Application Note

Instrument: GDS900

Bulk Analysis of Copper Alloys

LECO Corporation; Saint Joseph, Michigan USA

Key Words: Copper Alloys, GDS900 Atomic Emission Spectrometer

Introduction

Copper alloys are widely used due to their excellent electrical and thermal conductivity, corrosion resistance, ease of fabrication, and good strength. They are used in electrical generation and distribution, automotive, heating, and water distribution. Traditionally, alloys containing tin were known as bronze and those with zinc were known as brass. Modern copper alloys have a wider range of important alloying elements including Al, Fe, Ni, P, Mn, Si, Sn, and Zn. Major copper alloy families include brass containing Zn; phosphor bronze with P and Sn; aluminum bronze with Al, Fe, and Ni; silicon bronze with Si and Zn; cupronickel and nickel silver with Ni.

Chemical composition can be used as a basis for classifying copper alloys. The copper alloy producer must control the alloying composition of the heat to be sure it meets specification, and thereby have the desired properties of the target grade. Manufacturers that use copper alloys in their products should also verify the material before it is used in the final product. Copper alloys have a wide color range from red to yellow to silver, but completely different alloys can have a similar color. If the copper material is out of specification, then it will not hold up under the specific environment that it was intended for, and premature failure of the product could result.

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

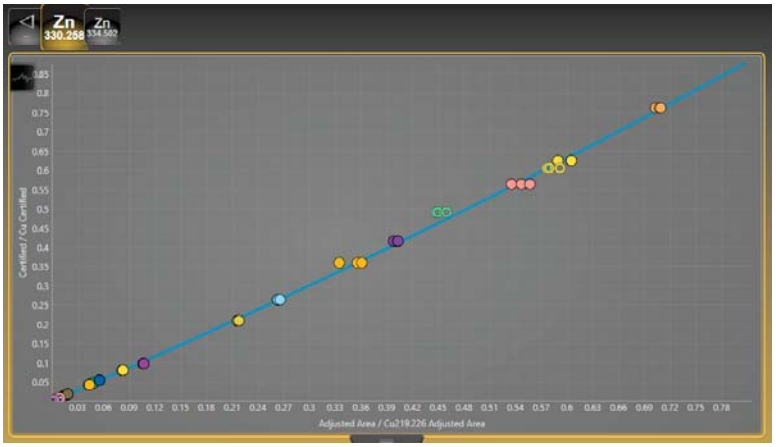
Copper alloys are prepared by using a 320-grit SiC disk with water.

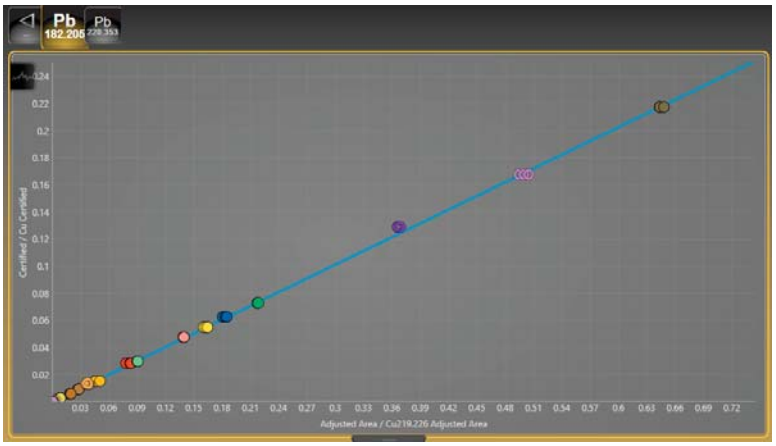
Accessories

Sample surface preparation: Polisher (LECO PX).

Calibration Curves

- The zinc curve shows a good fit from minor alloying levels to highly alloyed brass in a single calibration curve.
- The lead curve demonstrates the ability of GDS to analyze lead from minor alloying levels to grades with percent levels of lead on a single linear calibration curve.





