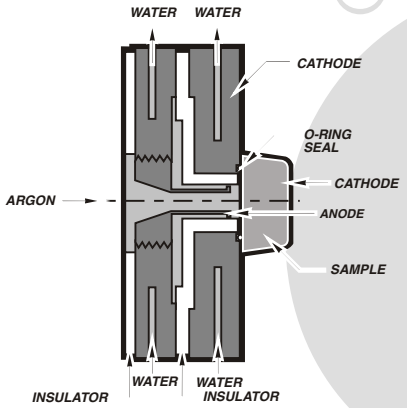
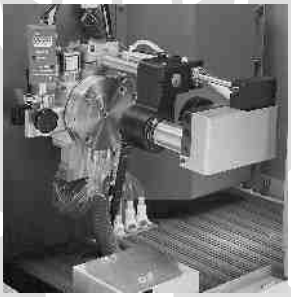
Spectroscopy Application Note

Analysis of Aluminum Base Alloys



GDS Source



GDS Lamp

The broad range of physical and mechanical properties developed from aluminum make it one of the most versatile and economical metals satisfying a wide variety of uses. While convenience divides aluminum alloys into cast and wrought compositions, individual alloys are based on the development of specific properties.

LECO manufactures three glow discharge optical emission spectrometers designed for optimum elemental determination in ferrous and nonferrous materials. A "glow discharge" source uniformly removes material from the sample surface. The separation of sampling from sample excitation reduces the effect of metallurgical and chemical history inherent in all samples. The excitation of primarily ground state atom lines gives rise to less complex spectra, minimizing and/or eliminating many interferences. Calibration curves are linear and cover a very wide dynamic range. The same wavelengths are often used for both high and low concentration ranges.

Sample Preparation

The techniques specified in ASTM Practices and Standards apply to glow discharge. As a non-thermal sputtering source, glow discharge does not rely on high temperatures to melt and volatize samples. Craftsman-like machining techniques are avoided, and surface preparation with belt or disc grinders will easily provide a uniform surface sufficient for glow discharge. Aluminum base alloys are typically abraded with a 320 grit silicon carbide wet disc to provide a uniform surface and prevent smearing.

Accessories

Sample surface preparation (LECO VP-160 or other suitable equipment).

Calibration Standards

Based on customer requirements; NIST, Alcoa, Alcan or other suitable standards.

Typical Analysis Times

Start-up and Pre-burn	~30 seconds
Analyze	~15 seconds
Total	~45 seconds

GDS-Series

Typical Sample Results

Al Alloy AA 390 # LO 2530

	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Sr	Sn
Avg (%)	15.88	0.38	4.49	0.11	0.58	0.008	0.075	0.019	N/A	N/A	0.010
Std Dev	0.12	0.010	0.0073	0.0014	0.0031	0.0025	0.0007	0.0003	—	—	0.0003
RSD (%)	0.75	2.66	0.16	1.30	0.53	29	0.95	1.50	—	—	3.27

383 Al Alloy # LO 2668

	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Sr	Sn
Avg (%)	11.06	1.06	2.71	0.25	0.024	2.35	0.049	0.081	0.046	0.0021	0.046
Std Dev	0.032	0.0021	0.028	0.0029	0.0007	0.018	0.0001	0.0007	0.0019	0.00005	0.0008
RSD (%)	0.29	0.20	1.02	1.19	2.98	0.76	0.24	0.89	4.09	2.25	1.67

Al - 6.5 Sn LO 530

	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Sr	Sn
Avg (%)	N/A	0.14	0.97	0.016	0.0039	0.012	N/A	N/A	0.75	N/A	6.30
Std Dev	—	0.0010	0.0022	0.00016	0.00019	0.00078	—	—	0.0076	—	0.065
RSD (%)	—	0.76	0.23	1.0	4.9	6.8	—	—	1.0	—	1.0

Hypereutectic Al # LO 2404

	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Sr	Sn
Avg (%)	18.72	0.48	0.95	0.11	0.88	0.067	0.059	0.031	0.50	N/A	N/A
Std Dev	0.047	0.016	0.017	0.0015	0.017	0.0046	0.0009	0.0005	0.0037	—	—
RSD (%)	0.25	3.40	1.82	1.35	1.94	6.94	1.56	1.78	0.74	—	—

AL 319 Alloy #91196 H-2 319

	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Sr	Sn
Avg (%)	6.66	0.65	3.58	0.24	0.16	0.38	0.065	0.053	0.022	0.0068	0.011
Std Dev	0.068	0.010	0.012	0.0036	0.0006	0.0009	0.0004	0.0006	0.0006	0.0001	0.0003
RSD (%)	1.02	1.50	0.32	1.48	0.39	0.24	0.60	1.04	2.87	0.81	2.57

The following materials represent an Al-Si-C matrix. SiC can be calculated by percent weight or percent volume. Percent Si can be calculated in the Al metal as well.

