HIDEN ANALYTICAL

EQP

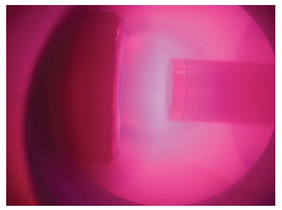
Mass and energy analyser for plasma diagnostic

Introduction

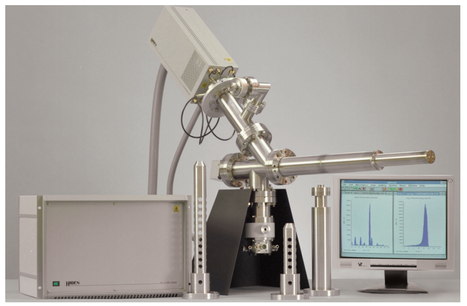
The EQP mass spectrometer combines an electrostatic sector energy analyser with a high performance quadrupole mass filter in an instrument designed for plasma diagnostics. The EQP can acquire the mass spectra and energy distributions of neutrals, radicals and ions (positive and negative). Trends in intensity can be plotted against time. Fast acquisition modes mean that transients and afterglows can be studied.

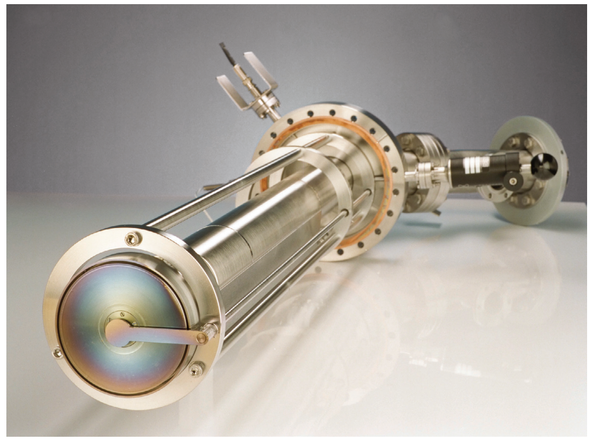
Configuration

The EQP mass spectrometer is a PC controlled instrument for plasma analysis and diagnostics. Spectra can be easily acquired, stored and manipulated using Windows™ based MASsoft software. The EQP uses an electrostatic sector field energy analyser for ion energy analysis, the transmission and resolution of this device making it the instrument of choice for plasma diagnostics.



The energy analyser is followed by a triple section quadrupole mass filter. A pulse counting electron multiplier, which can be configured for positive or negative ion operation is used for ion detection. This detector provides high sensitivity, fast response and high dynamic range (>10^{10}) for plasma ions and neutrals. Mass range options are 300 amu, 510 amu,1000 amu and 2500 amu. An energy range of 100 eV is standard and 1000 eV optional to provide the user with analysis of positive and negative ions and appearance potential spectra for radicals analysis. Signal gating by direct TTL input is also available with gating resolution to 1 μs for afterglow studies.





OPERATION

The main constituents of the EQP Plasma Diagnostic System are as follows:

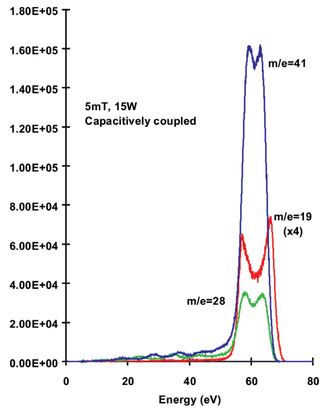
1. **Sampling Orifice:** The sampling orifice is removable and is mounted at the probe tip. This can be configured in various ways which include grounded, dc biased, heated, RF driven and electrically floating.
2. **Electron Impact (EI) Ion Source:** The electron impact ion source is not used in plasma ion mode. In EI mode the dual filament electron impact ion source is used to create ions from the neutral species which diffuse into the ion source. The selected filament emits electrons with an energy defined by the variable electron energy. The electron emission current is the current collected by the ion source cage, this current is measured and used to stabilise the filament current. The electron emission current can be user controlled to enable the user to find the ionisation potential of radicals and neutrals. The electron energy is scanned with other parameters fixed and intensity is plotted against electron energy.
3. **Transfer Ion Optics:** A drift space and lens are used to transfer the EI or PI ions to the input of the energy filter. In this drift space ions are accelerated to a higher kinetic energy. A lens is used to match the ion (EI or PI) into the energy filter.
4. **Quadrupole Lens:** To focus ions in both x and y directions into the energy filter.
5. **Energy Filter:** The energy filter is a 45° sector field electrostatic energy analyser fitted with fringe field correction apertures. The analyser radius is 75 mm providing high resolution and transmission. Energy pass band is 0.5 eV with 100% transmission within pass band.
6. **Decelerating Lens:** A decelerating lens reduces the kinetic energy of the ion beam before injection into the quadrupole mass filter.
7. **Quadrupole Mass Filter:** The quadrupole mass filter is constructed in three sections, prefilter (RF only), main filter (RF and dc) and post filter (RF only). The mass filter resolution is electronically controlled and is software adjustable to allow the user to easily optimise all parameters according to the requirements of the experiment.
8. **Detector:** The detector is an off axis mounted continuous dynode electron multiplier which operates in the pulse counting mode. The three variables which control the detector are: (i) the first dynode voltage - this is the voltage on the front of the detector; (ii) the multiplier HT - this is the voltage across the detector; and (iii) a discriminator which is used to set a counting threshold on the pulse output from the multiplier. The pulses from the detector can be electronically gated so that only pulses detected during the gate time are included in the energy or mass spectra. This feature can be used to study after glows and transient phenomena.
9. **Differential Pump Port:** High conductance ConFlat® port for turbo pump mounting.

Application

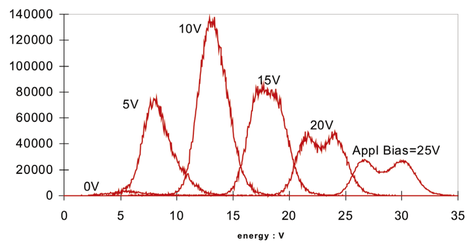
The EQP operates in one of two modes:

PI Mode: Ions can be directly extracted from the plasma. These plasma ions (PI) are formed in the plasma, extracted from it and focussed into the energy filter.

EI Mode: Neutrals and radicals are sampled from the plasma and then ionised at low pressure (10^{-5} torr) inside an electron impact (EI) ion source. The energy of the ionising electrons may be controlled to enable the detection of radicals. Ions from the electron beam source are first transferred and then focussed directly into the energy filter.



Typical IEDs are shown in the figures. The spectra show the energy distributions for mass resolved ions as indicated. The energy range of the instrument is 100 eV with an option for 1000 eV operation. The energy spectrum can be used to determine the plasma potential, tailing on the energy spectra is an indication of collisions taking place in the plasma sheath.



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