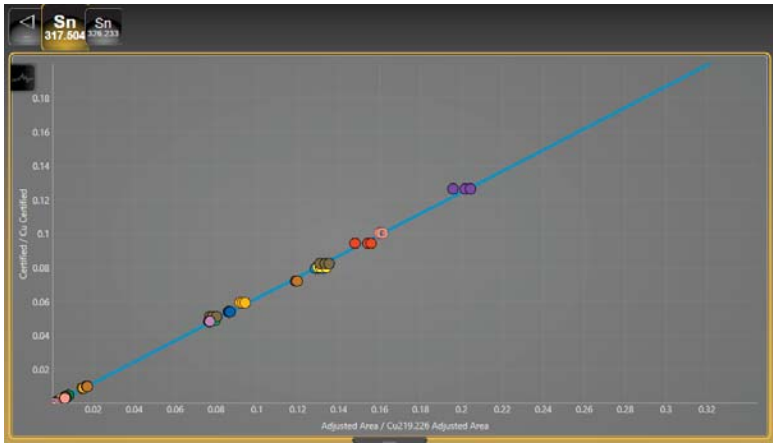
- The tin curve shows a good fit from minor alloying levels to highly alloyed bronze in a single linear calibration curve.
- The aluminum curve shows a good fit from minor alloying levels to highly alloyed aluminum bronze in a single calibration curve.
- The nickel curve shows a good fit from minor alloying levels to highly alloyed cupronickel in a single linear calibration curve.

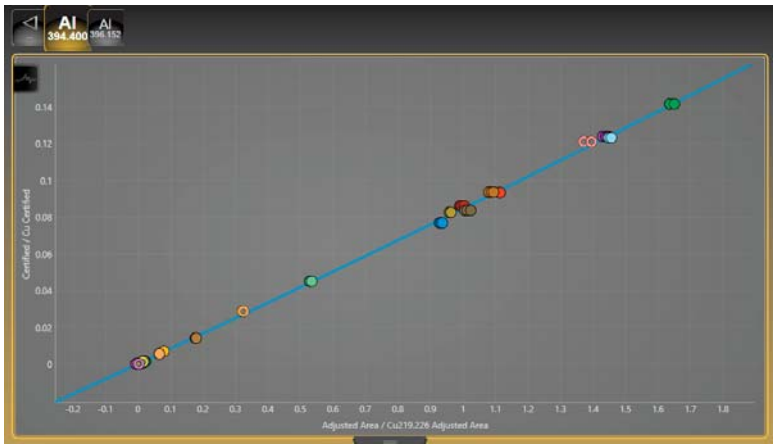
Calibration Standards

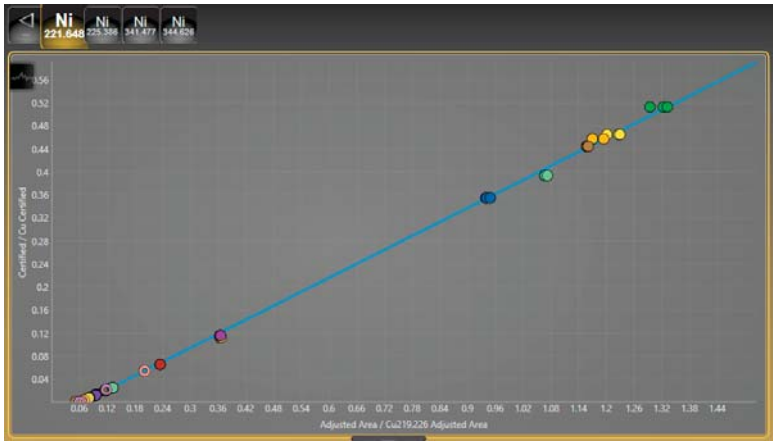
A factory-installed copper calibration is offered based upon specific customer requirements. Working curves are comprised of Certified Reference Materials (CRM's) and Reference Materials (RM's), and may include standards from the following manufacturers: Brammer, CTIF, ARMI, MBH, and NIST. Customer-supplied 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 can be substituted.







Analysis Times

The LECO GDS900 has the ability to perform multiple analyses without dropping the sample. This is possible due to the sputtering away of material constantly revealing new untouched sample for each analysis. 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.

