Hiden HPR-60

Molecular Beam Mass Spectrometer (MBMS) for the quantitative analysis of reactive gas species
HPR-60 Overview

• The Hiden HPR60 Molecular Beam Mass Spectrometer (MBMS) is a compact, mobile gas analysis system for the quantitative analysis of reactive gas species.

• Radicals, ions, polymers and clusters are sampled via a multistage differentially pumped inlet, forming a molecular beam that is transferred to the ion source of a precision triple filter quadrupole mass spectrometer.
Both two and three stage differentially pumped versions are available to address a broad range of applications covering the pressure range $10^{-4}$ mbar to atmospheric, including reaction kinetics in:

- Environmental and atmospheric chemistry
- Low and high pressure plasma chemistry
- Catalytic reactors
- CVD / MOCVD
- Combustion chemistry
- Flame chemistry
- Semiconductor gas abatement
Sensitivity - Detection of Xenon in Air

- Xenon Measured in air using a 2 stage HPR-60
- Inlet – Dry compressed air at 1.1 Torr
- Skimmer cones used: 0.8 mm (front), 2 mm (rear).
Ion Chemistry in Dielectric Barrier Discharge (DBD) Plasma

- HPR-60 MBMS used to investigate the effect of humidity on ion chemistry from high voltage 10 kHz He DBD plasma source.
- +ve and -ve ions and neutral species studied.

After Z. Abd-Allah et al. 2015

*The 14th International Symposium on High Pressure Low Temperature Plasma Chemistry (HAKONE XIV), Sep. 21-26, 2014*
Ion Chemistry in Dielectric Barrier Discharge (DBD) Plasma

- Main positive ions are: $\text{H}^+(\text{H}_2\text{O})_n$ and $\text{H}_3^+(\text{H}_2\text{O})_n$.
- Increasing the water concentration resulted in increasing the number of water-based ion clusters detected.

$\text{H}_2\text{O} \approx 0.055 \%$

$\text{H}_2\text{O} \approx 0.3 \%$
• The main negative ions are: O\textsuperscript{-}, OH\textsuperscript{-}, NO\textsubscript{2}\textsuperscript{-}, O\textsuperscript{-}(H\textsubscript{2}O)\textsubscript{n}, OH\textsuperscript{-}(H\textsubscript{2}O)\textsubscript{n} and NO\textsubscript{2}\textsuperscript{-}(H\textsubscript{2}O)\textsubscript{n}.

• The negative ion data is similar to the positive ions, with larger water-based clusters detected with increased humidity.
Ion Chemistry in Dielectric Barrier Discharge (DBD) Plasma

- Water concentration has a marked effect on the appearance of both positive and negative ion clusters. With higher water concentration producing larger ion clusters.
An RF-generated atmospheric plasma was used to ionise species on the surface of pharmaceutical samples.

The species produced were sampled by the HPR-60 in external ion mode.
PADI spectra obtained for the detection of active pharmaceutical ingredients

Lucy V. Ratcliffe et al. 2007 Anal. Chem 79 6094-6101
Positive ions from a DBD atmospheric discharge

- Hydrated clusters, $\text{H}_3\text{O}^+ (\text{H}_2\text{O})_n$
- Ion energies are essentially thermal at around 0.3 eV
Negative ions from a DBD atmospheric discharge

- Hydrated clusters with a series of different core ions, $X^-$ \((\text{H}_2\text{O})_n^-\), where $X=\text{O, O}_2, \text{O}_3, \text{OH, CO}_3, \text{N}_2\text{O}$
- Ion energies are essentially thermal at around 0.3 eV.
Selected Publications


Hiden HPR-60 Users

- Samsung Electronics
- Xian Jiaotong University
  - KAUST
- Old Dominion University
- University College London
- Institute of Plasma Physics
- Atmospheric Afterglow Technologies
- University of Liverpool
  - CEA LETI
  - CBTE
- Nagoya Institute
- Oak Ridge National Laboratory
- Paul Scherrer Institut
Summary

• Molecular beam Mass Spectrometer (MBMS)

• Designed and manufactured by Hiden in the UK

• Radicals, ions, polymers and clusters are sampled via a multistage differentially pumped inlet, forming a molecular beam that is transferred to the ion source of a precision triple filter Quadrupole mass spectrometer.
Quadrupole Mass Spectrometers for Advanced Science

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