SIMS

Dynamic Secondary Ion Mass Spectrometry

Technique

Atoms or groups of atoms are etched by a primary ion beam (0.25÷20keV). A small fraction of these (typically 1%) is ionized and can therefore be analyzed according to the mass/charge ratio. Either a magnetic sector or a quadrupole are generally used as mass spectrometers. Typical performances of the SIMS technique are the ability to detect each isotope of the periodic table with detection limits ranging from 1ppm to 1ppb, a mass resolution M/ΔM up to 20000, a lateral resolution of the order of 1µm and a depth resolution of 1nm.

Two distinct approaches towards lateral resolution are used in SIMS instruments. Lateral resolution is in fact either associated with the use of a finely focused primary ion beam (ion microprobe), or with the optics dealing with secondary ions in such a way as to preserve their spatial relationships (ion microscope). Lateral resolution is therefore limited by the primary beam diameter in the former case and by lenses aberrations in the second case.

Most important features

The sequential detection of masses simultaneously generated makes the technique best suited for depth-profiling. The **most important feature** is in fact its ability to follow elemental depth distributions with very low detection limits and with high lateral resolution.

Applications

As a consequence, wide **applications** of dynamic SIMS are found primarily in microelectronics (depth profiles of dopants and impurities are the typical examples), but also in metallurgy, geology and biology.

Instrument	**CAMECA IMS-4f** (operating since 1985)	**CAMECA SC ULTRA** (installed July 2001)
Ion sources	O_2 and Cs	Oxygen and cesium
Impact energy	2÷15keV	0.2÷15keV
Analyzer	The instruments can operate both as ion microprobe and as ion microscope	
Min depth resolution	4nm 3÷20nm is typically obtainable	1.5nm 1÷20nm is typically obtainable
Mass resolution M/ΔM	up to 20000	up to 20.000
Mass range	1÷300amu	> 500 amu at 5 kV sec. ext. Volt.
Spatial resolution	1µm	1µm
Charge compensation	an electron gun is provided	an electron gun is provided
Beam intensity stability		< 1% over 10 min for O_2^+ and Cs^+
Secondary extraction voltage		≤ 3 kV for a primary impact energy of 250 eV
Detection limit (deep profile)		B, P and As < 1E10^{15} at/cm^3
Det. limit (shallow profile)		B, P and As < 1E10^{16} at/cm^3
Det. limit (surface contamination)		Metals < 5E10^9 at/cm^2