



LAB REPORT OES 26

Q4 POLO

Analysis of Aluminum Alloys

Aluminum alloys are soft and lightweight alloys with physical properties that make them ideal for a wide range of applications. Mainly aerospace, automotive, and marine industries use aluminum alloys as they can have excellent heat transfer rate, corrosion resistance, and high strength, depending on the alloy type.

The Q4 POLO is an ideal tool for the accurate analysis of all common aluminum alloys. With the new optimized MultiVision™ optics, the Q4 POLO provides excellent analytical performance, enabling the instrument to monitor the main chemical elements, to determine other trace elements, and, of course, to deliver trustworthy results on all relevant alloying elements.

Sampling and Sample Preparation

The molten metal must be sampled in a manner representative for the entire furnace melt and is poured or drawn into a specified mold to produce a chill-cast disk. The samples are prepared by milling to have a flat and homogeneous surface.

All samples in this lab report were prepared following the sample preparation procedure with a milling machine.



Figure 1
Typical aluminum samples

Certified Reference Material (CRM)

Certified Reference Material (CRM) are reference material characterized by a metrologically valid procedure for one or more specified properties, accompanied by a certificate that provides the value of the specified property, its associated uncertainty at a stated confidence level, and a statement of metrological traceability.

CRMs are certified by a recognized certifying organization using approved certification procedures, as instructed in the most recent ISO Guide 35. A CRM is the highest level which an analytical reference material can be elevated to because it is directly traceable to SI units and because of the attributed confidence in the company or organization which produced the material.

In contrast, reference materials RMs are material whose property values are sufficiently homogeneous and well established to be used for calibration. RMs have been through interlaboratory testing using many analysts.

Statistics

Population: the entire group that you want to draw conclusions about.

Sample: a specific group that you will collect data from.

Average (\bar{X}): a number expressing the central or typical value in a set of data, in particular the mode, median, or (most commonly) the mean, which is calculated by dividing the sum of the values in the set by their number.

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n X_i$$

Standard Deviation (σ): a measure of the amount of variation or dispersion of a set of values.

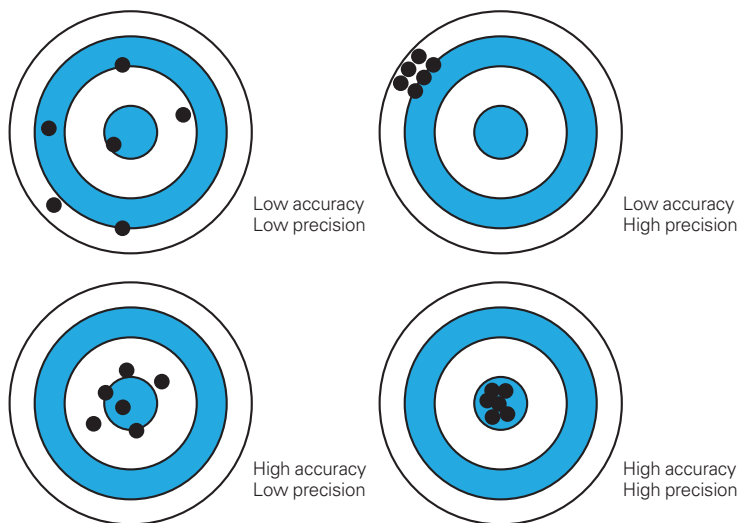
$$\sigma(r) = \sqrt{\frac{1}{N-1} \sum_{i=1}^n (X_i - r)^2}$$

Precision and Accuracy

The International Organization for Standardization (ISO) defines precision as the closeness of agreement between independent test results obtained under stipulated conditions.

Precision depends only on the distribution of random errors and does not relate to the true value or the specified value, while accuracy is defined as the closeness of agreement between a test result and the accepted reference value.

Figure 2
Precision and accuracy



Element	Fe	Ga	Hg	In	La	Li	Mg	Mn	Mo	Na	Ni
min %	0,0008	0,0002	0,0020	0,0005	0,0008	0,0001	0,00005	0,0002	0,0002	0,00005	0,0005
max %	5,5	0,07	0,08	0,12	0,035	2	11	12	0,85	0,025	5,2
Conc. Level %											
0.001	0,0002	0,00005		0,00005	0,0001	0,00001	0,00005	0,0001	0,00005	0,00002	0,0001
0.005	0,0005	0,00007	0,0005	0,00008	0,0005	0,0001	0,00005	0,0001	0,0001	0,00005	0,0001
0.01	0,0005	0,0001	0,0010	0,0001	0,0009	0,0002	0,00007	0,0003	0,0003	0,0003	0,0001
0.02	0,0010	0,0002	0,0020	0,0003	0,0018	0,0002	0,0001	0,0005	0,001	0,0006	0,0003
0.05	0,0015	0,0002	0,0025	0,0006		0,0006	0,0003	0,0005	0,002		0,0004
0.1	0,0020			0,0012		0,0015	0,0010	0,0015	0,015		0,0010
0.2	0,0025					0,0030	0,0025	0,0040	0,030		0,0015
0.5	0,0040					0,0075	0,0050	0,0050	0,080		0,0090
1	0,0060					0,015	0,0080	0,0080			0,010
2	0,010					0,030	0,0085	0,016			0,020
3	0,030						0,015	0,024			0,025
4	0,045						0,020	0,035			0,025
5	0,065						0,035	0,060			0,030
10							0,080	0,080			
20											
30											

