Agilent 7800 Quadrupole ICP-MS

SUCCESSFUL LOW LEVEL MERCURY ANALYSIS

Challenges of Hg analysis by ICP-MS

- High 1st ionization potential (10.44 eV), leads to low ionization (4%) and low sensitivity
- Multiple (7) natural isotopes means that sensitivity for each is reduced (most abundant is <30%)
- Poor chemical stability and volatility means Hg is easily lost from solution, and requires chemical complexation. Requires closed-vessel digestion and the addition of chloride (HCl) to all solutions

Analysis of mercury by ICP-MS

Mercury (Hg) is a rare heavy metal, many forms of which are highly toxic by inhalation, ingestion or absorption through the skin. Hg has many industrial uses, including as a component of compact fluorescent light bulbs, and is typically monitored and regulated in commodities such as drinking water, seafood, consumer goods, pharmaceutical products and children's toys.

Traditional methods for Hg analysis require a separate sample preparation combined with a single-element Hg analyzer, which reduces sample throughput and productivity. Mercury analysis can be combined with the typical multi-element analysis performed by ICP-MS, but this requires optimized ICP-MS methodology:

- The plasma must be operated at the highest possible temperature (lowest possible CeO^+/Ce^+ ratio) to maximize ionization of the Hg atoms
- The system must provide high sensitivity to compensate for the low degree of ionization and the low abundance of each Hg isotope
- Appropriate sample preparation and preservation chemistry must be used to ensure stability of Hg

The Agilent 7800 ICP-MS addresses the first two requirements and the simplest approach to the third is to prepare all samples and standards using a low % level of HCl, which ensures the formation of a stable complex $[HgCl_4]^{2-}$ that keeps the Hg in solution.

Chemical stability of Hg

Sample preparation and preservation using HNO_3 alone (specifically excluding HCl) is recommended in many ICP-MS methods to avoid problems caused by the Cl-based polyatomic interferences on V, Cr, As, and Se. However, excluding HCl can cause problems with the stability of many elements, including Hg, As, Se, Mo, Tl, and Ag.

Even with the advent of collision/reaction cell (CRC) ICP-MS, the presence of chloride is still a major problem for instruments that use reactive cell gases to remove interferences. Ammonia (NH_3) reaction gas is commonly recommended for removing ClO and ClOH interferences on V and Cr, but NH_3 is not effective for ArCl and CaCl interferences on As. Consequently, a second reaction gas (such as O_2, H_2, or CH_4) is required when V, Cr, and As all have to be measured. None of these reactive cell gases is reliable in all sample types.

Advances in CRC technology for the 7800 ICP-MS now allow a simple approach to removing all the Cl-based interferences using a single, universal He mode (Figure 1).

HCl at 0.5 to 1.0% can now routinely be included in acidic sample preparation and stabilization for ICP-MS analysis. In addition, samples with high or variable natural levels of Cl can now be measured reliably, without the extensive method development and multiple cell gases required when reaction mode is used. The improved chemical stability from the presence of HCl allows Hg to be measured routinely at single ppt detection limits on the 7800 ICP-MS (Figure 2). The ^{201}Hg isotope (13.18% abundance) was measured, as it is free from polyatomic overlap by tungsten oxide (WO).

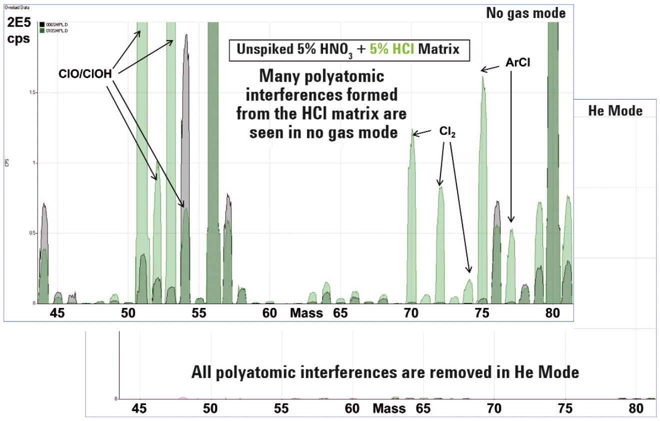

Figure 1. Comparison of polyatomic interferences from 5% HCl matrix in no-gas mode (top) and He mode (bottom), shown on the same scale.

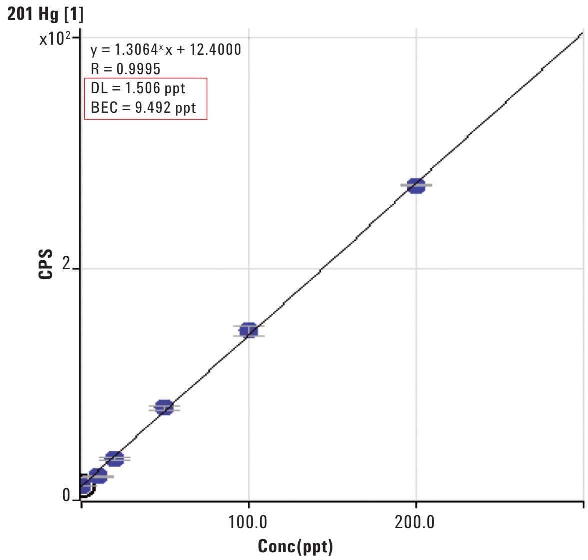

Figure 2. Calibration for mercury at ng/L (ppt) levels, demonstrating single ppt DL and BEC (background equivalent concentration)

For more information visit:
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