Application Note

Instrument: GDS900

Bulk Analysis of Cast and Wrought Aluminum Alloys

LECO Corporation; Saint Joseph, Michigan USA

Key Words: Aluminum Alloys, GDS900 Atomic Emission Spectrometer

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 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) 320-grit silicon carbide disk. Other acceptable methods for preparing samples and standards are lathing and milling to the industry accepted standard machine finish of 1.6 E-3 mm (63 μ inches). Wet grinding on a polisher will conserve material and require less operator experience to produce the desired surface quality.

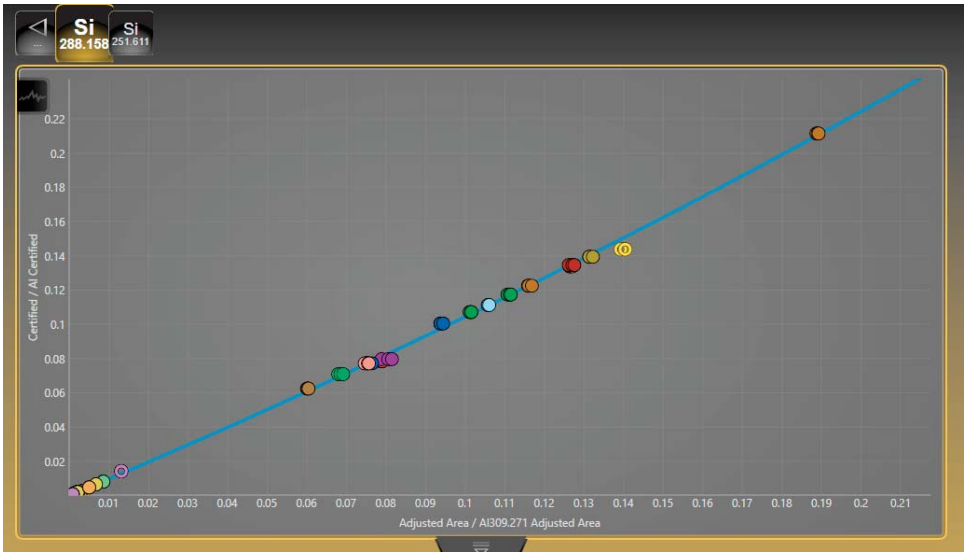
Surface contaminates, if any, are sputtered away and not analyzed. The glow discharge uniformly removes the surface as shown by the flat bottomed sputter crater during the pre-burn time, and analyzes untouched substrate.

Accessories

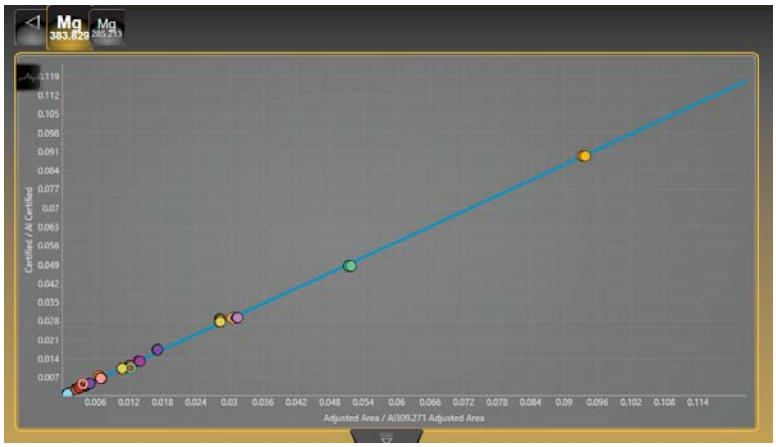
Sample surface preparation: Polisher (LECO PX).

Calibration Curves

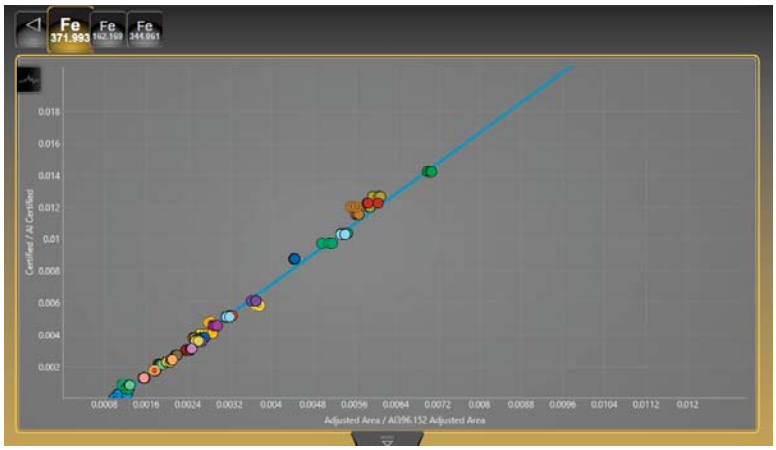
The silicon curve is a very good fit through all the many grades of aluminum alloy.



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.



