Application Note

Instrument: GDS900

Bulk Analysis of a Plain Carbon Steel Sample Taken With an Immersion Sampling Probe

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Key Words: Carbon, Steel, Immersion Sampling Probe, GDS900 Atomic Emission Spectrometer

Introduction

Bulk analysis of steels can be performed quickly and easily using the LECO GDS900 atomic emission spectrometer. Sampling the furnace melt before and after additions is essential for monitoring and controlling alloying constituents. This ensures the final product meets grade specifications. Sampling liquid steel can be performed using dual thickness immersion type sampling probe as described in ASTM E1806-18 (see Figure 1). The thin part of the disk can be used to punch out a slug of material that is analyzed by thermal technique while the larger portion is typically used for spectrochemical determination of the composition.

The results presented in this application note were obtained by first sectioning the thin portion of the disk away from the thick part with a water cooled cut-off saw as in Figure 1. Next the thin and thick sections were linished to remove the skin of surface oxidation and reveal representative analytical layer prior to analysis. Although not typical, both the thin and thick sections were analyzed by GDS to check homogeneity. Result of the analysis from the LECO GDS900 are provided for each section in Tables 1 and 2. Figure 3 shows the sputter craters left after analyzing by glow discharge. For comparison, the thin portion of the disk was also analyzed for carbon and sulfur using the LECO CS744. These results are provided in Table 3.

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 belt

Accessories

Sample surface preparation: Sectioning Machine (LECO MSX); Belt grinder (LECO BG)

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 of sample material, which does not negatively affect the proximate material, always revealing new unadulterated sample for analysis. Three analyses can be completed in 90 seconds when using the "Analyze all consecutive burns in the same spot" option in the Cornerstone software. The ten analyses were completed in 160 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**

Figure 1: Dual thickness immersion disk.

Figure 2: Thin portion of disk sectioned from thicker part of disk.

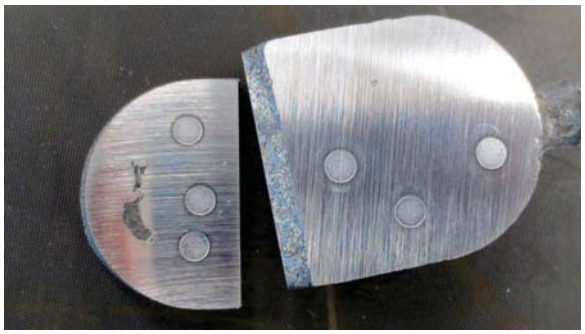

Figure 3: Sputter craters in both sections of disk.

Typical Analysis Results

Table 1. RESULTS OF ANALYSIS FOR IMMERSION SAMPLE THIN; PLAIN CARBON STEEL

ELEMENT	AVG	STDEV	RSD	RUN#1	RUN#2	RUN#3
C %	0.154	0.003	2.0	0.153	0.151	0.157
Cr %	0.124	0.001	0.5	0.123	0.124	0.124
Co %	0.018	0.002	12.3	0.020	0.016	0.017
Cu %	0.154	0.001	0.4	0.153	0.154	0.154
Mn %	0.829	0.001	0.1	0.830	0.829	0.829
Mo %	0.019	0.001	5.1	0.020	0.019	0.019
Ni %	0.089	0.005	5.6	0.095	0.087	0.086
P %	0.0269	0.0003	1.1	0.0266	0.0272	0.0270
Si %	0.132	0.002	1.3	0.133	0.133	0.130
S %	0.0273	0.0003	1.2	0.0271	0.0272	0.0277
Zr %	0.254	0.040	15.9	0.300	0.227	0.234
Fe %	98.17	-	-	98.12	98.21	98.20

Table 2. RESULTS OF ANALYSIS FOR IMMERSION SAMPLE THICK; PLAIN CARBON STEEL

ELEMENT	AVG	STDEV	RSD	RUN#1	RUN#2	RUN#3
C %	0.153	0.003	1.6	0.150	0.155	0.153
Cr %	0.119	0.001	0.5	0.119	0.119	0.120
Co %	0.0180	0.0005	2.5	0.0184	0.0180	0.0175
Cu %	0.154	0.001	0.4	0.153	0.154	0.154
Mn %	0.827	0.012	1.4	0.823	0.818	0.840
Mo %	0.017	0.002	10.1	0.018	0.019	0.015
Ni %	0.094	0.004	4.7	0.096	0.089	0.096
P %	0.0264	0.0002	0.7	0.0265	0.0265	0.0262
Si %	0.134	0.001	0.9	0.133	0.133	0.135
S %	0.0270	0.0002	0.7	0.0272	0.0268	0.0270
Zr %	0.240	0.019	8.0	0.248	0.254	0.218
Fe %	98.19	-	-	98.19	98.19	98.20

Table 3. CS744 COMBUSTION RESULTS

ELEMENT	AVG	STDEV	RSD	RUN#1	RUN#2	RUN#3
C %	0.158	0.001	0.36	0.158	0.158	0.159
S %	0.0288	0.0003	1.00	0.0286	0.0286	0.0291

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