Application Note

Instrument: GDS900

Aluminum Alloy Analysis by LECO Glow Discharge

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Key Words: Aluminum Alloys, GDS900 Atomic Emission Spectrometer, GDS950, Cast Aluminum Alloys, Wrought Aluminum Alloys

Introduction

Aluminum alloys have a number of advantages as a structural metal: a high strength-to-weight ratio that can exceed that of structural steel, high corrosion resistance, good thermal and electrical conductivity, and desirable mechanical properties. Typical alloying elements include Cu, Mg, Mn, Si and Zn. Aluminum alloys can be divided into two major groups: casting alloys and wrought alloys. Wrought products include plate, foil, and extrusions. Casting alloys often include high levels of Silicon which contributes to good casting characteristics. Aluminum alloys are particularly important in automotive and aerospace manufacturing due to their light weight.

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

Aluminum samples are prepared using a wet 120-grit zirconium oxide disc. Other acceptable methods for preparing samples and standards are lathing and milling to the industry accepted standard machine finish of 1.6×10^{-3} mm (63 μin). Wet grinding on a polisher will conserve material and require less operator experience to produce the desired surface quality.

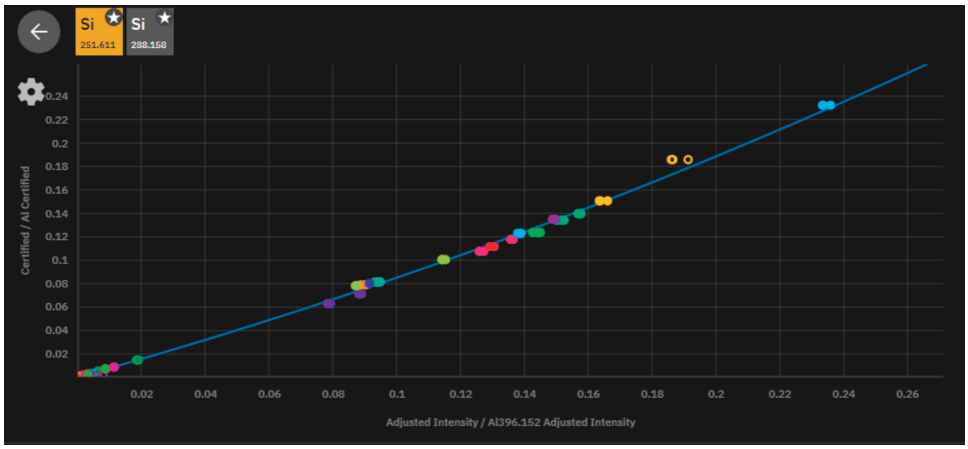
Surface contaminates, if any, are sputtered away and not analyzed. The glow discharge uniformly removes the surface as shown by the flat bottomed sputter crater during the pre-burn time, and analyzes untouched substrate.

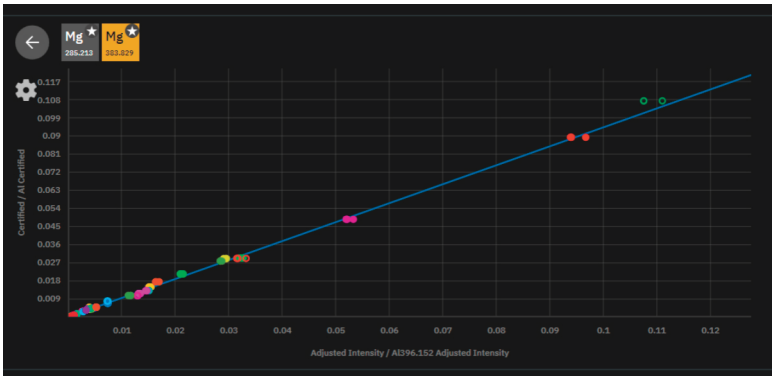
Accessories

Sample surface preparation: LECO PX Series Polisher

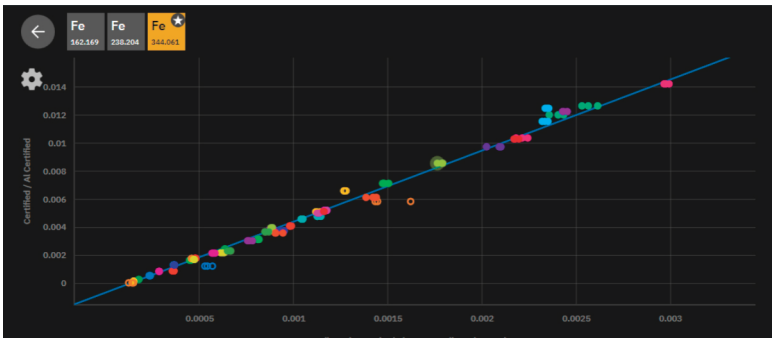
Calibration Curves

The Silicon curve is a very good fit through all the many grades of aluminum alloy.

