Spectroscopy Performance Note

Analysis of Low Alloy, Cr-Mo, 12L14 and Hadfield Steels

Preface

With the existence of thousands of ferrous alloys (steels), 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 level 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 on 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 elements 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 machineability, 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 GDS500A** 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. GDS outperforms other excitation sources when analyzing steels, because it uniformly removes (sputters) material from the sample surface and the analysis takes place away from the sample surface, reducing the effect of metallurgical history inherent in all samples. Furthermore, since GDS records the excitation of primarily ground state atom lines the spectra are less complex and interferences are reduced. Countless materials can be analyzed since GDS calibrations are inherently linear and cover a wide dynamic range.

Typical Analysis Results

RESULTS OF ANALYSIS FOR NIST STANDARD 1762 • MATERIAL: LOW ALLOY STEEL

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
Al %	0.071	0.071	0.071	0.071	0.069	3.43	0.0001	0.08
B %	0.0044	0.0046	0.0040	0.0043	0.0049	11.6	0.0003	7.05
C %	0.34	0.34	0.34	0.34	0.34	0.58	0.0001	0.02
Cr %	0.94	0.95	0.94	0.94	0.92	2.10	0.007	0.71
Cu %	0.12	0.12	0.12	0.12	0.12	1.94	0.001	0.49
Mn %	1.99	1.99	1.99	1.99	2.00	0.48	0.0006	0.03
Mo %	0.36	0.36	0.36	0.36	0.35	2.10	0.001	0.32
Ni %	1.14	1.16	1.16	1.15	1.15	0.29	0.012	1.00
P %	0.029	0.031	0.031	0.030	0.033	7.88	0.001	3.48
Si %	0.34	0.34	0.34	0.34	0.35	2.00	0.001	0.29
S %	0.030	0.028	0.030	0.029	0.030	2.33	0.001	2.67
V %	0.20	0.20	0.20	0.20	0.20	0.17	0.002	1.04
Fe %	94.45	94.42	94.43	94.43	-	-	-	-

GDS500

RESULTS OF ANALYSIS FOR IARM STANDARD 183A • MATERIAL: 12L14 STEEL ALLOY

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
C %	0.072	0.071	0.070	0.071	0.072	1.02	0.001	1.69
Cr %	0.011	0.011	0.011	0.011	0.010	6.67	0.0001	0.54
Cu %	0.006	0.005	0.005	0.005	0.006	12.2	0.001	12.2
Mn %	1.03	1.02	1.02	1.02	1.01	1.32	0.006	0.56
Mo %	<0.003	<0.003	<0.003	<0.003	0.002	-	-	-
Ni %	0.005	0.005	0.005	0.005	0.006	15.0	0.0003	5.19
P %	0.069	0.070	0.071	0.070	0.070	0.005	0.001	1.21
Pb %	0.23	0.23	0.22	0.22	0.24	6.94	0.005	2.07
S %	0.31	0.30	0.31	0.31	0.31	1.61	0.002	0.57
Fe %	98.27	98.29	98.29	98.29	-	-	-	-

RESULTS OF ANALYSIS FOR IARM STANDARD 38A • MATERIAL: LOW ALLOY STEEL

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
Al %	0.010	0.010	0.010	0.010	0.009	8.89	0.0001	1.02
C %	0.13	0.13	0.13	0.13	0.13	1.03	0.001	0.90
Co %	0.03	0.03	0.03	0.03	0.029	4.60	0.001	3.28
Cr %	8.62	8.66	8.61	8.63	8.67	0.46	0.026	0.31
Cu %	0.15	0.15	0.15	0.15	0.15	1.33	0.001	0.66
Mn %	0.41	0.41	0.41	0.41	0.41	0.24	0.003	0.65
Mo %	0.95	0.95	0.95	0.95	0.96	0.83	0.002	0.21
Ni %	0.24	0.24	0.24	0.24	0.24	0.83	0.002	0.83
P %	0.008	0.010	0.009	0.009	0.008	8.33	0.001	9.25
S %	0.019	0.018	0.017	0.018	0.018	1.11	0.001	5.04
Si %	0.39	0.39	0.38	0.39	0.38	1.67	0.003	0.79
V %	0.019	0.017	0.017	0.018	0.020	11.7	0.001	6.54
Fe %	89.03	88.99	89.04	89.02	-	-	-	-

