

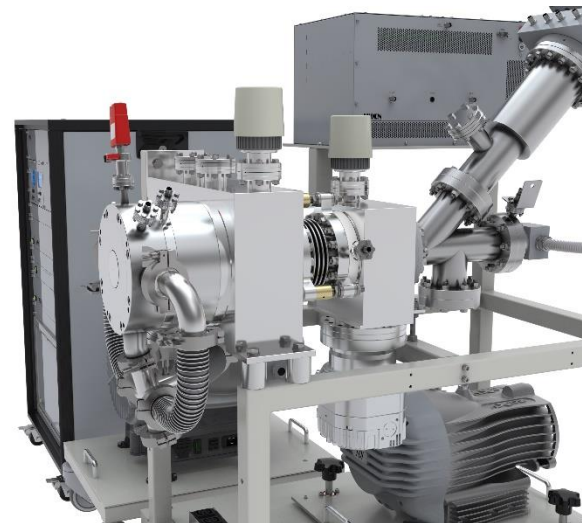
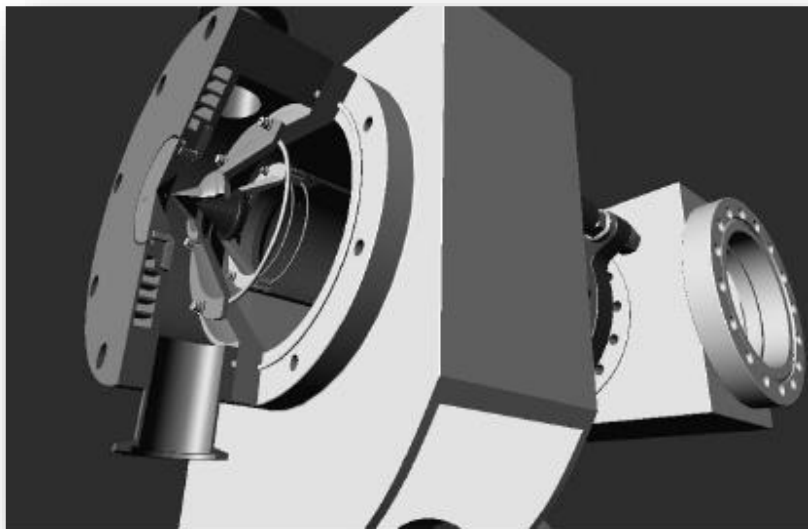
Hidden HPR-60 MBMS

Molecular Beam Mass Spectrometer
(MBMS)

for the quantitative analysis of reactive
gas species

HPR-60 Overview

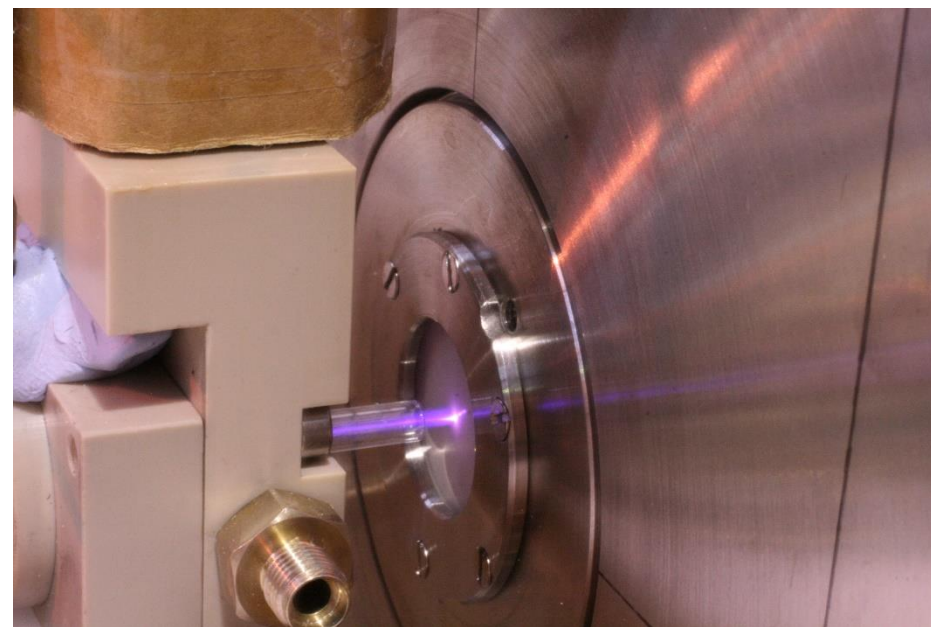
- The Hiden HPR-60 Molecular Beam Mass Spectrometer (MBMS) is a compact, mobile gas analysis system for the quantitative analysis of reactive gas species.
- Radicals, ions, polymers and clusters are sampled via a multistage differentially pumped inlet, forming a molecular beam that is transferred to the ion source of a precision triple filter quadrupole mass spectrometer.