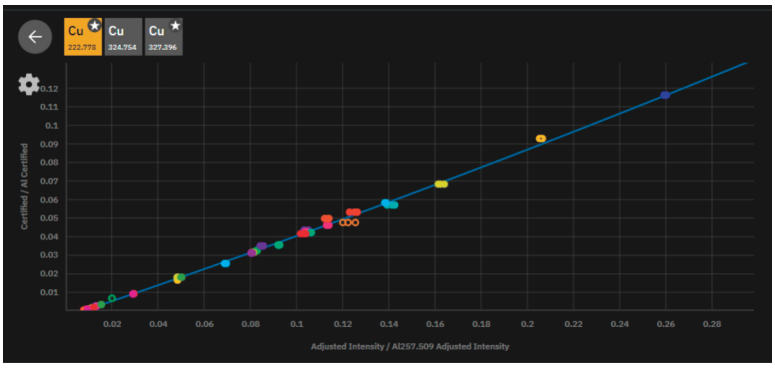




The Magnesium curve demonstrates a very good fit with high, mid, and low Magnesium containing Aluminum.



The minor alloying element of Iron has a very good fit through all points as shown in the Chromium calibration curve.



The Copper curve is a very good fit through all the many grades of aluminum alloy.

Calibration Standards

A factory-installed Aluminum calibration is offered based upon specific customer requirements. Working curves are comprised of Certified Reference Materials (CRMs) and Reference Materials (RMs) and may include standards from the following manufacturers: Alcoa, Arconic, Alcan, MBH, and NIST. Customer supplied calibration pieces are useful to complement the calibration.

Drift Control of Calibration

Homogenous non-certified set-up standards (SUSs) are used to drift correct calibration curves. When necessitated by customer ranges or lack of suitable SUS material, RMs and CRMs may be substituted.

Analysis Times

The LECO GDS900 has the ability to perform multiple analyses without dropping the sample. Three analyses can be completed in ninety seconds (compared to seventy seconds for one analysis) when using the "analyze all in one spot" option in the software. This is possible since the actual analysis occurs away from the surface and the sputtering process continuously reveals fresh unsputtered sample material for each analysis.

	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 Results

3004 ALUMINUM ALLOY - ALCAN 3004AO

ELEMENT	Cert	Average	STDEV	RSD	Run #1	Run #2	Run #3
Al	96.3	96.2			96.3	96.2	96.3
Si	0.23	0.21	<0.01	-	0.21	0.21	0.21
Fe	0.48	0.48	<0.01	-	0.48	0.49	0.47
Cu	0.21	0.21	<0.01	-	0.21	0.22	0.22
Mn	1.20	1.24	0.01	0.8	1.23	1.25	1.23
Mg	1.24	1.31	0.01	1.0	1.30	1.33	1.31
Cr	0.029	0.029	0.001	2.0	0.029	0.030	0.029
Ni	0.027	0.024	<0.001	-	0.024	0.024	0.024
Zn	0.13	0.12	<0.01	-	0.12	0.12	0.11
Ti	0.029	0.031	0.001	1.9	0.030	0.031	0.031
Pb	0.008	0.011	0.001	5.1	0.011	0.012	0.011
Sn	0.013	0.017	0.002	12	0.019	0.015	0.018
Sr	0.0031	0.0037	0.0001	-	0.0038	0.0037	0.0036
Bi	0.0069	0.0076	0.0009	12	0.0087	0.0073	0.0069
Ga	0.022	0.024	<0.001	-	0.024	0.024	0.024
V	0.019	0.022	0.001	2.7	0.022	0.022	0.021
Ca	0.0038	0.0037	0.0003	6.7	0.0035	0.0040	0.0037
Li	0.0019	0.0019	0.0001	3.1	0.0018	0.0019	0.0019
Na	0.0030	0.0026	0.0002	6.7	0.0025	0.0028	0.0025

