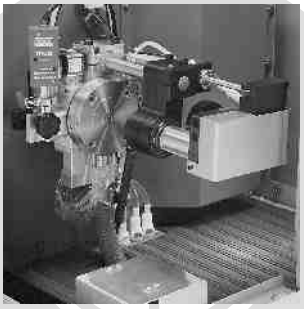
Spectroscopy Application Note

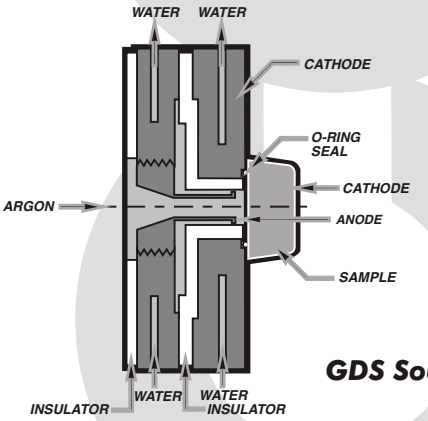
Analysis of Nickel and Nickel Base Alloys

As nickel will alloy with most metals, nickel alloys are used in a wide variety of applications primarily involving corrosion and heat resistance. Nickel base alloys are typically divided into groups based on their elemental composition.



GDS Lamp

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.



GDS Source

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. Nickel and Nickel base alloys are typically abraded with a silicon carbide wet disc to provide a uniform surface.

Accessories

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

Calibration Standards

Based on customer requirements; NIST, Brammer, ARMI or other suitable standards.

Typical Analysis Times

Start-up and Pre-burn	~30 seconds
Analyze	~10 seconds
Total	~40 seconds

GDS-Series

Typical Sample Results

Ni-30Cr-13W-9Co #LO 1940

	Cr	Al	C	Fe	Mo	Co	Nb	W	Cu	Mn	Si
Avg (%)	29.33	0.023	2.15	6.01	0.053	8.85	N/A	13.20	0.11	0.33	0.53
Std Dev	0.15	0.0004	0.015	0.11	0.0093	0.065	—	0.071	0.0016	0.0021	0.0085
RSD (%)	0.50	1.62	0.72	1.84	18	0.73	—	0.54	1.36	0.63	0.61

Ni-30Fe-23Cr-9Co #LO 2518

	Cr	Al	C	Fe	Mo	Co	Nb	W	Cu	Mn	Si
Avg (%)	22.85	0.011	0.16	29.49	0.016	9.38	0.009	N/A	0.027	0.84	0.84
Std Dev	0,046	0.0005	0.0020	0.056	0.00042	0.029	0.0014	—	0.0004	0.0060	0.0060
RSD (%)	0.20	4.75	1.25	0.19	2.60	0.31	14	—	1.37	0.72	0.72

IN-713C #LO 2569

	Cr	Al	C	Fe	Mo	Co	Nb	W	Cu	Mn	Si
Avg (%)	12.22	5.78	0.033	1.24	4.35	0.091	2.08	N/A	0.0051	0.036	0.42
Std Dev	0.018	0.016	0.0005	0.0068	0.0038	0.0009	0.022	—	0.0001	0.0008	68
RSD (%)	0.14	0.28	1.48	0.55	0.09	0.96	1.04	—	2.76	2.11	1.62

98% Ni #LO 706

	Cr	Al	C	Fe	Mo	Co	Nb	W	Cu	Mn	Si
Avg (%)	0.0055	N/A	0.41	0.56	0.0014	0.52	N/A	N/A	0.42	0.031	0.15
Std Dev	0.00005	—	0.0069	0.0033	0.00012	0.010	—	—	0.00078	0.00006	0.0020
RSD (%)	1.1	—	1.7	0.60	8.4	2.0	—	—	0.19	0.20	1.3

#5 Sample 6 960054

	Cr	Al	C	Fe	Mo	Co	Nb	W	Cu	Mn	Si
Avg (%)	9.56	0.022	0.38	2.26	N/A	N/A	N/A	1.46	0.0080	0.029	1.58
Std Dev	0.044	0.00004	0.0043	0.0060	—	—	—	0.010	0.0002	0.0010	0.012
RSD (%)	0.46	0.20	1.13	0.26	—	—	—	0.71	2.23	3.43	0.73

Nickel-Chromium alloys containing high concentrations of Boron are extremely hard and resilient materials. They behave well in extreme environments of acidity and temperature where resistance to corrosion and oxidation are important.