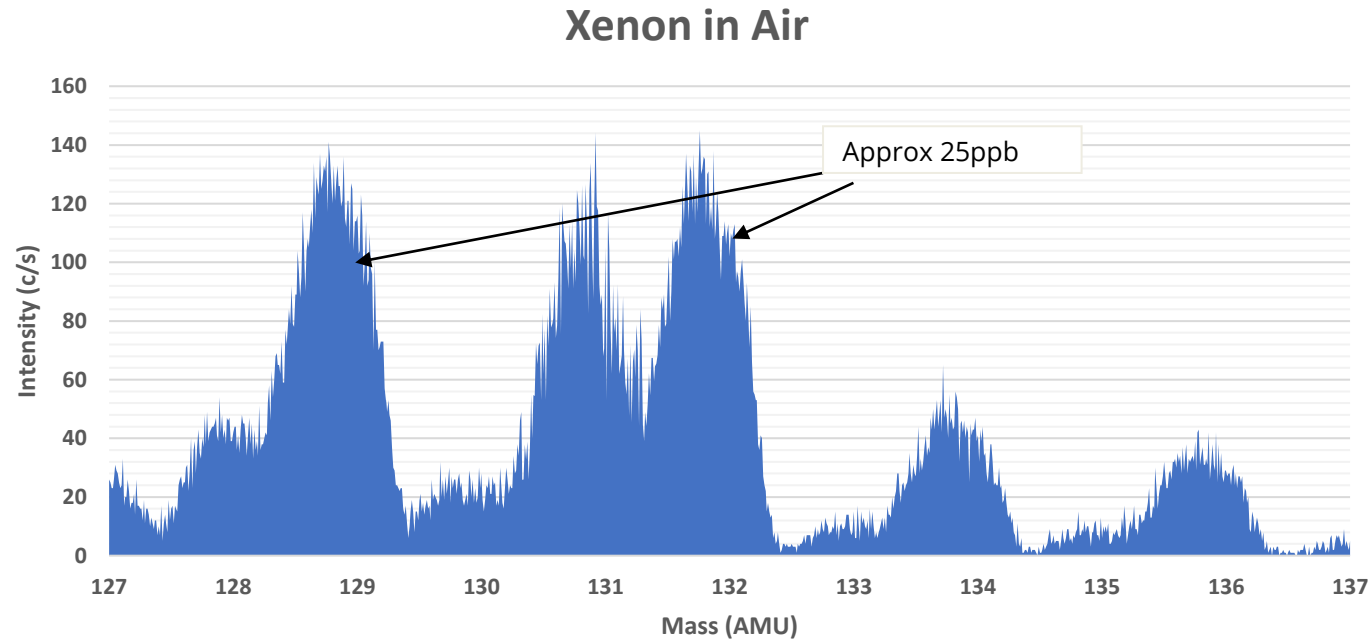
HPR-60 Applications

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

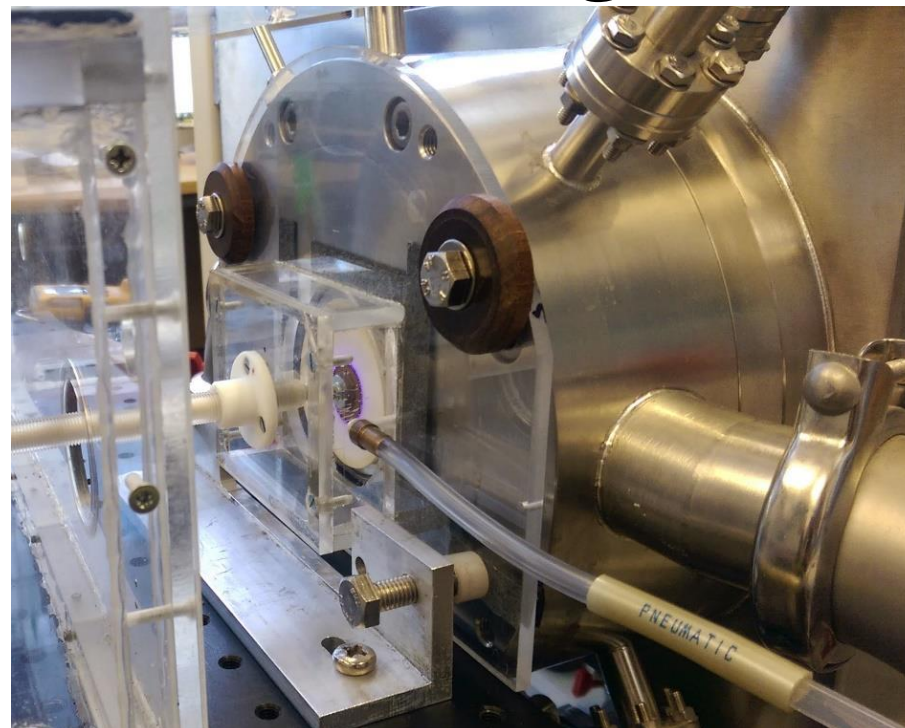
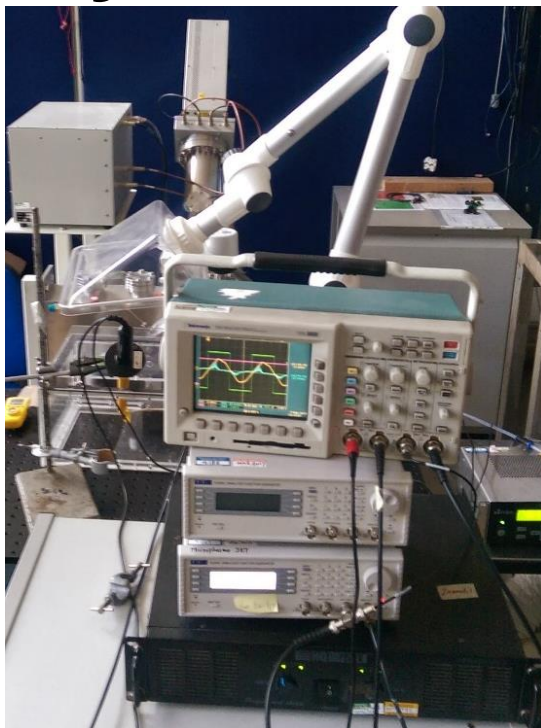


Sensitivity - Detection of Xenon in Air



- 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.

