Bulk Analysis of Nickel Based Alloys Using the GDS500A

LECO Corporation; Saint Joseph, Michigan USA

Instrument: GDS500A

Introduction

Nickel alloys are used in demanding environments that require high performance materials; harsh corrosive environments with high temperatures are considered the norm. Products fabricated from nickel alloys include airplane jet engine components, nuclear steam turbines, and refinery process equipment. High demands and critical applications make it extremely important that the nickel alloy is of the correct chemical composition. The nickel alloy producer must control composition of the heat to be sure it meets chemical specification and thereby have the desired properties for the targeted grade of alloy. Expensive alloying components are added to bring the heat into grade based upon the chemical analysis of the raw or intermediate material. Control of the composition therefore offers a way of controlling cost and increasing the quality of the final product.

Incoming inspection and receiving of nickel alloy materials prior to manufacture of the final product should include chemical analysis to ensure it is of the correct grade. Verification helps to ensure the quality and longevity of the manufactured product.

The LECO GDS500A is an optical emission spectrometer that electronically records the spectra of each analysis. Elemental wavelengths can be defined within the analytical range of the spectrometer. The glow discharge source uniformly removes (sputters) material from the sample surface. Analysis takes place away from the sample surface reducing the effect of metallurgical history inherent in all samples. The excitation of primarily ground state atom lines means less complex spectra and reduced interferences than other OES sources. This is extremely important when analyzing high alloy materials. Calibration curves are linear and cover a wide dynamic range. GDS is an excellent way to perform chemical analysis on nickel alloys.

Typical Analysis Results

RESULTS OF ANALYSIS FOR STANDARD BS718A
MATERIAL: NICKEL GRADE 718 - UNS N07718

ELEMENT	*RUN #1*	*RUN #2*	*RUN #3*	*AVERAGE*	*CERT*	*% REL*	*STDEV*	*RSD*
Al %	0.57	0.57	0.57	0.57	0.57	0.11	0.002	0.29
B %	0.0046	0.0047	0.0047	0.0047	0.0046	1.45	0.0001	1.24
C %	0.035	0.035	0.035	0.035	0.036	3.24	0.0005	1.42
Co %	0.33	0.32	0.32	0.32	0.32	0.45	0.005	1.48
Cr %	18.00	18.11	17.96	18.02	18.19	0.92	0.078	0.43
Cu %	0.059	0.060	0.059	0.059	0.06	1.50	0.0005	0.78
Fe %	19.34	19.39	19.45	19.39	19.21	0.95	0.055	0.28
Mn %	0.076	0.078	0.078	0.077	0.08	3.42	0.001	0.98
Mo %	3.07	3.08	3.06	3.07	3.06	0.37	0.009	0.28
Nb %	5.18	5.22	5.22	5.20	5.19	0.27	0.025	0.48
P %	0.007	0.007	0.007	0.007	0.007	0.48	0.0001	1.64
Si %	0.13	0.12	0.12	0.12	0.12	3.14	0.001	0.89
Ti %	1.02	1.02	0.99	1.01	1.02	0.96	0.017	1.68
Ni %	52.19	51.99	52.13	52.10	—	—	—	—

Spectroscopy Performance Note

Delivering the Right Results

RESULTS OF ANALYSIS FOR BRAMMER STANDARD BS199
MATERIAL: WASPALOY® - UNS N07001

ELEMENT	*RUN #1*	*RUN #2*	*RUN #3*	*AVERAGE*	*CERT*	*% REL*	*STDEV*	*RSD*
Al %	1.38	1.39	1.39	1.39	1.38	0.41	0.002	0.15
B %	0.0060	0.0061	0.0061	0.0061	(0.006)	—	0.0001	0.95
C %	0.079	0.080	0.080	0.080	0.077	3.33	0.0003	0.32
Co %	13.60	13.58	13.58	13.59	13.53	0.42	0.012	0.085
Cr %	19.25	19.33	19.42	19.33	19.28	0.28	0.085	0.44
Cu %	0.023	0.022	0.022	0.022	0.022	0.61	0.0004	1.88
Fe %	1.26	1.26	1.24	1.26	1.27	1.15	0.010	0.78
Mn %	0.031	0.030	0.030	0.030	0.030	0.78	0.001	2.32
Mo %	4.18	4.19	4.18	4.19	4.17	0.40	0.006	0.13
Nb %	0.049	0.059	0.056	0.055	0.057	4.27	0.005	8.69
P %	0.003	0.003	0.003	0.003	0.003	2.22	0.0002	5.21
Si %	0.062	0.058	0.059	0.060	0.06	0.78	0.002	3.08
Ti %	3.06	3.06	3.05	3.05	3.04	0.47	0.006	0.19
V %	0.027	0.028	0.026	0.027	0.028	3.45	0.001	4.77
Zr %	0.060	0.058	0.057	0.059	0.058	0.92	0.001	2.06
Ni %	56.86	56.79	56.74	56.80	—	—	—	—

