SciAps ApNotes
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In-Field Analysis of **Beryllium in Alloys** and other Materials Using Hand Held Laser Induced Breakdown Spectroscopy [LIBS]

Overview

The element Beryllium (Be) is used as a metal and in alloys in nuclear power reactors, aerospace applications, electrical equipment and in missile fuel. Most notably it's used in nuclear weapons manufacturing both as part of the trigger to initiate the nuclear reaction, and to contain the reaction in the early changes to increase the overall force of the explosion. As part of site cleanup and decommissioning, there has been significant interest for a handheld analyzer capable of measuring Be in the field[1,2].

SciAps has introduced the Z-series for in-field Be measurements. The Z is a truly handheld analyzer that utilizes laser-induced Breakdown Spectroscopy (LIBS). It can measure Be in alloys, soils and other materials with a limit of detection (LOD) of 5 ppm. In addition to Be, the Z can measure every element in the periodic table including other low atomic number elements Li, B, C, Na, F. One user is in fact using the Z for hydrogen measurements.

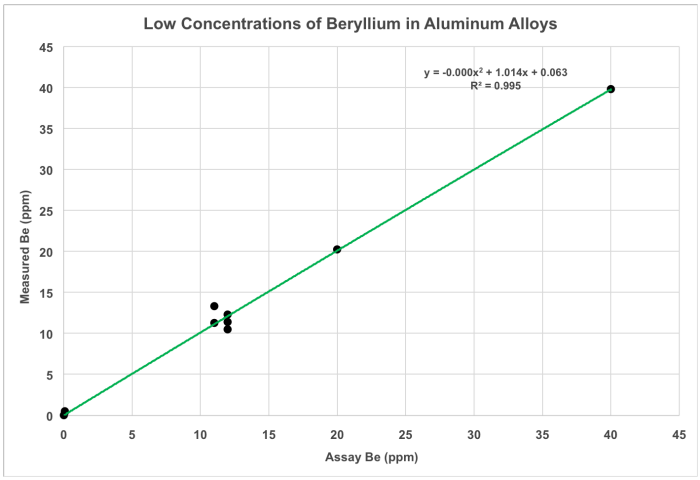

Fig. 1.

Analyzer Description

SciAps manufactures two models the Z-200 and Z-300. Both measure Be equally well. The Z uses a 5-6 mJ 1064 nm laser (Class 3b, but operable under Class 1 conditions) pulsed at 50 Hz which is powerful enough to generate the plasma in non-metals as well as metals. The Z-200 has spectrometer range of 190 nm up to 615 nm, allowing for measurement of every element except H, N, O, F, Br, Cl, Rb, Ce, K and S. The Z-300 covers spectral range from 190 nm to 950 nm which yields wavelength coverage for the entire periodic table of elements. The Z operates in either an air or patented argon purge environment. Testing times are 2-3 seconds. The analyzer has factory calibrations and software to support user-based calibrations and complete test methods. The system runs on an Android operating system, offers WiFi, Bluetooth and GPS, and supports AirWatch for use in secure locations.

Data and Discussion

Data for beryllium measurements in aluminum and copper alloys is shown in figures 1 and 2. Figure 1 shows measured Be concentrations versus assayed values for several aluminum alloys from blanks up to 50 ppm concentration (maximum available commercially). Measurements on copper alloys (not shown) produced good linearity up to percent levels of beryllium. As mentioned the LOD is 5 ppm and LOQ 15 ppm. Materials can therefore be classified as being below or above the typical compliance level of 130 ppm Be.

Figure 2 shows 3 spectra, zoomed into the beryllium spectral region, for copper alloys. Multiple spectra are shown for three copper alloys, one containing 4,500 ppm Be, one at 42 ppm Be and a blank (< 1 ppm). All tests are 3 seconds maximum. As shown, the sample with 42 ppm Be produces a clear signal above the blank. Further analysis supports the 5 ppm LOD in copper alloys as well.

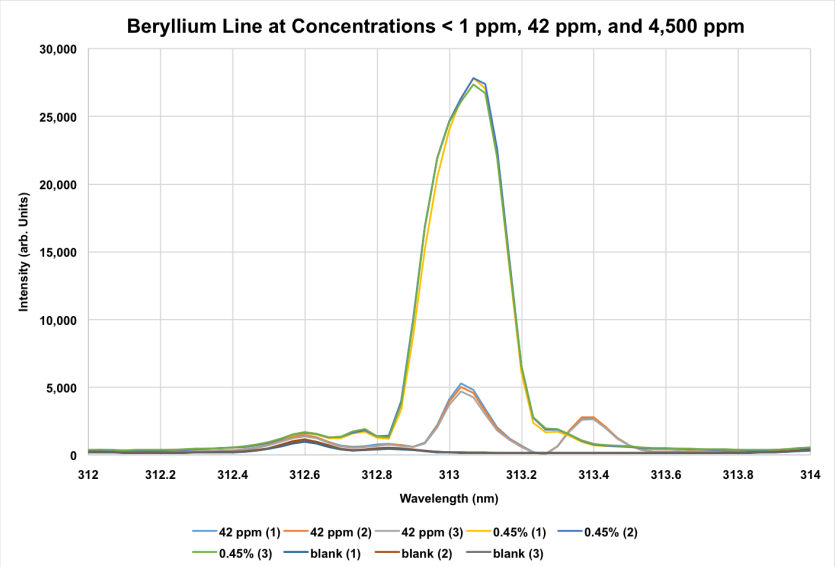

Fig. 2. Spectral plots (zoomed to Be region) of three copper alloys containing 4,500 ppm, 42 ppm and < 1 ppm of Be. Spectral analysis indicates an LOD of 5 ppm for Be in copper alloys as well.

Previously measurements of beryllium in soil were also evaluated. The LOD in soils scales approximately as the density of the sample, as a denser sample produces a stronger plasma and therefore more signal. We found that for loose soil samples (testing on the ground) LODs were elevated by about 3-4x compared to alloys, thus closer to 20 ppm LOD. Pressing soils with a portable, 5-7 ton press will yield LOD performance comparable with alloys. With loose or pressed soils, the results versus assay were more scattered (than alloys) due to the lack of sample homogeneity.

Conclusions

The Z is the first ever handheld technology that offers fast, in-field analysis of beryllium. The device uses laser induced breakdown spectroscopy, and offers an LOD of 5 ppm for Be in alloys, and 15-20 ppm for unpressed (i.e. loose) soil. Indeed the Z can measure every element of the periodic table. Previous publications[1,2] note the need for a handheld analyzer capable of fast, in-field measurements of Be in soil, and also note, as of 2009 no such technology exists. The Z handheld libs has been commercially available for the past few years, and is widely used in the alloy and mining industries for elemental analysis.

[1] www.wmsym.org/archives/2009/pdfs/9372.pdf

[2] https://bhsc.llnl.gov/documents/04_14_BHSC_Meeting/Analysis_in_Soils_Durham_04-2014.pdf