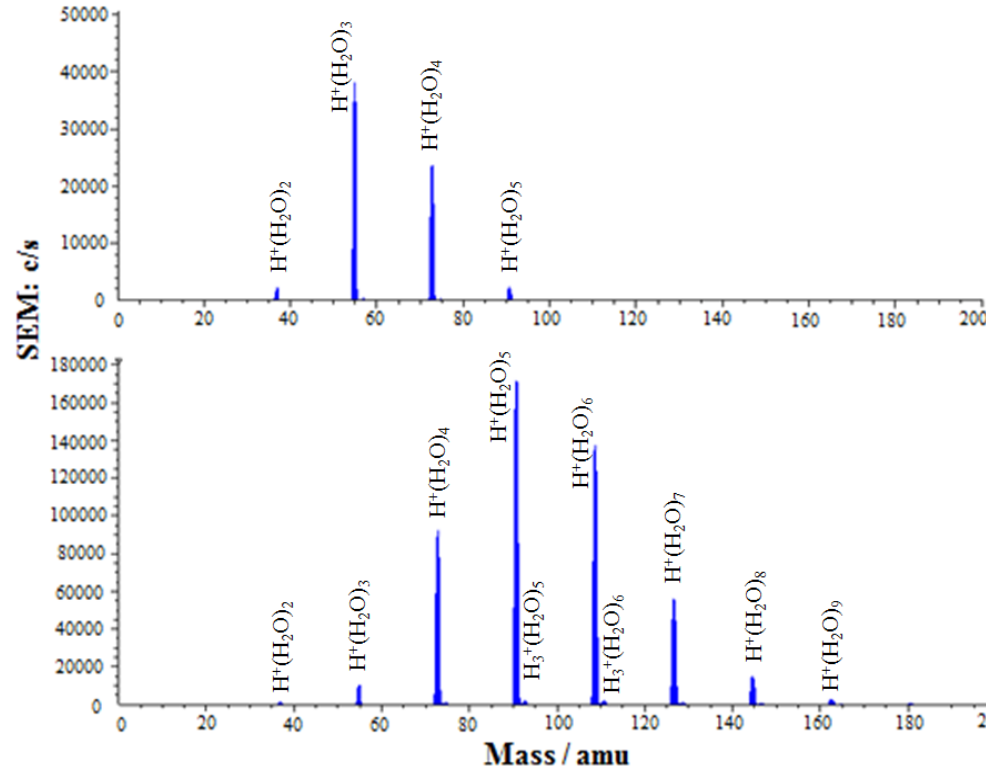
After Z. Abd-Allah et al. 2015

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

Positive ions

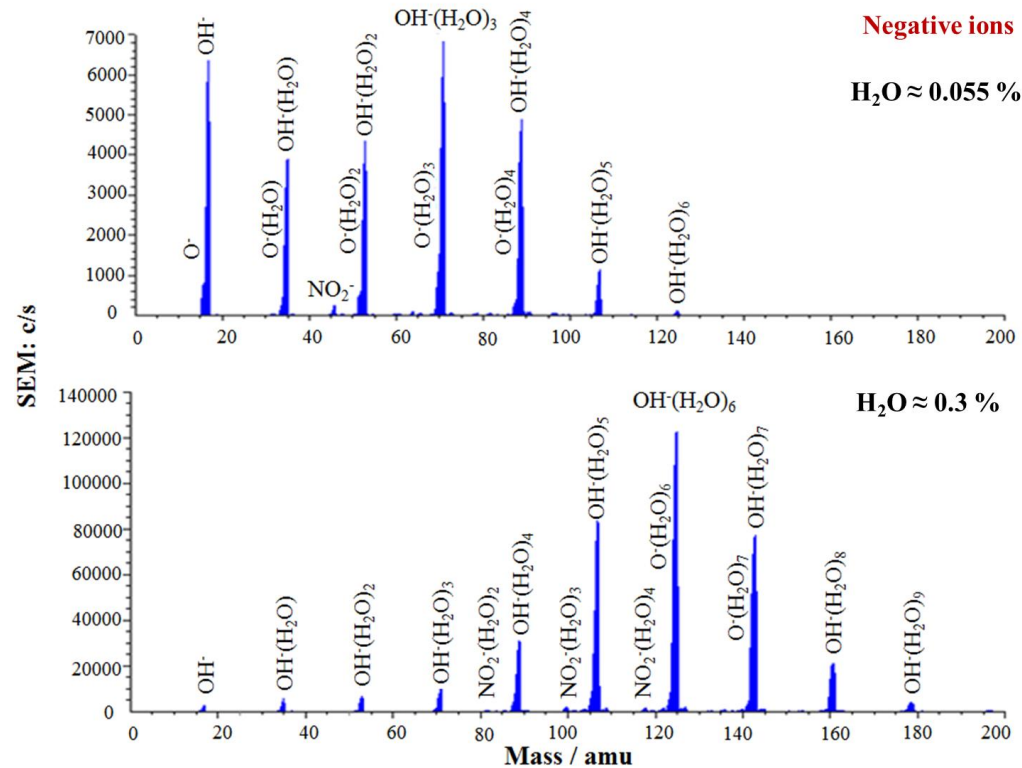
H₂O ≈ 0.055 %



H₂O ≈ 0.3 %

