Ambient Pressure Molecular Concentration Mapping Using Simultaneous MeV-SIMS and PIXE

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Since the 1970s it has been known MeV heavy ions efficiently sputter insulating targets. An analysis technique, Plasma Desorption Mass Spectrometry (PDMS)[1], resulted in commercial instrumentation which employed Cf fission fragments as a source of MeV heavy ions. The technique was able to desorb large molecular secondary ions (>10kDa) from surfaces, which at the time was not possible with standard secondary ion mass spectrometry (SIMS) techniques using lower keV energies. In the 1980s, however, Laser Desorption techniques (such as Matrix Assisted Laser Desorption (MALDI) were also being demonstrated, which didn't require the presence of radioactive material or a large accelerator. The use of clusters in conventional SIMS also allowed much higher molecular masses (~10kDa) to be imaged. Consequently PDMS was all but forgotten.

There has been a resurgence of interest in the technique recently when it was shown the PDMS (renamed MeV-SIMS) can be used with a focussed beam[2] to produce images with a much higher spatial resolution than is currently possible with laser techniques such as MALDI. It has also been demonstrated that the technique can be performed simultaneously with Heavy Ion PIXE measurements[3]. One of the limitations of SIMS techniques (including MALDI) is the effects of the matrix on the secondary ion yield which can make even relative measurements difficult and isotopic isomers which can even make trace elemental identification difficult, the combination with the PIXE elemental signals removes some of the ambiguity in these measurements.

A further recent development has been the demonstration that the Mass Spectrometry can be performed at pressures above the vapour pressure of water enabling SIMS to be performed on wet samples[4].

The new equipment being commissioned at Surrey is described, which will allow simultaneous MeV-SIMS and PIXE to be collected in full ambient pressures with a micron beam resolution. SIMS spectra and images taken for the first time at fully ambient pressure are presented to demonstrate the potential of this new instrument.

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