Introduction

The determination of multiple trace elements in high-matrix samples has always been a difficult analytical challenge. ICP-optical emission spectroscopy (OES) has excellent matrix tolerance and multielement capability, but lacks sensitivity and can suffer from complex spectral interferences. ICP-MS has unsurpassed sensitivity and fewer interferences, but dissolved solids levels must be limited to about 0.1% or less.

The ability of the ICP-MS (and ICP-OES) to tolerate high dissolved solids without introducing stability or other performance problems has been termed robustness. In ICP-MS this is measured by looking at the ratio of CeO^+ to Ce^+ when tuning – a lower CeO^+/Ce^+ ratio means a more robust plasma.

Agilent has pioneered many innovations to improve robustness, including an optimized, low-flow sample introduction system, wide-diameter (2.5-mm) torch injector, and a digitally driven 27 MHz RF generator. Combined, these innovations

Note that no internal standard correction was applied to any of the data in Figure 2. This means that, with HMI, undiluted seawater can be run against a 1% HNO_3 calibration with acceptable recoveries, something no other ICP-MS can claim. The presence of high levels of easily ionized elements (in this case approximately 3% TDS – mostly NaCl) has little effect on the Zn signal, demonstrating the improved robustness of the plasma with HMI.

A further example of improved robustness with HMI is illustrated in Figure 3. This plot shows the signal recovery for several elements measured in a series of solutions containing increasing concentrations of Zn, from 0 ppm up to 1% (10,000 ppm) Zn. The trace element signals are shown relative to the 0 ppm Zn matrix. Despite the lack of any internal standard correction, less than 20% suppression is observed, even in the 1% Zn matrix. In addition, all elements are closely grouped – there is no mass-dependence to the suppression effect. Note that the Zn concentration was ramped from

0 to 10,000 ppm twice and the recovery plots are consistent for both sample sets. Minimal suppression and minimal mass-dependent sensitivity change means that the HMI can measure sample matrices ranging from 0% to 1% metal (in this case Zn), using a single aqueous calibration. When internal standardization is used, much less correction is needed, which increases accuracy and makes it easier to choose suitable internal standards. Productivity is increased since there is no need for close matrix matching.

Matrix buildup on the interface cones and lenses results in poor long-term stability, requiring frequent maintenance and retuning. The HMI kit, by significantly reducing buildup, increases the long-term stability and minimizes maintenance and retuning. Figure 4 shows the normalized internal standard recoveries for five internal standards measured in both H_2 and He mode over a 150-sample sequence of a 1% Cu in 10% nitric acid solution.

Simple to Use

In practice, the HMI is extremely simple to set up
and operate. Sophisticated software algorithms