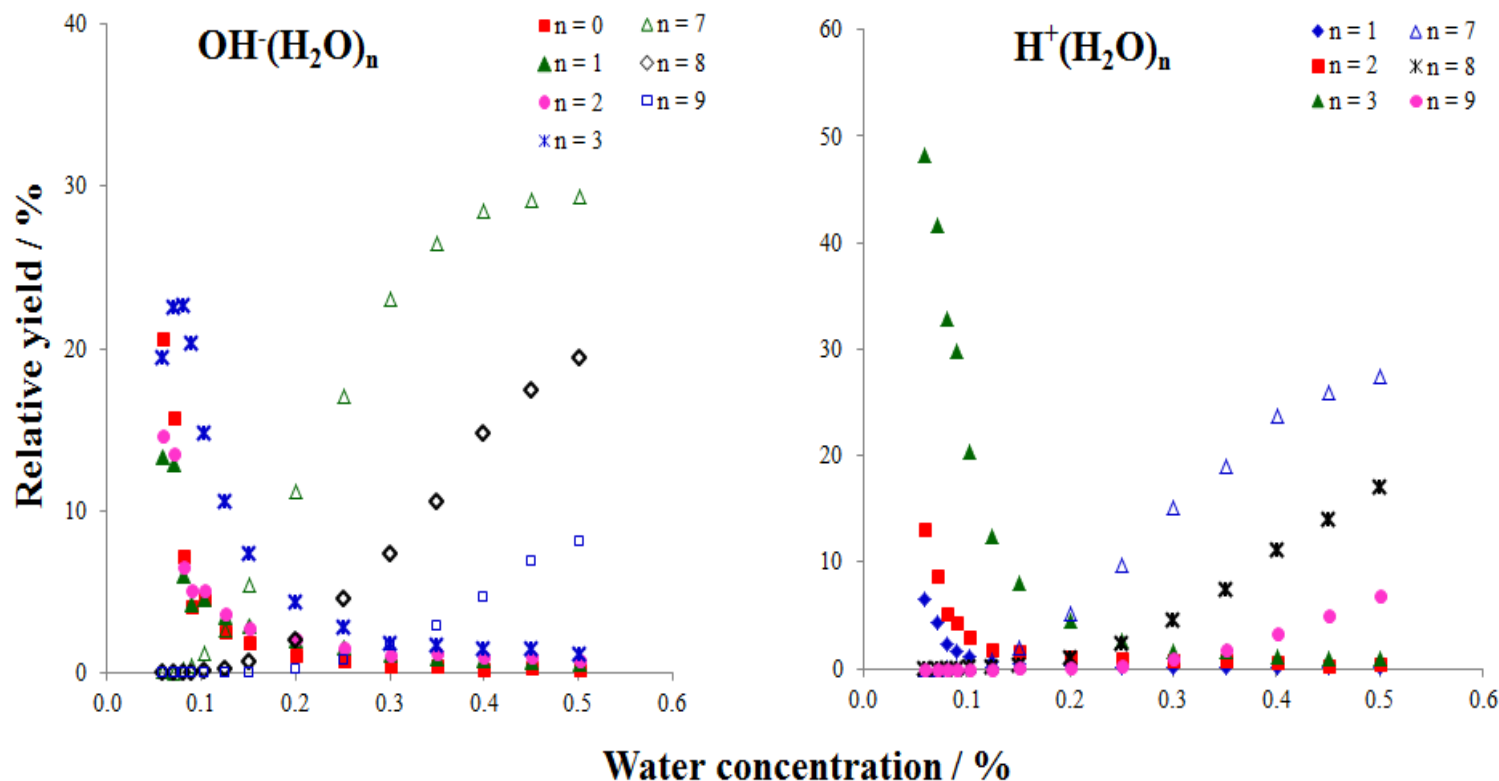
- Main positive ions are: H⁺(H₂O)_n and H₃⁺(H₂O)_n.
- Increasing the water concentration resulted in increasing the number of water-based ion clusters detected.

