Low Alloy and Carbon Steel Performance Characteristics

Using the Niton Apollo Handheld LIBS Analyzer

Introduction

The Thermo Scientific™ Niton™ Apollo™ handheld LIBS analyzer is built for your most demanding applications. When low detection limits and high sample throughput are critical, the Niton Apollo's combination of hardware and software provides you with solutions designed to meet your most difficult analytical requirements. Featuring an effective laser and high purity argon purge, the Niton Apollo accurately measures carbon in about 10 seconds. Weighing just 6.4 lbs. (2.9 kg.), the Niton Apollo transforms a traditional laboratory, or cart-mounted Optical Emission Spectroscopy (OES) system, into a highly portable handheld analyzer.

The Importance of Sample Preparation

Good sample preparation is essential to obtaining reliable results when using the Niton Apollo. Trace amounts of contaminants, such as paint, grease or scale may yield unreliable outcomes. This is because the Niton Apollo uses a laser to ablate the surface of the sample. When this occurs, only a small portion of the sample (a few nanograms) is removed. If the surface is diluted, then there is not a representative sample of the metal to provide accurate results.

Instrument Performance

The results listed are obtained from well-prepared samples and are an indication of the best performance to be expected from the Niton Apollo. Accuracy and precision are typical ways of determining instrument performance. Accuracy describes how close the read values (concentration) are to the certified or true value. Precision is an indication of how close multiple readings are to one another on any given sample.

Accuracy is dependent on the calibration of the instrument and sample preparation. Precision is dependent on both the instrument performance in terms of stability and equally on the homogeneity of the sample analyzed. Due to the small amount of material being ablated, spot to spot variation can occur increasing (worsening) the measured precision. It is highly recommended to perform at least three (3) or more analysis and average the results. Users may also delete questionable burns if they occur.

The Niton Apollo has an easy to read average screen (Image 1). The on-board carbon equivalency (CE) equation is based on

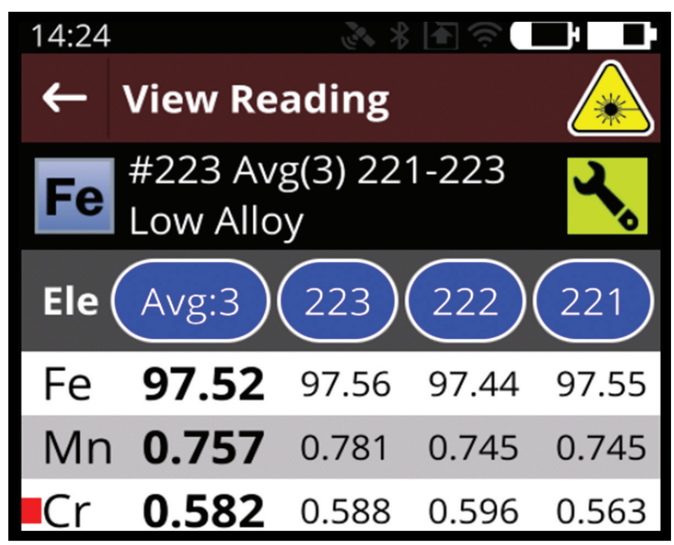

Image 1

International Institute of Welding (IIW)
CE = C+Mn/6+(Cr+Mo+V)/5+(Cu+Ni)/15

American Welding Society (AWS)
CE = C+(Mn+Si)/6+(Cr+Mo+V)/5+(Cu+Ni)/15

Image 2

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the International Institute of Welding (IIW) formula, but any other CE calculations may easily be entered by the user (Image 2). The following examples indicate typical instrument performance, in terms of reproducibility (between instruments) and repeatability (single instrument performance).

Reproducibility

Multiple instrument comparison (average of six (6) readings from twelve (12) instruments) demonstrating typical accuracy and average recovery (an indication of closeness to true value), (Tables 1-3).

