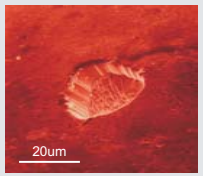
Secondary Ion Mass Spectrometry (SIMS)

EMMAC SIMS Facility

NERC Ion Microprobe Facility

SIMS Technique



Secondary Ion Mass Spectrometry (SIMS) is used for the chemical analysis of small volumes of solid material. In SIMS the surface of the sample is bombarded under vacuum with a finely focussed (~1-25μm) beam of primary ions (Cs+, O+, O2- or Ar+). The collision cascade results in the ejection and ionisation of atoms and molecules from the surface layers of the sample. These secondary ions are accelerated into a double focussing mass spectrometer where they are separated according to their energy and mass/charge ratio before being detected by electron multipliers or Faraday cups.

Strengths:

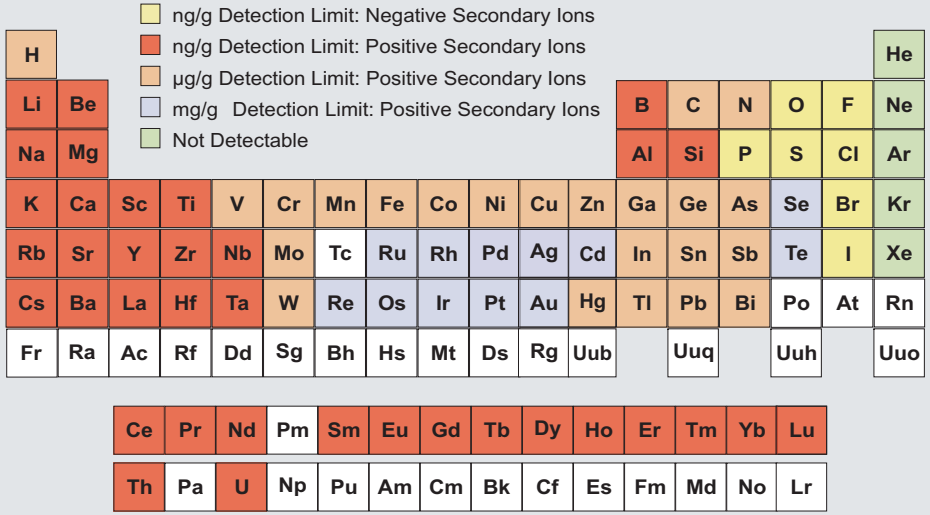
* Excellent detection sensitivity (down to ng/g)
* Depth profiles with excellent (nm) depth resolution
* Small area (<2μm) analysis
* Detection of virtually all elements and isotopes
* Excellent dynamic range (up to 6 orders of magnitude)
* Stoichiometry and quantitative analysis is possible

Limitations:

* Destructive technique
* No chemical bonding information
* Element specific sensitivity
* Calibration is matrix dependent
* Samples must be vacuum compatible
* Samples must have a flat surface

More Information can be found at: http://www.geos.ed.ac.uk/facilities/ionprobe/

SIMS Detection Limits



SIMS Instrumentation

Cameca ims-1270

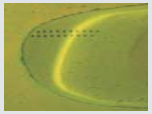
* Mass resolution up to 40,000 (m/Δm)
* High transmission at high mass resolution
* Duo-plasmatron ion source for O-, O+, Ar ions
* Thermal sublimation micro-beam source for the generation of Cs+ ions
* Multicollector option installed with 3 electron multipliers and 4 Faraday cups for simultaneous ion detection
* Electron flood gun for charge neutralisation
* Scanning ion imaging hardware and software

Cameca ims-4f

* Mass resolution up to 10,000 (m/Δm)
* Fast peak switching from ^{1}H to ^{238}U
* Duo-plasmatron ion source for O-, O+, Ar ions
* Thermal sublimation micro-beam source for the generation of Cs+ ions
* Monocollector, either a Faraday Cup or Electron Multiplier.
* Electron flood gun for charge neutralisation
* Scanning ion imaging hardware and software

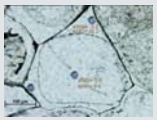
SIMS Applications

Elemental Analysis



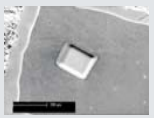
SIMS analysis allows the detection of virtually all the elements in the periodic table, often with ng/g (PPB) levels of detection and high precision. Although the technique is destructive, the volume analysed can be as small as 0.5μm^3.

Isotopic Analysis



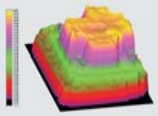
The isotopic ratio of many elements may be accurately determined by SIMS if the concentration and ionisation efficiency allows. Typically ratios of B, Li, C, O, Si, S can readily be determined to a precision of <0.05%.

Depth Profiles



As the ion beam slowly erodes the atomic layers of the sample, changes in the isotopic ratios are recorded with nanometre depth resolution. Applications are mainly concerned with the study of diffusion rates of isotopes in a variety of substrates, the composition and impurity of thin films and dopant measurements.

Images



Images may be acquired by a variety of methods (e.g. direct scanning ion image, multiple spot analysis, depth profiles). For many applications the best technique is multiple spot analyses and then contouring the data according to concentration or isotopic abundance.