Agilent 7800 Quadrupole ICP-MS

PLASMA ROBUSTNESS IN ICP-MS BENEFITS OF A LOW CeO/Ce RATIO

Benefits of the robust plasma of the Agilent 7800 ICP-MS

- Better matrix tolerance
- Better long-term stability
- Reduced matrix deposition and therefore less maintenance
- Improved ionization, especially for poorly ionized elements
- Lower interferences (better dissociation of polyatomic ions)
- Less signal suppression

ICP-MS plasma robustness

Plasma robustness, or effective plasma temperature, is one of the most critical performance characteristics of an ICP-MS instrument. It impacts many aspects of method development, routine operation and productivity, as well as directly affecting the quality of data generated.

ICP-MS plasma robustness is measured using the CeO^+/Ce^+ ratio, with a lower ratio indicating a more robust plasma. A more robust plasma dissociates the strongly bound CeO^+ molecule more efficiently, and decomposes the sample matrix more completely. This allows samples with a higher level of total dissolved solids (TDS) to be measured. The CeO/Ce ratios of commercial ICP-MS instruments typically range from <1% to ~3%. This variation is due to several factors:

- Design and operating frequency of the ICP RF generator (solid state power generation and 27.12 MHz contributes to a low CeO/Ce ratio)
- Internal diameter (id) of the ICP torch injector (a larger id normally increases plasma robustness)
- Operating conditions such as sample uptake rate, carrier gas flow, and sampling depth

The Agilent 7800 ICP-MS typically operates at <1% CeO/Ce – the lowest ratio of any commercial ICP-MS, and so samples with TDS levels of 2,000 ppm or more can be measured routinely.

Agilent's unique High Matrix Introduction (HMI) technology – standard on the 7800 ICP-MS – further increases plasma robustness. HMI reduces the CeO/Ce ratio to ~ 0.2% and improves matrix tolerance by about 5x compared to non-HMI operation.

IP range (eV)	Element
<6	Li, Na, Al, K, Ga, Rb, Sr, In, Cs, Ba, some REE
6 to 8	Mg, most transition elements, Ge, Y, Zr, Nb, Mo, Ru, Rh, Ag, Sn, some REE, Hf, Ta, W, Re, Tl, Pb, Bi, Th, U
8 to 11	Be, B, Si, P, S, Zn, As, Se, Pd, Cd, Sb, Te, I, Os, Ir, Pt, Au, Hg
>11	C, N, O, F, Cl, Br

Table 1. Elements grouped by 1st ionization potential (IP).

Figure 1 shows the % ionization (and therefore sensitivity) of all elements at different plasma temperatures. The vertical lines show how the % ionization of Cr, Cd, and Hg is affected by plasma temperature. For example, Cd is more than 80% ionized in the most robust plasma (plasma temperature 7800 K), but only 5% ionized at a plasma temperature of 5800 K.

HMI, plasma robustness, and matrix suppression

HMI uses intelligent auto-optimization of aerosol dilution to further improve matrix tolerance, allowing the 7800 ICP-MS to measure % level TDS samples routinely. By reducing both aerosol density and water vapor loading on the plasma, HMI increases the already unmatched plasma robustness of the 7800 ICP-MS.

A practical benefit of the improved matrix tolerance provided by HMI is the virtual elimination of matrix suppression. Matrix or ionization suppression in ICP-MS occurs when the plasma is overloaded by the matrix and has insufficient residual energy to fully ionize analytes. Signal loss due to suppression is greater for poorly ionized elements.

Figure 2 shows how HMI improves the recovery of a 10 ppb Cd spike in a salt matrix. At 2.5% CeO/Ce, which is typical for some ICP-MS systems, Cd recovery is 86% in the 0.03% salt matrix, and only 16% in the 3% salt matrix.

At the typical (non-HMI) 7800 ICP-MS plasma robustness level (1% CeO/Ce), suppression is much lower, but still apparent. In contrast, with HMI, Cd recovery is close to 100% for all samples – even at 3% TDS.

The Agilent 7800 ICP-MS with HMI can measure very high and variable matrix samples accurately, without matrix-matched calibration standards. This significantly improves data quality, productivity, and analytical workflow.

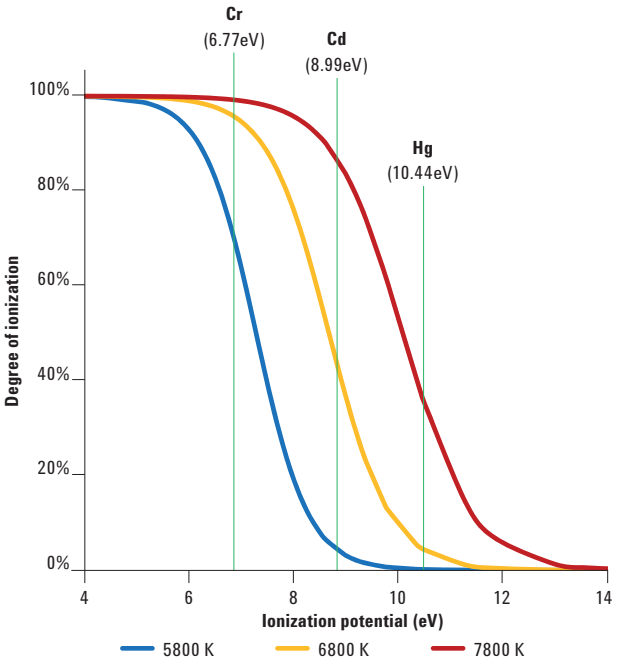

Figure 1. Degree of ionization at different plasma temperatures.

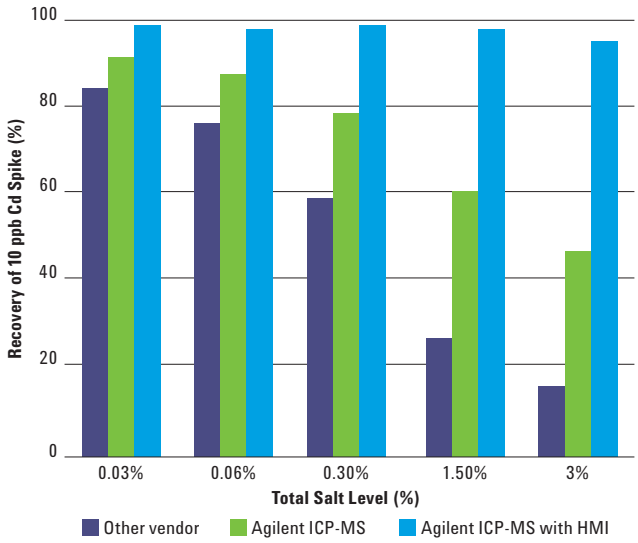

Figure 2. Cd recovery in samples up to 3% TDS. HMI ensures recovery is consistent in variable matrices, and so matrix-matching of calibration standards is not required.

For more information visit:
www.agilent.com/chem/7800icpms

Published June 1, 2015
5990-8060EN

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