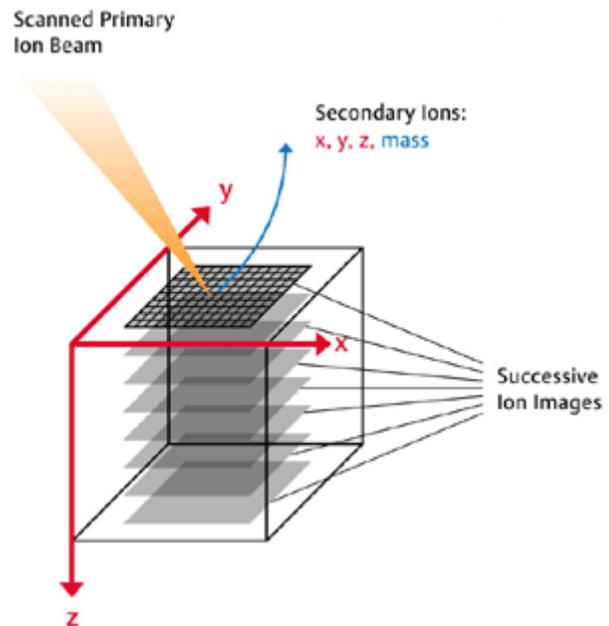
1. Parallel mass detection
2. High depth resolution
3. High image resolution

### **Retrospective Analysis**

As well as comprehensive on-line analysis, the parallel mass detection of the TOF-SIMS provides the means to carry out Retrospective Analysis.

Regardless of the knowledge about the sample before the measurement, the data can be explored afterwards to look for unexpected results, such as unknown structures, contaminants at interfaces and so on.

The software can reconstruct spectra from any coordinate or group of coordinates, images from any section, vertical or horizontal, depth profiles from any selected area and various 3D views as required.



### **Strengths and Limitations of Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS)?**

#### **Strengths**

1. Surveys of all masses on material surfaces; these may include single ions (positive or negative), individual isotopes, and molecular compounds;
2. Elemental and chemical mapping on a sub-micron scale;
3. High mass resolution, to distinguish species of similar nominal mass;
4. High sensitivity for trace elements or compounds, on the order of ppm to ppb for most species;
5. Surface analysis of insulating and conducting samples;

6. Depth profiling (in the near surface environment, on the order of nanometers);
7. Non-destructive analysis;
8. Retrospective analysis, for post-data acquisition analysis and interpretation of stored images and spectra;
9. Charge compensation routines are generally sufficient to overcome charging related problems.

### **Limitations**

1. Generally does not produce quantitative analyses (semi-quantitative at best);
2. Can be too surface sensitive so careful sample handling/packaging is important;
3. Samples must be vacuum compatible;
4. Too much data; the benefit of retrospective analysis is also its curse. Every pixel of an image produced by ToF-SIMS also contains a full mass spectrum for that point. Thus, it may take hours, days or weeks to fully analyze a single data set. Consequently, it is extremely important to have a very clear purpose in collecting ToF-SIMS data, and focus on analyzing and interpreting the data that are specifically related to the question at hand.

### **Ongoing projects on ToF-SIMS at TRC, IACS**

1. Analysis of perovskite nanocrystals
2. Characterization of different food grains
3. Analysis of the surface properties of a functional device
4. Characterization of the functional properties of monolayers (Langmuir blodgett films)

### **Instrument Details:**

IONTOF located at room no. 12 (ground floor, main building, IACS)

**Ion Guns:** LMIG, Bismuth and Argon Ion guns.

**Per Sample TOF-SIMS charges including GST:**

<b>Characterization Technique</b>	<b>University</b>	<b>National Lab/R&amp;D's</b>	<b>Industry</b>
Mass profile	Rs. 500/-	Rs. 700/-	Rs. 1000/-
Mass profile + 2D image	Rs. 700/-	Rs. 1000/-	Rs. 2000/-
Mass profile + 2D image + 3D profile	Rs. 1000/-	Rs. 2000/-	Rs. 4000/-

\*Charges exclude GST as applicable.

*Euro 100 will be charged for foreign samples with their 3D profiling, 2D images and mass spectral analysis.*

**The Demand Draft should be in favour of  
"Indian Association for the Cultivation of Science"**

**No Postal Charges for any analysis.**

Kindly include this note in your requesting letter exactly as it is:

“Content of this report/bill is meant for our information only and we will not use the content of this report for advertisement, evidence, litigation or quote as certificate to third party”