# Application Note

## *Instrument: GDS900*

# Bulk Analysis of Boron in Low Alloy Steel

*LECO Corporation; Saint Joseph, Michigan USA*

Key Words: Low Alloy Steel, Boron, GDS900 Atomic Emission Spectrometer

## *Introduction*

Boron is intentionally added to steel to control hardenability. It is added to low alloy steel to create the high strength low alloy steel used in the automotive, mining, petrochemical refinishing, and construction industries. It is especially important when typical alloying elements like chromium and nickel are in short supply, not desirable in the alloy, or are too expensive. Complex interactions between boron and alloying constituents requires complete knowledge of composition to obtain the desired physical properties in the final product. Alloying elements used in steel such as C, Mn, Ni, Cr, Mo, Si, Cu, and traces such as Ti, Nb, and Zr can be determined simultaneously alongside boron. The GDS900 can accurately determine low boron concentrations – standard calibration range is 5 ppm to 100 ppm.

The LECO GDS900 is an atomic emission spectrometer that determines the elemental content of solid conductive materials by measuring the intensity of characteristic light emitted from the sample when excited. The glow discharge source uniformly removes (sputters) material from the sample surface, outperforming other excitation sources. Excitation of the atoms occurs in the glow discharge plasma discretely apart from the sample surface thereby reducing the metallurgical and chemical history inherent in all samples. Neutral atomic emission lines predominate the glow discharge spectra. While singly ionized transitions are observed in the glow discharge, the spectra are notably less complex than those produced by most other atomic emission techniques, resulting in few spectral interferences. In addition, the response of the typical glow discharge analytical line is linear and thus fewer wavelengths are required to determine the full range of concentrations.

The GDS900 offers you state-of-the-art technology designed specifically for routine elemental determination in most ferrous and nonferrous materials. LECO's exclusive CCD-based design ensures measurement stability, flexibility, and analytical performance in a production environment.

## *Sample Preparation*

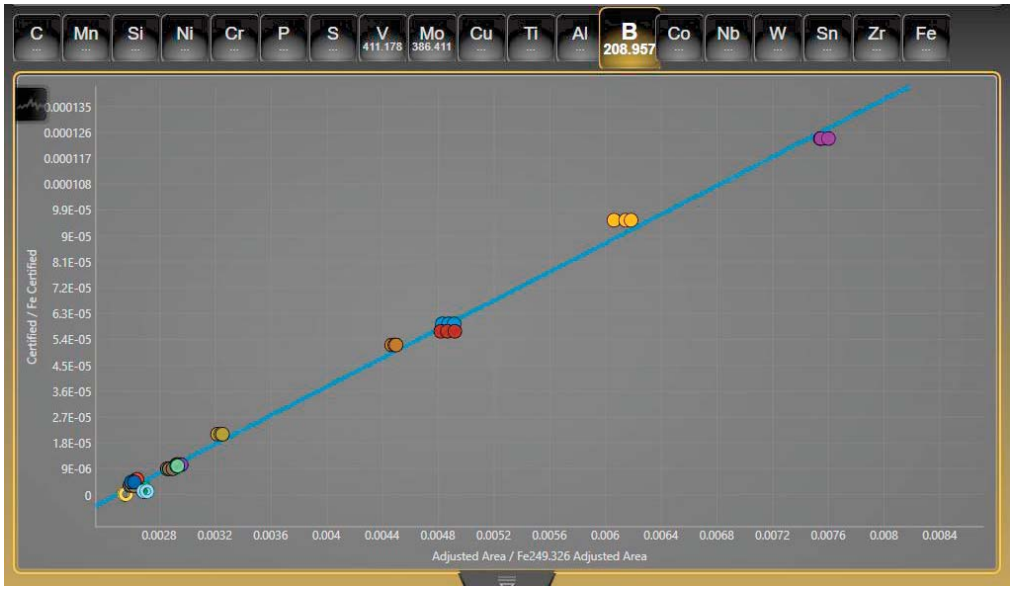
120 grit zirconium oxide disk with water
Optional: 220 grit zirconium oxide with water; 120 grit zirconium oxide belt

## *Accessories*

Sample surface preparation: Belt grinder (LECO BG) or polisher (LECO PX).