RESULTS OF ANALYSIS FOR BRAMMER STANDARD BS17 • MATERIAL: HADFIELD STEEL

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
C %	0.62	0.62	0.62	0.62	0.63	1.96	0.003	0.41
Cr %	1.47	1.45	1.47	1.46	1.46	0.23	0.010	0.68
Cu %	0.076	0.076	0.075	0.076	0.075	0.89	0.001	0.76
Mn %	19.56	19.61	19.64	19.60	19.59	0.07	0.040	0.21
Mo %	0.45	0.45	0.45	0.45	0.46	2.83	0.002	0.39
Ni %	0.031	0.030	0.029	0.030	0.030	0.11	0.001	4.33
P %	0.052	0.052	0.051	0.052	0.047	9.93	0.001	1.12
S %	0.006	0.006	0.005	0.006	0.007	19.0	0.001	10.2
Si %	0.21	0.21	0.21	0.21	0.21	1.59	0.002	0.74
Fe %	77.54	77.50	77.46	77.50	-	-	-	-

RESULTS OF ANALYSIS FOR NIST STANDARD 1262B • MATERIAL: AISI 94B17 STEEL (MODIFIED)

ELEMENT	RUN#1	RUN#2	RUN#3	RUN#4	RUN#5	RUN#6	RUN#7	RUN#8	RUN#9	RUN#10	AVERAGE	CERT	% REL	STDEV
Al %	0.078	0.077	0.078	0.079	0.081	0.078	0.078	0.077	0.078	0.079	0.078	0.081	3.46	0.001
B %	0.0025	0.0028	0.0023	0.0024	0.0026	0.0026	0.0024	0.0023	0.0025	0.0023	0.0025	0.0025	0.12	0.0002
C %	0.16	0.16	0.15	0.15	0.16	0.16	0.16	0.15	0.16	0.15	0.15	0.16	3.38	0.003
Co %	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.29	0.30	0.30	0.30	0.30	0.30	0.005
Cr %	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.30	5.87	0.002
Cu %	0.49	0.49	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.50	0.49	0.51	3.67	0.005
Mn %	1.05	1.05	1.06	1.05	1.05	1.05	1.06	1.03	1.06	1.06	1.05	1.05	0.19	0.009
Mo %	0.068	0.069	0.069	0.068	0.069	0.069	0.067	0.068	0.070	0.070	0.069	0.070	1.84	0.001
Nb %	0.33	0.32	0.31	0.30	0.32	0.30	0.31	0.29	0.31	0.32	0.31	0.30	3.70	0.012
Ni %	0.59	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.59	0.60	0.60	0.59	1.00	0.004
P %	0.041	0.043	0.042	0.040	0.042	0.042	0.040	0.040	0.040	0.042	0.041	0.044	6.52	0.001
Si %	0.40	0.40	0.39	0.39	0.40	0.40	0.39	0.37	0.38	0.38	0.39	0.40	2.23	0.010
S %	0.036	0.038	0.039	0.036	0.039	0.036	0.035	0.036	0.037	0.039	0.037	0.037	0.38	0.002
Ti %	0.12	0.11	0.10	0.10	0.10	0.10	0.10	0.09	0.10	0.10	0.10	0.10	2.39	0.007
V %	0.039	0.038	0.038	0.038	0.039	0.037	0.039	0.037	0.039	0.038	0.038	0.041	6.88	0.001
Zr %	0.20	0.21	0.21	0.21	0.23	0.21	0.21	0.20	0.21	0.22	0.21	0.20	5.25	0.009
Fe %	95.81	95.83	95.83	95.88	95.80	95.87	95.83	95.95	95.85	95.81	95.84	-	-	-