6061 ALUMINUM ALLOY: ALCOA SS-6061-JS

ELEMENT	Cert	Average	STDEV	RSD	Run #1	Run #2	Run #3
Al	97.2	97.1			97.1	97.1	97.1
Si	0.64	0.67	<0.01	-	0.68	0.67	0.67
Fe	0.35	0.35	<0.01	-	0.35	0.34	0.35
Cu	0.30	0.32	<0.01	-	0.32	0.32	0.32
Mn	0.052	0.052	<0.001	-	0.052	0.051	0.052
Mg	1.00	1.02	<0.01	-	1.03	1.02	1.02
Cr	0.230	0.245	0.001	0.5	0.245	0.246	0.243
Ni	0.050	0.045	<0.001	-	0.046	0.045	0.045
Zn	0.080	0.080	0.002	2.1	0.081	0.080	0.078
Ti	0.043	0.045	<0.001	-	0.045	0.045	0.045
Ga	0.021	0.020	<0.001	-	0.020	0.020	0.020
V	0.010	0.011	<0.001	-	0.012	0.011	0.011

7075 ALUMINUM ALLOY 7075: ALCOA SS-7075-HA

ELEMENT	Cert	Average	STDEV	RSD	Run #1	Run #2	Run #3
Al	89.3	89.2			89.2	89.2	89.3
Si	0.163	0.161	<0.001	-	0.161	0.161	0.161
Fe	0.243	0.264	0.004	1.5	0.269	0.261	0.263
Cu	1.57	1.67	0.01	0.6	1.68	1.67	1.66
Mn	0.069	0.071	<0.001	-	0.071	0.071	0.072
Mg	2.57	2.50	0.01	0.3	2.51	2.50	2.50
Cr	0.22	0.23	0.01	2.8	0.22	0.23	0.24
Zn	5.78	5.81	0.02	0.3	5.82	5.81	5.79
Ti	0.042	0.044	0.001	1.8	0.043	0.044	0.044
Ga	0.021	0.019	<0.001	-	0.019	0.019	0.019
V	0.012	0.010	<0.001	-	0.010	0.010	0.010

356 ALUMINUM ALLOY: ARCONIC SS-356-RW

ELEMENT	Cert	Average	STDEV	RSD	Run #1	Run #2	Run #3
Al	91.7	91.7			91.6	91.7	91.7
Si	7.13	7.07	0.02	0.2	7.09	7.06	7.06
Fe	0.361	0.352	0.002	0.6	0.352	0.350	0.354
Cu	0.120	0.117	0.001	0.5	0.118	0.117	0.117
Mn	0.051	0.052	<0.001	-	0.052	0.052	0.052
Mg	0.350	0.347	0.003	0.9	0.348	0.343	0.349
Ni	0.030	0.025	0.001	2.3	0.025	0.025	0.026
Zn	0.102	0.094	0.002	1.6	0.095	0.092	0.094
Ti	0.125	0.127	0.002	1.6	0.125	0.127	0.129
Ga	0.020	0.023	<0.001	-	0.023	0.023	0.023
Sr	0.022	0.021	0.001	2.7	0.022	0.021	0.021
V	0.012	0.014	<0.001	-	0.015	0.014	0.014

380 ALUMINUM ALLOY: ALCOA KF-380-AM

ELEMENT	Cert	Average	STDEV	RSD	Run #1	Run #2	Run #3
Al	83.4	82.9			82.8	82.9	82.9
Si	8.38	8.52	0.05	0.5	8.48	8.52	8.57
Fe	0.73	0.71	<0.01	-	0.71	0.71	0.71
Cu	2.60	2.66	0.03	1.3	2.70	2.65	2.63
Mn	0.47	0.46	<0.01	-	0.46	0.46	0.47
Mg	0.32	0.34	0.01	1.8	0.34	0.34	0.33
Cr	0.023	0.023	<0.001	-	0.023	0.023	0.023
Ni	0.11	0.10	<0.01	-	0.10	0.10	0.10
Zn	3.46	3.80	0.02	0.4	3.82	3.80	3.78
Ti	0.10	0.10	<0.01	-	0.10	0.10	0.10
Bi	0.12	0.11	<0.01	-	0.12	0.11	0.11
Pb	0.11	0.11	<0.01	-	0.11	0.11	0.10
Sn	0.16	0.16	<0.01	-	0.17	0.16	0.16
Sr	0.025	0.026	0.001	-	0.026	0.026	0.025

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