Bulk Analysis of Cast and Wrought Aluminum Alloys

LECO Corporation; Saint Joseph, Michigan USA

Instrument: GDS500A

Introduction

Aluminum alloys can be divided into two major groups: cast alloys and wrought alloys. Casting alloys typically employ higher alloying constituents such as silicon, which ranges from 3 to 15%. Hypereutectic aluminum is even higher in silicon approaching 27%. Wrought aluminum, however, contains silicon at around 1.5% or less. Wrought material is typically not cast into parts but rather rolled, hammered, or milled into the final product. Other alloying elements of interest include Mg, Cr, Cu, Mn, Zn, and traces Fe, Ti, V, and Ni. Aluminum alloys are unique in many ways. They have a high strength-to-weight ratio that can exceed that of structural steel, are resistant to many types of corrosion, and have desirable mechanical properties.

Chemical composition is of utmost importance when classifying aluminum alloys and their properties. The aluminum producer needs to control alloying composition of the heat to ensure that it meets the respective chemical specification, which thereby give it the desired properties for the targeted grade of alloy. Expensive alloying ingredients are added to bring the heat into grade based upon the chemical analysis of the raw or intermediate material. Compositional analysis therefore offers a way of controlling cost while increasing the quality of the final product. A manufacturer that uses aluminum alloys should also verify the material before it is used. Verification of the chemical composition helps to ensure the quality and longevity of the manufactured product.

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 both cast and wrought aluminum since 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 spectral interferences are reduced, which is extremely important when analyzing high alloy materials. Additionally, countless materials can be analyzed since GDS calibrations are inherently linear and cover a wide dynamic range.

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.

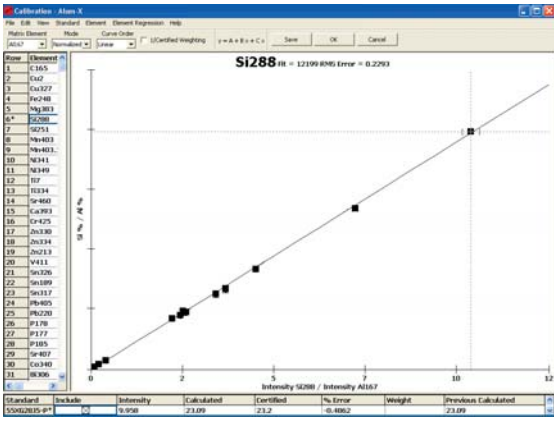
Surface contaminates, if any, are sputtered away and not analyzed. The glow discharge uniformly removes the surface as shown by the flat bottomed sputter crater during the pre-burn time, and analyzes untouched substrate.

Accessories

Sample surface preparation: Polisher (LECO VP).

Calibration Curves

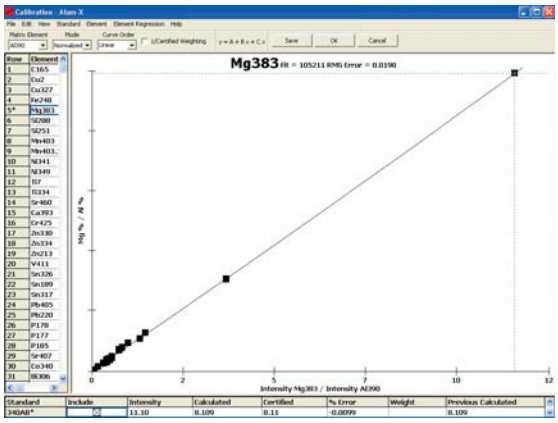
GDS calibration curves are linear over a large concentration range. The silicon curve below is a very good fit through all the many grades of aluminum alloy.