## *Calibration Curve*

Boron calibration curve with linear fit.



## Calibration Standards

A factory installed calibration is based on each customer's distinctive requirements. Working curves are comprised of Certified Reference Materials (CRM's) and Reference Materials (RM's) from the following manufacturers: NIST, Brammer, CKD, MBH, and IARM. Customer supplied calibration pieces are useful to complement the calibration.

## Drift Control of Calibration

Homogenous non-certified set up standards (SUS's) are used to drift correct calibration curves. When necessitated by customer ranges or lack of suitable SUS material, RM's and CRM's can be substituted.

## Analysis Times

The LECO GDS900 has the unique ability to perform multiple analyses without dropping the sample. This is possible due to the sputtering away of material to reveal new untouched sample. Three analysis can be completed in a minute and a half when using the "Analyze all consecutive burns in the same spot" option in the software. The ten analysis were accomplished in 160 seconds or two minutes and forty seconds.

| | Single Burn | Three Burns w/o Dropping |
|---|---|---|
| Start-up and Pre-burn | 60 s | 60 s |
| Analyze | 10 s | 10 s |
| Analyze | | 10 s |
| Analyze | | 10 s |
| **Total** | **70 s** | **90 s** |

## Typical Analysis Results

***RESULTS OF ANALYSIS FOR CKD 183A; TEN INDIVIDUAL ANALYSES***

| ELEMENT | AVG | CERT | STDEV | RSD | RUN#1 | RUN#2 | RUN#3 | RUN#4 | RUN#5 | RUN#6 | RUN#7 | RUN#8 | RUN#9 | RUN#10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fe** | 94.50 | 94.49 | | | 94.42 | 94.47 | 94.47 | 94.51 | 94.48 | 94.50 | 94.54 | 94.54 | 94.58 | 94.47 |
| **B** | 0.0005 | 0.0005 | 0.00004 | 7.0% | 0.00053 | 0.00054 | 0.00050 | 0.00049 | 0.00048 | 0.00054 | 0.00056 | 0.00050 | 0.00060 | 0.00051 |
| **Al** | 0.148 | 0.150 | 0.001 | 0.7% | 0.146 | 0.146 | 0.149 | 0.148 | 0.147 | 0.149 | 0.148 | 0.147 | 0.148 | 0.147 |