Ion Chemistry in Dielectric Barrier Discharge (DBD) Plasma



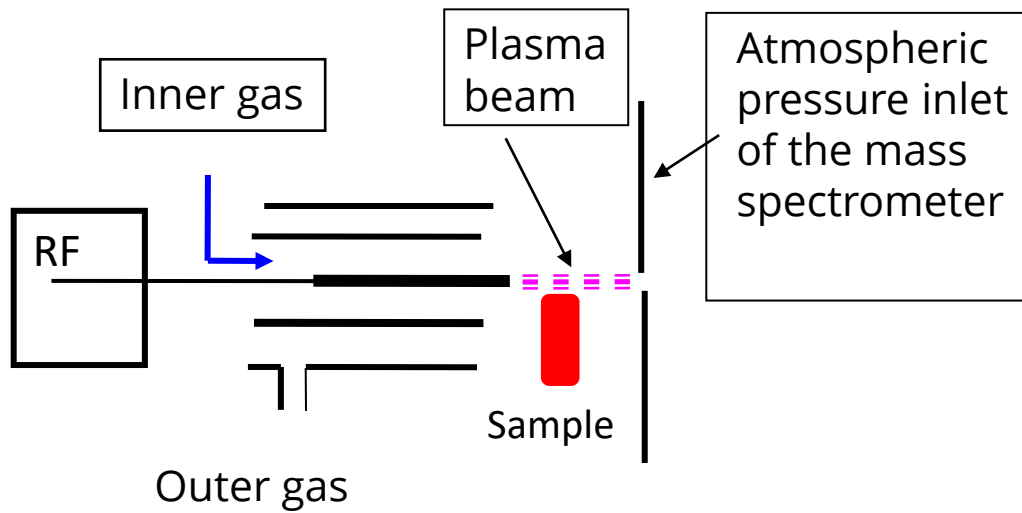
- The main negative ions are: O⁻, OH⁻, NO₂⁻, O⁻(H₂O)_n, OH⁻(H₂O)_n and NO₂⁻(H₂O)_n.
- The negative ion data is similar to the positive ions, with larger water-based clusters detected with increased humidity.