Calibration Standards

A factory-installed aluminum 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: Alcoa, Alcan, MBH, 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 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

WROUGHT ALUMINUM ALLOY 1080: ALCAN 122-06

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Al	99.53	99.60			99.59	99.60	99.61
Bi	0.009	0.008	0.0008	10.0	0.0090	0.0081	0.0074
Cr	0.020	0.022	0.0001	0.5	0.0215	0.0216	0.0217
Cu	0.021	0.020	0.00005	0.2	0.01978	0.01975	0.01969
Fe	0.059	0.045	0.001	2.4	0.046	0.045	0.044
Ga	0.026	0.028	0.0002	0.7	0.0282	0.0284	0.0286
Mn	0.020	0.019	0.0002	0.9	0.0191	0.0194	0.0195
Ni	0.020	0.018	0.0003	1.5	0.0183	0.0188	0.0183
Si	0.050	0.048	0.0002	0.5	0.0482	0.0479	0.0478
Sn	0.010	0.009	0.0008	9.9	0.0095	0.0080	0.0082
Ti	0.020	0.020	0.0001	0.4	0.0196	0.0194	0.0196
V	0.017	0.018	0.0003	1.6	0.0183	0.0181	0.0177
Zn	0.019	0.020	0.002	10.8	0.021	0.020	0.017

CAST ALUMINUM ALLOY 380: ALCOA KF-380-AM

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Al	83.39	82.85			82.83	82.87	82.86
Bi	0.12	0.11	0.004	3.4	0.115	0.112	0.108
Cr	0.023	0.023	0.0001	0.5	0.0234	0.0233	0.0232
Cu	2.60	2.66	0.03	1.3	2.70	2.65	2.63
Fe	0.73	0.71	0.002	0.2	0.711	0.714	0.713
Mg	0.32	0.34	0.006	1.8	0.343	0.336	0.331
Mn	0.47	0.46	0.003	0.6	0.465	0.461	0.467
Ni	0.11	0.10	0.0005	0.5	0.1002	0.0995	0.0992
Pb	0.11	0.11	0.001	0.9	0.106	0.105	0.104
Si	8.38	8.52	0.05	0.5	8.48	8.52	8.57
Sn	0.16	0.16	0.003	2.2	0.166	0.163	0.159
Sr	0.025	0.026	0.001	2.7	0.026	0.026	0.025
Ti	0.10	0.10	0.0001	0.1	0.1033	0.1034	0.1032
Zn	3.46	3.80	0.02	0.4	3.82	3.80	3.78

CAST ALUMINUM ALLOY: ALCOA SS-356-MM

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Al	91.75	91.56			91.49	91.57	91.61
Bi		0.018	0.001	5.8	0.019	0.018	0.017
Cu	0.12	0.13	0.0005	0.4	0.1288	0.1285	0.1279
Fe	0.35	0.35	0.002	0.6	0.350	0.347	0.346
Ga	0.019	0.021	0.0002	1.0	0.0214	0.0216	0.0212
Mg	0.35	0.37	0.001	0.3	0.372	0.370	0.369
Mn	0.049	0.050	0.0002	0.4	0.0499	0.0498	0.0495
Ni	0.033	0.030	0.0004	1.4	0.0308	0.0299	0.0303
Si	7.09	7.16	0.05	0.7	7.21	7.15	7.12
Sr	0.018	0.018	0.0001	0.3	0.0177	0.0176	0.0175
Ti	0.12	0.12	0.001	0.6	0.115	0.116	0.117
V	0.008	0.013	0.0004	3.1	0.0138	0.0134	0.0130
Zn	0.098	0.12	0.003	2.4	0.122	0.121	0.117

WROUGHT ALUMINUM ALLOY 6061: ALCOA SS-6061-JS

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Al	97.22	97.10			97.08	97.11	97.12
Cr	0.23	0.24	0.001	0.5	0.245	0.246	0.243
Cu	0.30	0.32	0.001	0.5	0.322	0.320	0.321
Fe	0.35	0.35	0.004	1.1	0.352	0.345	0.346
Ga	0.021	0.020	0.0001	0.5	0.0200	0.0198	0.0198
Mg	1.00	1.02	0.003	0.2	1.026	1.023	1.021
Mn	0.052	0.052	0.0002	0.4	0.0515	0.0513	0.0517
Ni	0.05	0.045	0.0006	1.3	0.0457	0.0445	0.0450
Si	0.64	0.67	0.004	0.6	0.675	0.668	0.668
Ti	0.043	0.045	0.0002	0.4	0.0449	0.0450	0.0447
V	0.010	0.011	0.0003	2.8	0.0117	0.0111	0.0112
Zn	0.080	0.080	0.002	2.1	0.081	0.080	0.078

WROUGHT ALUMINUM ALLOY 7075: ALCOA SS-7075-HA

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Al	89.30	89.22			89.18	89.22	89.25
Cr	0.22	0.23	0.006	2.8	0.225	0.234	0.237
Cu	1.57	1.67	0.01	0.6	1.68	1.67	1.66
Fe	0.24	0.26	0.004	1.5	0.269	0.261	0.263
Ga	0.021	0.019	0.0001	0.3	0.0193	0.0194	0.0194
Mg	2.57	2.50	0.008	0.3	2.513	2.501	2.498
Mn	0.069	0.071	0.0001	0.2	0.0713	0.0714	0.0716
Si	0.16	0.16	0.0002	0.1	0.1612	0.1609	0.1611
Ti	0.042	0.044	0.001	1.8	0.043	0.044	0.044
V	0.012	0.010	0.0002	2.2	0.0099	0.0103	0.0100
Zn	5.78	5.81	0.02	0.3	5.82	5.81	5.79

LECO Corporation | 3000 Lakeview Avenue | St. Joseph, MI 49085 | Phone: 800-292-6141 | 269-985-5496
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