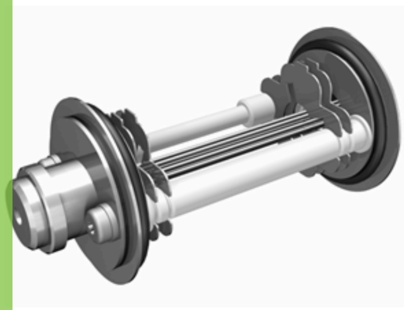

Octopole Collision/Reaction Cell and Helium mode

Agilent ICP-MS technology brief

How helium collision mode works

He collision mode takes advantage of the greater energy loss of polyatomic ions vs the analyte ions they overlap, as they pass through a collision cell containing He gas.

Polyatomic (molecular) ions have a larger collision cross section than analyte (atomic) ions at the same mass. Polyatomic ions therefore collide more frequently with the He cell gas atoms, so lose more energy.

By the exit of the cell, the lower energy of the polyatomic ions allows them to be rejected by applying a positive kinetic energy discrimination (KED) bias voltage. Analyte ions retain enough energy to overcome the KED barrier and pass through to the quadrupole.

In this way, polyatomics are filtered out of the ion beam, enabling more accurate and more consistent results to be obtained for many previously difficult analytes.

He mode:

- Is effective for all polyatomic ions
- Is suitable for multi-element analysis
- Can be used for unknown samples
- Does not lead to analyte signal loss by reaction

An octopole-based cell is the optimum configuration for effective He mode.

Helium mode and polyatomic interferences

Helium (He) collision mode has transformed Agilent ICP-MS performance. Matrix-dependent polyatomic interferences, which are difficult to predict in unknown sample types, affect many analytes. Agilent ICP-MS systems use He collision mode to address these interferences while maintaining analyte sensitivity, as illustrated in Figure 1.

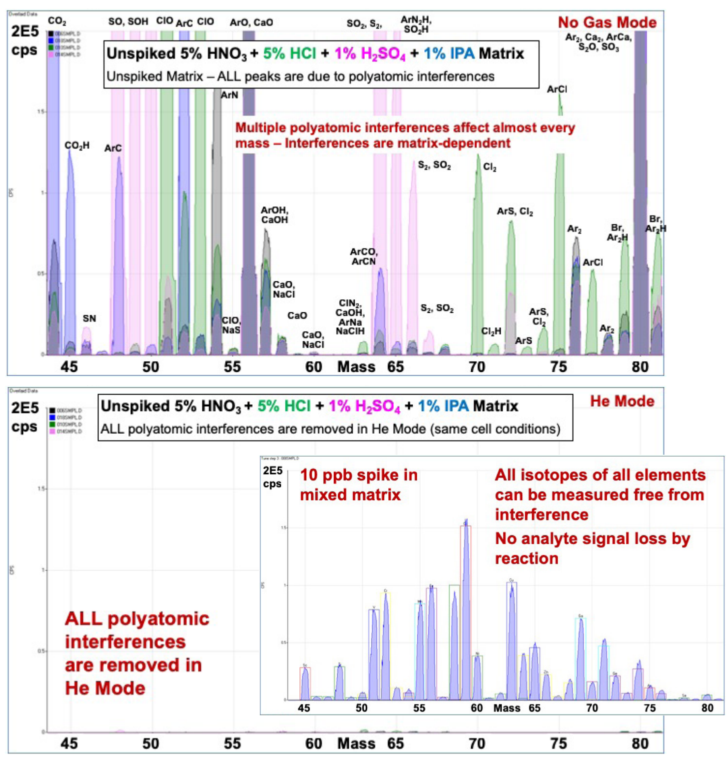

Figure 1. Polyatomic interferences formed from different matrix components affect most analytes between *m/z* 40 and 80 in no gas mode (top). All these interferences are suppressed in He mode (bottom), allowing accurate measurement of all isotopes of all analytes in this region (inset).

