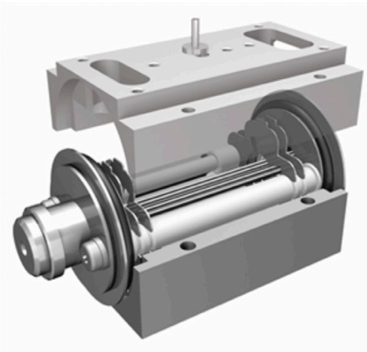

Enhanced Helium Collision Mode with Agilent ORS[4] Cell

Agilent ICP-MS technology brief

Helium collision mode in ICP-MS

Helium (He) mode with kinetic energy discrimination (KED) is the preferred collision/reaction cell (CRC) mode for effective and reliable removal of polyatomic interferences in single quadrupole ICP-MS.

Reactive cell gases may be effective at separating individual interferences from individual analyte isotopes. But they are unable to simultaneously remove all the interferences that occur in real-world applications, where the sample composition is often unknown, complex, or variable.

Furthermore, reactive cell gases lead to the formation of unwanted reaction product ions, unless the ions that enter the cell are controlled using an additional mass filter before the cell (ICP-MS/MS).

On single quadrupole ICP-MS, therefore, He mode is preferred, as it is applicable to multiple analytes and to variable samples. He mode also has the benefit that it gives access to confirmatory isotopes for many analytes.

High-intensity interferences on selenium

Conventional He mode works well for most multi-element analyses. When analytes are affected by intense background interferences, typical He mode conditions cannot reduce the interferences sufficiently for trace analysis. A good example is the low ng/L (ppt) level analysis of Se, where a reactive gas (typically H_2) is often required to achieve the required detection limits.

Enhanced helium mode on Agilent ICP-MS systems

The Octopole Reaction System (ORS[4]) fitted to all Agilent ICP-MS systems supports an enhanced He mode, due to a cell design which uses:

- A long, high frequency octopole to increase the number of collisions
- High cell gas flow rates to increase cell pressure
- High bias voltage range to promote higher collision energy

The combined effect of these features is illustrated in Figure 1, which shows the kinetic energy of ions exiting the cell under conventional He mode conditions and enhanced ORS[4] helium mode conditions. Enhanced He mode gives a much smaller overlap between the residual energies of the Se analyte ions (in green) and the Ar_2 interfering ions (in red). The smaller energy overlap with enhanced He mode means the KED bias voltage at the cell exit rejects polyatomic interferences more effectively, while also increasing sensitivity for analyte ions.

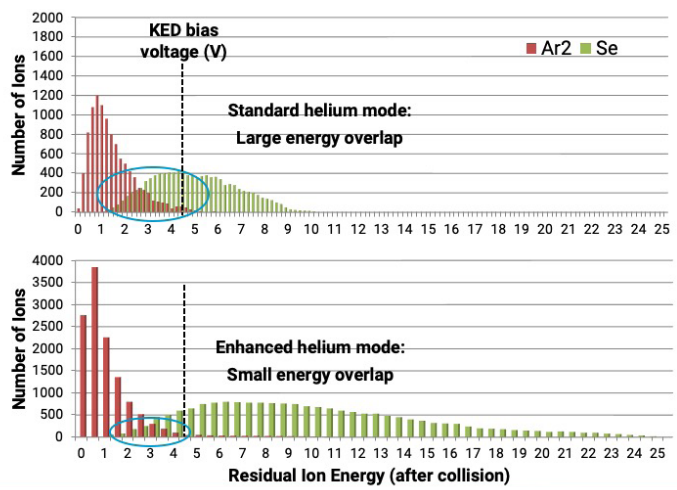

Figure 1. Comparison showing greater overlap of residual energy of Se analyte ions and Ar_2 polyatomic ions in standard He mode (top) than in enhanced He mode (bottom).

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Applications that benefit from enhanced He mode

Several applications require the measurement of analytes at levels that can be difficult to achieve using conventional He collision mode conditions.

These analytes may suffer intense interference from polyatomic ions formed from components of the plasma and sample solution. These components include Ar, N, and C from the plasma and surrounding air, O and H from the aqueous solvent, N from the dilute nitric acid, and so on. Example analytes and interferences are shown in Table 1.

Table 1. Examples of analytes that suffer intense background interferences that may not be adequately resolved using conventional helium collision mode.

Analyte	Isotope	Interferences
Se	78	Ar_2
Se	80	Ar_2
Si	28	N_2, CO
P	31	NO, NOH
S	34	O_2, O_2H, O_2H_2

The usual approach for these analytes is to use a reactive cell gas, but such gases are not suitable for multi-element analysis of complex and variable samples using single quadrupole ICP-MS. The Agilent ORS^4 cell with enhanced He mode offers an alternative approach, providing better discrimination between analyte and interfering ions (Figure 1). Agilent ORS^4 He mode provides superior interference removal, allowing Se to be measured at ppt levels using a single He mode cell gas. This improvement is illustrated in Figure 2, which shows the cell gas optimization plot for ^{78}Se in enhanced He mode.

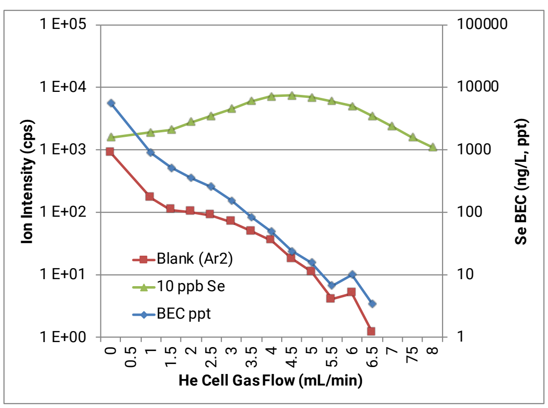

Figure 2. Cell gas optimization plot in enhanced He mode, showing effective reduction of Ar_2 background and low single-ppt background equivalent concentration (BEC) for ^{78}Se.

ORS^4 He mode gives much better rejection of Ar_2 polyatomic ions, while increasing transmission of the Se ions, giving a combination of lower background and higher sensitivity. This translates into much lower detection limits, allowing Se to be measured without the need for a reactive cell gas (or cell gas mixture).

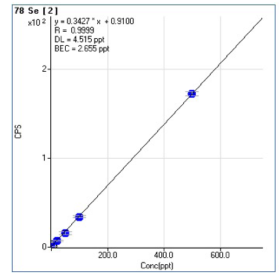

Figure 3. Calibration plot for ^{78}Se in enhanced He mode, showing DL of 4.52 ppt and BEC of 2.66 ppt.

In addition to improved performance for Se, much lower DLs and BECs are achieved for Si, P, and S in ORS^4 He mode, as shown in Table 2.

Table 2. DLs and BECs for Si, P, and S in enhanced He mode.

Analyte	Isotope	DL (ppb)	BEC (ppb)
Si	28	0.161	9.92
P	31	0.17	0.29
S	34	8.94	187

These detection limits are far lower than can be achieved using conventional He mode, and in some cases match or exceed the performance achieved using a reaction gas.

Conclusion

Enhanced He mode with Agilent ORS^4 offers a significant improvement in the analysis of some difficult interfered elements, notably Se, Si, P, and S. The DLs achieved meet the method requirements for many applications, allowing simple, single cell gas methodology and eliminating the need for reactive cell gases in these routine methods.

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DE44140.8951157407

Published in the USA, November 9, 2020
5994-1171EN

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