Al - Si - C Composite LO 2704

	C	Si	Fe	Cu	Mn	Mg	Zn	Ti	Ni	Sr	V
Avg (%)	6.23	22.32	0.11	0.011	0.0028	0.58	0.0053	0.063	0.0091	0.011	0.0097
Std Dev	0.020	0.12	0.0029	0.0004	0.0008	0.0088	0.0032	0.0014	0.0020	0.0002	0.0004
RSD (%)	0.32	0.54	2.50	3.40	30.0	1.51	60.0	2.20	22	2.09	4.40

Alcan F3S20SAB Duralcan Reference Material

	C	Si	Fe	Cu	Mn	Mg	Zn	Ti	Ni	Sr	V
Avg (%)	7.37	25.86	0.087	0.0033	0.0020	0.52	0.015	0.0087	0.0053	0.015	0.0097
Std Dev	0.036	0.13	0.0010	0.00028	0.00084	0.0094	0.0016	0.00022	0.00074	0.00023	0.00044
RSD (%)	0.49	0.51	1.2	8.8	0.32	1.8	11.0	2.6	14	1.6	4.6
Certified	*7.34*	*26.05*	*0.086*	*0.0030*	*0.0026*	*0.53*	*0.014*	*0.0080*	*0.0050*	*0.013*	*0.0090*

Typical Results—Certified Aluminum Standards

NIST 1256A-7 Casting Alloy 380

	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Sr	Sn
Avg (%)	9.16	0.90	3.50	0.38	0.062	1.00	0.086	0.054	0.41	0.016	0.099
Std Dev	0.0095	0.0015	0.025	0.00061	0.00046	0.0050	0.00031	0.00006	0.0044	0.00020	0.00080
RSD (%)	0.1	0.2	0.7	0.2	0.8	0.5	0.4	0.13	1.1	1.3	0.8
Certified	*9.16*	*0.91*	*3.51*	*0.38*	*0.063*	*1.02*	*0.086*	*0.055*	*0.41*	*0.016*	*0.10*

Alcoa SS 383-C AA383

	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Sr	Sn
Avg (%)	10.96	1.04	2.53	0.38	0.26	2.48	0.082	0.061	0.10	0.019	0.16
Std Dev	0.059	0.015	0.0089	0.0093	0.0028	0	0.0003	0.0020	0.0011	0.0001	0.0025
RSD (%)	0.53	1.48	0.35	2.44	1.10	1.02	0.36	3.21	1.07	0.79	1.59
Certified	*11.10*	*1.01*	*2.52*	*0.37*	*0.26*	*2.49*	*0.081*	*0.059*	*0.10*	*0.019*	*0.016*

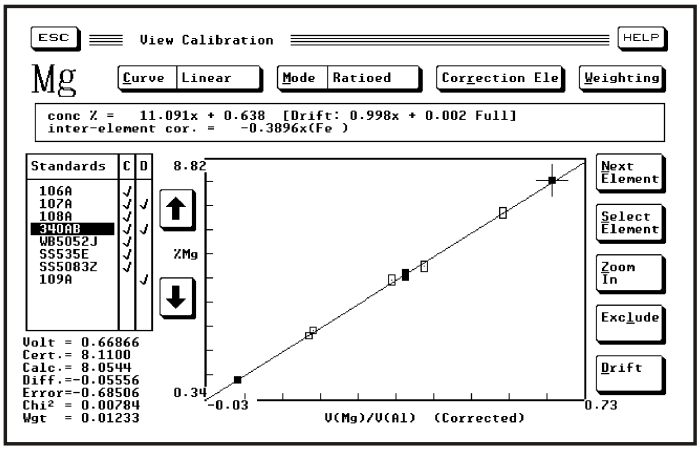
Alcan B 319.1AC AA319.1

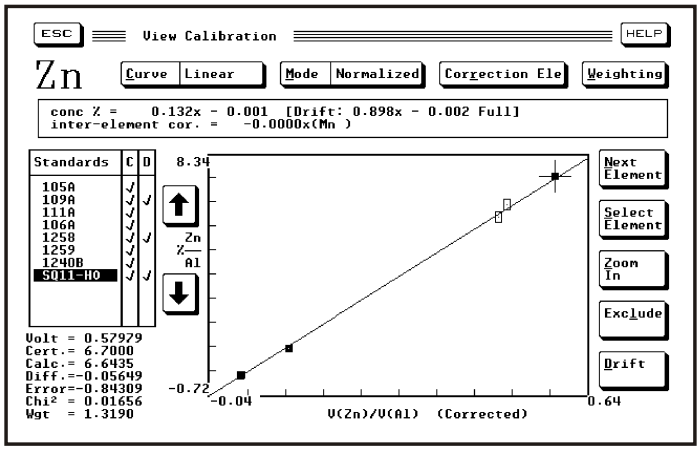
	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Ni	Sr	Sn
Avg (%)	6.13	0.69	3.19	0.44	0.28	0.24	0.070	0.020	0.059	0.0032	0.026
Std Dev	0.032	0.0041	0.0012	0.0016	0.0025	0.0028	0.00062	0.00021	0.00020	0.00002	0.0021
RSD (%)	0.53	0.59	0.039	0.36	0.91	1.1	0.90	1.1	0.35	0.77	8.1
Certified	*6.15*	*0.65*	*3.23*	*0.40*	*0.29*	*0.25*	*0.068*	*0.020*	*0.055*	*0.0030*	*0.032*

Analyses shown were run on the LECO GDS-400A.

Calibration

Linear working curves are found with LECO glow discharge spectrometers. Single wavelength lines often cover full concentration ranges. Linear calibrations correlate to low reference material consumption and few spectral interferences.





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