High Resolution Power at Low Masses

APPLICATION NOTE

Resolving Closely Separated Masses

There are a number of important academic and industrially relevant applications that require high-resolving power at low masses. These include the measurement of hydrogen isotopes in the presence of helium (e.g. $^4He/D_2$) and also CO in the presence of N_2. The difference in mass between ^4He and D_2 is just 0.0033 amu.

Resolving such closely separated masses is far beyond the capabilities of most commercially available quadrupole mass spectrometer instruments. With more than 50 years of experience in quadrupole development and advanced manufacturing techniques, Extrel is able to demonstrate routine, high stability, high resolution performance with the MAX-50 quadrupole instrument; a 19mm tri-filter mass filter with coupled 2.9MHz RF electronics. The MAX-50 by itself can address a broad range of UHV applications such as high resolution SIMS, TPD and geochronology. When combined with our application matched VeraSpec HRQ gas analysis systems, the field of measurement is extended to include a wide range of gas analysis applications up to atmospheric pressure.

The MAX-50 is the high-resolution instrument of the MAX-QMS Series of quadrupole mass spectrometers.

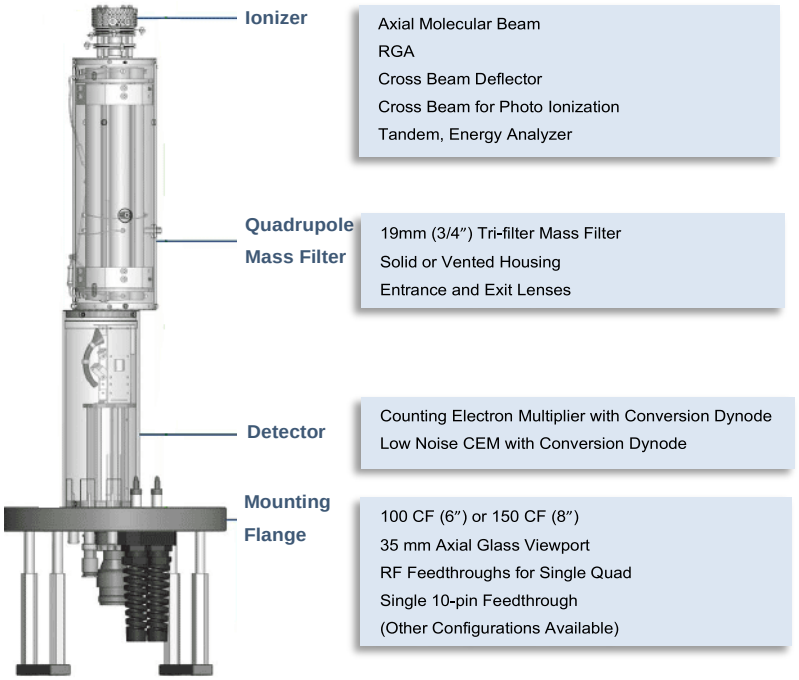

Figure 1. MAX-50 Probe

The following spectra were all measured with standard MAX-50 production instruments comprising 19mm tri-filter mass filter, 2.9MHz electronics, axial electron impact ionizer with dual thoriated iridium filaments and positive/negative ion pulse counting multiplier with conversion dynode.

In geochemistry, analysis of C, N, O, Ar and S isotopes are areas of interest. Figure 2 demonstrates the typical resolution performance measured at m/z=40 and demonstrates the top end resolution. Extrel systems boast a resolution of at least 3000 FWHM at 40 m/z. With a careful tune, users are able to push these limits as well.