Ni-Cr-B #LO 720

	Cr	Al	C	Fe	Mo	Co	B	W	Cu	Mn	Si
Avg (%)	11.4	0.024	0.54	3.24	0.040	0.22	2.35	0.14	0.012	0.11	4.25
Std Dev	0.096	0.00003	0.011	0.020	0.00011	0.00053	0.0036	0.0013	0.00044	0.0016	0.024
RSD (%)	0.84	0.14	2.0	0.61	0.29	0.24	0.15	0.96	3.7	1.5	0.57

Ni-Cr-B #LO 721

	Cr	Al	C	Fe	Mo	Co	B	W	Cu	Mn	Si
Avg (%)	10.55	0.023	0.36	3.11	0.018	0.093	1.32	0.17	0.015	0.042	3.70
Std Dev	0.037	0.00006	0.011	0.033	0.00048	0.0079	0.028	0.0041	0.00060	0.0014	0.026
RSD (%)	0.35	0.28	2.9	1.1	2.7	8.5	2.1	2.5	4.1	3.3	0.71

Typical Results—Certified Nickel Standards

BS200-4 98% Ni

	Cr	Al	C	Fe	Mo	Co	Nb	W	Cu	Mn	Si
Avg (%)	0.12	0.0069	0.11	0.28	0.0016	0.091	N/A	N/A	0.049	0.30	0.10
Std Dev	0.00037	0.00008	0.0003	0.00089	0.00006	0.0056	—	—	0.004	0.00065	0.0026
RSD (%)	0.31	2.2	0.30	0.32	4.1	7.6	—	—	8.2	0.21	2.5
Certified	*0.13*	*[0.007]*	*0.11*	*0.29*	*0.0020*	*0.091*	—	—	*0.049*	*0.31*	*0.10*

IARM 67A Hast G-30

	Cr	Al	C	Fe	Mo	Co	Nb	W	Cu	Mn	Si
Avg (%)	28.47	0.20	0.018	14.85	5.05	3.62	0.70	3.10	1.89	1.12	0.30
Std Dev	0.37	0.00036	0.00022	0.009	0.015	0.017	0.0039	0.010	0.0077	0.0050	
0.00068											
RSD (%)	1.3	0.18	1.3	0.060	0.29	0.47	0.56	0.34	0.41	0.45	0.23
Certified	*28.77*	*0.20*	*0.019*	*14.88*	*5.02*	*3.61*	*0.70*	*3.13*	*1.88*	*1.11*	*0.30*

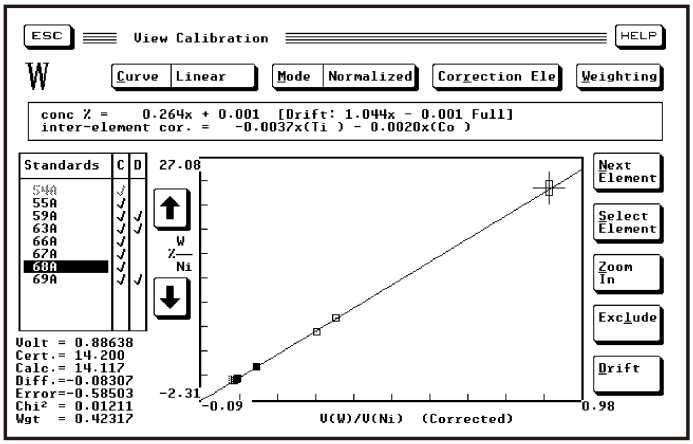
BS 750A

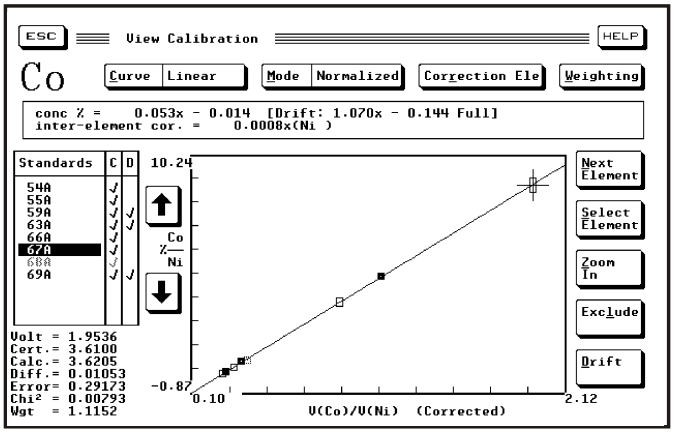
	Cr	Al	C	Fe	Mo	Co	Nb	W	Cu	Mn	Si
Avg (%)	15.65	0.74	0.045	7.13	0.22	0.29	1.06	N/A	0.040	0.088	0.099
Std Dev	0.066	0.0035	0.0016	0.010	0.0003	0.0003	0.013	—	0.0003	0.0020	0.0008
RSD (%)	0.42	0.47	3.7	0.15	0.13	0.12	1.3	—	0.66	2.3	0.85
Certified	*15.68*	*0.74*	*0.047*	*7.07*	*0.22*	*0.29*	*1.07*	—	*0.040*	*0.090*	*0.10*

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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