| **C** | 0.048 | 0.047 | 0.001 | 2.3% | 0.049 | 0.048 | 0.047 | 0.047 | 0.048 | 0.047 | 0.049 | 0.047 | 0.046 | 0.048 |
| **Cr** | 0.199 | 0.204 | 0.001 | 0.4% | 0.200 | 0.199 | 0.199 | 0.199 | 0.199 | 0.198 | 0.201 | 0.200 | 0.199 | 0.199 |
| **Co** | 0.116 | 0.119 | 0.001 | 0.7% | 0.116 | 0.117 | 0.117 | 0.116 | 0.116 | 0.117 | 0.117 | 0.115 | 0.115 | 0.116 |
| **Cu** | 0.579 | 0.577 | 0.004 | 0.8% | 0.585 | 0.582 | 0.581 | 0.577 | 0.584 | 0.579 | 0.574 | 0.576 | 0.572 | 0.583 |
| **Mn** | 1.73 | 1.74 | 0.02 | 1.3% | 1.78 | 1.74 | 1.75 | 1.72 | 1.74 | 1.73 | 1.70 | 1.72 | 1.70 | 1.75 |
| **Mo** | 0.036 | 0.036 | 0.0005 | 1.5% | 0.0350 | 0.0361 | 0.0358 | 0.0365 | 0.0359 | 0.0359 | 0.0369 | 0.0365 | 0.0364 | 0.0358 |
| **Ni** | 1.13 | 1.09 | 0.008 | 0.7% | 1.129 | 1.133 | 1.135 | 1.127 | 1.135 | 1.131 | 1.116 | 1.118 | 1.115 | 1.133 |
| **Nb** | 0.007 | 0.005 | 0.0006 | 7.7% | 0.0084 | 0.0079 | 0.0076 | 0.0080 | 0.0076 | 0.0072 | 0.0078 | 0.0065 | 0.0072 | 0.0067 |
| **P** | 0.009 | 0.009 | 0.0003 | 2.8% | 0.0089 | 0.0093 | 0.0094 | 0.0093 | 0.0092 | 0.0093 | 0.0097 | 0.0089 | 0.0091 | 0.0096 |
| **Si** | 1.02 | 1.02 | 0.008 | 0.8% | 1.039 | 1.031 | 1.027 | 1.025 | 1.026 | 1.025 | 1.019 | 1.016 | 1.008 | 1.028 |
| **S** | 0.012 | 0.012 | 0.0004 | 3.5% | 0.0120 | 0.0125 | 0.0119 | 0.0116 | 0.0119 | 0.0115 | 0.0124 | 0.0118 | 0.0111 | 0.0120 |
| **Sn** | 0.048 | 0.051 | 0.002 | 4.8% | 0.052 | 0.050 | 0.050 | 0.047 | 0.050 | 0.048 | 0.046 | 0.046 | 0.044 | 0.050 |
| **Ti** | 0.003 | 0.003 | 0.0004 | 11.5% | 0.0041 | 0.0034 | 0.0037 | 0.0033 | 0.0035 | 0.0036 | 0.0028 | 0.0033 | 0.0029 | 0.0035 |
| **W** | 0.328 | 0.354 | 0.002 | 0.7% | 0.330 | 0.325 | 0.326 | 0.328 | 0.326 | 0.328 | 0.326 | 0.331 | 0.332 | 0.329 |
| **V** | 0.003 | 0.004 | 0.0003 | 11.9% | 0.0029 | 0.0021 | 0.0028 | 0.0027 | 0.0029 | 0.0027 | 0.0033 | 0.0029 | 0.0025 | 0.0025 |
| **Zr** | 0.080 | 0.078 | 0.003 | 4.1% | 0.082 | 0.084 | 0.082 | 0.081 | 0.080 | 0.080 | 0.082 | 0.078 | 0.073 | 0.078 |

