

# Molecular imaging using micro-MeV-SIMS

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An impacting heavy ion with enough kinetic energy (typically in the MeV/amu range) will deposit an appreciable amount of this energy into the electronic system near the surface of the target. Some of this deposited energy is subsequently converted to atomic and molecular motion at the target's surface. This process has been shown to produce high sputtering yields, especially in the case of organic material, and is referred to as electronic sputtering. Electronic sputtering was put to use by the mass spectrometry community four decades ago with a technique called Plasma Desorption Mass Spectrometry (PDMS). Despite having certain limitations, PDMS became a popular way to analyse large biomolecular samples until other techniques, such as matrix-assisted laser desorption/ionisation (MALDI), became readily available.

There are many ion beam analysis (IBA) facilities operating throughout the world dedicated to accelerating and focusing MeV ion beams. IBA already offers sensitive elemental analysis options using particle-induced X-ray emission (PIXE) or Rutherford backscattering spectrometry (RBS). The research presented here describes efforts being made to perform molecular imaging using secondary ion mass spectrometry (SIMS) with focused MeV primary ions (MeV-SIMS). MeV-SIMS improves upon PDMS by exploiting the high molecular ion yields induced by electronic sputtering in an imaging mode using established IBA technology and techniques. The use of an IBA facility allows, for example, for the acquisition of simultaneous MeV-SIMS/PIXE/RBS data. Perhaps the most important consequence of using MeV primary ions is that these ions can be focused through thin exit windows to analyse a sample outside of the vacuum using an external scanning microprobe. As a result, MeV-SIMS has been developed into a fully ambient pressure (AP) micron imaging mass spectrometry technique. The challenges encountered while developing AP-MeV-SIMS will be highlighted.