Sample SPL-LA-2d										
Instrument	C	Mn	Cr	Ni	Mo	Cu	Al	Si	V	CE
1	.074	.254	.118	2.02	.535	.539	.171	1.50	.275	.473
2	.069	.251	.156	2.00	.574	.542	.169	1.44	.284	.483
3	.080	.253	.124	1.89	.502	.586	.154	1.54	.265	.465
4	.063	.235	.162	2.04	.524	.533	.168	1.61	.252	.461
5	.079	.252	.127	1.87	.575	.545	.179	1.54	.293	.481
6	.083	.262	.125	1.93	.568	.562	.170	1.61	.274	.486
7	.078	.256	.117	1.98	.525	.542	.165	1.52	.259	.469
8	.055	.251	.114	1.85	.568	.525	.155	1.47	.290	.450
9	.060	.234	.122	2.08	.545	.583	.173	1.47	.283	.467
10	.070	.249	.131	1.97	.575	.511	.169	1.59	.284	.476
11	.056	.221	.114	2.03	.552	.522	.174	1.49	.280	.452
12	.066	.243	.122	2.03	.545	.525	.175	1.50	.293	.469
Average	.069	.247	.128	1.97	.549	.543	.169	1.52	.278	.469
Certified	.065	.260	.135	2.00	.570	.530	.180	1.48	.300	.478
Avg. Rec %	106.9	94.9	94.6	98.7	96.3	102.4	93.6	103.0	92.6	98.2

Table 1

Sample IARM 259a									
Instrument	C	Mn	Cr	Ni	Mo	Cu	Al	Si	V
1	.477	.436	3.04	.193	1.36	.081	.018	.441	.294
2	.476	.424	3.36	.212	1.50	.086	.018	.443	.303
3	.505	.491	3.41	.211	1.57	.071	.014	.478	.304
4	.504	.384	3.33	.219	1.31	.083	.018	.467	.264
5	.496	.423	3.12	.191	1.45	.080	.010	.459	.319
6	.468	.423	3.15	.207	1.41	.092	.017	.503	.283
7	.517	.423	3.10	.188	1.39	.079	.022	.462	.280
8	.449	.434	3.37	.181	1.44	.080	.017	.481	.294
9	.515	.409	3.29	.204	1.48	.087	.019	.453	.309
10	.513	.419	3.28	.190	1.35	.078	.019	.474	.299
11	.484	.426	3.45	.224	1.30	.083	.015	.438	.251
12	.501	.417	3.09	.204	1.44	.081	.015	.452	.299
Average	.492	.426	3.25	.202	1.42	.082	.017	.463	.292
Certified	.479	.399	3.27	.194	1.43	.081	.016	.440	.256
Avg. Rec %	102.7	106.7	99.4	104.1	99.0	100.9	104.8	105.1	113.9

Table 2

Sample BS 70b									
Instrument	C	Mn	Cr	Ni	Mo	Cu	Al	Si	V
1	.415	1.02	1.09	.270	.216	.122	.021	.251	.873
2	.363	.908	1.06	.261	.240	.131	.021	.254	.803
3	.413	.888	1.08	.248	.198	.125	.018	.275	.845
4	.442	.852	1.15	.253	.203	.121	.016	.275	.882
5	.420	.951	.91	.239	.243	.118	.020	.271	.833
6	.390	.965	1.08	.252	.226	.140	.026	.294	.841
7	.429	.950	1.05	.238	.210	.126	.013	.258	.865
8	.344	.988	1.01	.210	.246	.124	.017	.266	.783
9	.405	.935	1.06	.260	.205	.131	.020	.274	.839
10	.417	.975	1.06	.229	.251	.114	.021	.269	.867
11	.417	.916	1.04	.262	.221	.122	.017	.265	.848
12	.400	.862	1.03	.245	.212	.124	.021	.262	.813
Average	.404	.934	1.05	.247	.223	.125	.019	.268	.841
Certified	0.400	.900	1.00	.250	.205	.130	.024	.270	.816
Avg. Rec %	101.1	103.8	105.2	98.9	108.7	96.2	80.2	99.3	103.1

Table 3

Repeatability

Multiple samples analyzed eighty (80) times over a period of approximately four (4) hours to determine the stability of individual instruments. The following illustrates examples of single instrument repeatability, all showing good precision, for silicon (Si), carbon (C), and chromium (Cr) in various certified reference materials (Charts 1-3).