Element	P	Pb	Sb	Sc	Si	Sn	Sr	Ti	V	Zn	Zr
min %	0,0035	0,0010	0,0030	0,0002	0,0003	0,0005	0,00005	0,0005	0,0005	0,0008	0,0005
max %	0,018	1,7	0,6	0,8	25	22	0,15	0,6	0,18	56	0,85
Conc. Level %											
0.001				0,0001	0,0001	0,0001	0,00001	0,0001	0,0001		0,00005
0.005	0,0003	0,0002	0,0008	0,0002	0,0002	0,0001	0,00005	0,0002	0,0001	0,0002	0,0001
0.01	0,0004	0,0003	0,0010	0,0003	0,0002	0,0003	0,0001	0,0003	0,0002	0,0002	0,0002
0.02	0,0004	0,0004	0,0012	0,0003	0,0003	0,0006	0,0002	0,0003	0,0002	0,0005	0,0002
0.05	0,0005	0,0006	0,0020	0,0005	0,0003	0,0010	0,0004	0,0006	0,0015	0,0006	0,0010
0.1	0,0007	0,0020	0,0025	0,0008	0,0010	0,0015	0,0008	0,0015	0,0020	0,0015	0,0015
0.2		0,0050	0,0035	0,0035	0,0010	0,0020		0,0060		0,0020	0,0025
0.5		0,012	0,0075	0,0055	0,0015	0,0030		0,010		0,0035	0,010
1		0,025			0,0085	0,0040				0,0045	
2					0,015	0,0080				0,010	
3					0,020	0,010				0,015	
4					0,025	0,015				0,020	
5					0,040	0,020				0,025	
10					0,080	0,1				0,050	
20					0,12					0,100	
30										0,150	

Performance Disclaimer and Remarks

The published values have been acquired from quite different types of materials and should be regarded as "typical" values.
The given performances only apply for homogeneous samples, appropriately prepared, and are subject to technical modification.
Calibration ranges can be extended with samples provided by the customers.

Q4 POLO – Certified Reference Material and Reference Materials

Results

The reproducibility of the Q4 POLO and the method outlined is demonstrated by a series of repetitive measurements of CRMs or RMs in different alloy groups and element concentrations. Only chemical elements with certified reference values are shown in the following tables. The number of chemical elements analyzed varies according to the method (analytical program) selected.

Table 2

RM 121/02 – Al110 (low alloys)

Element %	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	B	Be
MEAN ¹⁾	0.0204	0.0303	0.0096	0.0097	0.0077	0.0096	0.0099	0.0102	0.0096	0.0052	0.0002	0.0005
STD ²⁾	0.0006	0.0007	0.0001	0.0001	0.00004	0.0002	0.0002	0.0003	0.0003	0.00008	0.00005	0.00001
1	0.0207	0.0309	0.0098	0.0098	0.0077	0.0095	0.010	0.0099	0.0099	0.0052	0.0003	0.0005
2	0.0208	0.0310	0.0094	0.0097	0.0077	0.0097	0.010	0.0101	0.0094	0.0052	0.0003	0.0005
3	0.0209	0.0300	0.0096	0.0096	0.0077	0.0095	0.010	0.0099	0.0093	0.0051	0.0002	0.0005
4	0.0195	0.0293	0.0096	0.0097	0.0077	0.0094	0.0096	0.0105	0.0097	0.0051	0.0002	0.0005
5	0.0203	0.0304	0.0095	0.0097	0.0078	0.0098	0.0098	0.0105	0.0098	0.0053	0.0002	0.0005
<i>Certified Values</i>												
Value	0.020	0.030	0.010	0.010	0.0075	0.010	0.010	0.010	0.010	0.005	0.0002	0.0006 - 0.0007