## *RESULTS OF ANALYSIS FOR CKD 183A; TEN ANALYSIS DEEP IN ONE AREA WITHOUT DROPPING*

| ELEMENT | AVG | CERT | STDEV | RSD | RUN#1 | RUN#2 | RUN#3 | RUN#4 | RUN#5 | RUN#6 | RUN#7 | RUN#8 | RUN#9 | RUN#10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fe** | 94.51 | 94.49 | | | 94.51 | 94.51 | 94.51 | 94.51 | 94.51 | 94.51 | 94.51 | 94.50 | 94.51 | 94.50 |
| **B** | 0.0005 | 0.0005 | 0.00003 | 6.7% | 0.00051 | 0.00045 | 0.00050 | 0.00049 | 0.00047 | 0.00046 | 0.00049 | 0.00049 | 0.00051 | 0.00057 |
| **Al** | 0.15 | 0.150 | 0.0005 | 0.4% | 0.1480 | 0.1480 | 0.1470 | 0.1480 | 0.1480 | 0.1470 | 0.1470 | 0.1470 | 0.1470 | 0.1470 |
| **C** | 0.048 | 0.047 | 0.0002 | 0.4% | 0.0482 | 0.0487 | 0.0482 | 0.0484 | 0.0485 | 0.0484 | 0.0482 | 0.0485 | 0.0484 | 0.0487 |
| **Cr** | 0.197 | 0.204 | 0.001 | 0.6% | 0.199 | 0.198 | 0.198 | 0.197 | 0.197 | 0.196 | 0.196 | 0.196 | 0.196 | 0.196 |
| **Co** | 0.117 | 0.119 | 0.001 | 0.7% | 0.116 | 0.117 | 0.117 | 0.117 | 0.117 | 0.117 | 0.117 | 0.118 | 0.118 | 0.119 |
| **Cu** | 0.579 | 0.577 | 0.001 | 0.1% | 0.578 | 0.579 | 0.578 | 0.579 | 0.579 | 0.578 | 0.579 | 0.580 | 0.580 | 0.580 |
| **Mn** | 1.72 | 1.74 | 0.008 | 0.5% | 1.732 | 1.728 | 1.724 | 1.720 | 1.717 | 1.715 | 1.713 | 1.712 | 1.709 | 1.710 |
| **Mo** | 0.036 | 0.036 | 0.0002 | 0.7% | 0.0363 | 0.0362 | 0.0364 | 0.0365 | 0.0366 | 0.0363 | 0.0362 | 0.0361 | 0.0363 | 0.0357 |
| **Ni** | 1.14 | 1.09 | 0.006 | 0.5% | 1.129 | 1.132 | 1.134 | 1.137 | 1.138 | 1.141 | 1.142 | 1.143 | 1.146 | 1.146 |
| **Nb** | 0.007 | 0.005 | 0.001 | 7.8% | 0.006 | 0.007 | 0.007 | 0.006 | 0.007 | 0.007 | 0.007 | 0.007 | 0.008 | 0.008 |
| **P** | 0.009 | 0.009 | 0.0001 | 1.4% | 0.0092 | 0.0092 | 0.0091 | 0.0095 | 0.0092 | 0.0093 | 0.0090 | 0.0093 | 0.0094 | 0.0093 |
| **Si** | 1.02 | 1.02 | 0.005 | 0.5% | 1.014 | 1.016 | 1.017 | 1.020 | 1.022 | 1.021 | 1.025 | 1.026 | 1.027 | 1.030 |
| **S** | 0.012 | 0.012 | 0.0002 | 1.4% | 0.0119 | 0.0120 | 0.0121 | 0.0120 | 0.0119 | 0.0122 | 0.0121 | 0.0124 | 0.0123 | 0.0123 |
| **Sn** | 0.046 | 0.051 | 0.001 | 3.0% | 0.043 | 0.046 | 0.046 | 0.045 | 0.045 | 0.046 | 0.047 | 0.048 | 0.046 | 0.048 |
| **Ti** | 0.003 | 0.003 | 0.0001 | 1.8% | 0.0031 | 0.0032 | 0.0033 | 0.0032 | 0.0031 | 0.0031 | 0.0032 | 0.0031 | 0.0032 | 0.0032 |
| **W** | 0.327 | 0.354 | 0.003 | 0.8% | 0.329 | 0.330 | 0.329 | 0.328 | 0.328 | 0.326 | 0.324 | 0.325 | 0.323 | 0.323 |
| **V** | 0.003 | 0.004 | 0.0002 | 6.6% | 0.0031 | 0.0026 | 0.0027 | 0.0024 | 0.0029 | 0.0028 | 0.0030 | 0.0028 | 0.0028 | 0.0027 |
| **Zr** | 0.080 | 0.078 | 0.001 | 1.3% | 0.0782 | 0.0801 | 0.0795 | 0.0809 | 0.0807 | 0.0793 | 0.0798 | 0.0816 | 0.0812 | 0.0814 |


**LECO Corporation** | 3000 Lakeview Avenue | St. Joseph, MI 49085 | Phone: 800-292-6141 | 269-985-5496
info@leco.com • www.leco.com | ISO-9001:2015 Q-994 | *LECO is a registered trademark of LECO Corporation.*