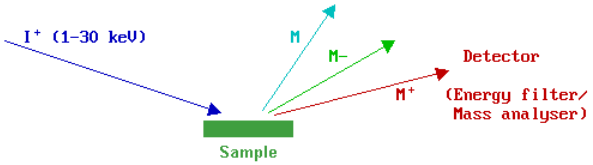
5.5: Secondary Ion Mass Spectrometry

The technique of Secondary Ion Mass Spectrometry (SIMS) is the most sensitive of all the commonly-employed surface analytical techniques - capable of detecting impurity elements present in a surface layer at < 1 ppm concentration, and bulk concentrations of impurities of around 1 ppb (part-per-billion) in favorable cases. This is because of the inherent high sensitivity associated with mass spectrometric-based techniques.

There are a number of different variants of the technique:

- All of these variations on the technique are based on the same basic physical process and it is this process which is discussed here, together with a brief introduction to the field of static SIMS. Further notes on dynamic and imaging SIMS can be obtained in Section 7.4 - SIMS Imaging and Depth Profiling.

  In SIMS the surface of the sample is subjected to bombardment by high energy ions - this leads to the ejection (or *sputtering*) of both neutral and charged (+/-) species from the surface. The ejected species may include atoms, clusters of atoms and molecular fragments.



  The mass analyzer may be a quadrupole mass analyzer (with unit mass resolution), but magnetic sector mass analyzers or time-of-flight (TOF) analyzers are also often used and these can provide substantially higher sensitivity and mass resolution, and a much greater mass range (albeit at a higher cost). In general, TOF analyzers are preferred for static SIMS, whilst quadrupole and magnetic sector analyzers are preferred for dynamic SIMS.

  The most commonly employed incident ions (generically denoted by I^+ in the above diagram) used for bombarding the sample are noble gas ions (e.g. Ar^+) but other ions (e.g. Cs^+, Ga^+ or O_2^+) are preferred for some applications. With TOF-SIMS the primary ion beam is pulsed to enable the ions to be dispersed over time from the instant of impact, and very short pulse durations are required to obtain high mass resolution.