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Requirements for effective He collision mode

Collision mode requires the ions to undergo many collisions so the difference in residual energy between analyte and polyatomic ions is large enough for them to be separated. For effective collision mode:

1. The initial ion energy spread must be as narrow as possible
2. The cell must operate with a light cell gas (He) at high cell gas pressure to produce the large number of collisions required
3. The ion guide must have a small internal diameter and a wide stability region, to minimize ion scattering

Narrow ion energy spread is a key requirement for effective interference removal in collision mode. Analyte and polyatomic ions enter the cell with the same mean ion energy, derived from the voltage difference between the plasma and interface. Agilent ICP-MS instruments use the ShieldTorch System to ground the plasma, giving a low mean ion energy and narrow energy spread. This improves the ability of KED to effectively resolve the analyte and polyatomic ions after the cell, as illustrated in Figure 2.

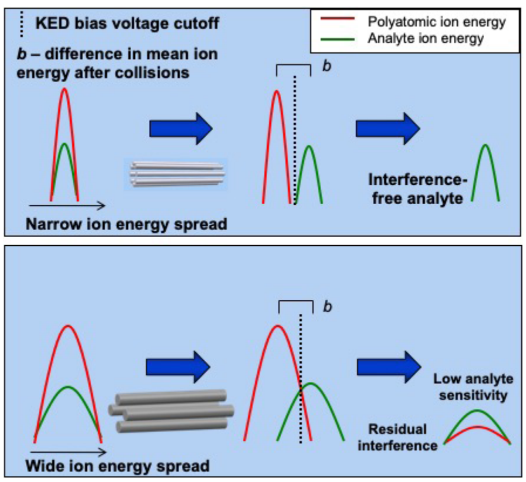

Figure 2. Top: Narrow ion energy spread on Agilent ICP-MS enables effective resolution of polyatomics using KED. Bottom: Wider energy spread on non-Agilent ICP-MS means analyte and polyatomic ions' energy still overlap after the cell, so interferences are not completely removed.

Narrow ion energy spread enables the KED bias voltage (dotted line in Figure 2) to efficiently reject the polyatomic ions while allowing the analyte ions to pass.

The ORS cell used on Agilent ICP-MS systems combines small size (low cell volume; narrow ion guide) with high transmission (large region of ion stability), as shown in Figure 3.

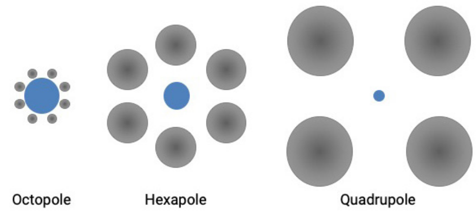

Figure 3. Relative size, internal diameter, and ion stability regions (in blue) for multipole ion guides.

An octopole cell gives the ideal combination of good ion transmission with a high number of collisions required for KED. By contrast, a quadrupole-based cell uses a large ion guide but has a small ion stability region, so transmission and sensitivity are low at high cell gas pressures. A quadrupole is, after all, designed to filter or reject ions in a low-pressure vacuum chamber, rather than transmit ions through a gas-filled chamber.

The ability of a quadrupole-based cell to reject off-mass precursor ions and therefore prevent the formation of cell-formed interferences is not relevant for He collision mode. He is inert, so doesn't form reaction product ions in the cell. Also, the polyatomic ions addressed by He mode are all on-mass interferences, so can't be rejected without also rejecting the analyte ions.

Conclusion

Controlling polyatomic interferences using helium collision mode and KED has been a major factor in improving data quality and expanding the range of ICP-MS applications.

He mode requires a combination of the right cell design and operating conditions, coupled with effective control of ion energy. The Agilent ORS octopole-based cell combines with the ShieldTorch System for ion energy control, to provide the highest collision mode performance.

Learn more:

www.agilent.com/chem/icpms

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