	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 Analysis Results

COPPER ALLOY 857 - LEADED YELLOW BRASS: IARM 87A

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Cu	59.98	60.57			60.96	60.22	60.54
Al	0.42	0.40	0.004	1.0	0.399	0.401	0.393
Fe	0.23	0.23	0.002	1.1	0.229	0.225	0.228
Ni	0.33	0.34	0.006	1.7	0.342	0.334	0.332
Pb	0.92	1.03	0.005	0.5	1.024	1.034	1.027
Si	<0.010	0.007	0.0005	7.7	0.0067	0.0065	0.0075
Sn	0.55	0.53	0.003	0.7	0.528	0.531	0.535
Zn	37.49	36.80	0.37	1.0	36.41	37.15	36.85

COPPER ALLOY 954 - ALUMINUM BRONZE: IARM 93A

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Cu	83.83	83.85			83.79	83.81	83.94
Al	10.39	10.20	0.06	0.5	10.23	10.24	10.14
Fe	3.77	3.76	0.02	0.6	3.78	3.74	3.74
Mn	0.37	0.36	0.005	1.4	0.365	0.360	0.355
Ni	1.15	1.15	0.006	0.5	1.150	1.154	1.142
P	0.015	0.023	0.0004	1.5	0.0237	0.0231	0.0237
Pb	0.060	0.078	0.0003	0.3	0.0778	0.0783	0.0779
Si	0.11	0.10	0.0004	0.4	0.1040	0.1047	0.1048
Sn	0.050	0.050	0.001	1.1	0.051	0.050	0.050
Zn	0.18	0.22	0.001	0.7	0.221	0.221	0.219

COPPER ALLOY 836 - LEADED RED BRASS: BRAMMER BS836A-4

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Cu	84.75	84.94			84.93	84.95	84.93
Ag	0.023	0.022	0.0002	1.0	0.0225	0.0224	0.0221
Fe	0.026	0.023	0.0003	1.4	0.0232	0.0226	0.0231
Ni	0.46	0.44	0.004	0.9	0.442	0.443	0.436
P	0.086	0.10	0.001	0.9	0.096	0.097	0.096
Pb	5.31	5.23	0.03	0.6	5.26	5.24	5.19
S	0.041	0.039	0.0008	2.1	0.0397	0.0389	0.0381
Sb	0.068	0.071	0.002	2.1	0.072	0.069	0.072
Sn	4.58	4.57	0.005	0.1	4.570	4.580	4.572
Zn	4.64	4.48	0.04	1.0	4.46	4.44	4.53

COPPER ALLOY - CUPRO-NICKEL: MBH 36XCN9-K

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Cu	67.03	65.87			65.82	65.88	65.92
Al	0.051	0.050	0.001	1.3	0.051	0.050	0.050
Co	0.079	0.078	0.001	1.3	0.077	0.079	0.079
Cr	2.02	2.01	0.004	0.2	2.003	2.010	2.008
Fe	1.26	1.20	0.001	0.1	1.202	1.202	1.200
Mn	1.01	0.94	0.001	0.1	0.938	0.936	0.937
Ni	26.40	26.73	0.05	0.2	26.78	26.72	26.69
Pb	0.070	0.069	0.0002	0.2	0.0695	0.0694	0.0692
Si	0.41	0.41	0.002	0.4	0.409	0.406	0.405
Nb	1.37	1.35	0.004	0.3	1.341	1.347	1.348
Ti	0.11	0.11	0.0002	0.1	0.1092	0.1094	0.1095
Zr	0.10	0.10	0.001	0.6	0.100	0.100	0.101

COPPER ALLOY 510 - PHOSPHOR BRONZE: MBH 32X51000-A

ELEMENT	CERT	AVG	STDEV	RSD	Run #1	Run #2	Run #3
Cu	94.81	95.12			95.12	95.12	95.11
Ag	0.0024	0.0023	0.00002	0.9	0.00232	0.00232	0.00229
P	0.30	0.31	0.001	0.4	0.310	0.308	0.308
Sn	4.86	4.53	0.006	0.1	4.529	4.531	4.541
Zn	0.011	0.015	0.0003	2.3	0.0150	0.0150	0.0144

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