Ion Chemistry in Dielectric Barrier Discharge (DBD) Plasma



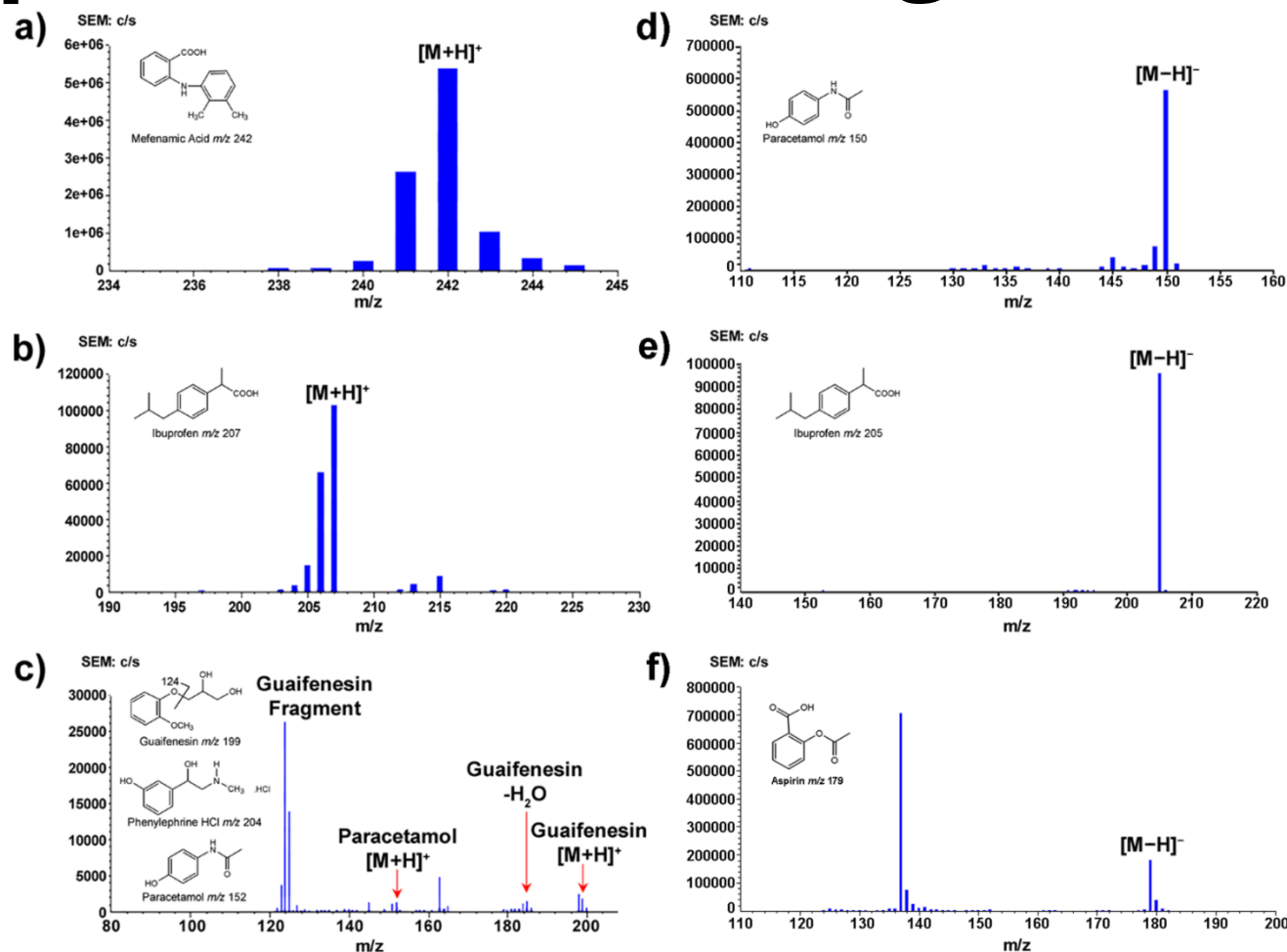
- Water concentration has a marked effect on the appearance of both positive and negative ion clusters. With higher water concentration producing larger ion clusters.

Plasma-Assisted Desorption Ionisation (PADI)



- 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.