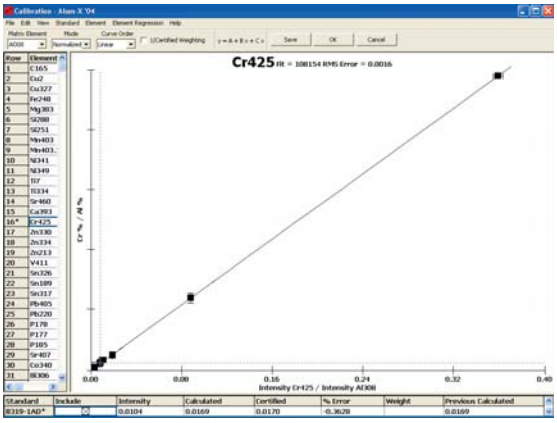
Spectroscopy Performance Note

Delivering the Right Results

The magnesium curve below demonstrates a very good fit with high, mid, and low magnesium containing aluminum.



The minor alloying element of chromium has a very good fit through all points as shown in the chromium calibration here.



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, NIST, and ARMI. 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 GDS500A 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.

	A single burn	*Three burns without dropping*
Start-up and Preburn	60 s	60 s
Analyze	10 s	10 s
Analyze		10 s
Analyze		10 s
Total	70 s	90 s

Please see pages 3 and 4 for Typical Results.

LECO Corporation
3000 Lakeview Avenue • St. Joseph, MI 49085 • Phone: 800-292-6141 • Fax: 269-982-8977
info@leco.com • www.leco.com • ISO-9001:2008 • No. FM 24045 • ***LECO is a registered trademark of LECO Corporation.***

Typical Analysis Results

RESULTS OF ANALYSIS FOR ALCOA STANDARD SS-356-ME
MATERIAL: ALUMINUM CASTING ALLOY 356

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
Si %	7.24	7.16	7.07	7.16	7.11	0.64	0.081	1.13
Fe %	0.36	0.36	0.36	0.36	0.35	2.92	0.005	1.27
Cu %	0.12	0.12	0.12	0.12	0.12	2.04	0.0005	0.42
Mn %	0.052	0.054	0.053	0.053	0.053	0.19	0.001	1.99
Mg %	0.35	0.35	0.35	0.35	0.35	0.87	0.003	0.76
Cr %	<0.002	<0.002	<0.002	<0.002	0.001	-	-	-
Ni %	0.034	0.033	0.031	0.033	0.034	3.53	0.002	5.71
Zn %	0.098	0.097	0.100	0.098	0.097	1.24	0.002	1.78
Ti %	0.13	0.13	0.12	0.13	0.12	0.86	0.001	1.17
V %	0.012	0.011	0.011	0.011	0.011	2.42	0.0003	2.71
Pb %	<0.003	<0.003	<0.003	<0.003	0.0007	-	-	-
Sr %	0.023	0.024	0.022	0.023	0.022	3.18	0.001	4.91
Al %	91.59	91.67	91.77	91.68	-	-	-	-

RESULTS OF ANALYSIS FOR ALCOA STANDARD SS-383-T
MATERIAL: ALUMINUM CASTING ALLOY 383

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
Si %	11.01	11.02	10.99	11.01	11.00	0.06	0.015	0.14
Fe %	0.98	1.00	1.00	0.99	1.00	0.97	0.011	1.09
Cu %	2.58	2.57	2.57	2.57	2.53	1.71	0.008	0.29
Mn %	0.35	0.35	0.35	0.35	0.35	0.31	0.001	0.32
Mg %	0.26	0.26	0.27	0.26	0.26	1.63	0.003	1.05
Cr %	0.062	0.063	0.062	0.062	0.062	0.48	0.0003	0.42
Ni %	0.10	0.11	0.10	0.11	0.10	2.01	0.0004	0.36
Zn %	2.53	2.52	2.52	2.52	2.52	0.15	0.004	0.16
Ti %	0.082	0.080	0.081	0.081	0.080	1.00	0.001	1.34
V %	0.011	0.011	0.011	0.011	0.011	2.12	0.0003	2.34
Pb %	0.20	0.20	0.20	0.20	0.20	1.29	0.003	1.37
Sr %	0.030	0.030	0.030	0.030	0.030	0.11	0.0001	0.19
Al %	81.80	81.79	81.81	81.80	-	-	-	-