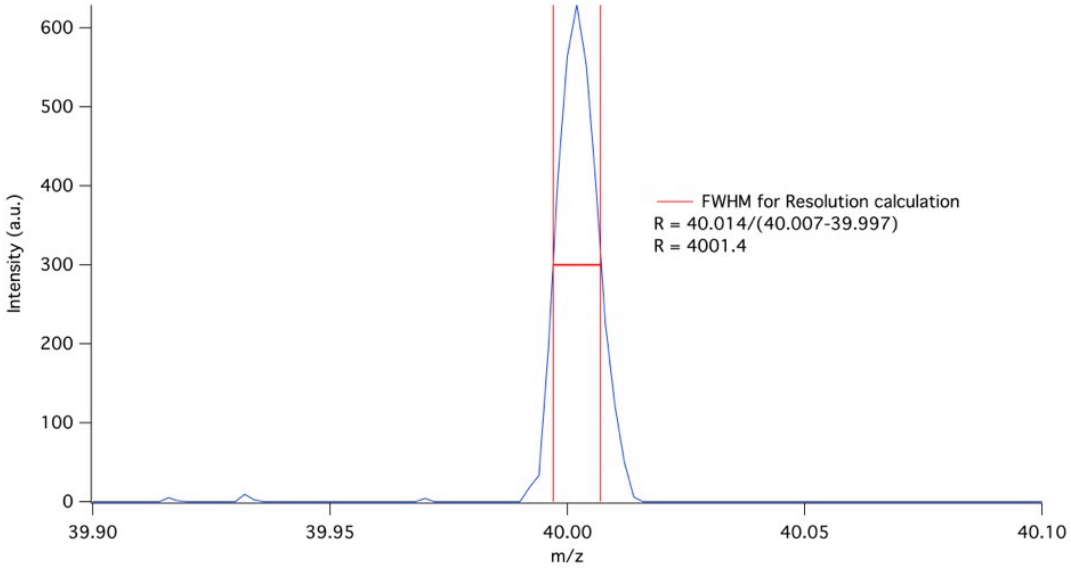

Figure 2. Argon mass 40 showing a resolution of 4001 = M/ΔM

Figure 3 shows the resolution performance for low masses, specifically. The measurements were performed in a UHV chamber where a blend of 10% UHP helium and 10% deuterium diluted in UHP argon was admitted to a pressure of 5 x 10^6 Torr and demonstrates exceptional characteristics, such as peak shape and baseline separation.

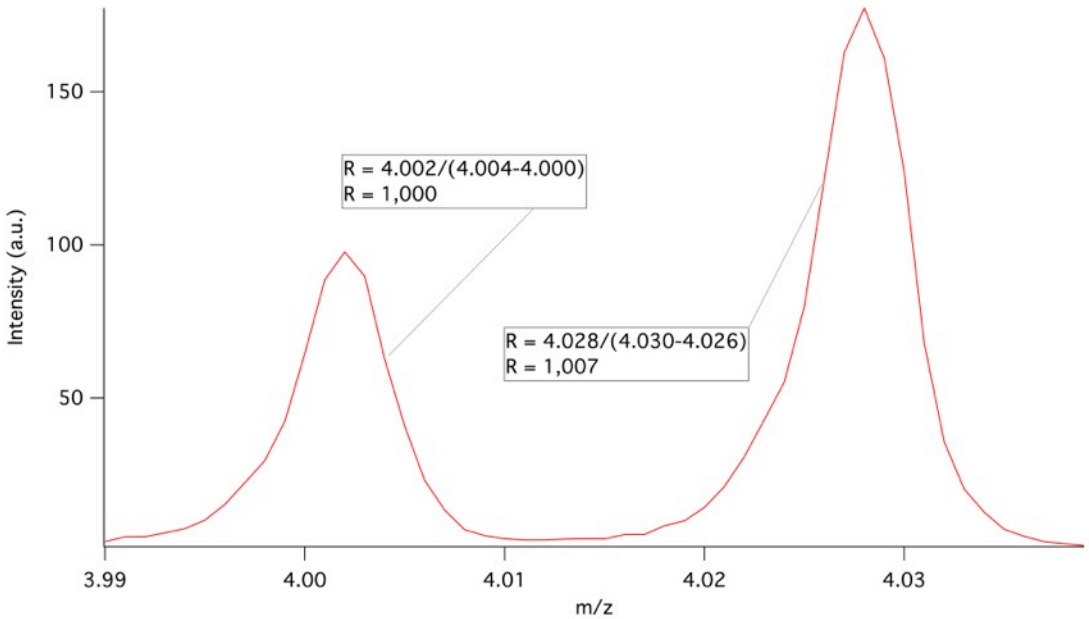

Figure 3. Separation of helium at 4.002 amu and D_2 at 4.028 amu

Peak stability is arguably as important as anything else in high-resolution experiments. When separating analytes, only a few thousandths of an amu apart, exact reading of the mass position is absolutely necessary. One of the toughest pairs of compounds to analyze simultaneously are CO (MW=28.008) and N_2 (MW=28.019). The MAX is able to separate and distinguish the two peaks to more than a 30% valley.