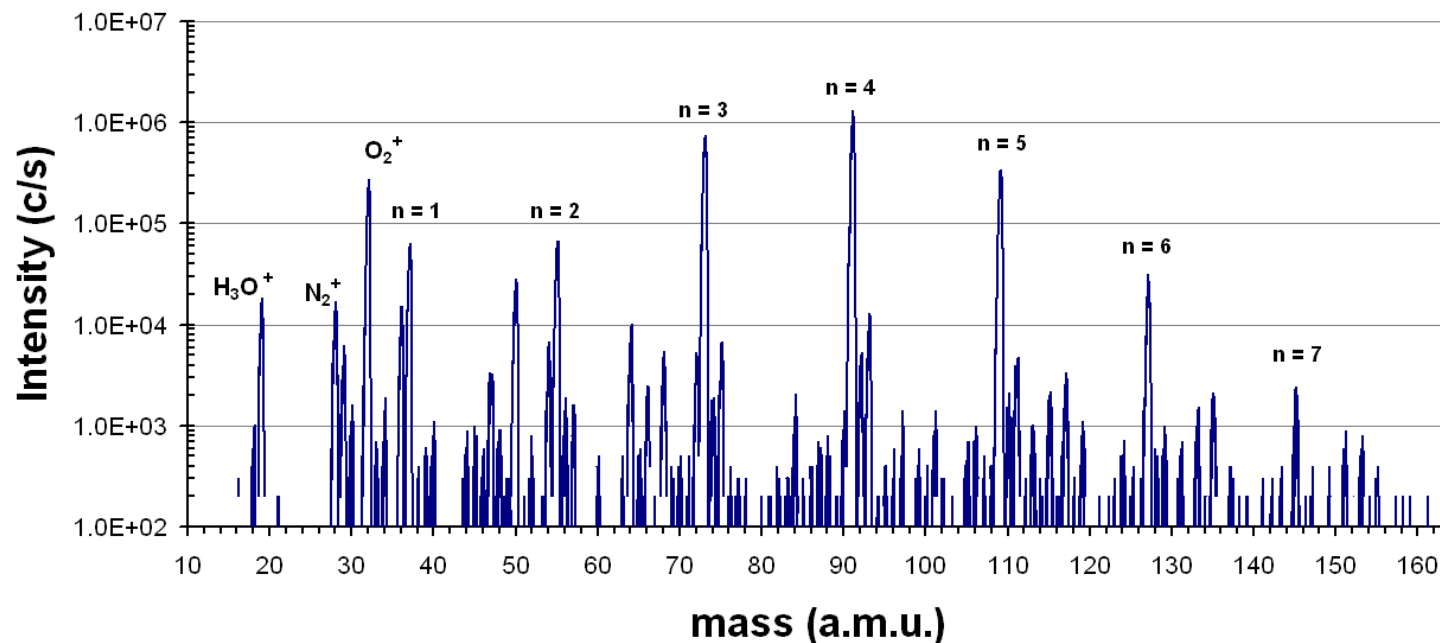
PADI spectra obtained for the detection of active pharmaceutical ingredients



Lucy V. Ratcliffe et al. 2007 *Anal. Chem* **79** 6094-6101

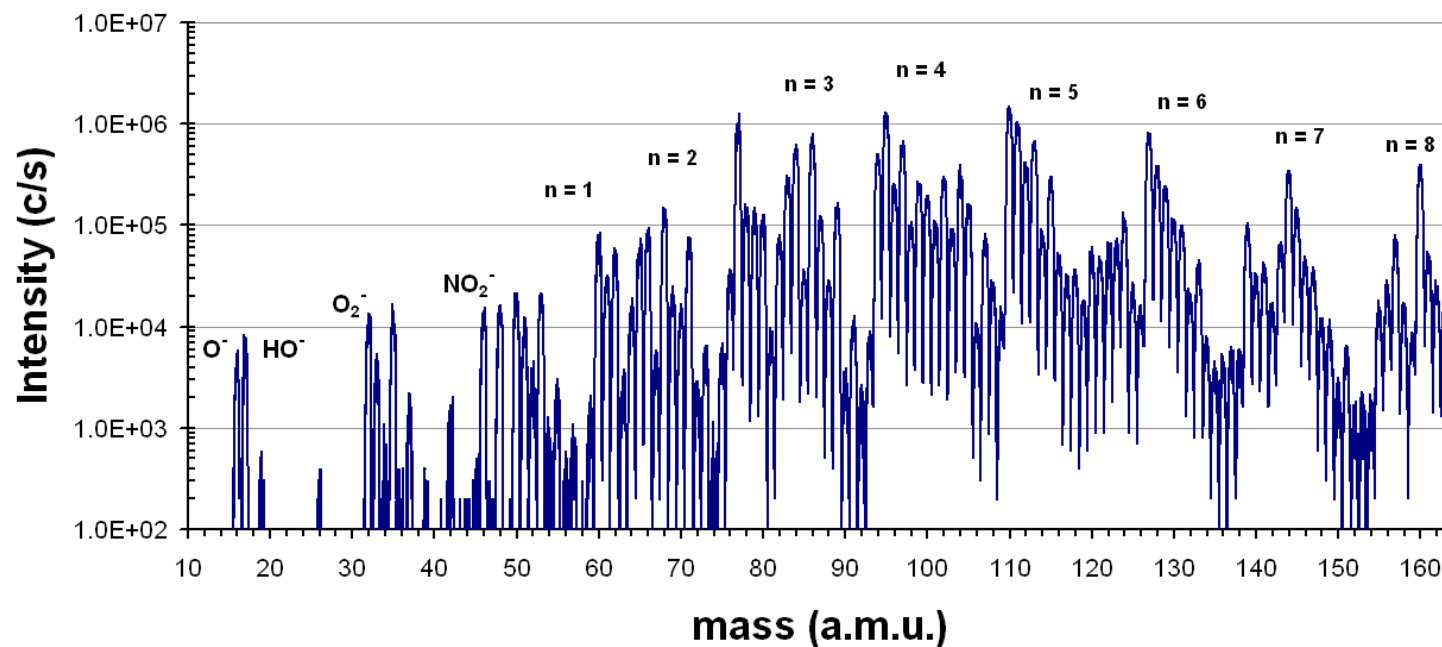
Positive ions from a DBD atmospheric discharge