RESULTS OF ANALYSIS FOR MBH STANDARD 55XG28J5-P
MATERIAL: CAST ALUMINUM/SILICON/COPPER

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
Cu %	0.88	0.88	0.94	0.90	0.88	2.25	0.031	3.47
Mg %	0.55	0.55	0.58	0.56	0.52	7.51	0.016	2.92
Si %	23.85	23.58	22.21	23.21	23.20	0.06	0.88	3.79
Fe %	0.42	0.43	0.45	0.43	0.45	4.44	0.017	4.02
Mn %	0.76	0.76	0.77	0.76	0.76	0.09	0.006	0.84
Ni %	0.61	0.62	0.62	0.62	0.60	2.97	0.006	0.95
Ti %	0.19	0.19	0.19	0.19	0.19	0.88	0.001	0.29
Pb %	0.17	0.17	0.20	0.18	0.18	0.81	0.014	7.61
Al %	72.58	72.82	74.05	73.15	-	-	-	-

Delivering the Right Results

RESULTS OF ANALYSIS FOR NIST STANDARD 1240B
MATERIAL: ALUMINUM WROUGHT ALLOY 3004

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
Si %	0.19	0.18	0.18	0.18	0.18	1.81	0.002	1.02
Fe %	0.47	0.49	0.51	0.49	0.50	1.29	0.020	4.01
Cu %	0.15	0.15	0.15	0.15	0.15	2.53	0.0001	0.07
Mn %	1.28	1.27	1.30	1.28	1.27	0.92	0.012	0.91
Mg %	1.15	1.12	1.14	1.13	1.11	2.10	0.015	1.29
Cr %	<0.002	<0.002	<0.002	<0.002	<0.001	-	-	-
Ni %	<0.005	<0.005	<0.005	<0.005	0.004	-	-	-
Zn %	0.049	0.047	0.050	0.049	0.051	4.90	0.002	3.11
Ti %	0.020	0.020	0.022	0.021	0.021	2.38	0.002	7.62
V %	0.017	0.017	0.018	0.017	0.017	0.39	0.001	2.95
Al %	96.68	96.70	96.63	96.67	-	-	-	-

RESULTS OF ANALYSIS FOR NIST STANDARD 1259
MATERIAL: ALUMINUM WROUGHT ALLOY 7075

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
Si %	0.18	0.18	0.18	0.18	0.18	1.26	0.002	0.98
Fe %	0.18	0.21	0.23	0.21	0.21	1.14	0.021	9.95
Cu %	1.62	1.60	1.57	1.60	1.60	0.23	0.027	1.69
Mn %	0.079	0.078	0.077	0.078	0.079	1.27	0.001	1.64
Mg %	2.55	2.52	2.39	2.49	2.48	0.22	0.083	3.32
Cr %	0.17	0.17	0.17	0.17	0.17	0.92	0.002	1.06
Ni %	0.065	0.061	0.068	0.065	0.063	2.86	0.004	5.56
Zn %	5.43	5.42	5.44	5.43	5.44	0.19	0.009	0.16
Al %	89.71	89.76	89.88	89.78	-	-	-	-

RESULTS OF ANALYSIS FOR ALCOA STANDARD SS-6061-EN
MATERIAL: ALUMINUM WROUGHT ALLOY 6061

ELEMENT	RUN#1	RUN#2	RUN#3	AVERAGE	CERT	% REL	STDEV	RSD
Si %	0.64	0.63	0.63	0.63	0.64	1.20	0.007	1.16
Fe %	0.34	0.33	0.32	0.33	0.35	5.62	0.012	3.67
Cu %	0.31	0.30	0.30	0.30	0.30	1.48	0.002	0.67
Mn %	0.053	0.053	0.052	0.052	0.051	2.88	0.0003	0.48
Mg %	1.02	1.01	1.01	1.01	1.00	1.23	0.005	0.45
Cr %	0.25	0.24	0.25	0.246	0.24	2.62	0.001	0.57
Ni %	0.047	0.043	0.043	0.044	0.049	9.66	0.002	4.96
Zn %	0.077	0.077	0.076	0.077	0.080	4.21	0.001	0.93
Ti %	0.041	0.043	0.047	0.04	0.044	0.30	0.003	7.21
Al %	97.23	97.26	97.28	97.26	-	-	-	-