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Small high density plasma sources for Focussed Ion Beam Applications

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Oregon Physics has developed the HyperionTM system of high brightness plasma ion sources which are now being used on Focused Ion Beams and TOF-SIMS around the world. The original research on the plasma source ion beam system was done at the Space Plasma Power and Propulsion Laboratory at the Australian National University. These plasma sources are ten times brighter than present sources and reduce the time necessary for analysis from days to hours. They are also more reliable and can be focused down to smaller spots. The development of these sources, especially the optimization of the rf antenna design and extraction geometry will be described. Extraction of positive ions is used for reverse engineering on the nano-metre scale and negative ions are used for Time of Flight Secondary Ion Mass Spectroscopy (TOFSIMS).

SIMS uses a beam of primary ions (typically O⁻) focused onto a target. Sputtered secondary ions are measured by mass spectrometer which can detect elements and their isotopes in the low parts per billion (10⁻⁹ or ng/g) range. Particles as small as a few 100 nanometres can be analysed.

Time of Flight (TOF)SIMS measures the time of arrival of the secondary ions at the detector, which depends on their mass yielding an extremely good high mass resolution. It can detect: cocaine in urine, benzodiazepines (eg. valium) in hair and gunshot residues in fingerprints even after strenuous washing! Additionally, TOF-SIMS can simultaneously detect cocaine in the presence of other drugs (i.e. flurazepam (a benzodiazepine hypnotic) and chlorpromazine (used for psychosis and heroin withdrawal) in urine. It is possible to relate the TOF-SIMS fingerprints to the evidence found at the crime scene, which can be considered as examination of forensic evidence transfer. Elemental composition of anthrax spores using TOF-SIMS has been carried out by Weber et. al. at LLNL. This is of use in assessing the origin of bio-weapons.

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