- 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^- (H_2O) $_n$, where $X = O, O_2, O_3, OH, CO_3, N_2O$
- Ion energies are essentially thermal at around 0.3 eV.



Selected Publications

- Ambient air particle transport into the effluent of a cold atmospheric-pressure argon plasma jet investigated by molecular beam mass spectrometry. 2013. M Dünnbier et al. *J. Phys. D: Appl. Phys.* **46** 435203
- The reaction mechanism of the spray Ion Layer Gas Reaction process to deposit In_2S_3 thin films. 2011. S Gledhill et al. *Thin Solid Films* **519** 6413-6419
- Atmospheric pressure plasma analysis by modulated molecular beam mass spectrometry. 2006. Y Aranda Gonzalvo et al. *J. Vac. Sci. Technol.* **A 24(3)** May/June
- A plasma needle generates nitric oxide. 2006. E stoffels et al. *Plasma Sources Sci. Technol.* **15** 501-506
- A mass spectrometric study of ions extracted from a point-to-plane dc corona discharge in N_2O at atmospheric pressure. 2008. JD Skalny et al. *J.Phys. D: Appl. Phys.* **41** 085202
- Positive Ion Mass Spectrometry during an Atmospheric Pressure Plasma Treatment of Polymers. 2009. AJ Beck et al. *Plasma Process. Polym.* **6** 521-529



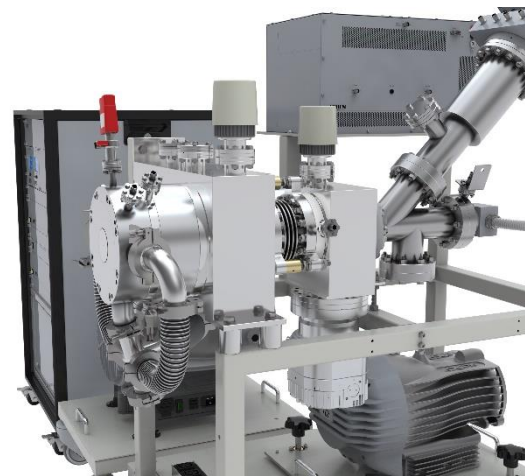
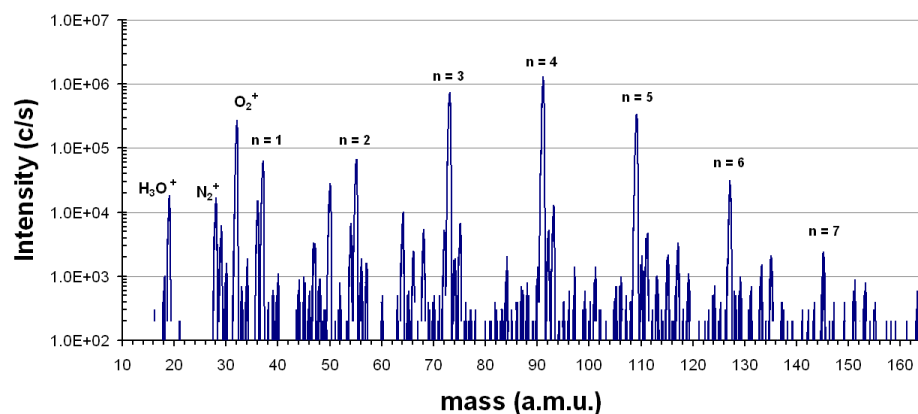
Hidden HPR-60 Users

- 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.



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- A photograph of a modern, two-story office building with a grey facade and large glass windows. The building has a prominent "HIDEN ANALYTICAL" sign on its side. The sky is clear blue, and there are green trees and bushes in the foreground. A large, semi-transparent white circle is overlaid on the left side of the image, containing a bulleted list.
- www.HidenAnalytical.com
 - The Hiden website is an excellent resource with product pages, brochures, catalogues, product pages with some application notes, presentation and other information.
 - Contact +44 1925 445225 for direct support.