Element%	Bi	Ca	Cd	Co	Ga	Li	Na	Pb	Sb	Sn	V	Zr
MEAN ¹⁾	0.0096	0.0017	0.0019	0.0098	0.0096	0.0012	0.0032	0.0032	0.0096	0.0053	0.0107	0.0108
STD ²⁾	0.0003	0.00004	0.0001	0.0002	0.0002	0.00004	0.0001	0.0002	0.0005	0.0003	0.0002	0.0002
1	0.010	0.0017	0.0020	0.010	0.0097	0.0012	0.0031	0.0033	0.010	0.0056	0.0109	0.0110
2	0.0092	0.0017	0.0020	0.010	0.0098	0.0012	0.0033	0.0033	0.0100	0.0056	0.0110	0.0109
3	0.0094	0.0017	0.0017	0.0097	0.0095	0.0012	0.0032	0.0031	0.0088	0.0051	0.0106	0.0106
4	0.0094	0.0018	0.0020	0.0096	0.0094	0.0012	0.0032	0.0032	0.0096	0.0053	0.0104	0.0109
5	0.0098	0.0017	0.0018	0.0098	0.0095	0.0011	0.0031	0.0029	0.0097	0.0051	0.0107	0.0105
<i>Certified Values</i>												
Value	0.009	0.0015 - 0.0023	0.002	0.010	0.010	0.0008 - 0.0012	0.0018 0.0032	0.0033	0.01	0.005	0.011	0.011

¹⁾ **MEAN** = arithmetic average

²⁾ **STD** = absolute standard deviation (1σ)

³⁾ **Error** = short for the absolute uncertainty of the certified value at the specified confidence level

Table 5

CRM: 533/03 – Method: Al150 Al-Mg

Element %	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti
MEAN ¹⁾	0.314	0.212	0.0544	0.100	5.069	0.101	0.0112	0.0319	0.0183
STD ²⁾	0.001	0.002	0.0005	0.002	0.033	0.002	0.0003	0.0007	0.0005
1	0.314	0.209	0.0542	0.102	5.067	0.103	0.0108	0.0319	0.0188
2	0.315	0.211	0.0552	0.100	5.107	0.101	0.0114	0.0321	0.0182
3	0.313	0.214	0.0541	0.098	5.083	0.098	0.0114	0.0321	0.0179
4	0.314	0.214	0.0541	0.099	5.017	0.100	0.0113	0.0308	0.0177
5	0.314	0.212	0.0543	0.101	5.071	0.103	0.0111	0.0326	0.0188
<i>Certified Values</i>									
Value	0.319	0.216	0.0544	0.102	5.03	0.102	0.0117	0.0311	0.0188
Error ³⁾	0.010	0.006	0.0015	0.003	0.09	0.003	0.0006	0.0011	0.0009

Element %	Be	Bi	Cd	Li	Pb	Sn	Sr	V	Zr
MEAN ¹⁾	0.0041	0.0013	0.0016	0.00028	0.0023	0.0012	0.0010	0.0057	0.0053
STD ²⁾	0.0001	0.0002	0.0001	0.00001	0.0005	0.0001	0.00001	0.0001	0.0001
1	0.0042	0.0012	0.0017	0.00026	0.0025	0.0011	0.0010	0.0055	0.0054
2	0.0041	0.0015	0.0016	0.00028	0.0030	0.0014	0.0010	0.0057	0.0054
4	0.0042	0.0014	0.0018	0.00029	0.0021	0.0012	0.0010	0.0057	0.0052
5	0.0040	0.0011	0.0015	0.00028	0.0018	0.0012	0.0010	0.0056	0.0051
6	0.0041	0.0015	0.0016	0.00030	0.0022	0.0012	0.0010	0.0058	0.0053
<i>Certified Values</i>									
Value	0.0041	0.0009	0.0015	0.00022	0.0022	0.0011	0.0010	0.0062	0.0055
Error ³⁾	0.0002	0.0002	0.0002	0.00005	0.0002	0.0002	0.0002	0.0004	0.0004



Summary

The Q4 POLO is a compact Spark Optical Emission Spectrometer (OES) combining high precision analysis capabilities with low cost of ownership and small footprint. It is the ready-to-analyze solution from day one, covering all relevant elements and wide concentration ranges. At the same time, the Q4 POLO provides high uptime, low maintenance, and hassle-free operation.

Reliable, high precision analysis is now available for every foundry and production floor to obtain results easier and more cost-effective than ever before.

ELEMENTAL.SUITE

ELEMENTAL.SUITE software assists you in your daily work. Automated average and limit checks ensure safe operation. Saving, printing, and reporting your analyses can be done with one click.

Designed for maximum usability, the plug-in based architecture of **ELEMENTAL.SUITE** provides maximum flexibility for your analytical requirements now and in the future.



Bruker AXS is continually improving its products and reserves the right to change specifications without notice. Order No. DOC-L79-EXS026. © 2022 Bruker AXS.

Bruker AXS
info.brkr@bruker.com

Worldwide offices
bruker.com/baxs-offices

Online information
bruker.com/q4polo

bruker.com