Sample Preparation

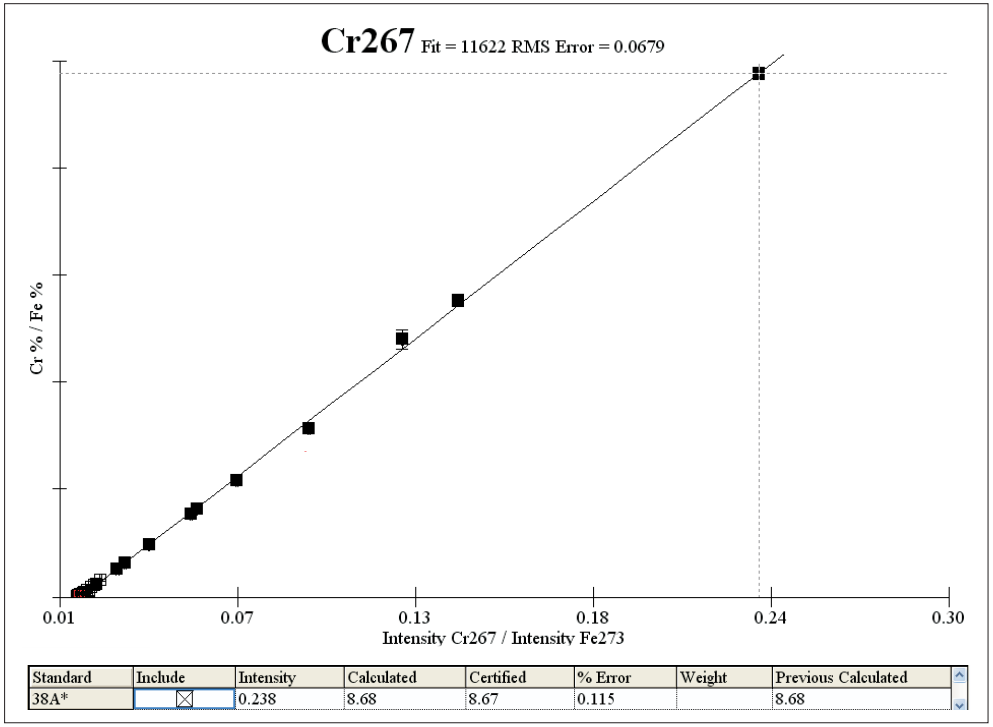
Low alloy steel is prepared using a 120-grit zirconium oxide belt or disc.

Accessories

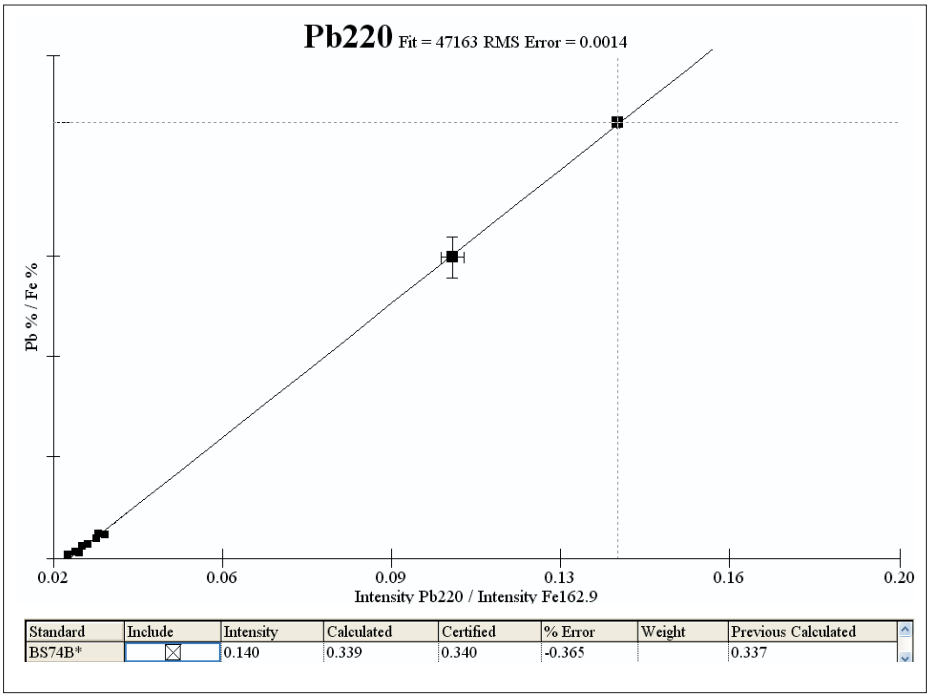
Sample surface preparation: Belt grinder (LECO BG) or polisher (LECO VP).

Calibration Curves

GDS calibration curves are linear over a large concentration range. The chrome curve on the right shows a linear fit to the highest point at 8.6%. 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.



Standard	Include	Intensity	Calculated	Certified	% Error	Weight	Previous Calculated
BS74B*	☒	0.140	0.339	0.340	-0.365		0.337

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, 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 **LECO GDS500A** 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.

	A single burn	Three burns without dropping
Start-up and Preburn	60 sec.	60 sec.
Analyze	10 sec.	10 sec.
Analyze	—	10 sec.
Analyze	—	10 sec.
Total	70 sec.	90 sec.

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