Values in parenthesis ( ) are non-certified

RESULTS OF ANALYSIS FOR BRAMMER STANDARD BSH-1B
MATERIAL: HASTELLOY® B2 - UNS N10665

ELEMENT	*RUN#1*	*RUN#2*	*RUN#3*	*AVERAGE*	*CERT*	*% REL*	*STDEV*	*RSD*
Al %	0.12	0.12	0.12	0.12	0.12	0.83	0.003	2.45
B %	0.0030	0.0032	0.0033	0.0032	0.003	5.56	0.0002	4.82
C %	0.006	0.006	0.007	0.006	0.006	7.78	0.001	7.78
Cu %	0.011	0.011	0.010	0.010	(0.01)	—	0.0004	3.98
Fe %	1.02	1.00	0.98	1.00	1.00	0.073	0.020	2.01
Mn %	0.81	0.82	0.81	0.81	0.81	0.19	0.006	0.73
Mo %	26.44	26.82	26.75	26.67	26.52	0.57	0.20	0.76
P %	0.003	0.003	0.003	0.003	0.003	3.44	0.00001	0.19
Si %	0.052	0.050	0.045	0.049	0.049	0.068	0.003	6.84
Ti %	0.11	0.11	0.11	0.11	0.11	0.70	0.002	1.77
Ni %	71.42	71.06	71.17	71.22	—	—	—	—

Values in parenthesis ( ) are non-certified

Sample Preparation

Nickel samples are prepared using a 120 grit zirconium oxide belt or equivalent.

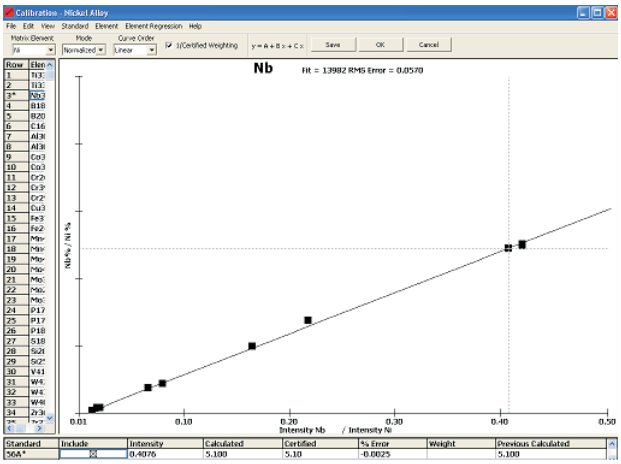
Surface contaminates, if any, are sputtered away and not analyzed. The glow discharge uniformly removes the surface as shown by the flat bottomed sputter crater during the preburn time and analyzes untouched substrate.

Accessories

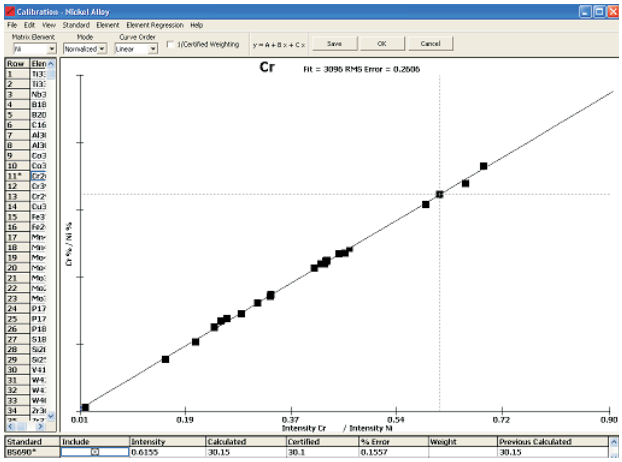
Sample surface preparation: LECO BG-30 belt grinder.

Calibration Curves

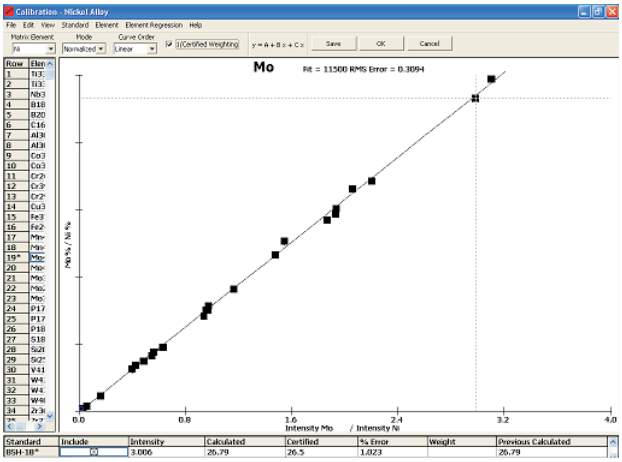
GDS calibration curves are linear over a large concentration range.



The niobium curve shows a good fit through grades of nickel that contain Nb such as Nickel 718 as well as those that have lower concentrations.



Nickel alloys contain Cr in the range of 0.5% to 30%. The chromium curve demonstrates a linear fit throughout this range.



Molybdenum is another major alloying constituent in nickel alloys ranging upwards of 28%. The Mo curve here shows the linear fit with high Mo containing Hastelloy® grades of nickel.

Calibration Standards

A factory-installed Nickel alloy 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: NIST, BAS, Brammer, MBH 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. This is possible due to the sputtering away of material constantly revealing new, untouched sample for each analysis. Three replicate analyses can be completed in a minute and a half when using the "analyze all in one spot" option in the software.

	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

Spectroscopy Performance Note

LECO Corporation

3000 Lakeview Avenue • St. Joseph, MI 49085 • Phone: 800-292-6141 • Fax: 269-982-8977

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