Application Note

Instrument: GDS900

Bulk Analysis of Low Alloy, Cr-Mo, Free Machining, and Austenitic High Mn Steels

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Key Words: Low Alloy, Cr-Mo, Free Machining, Austenitic High Mn, Steel, GDS900 Atomic Emission Spectrometer

Introduction

With the existence of thousands of steel alloys, proper identification and classification is a critical business practice that is required to meet industry and customer requirements. One of the most effective means of classifying steels is by chemical composition. Mechanical properties such as hardness and strength are not absolute techniques for identification of steels.

Glow discharge atomic emission spectrometry (GDS) is a chemical analysis technique that is well suited for routine determination in a wide variety of materials including steels. It has the power to determine not only the amount of iron and carbon present, but the levels of alloying constituents such as Ni, Cr, Mn, V, and Mo; modifiers such as S and Pb; as well as many other constituents. Steel producers can tailor mechanical properties, improve machinability, control shape, or promote corrosion resistance by varying the levels of these elements. It is the combination of the elements that are used to identify the material. For example, carbon steels are generally categorized according to their carbon content, and are subdivided into low, medium, high, and ultra-high designations by the American Iron and Steel Institute (AISI).

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

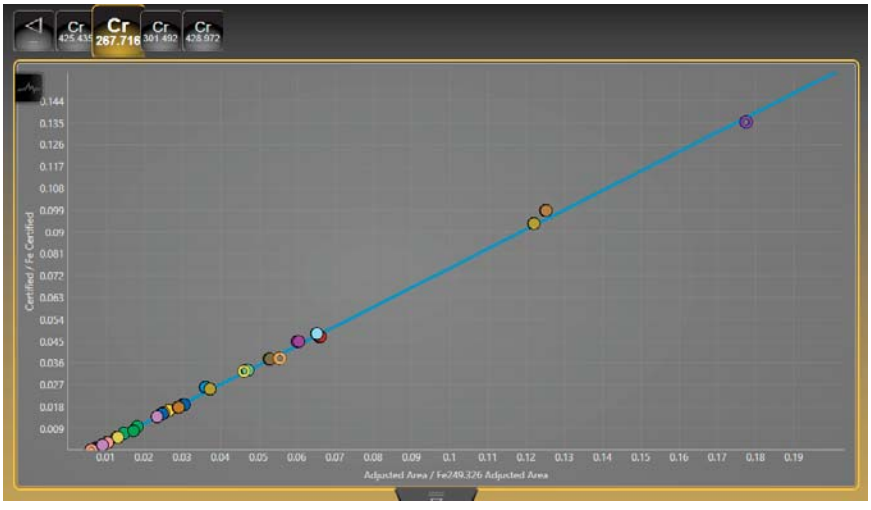
Low alloy steel is prepared using a 120-grit zirconium oxide belt or disc.

Accessories

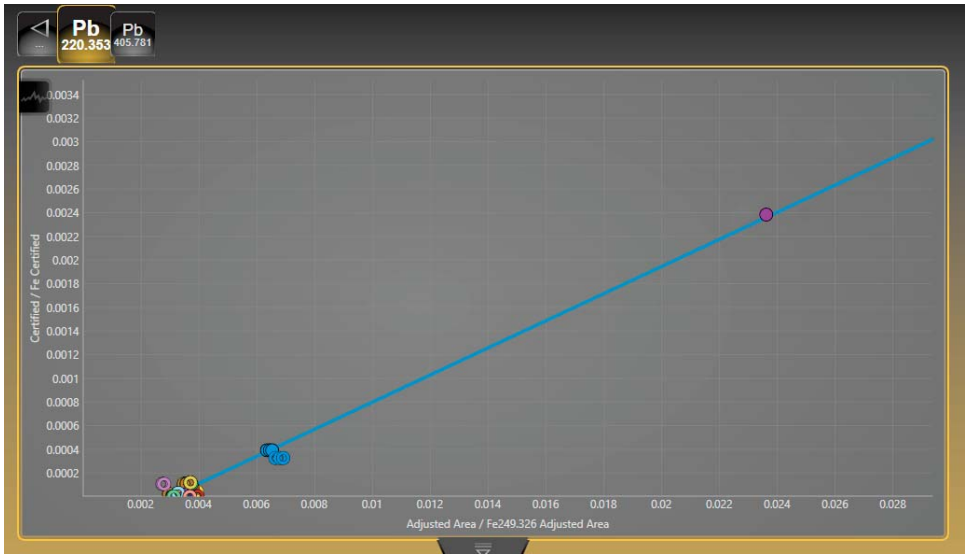
Sample surface preparation: Belt grinder (LECO BG) or polisher (LECO PX).