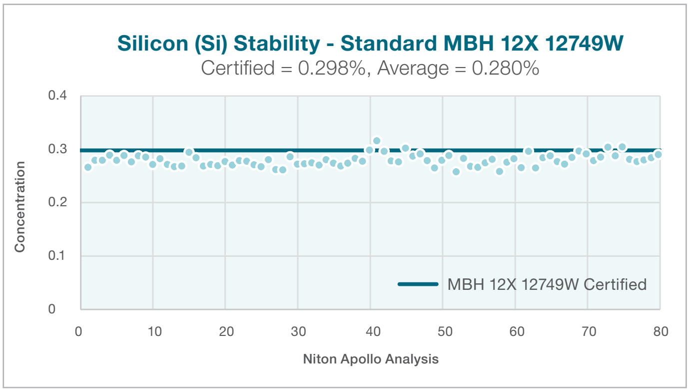

Chart 1

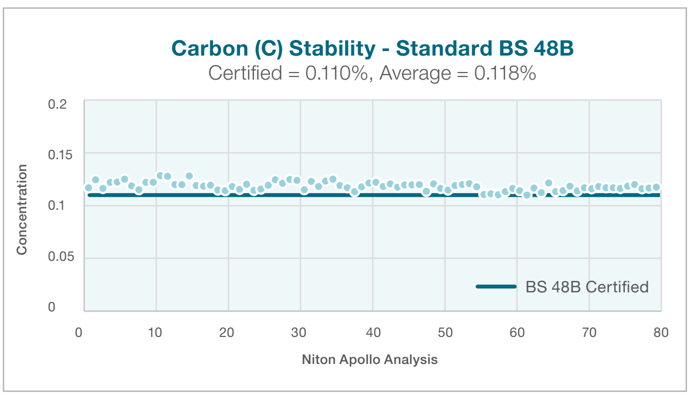

Chart 2

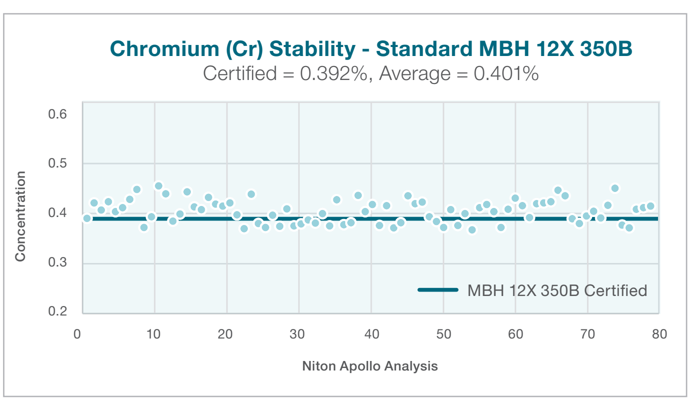

Chart 3

Typical maximum limits of detection (LODs) in ppm for low alloy samples (Table 4). Results may vary from alloy to alloy.

Element	LOD
Al	400
C	200
Cr	200
Cu	150
Mn	500
Mo	400
Ni	700
Si	350
Ti	100
V	200
W	1300

Table 4

Summary

The Niton Apollo handheld LIBS analyzer rapidly and accurately determines carbon content and various other elements in metals and alloys. Users can easily climb up pipelines, or into trenches due to its convenient, portable form factor. Data is displayed is real time, enabling fast and efficient decision making in the field.

Learn more at **thermofisher.com/NitonApollo**

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