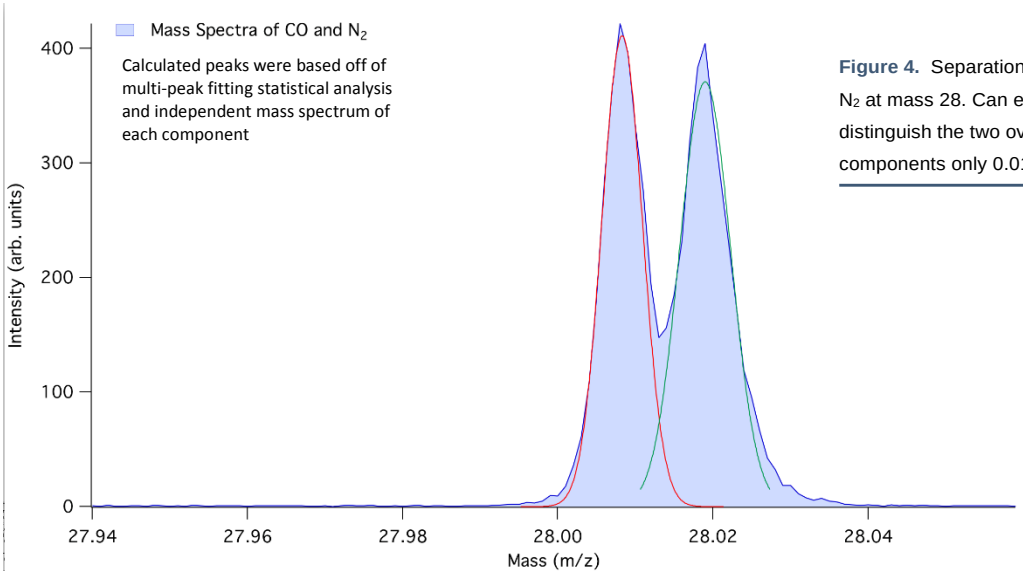

Figure 4. Separation of CO and N_2 at mass 28. Can easily distinguish the two overlapping components only 0.011 amu

Extrel's High Resolution QMS quadrupole systems are also used in isotopic analysis. Along with splitting He and D_2, nuclear research facilities often analyze isotopes of Hydrogen. Below, peaks of diatomic Hydrogen, as well as ^{3}He, D_2 and ^{4}He are illustrated.

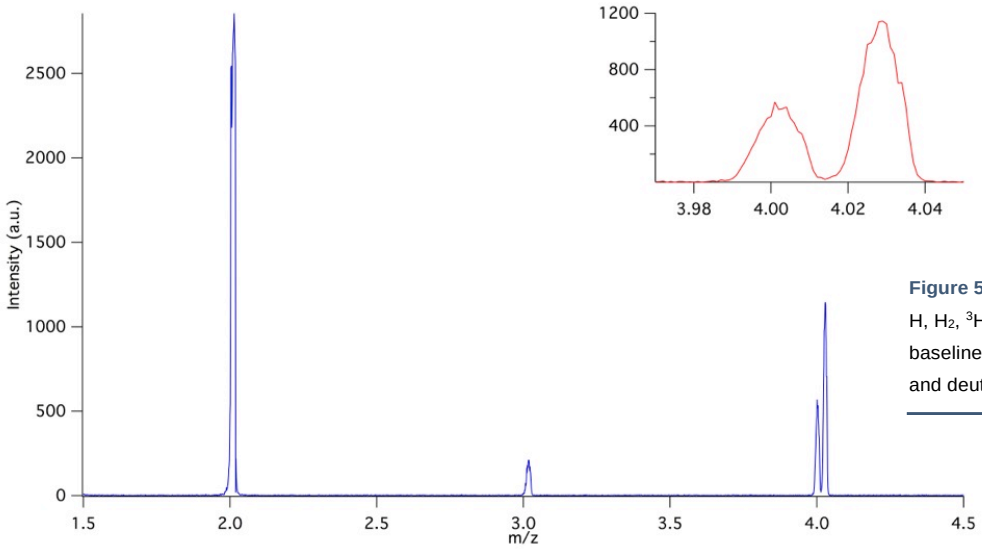

Figure 5. Isotope analysis of H, H_2, ^{3}He and ^{4}He. Inset shows baseline separation of helium and deuterium at mass 4

Extrel offers unique capabilities for low mass, high-resolution studies, excellent transmission and resolution and abundance-sensitivity characteristics unseen in any other available quadrupole mass spectrometer instrumentation. The MAX-50 can be used as a turnkey standalone VeraSpec HRQ system, as a probe based MS system, or can be added to any existing VeraSpec system.

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