Calibration Curves

GDS calibration curves are linear over a large concentration range. The chromium curve shows a linear fit to the highest point at 8.5%. The linearity can continue up to 1.5 times beyond the highest point on the curve.



The lead curve demonstrates how leaded steel plots with typical low alloy steels containing little or no lead. The GDS source does not melt the sample surface. Volatile species located at the grain boundary are left in place. A great advantage over other spectrographic sources is that the lamp is not contaminated, resulting in no carry over from sample type to sample type.



Calibration Standards

A factory-installed steel calibration is offered based upon specific customer requirements. Working curves are comprised of Certified Reference Materials (CRM's) and Reference Materials (RM's), and may include standards from the following manufacturers: BAS, Brammer, ARMI, CKD, and NIST. 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 GDS900 has the 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 analyses can be completed in a minute and a half when using the “analyze all in one spot” option in the software.

	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

LOW ALLOY STEEL: NIST 1761

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Fe	94.95	94.98			94.98	95.00	94.97
Al	0.055	0.048	0.0002	0.4	0.0483	0.0487	0.0484
B	0.0020	0.0018	0.00004	2.1	0.00178	0.00184	0.00177
C	1.03	1.06	0.005	0.4	1.061	1.052	1.055
Cr	0.22	0.23	0.003	1.2	0.227	0.232	0.227
Cu	0.30	0.30	0.0009	0.3	0.2993	0.2976	0.2984
Mn	0.68	0.69	0.007	1.0	0.687	0.701	0.690
Mo	0.103	0.099	0.001	0.9	0.099	0.098	0.100
Nb	0.021	0.024	0.002	9.6	0.023	0.022	0.027
Ni	1.99	1.99	0.002	0.1	1.988	1.985	1.984
P	0.040	0.041	0.0004	0.9	0.0416	0.0408	0.0413
S	0.035	0.036	0.001	3.8	0.037	0.034	0.036
Si	0.18	0.19	0.001	0.6	0.193	0.192	0.194
Ti	0.18	0.17	0.01	7.3	0.17	0.16	0.18
V	0.053	0.053	0.0005	1.0	0.0529	0.0519	0.0528

F9 GRADE Cr-Mo STEEL: BRAMMER BS 48A

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Fe	88.53	88.18			88.21	88.18	88.14
C	0.12	0.13	0.001	0.5	0.130	0.131	0.129
Cr	8.75	8.82	0.02	0.2	8.80	8.83	8.83
Cu	0.13	0.13	0.001	1.0	0.132	0.131	0.130
Mn	0.43	0.44	0.01	2.6	0.45	0.43	0.43
Mo	0.95	0.98	0.0004	< 0.1	0.9837	0.9840	0.9844
Ni	0.29	0.31	0.001	0.3	0.308	0.307	0.306
P	0.012	0.012	0.0002	1.9	0.0116	0.0119	0.0114
S	0.011	0.011	0.00005	0.4	0.01111	0.01119	0.01110
Si	0.68	0.68	0.001	0.2	0.682	0.681	0.680
V	0.014	0.013	0.0004	3.3	0.0137	0.0132	0.0128

FREE MACHINING STEEL GRADE 12L14: BRAMMER BS 74E

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Fe	98.16	98.10			98.08	98.13	98.09
C	0.079	0.083	0.004	5.0	0.088	0.079	0.083
Cr	0.020	0.021	0.0001	0.5	0.0211	0.0211	0.0213
Cu	0.006	0.006	0.0002	2.4	0.0066	0.0064	0.0063
Mn	1.04	1.14	0.008	0.7	1.137	1.133	1.149
P	0.065	0.061	0.003	4.9	0.064	0.058	0.061
Pb	0.23	0.23	0.01	4.2	0.24	0.23	0.23
S	0.31	0.34	0.02	4.7	0.35	0.32	0.34

HIGH MANGANESE AUSTENITIC STEEL: BAS SS495-3

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Fe	80.51	80.62			80.7	80.60	80.57
C	0.81	0.73	0.002	0.3	0.731	0.727	0.730
Cr	2.03	2.06	0.004	0.2	2.055	2.054	2.062
Mn	14.05	13.89	0.07	0.5	13.82	13.91	13.95
Mo	0.30	0.30	0.002	0.7	0.296	0.300	0.298
Ni	1.59	1.54	0.006	0.4	1.548	1.539	1.536
P	0.079	0.075	0.001	0.9	0.075	0.074	0.075
S	0.020	0.021	0.0002	1.0	0.0206	0.0209	0.0210
Si	0.60	0.61	0.003	0.5	0.606	0.611	0.609

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