



LAB REPORT OES 27

Q4 POLO

Analysis of Copper Alloys

Copper and its alloys are among the most widely used metals in the world and have been used in a variety of applications since ancient times. Alloying copper with elements such as zinc and tin creates brass and bronze, which are indispensable in our daily lives. Due to its good electrical and thermal conductivity and its workability, pure copper is not only irreplaceable in electrical engineering, but also finds numerous applications in the construction sector.

The Q4 POLO is an ideal tool for the accurate analysis of all common copper alloys. With the new optimized MultiVision™ optics, the Q4 POLO provides excellent analytical performance, enabling the monitoring of the main chemical elements and the determination of other trace elements, delivering, of course, trustable results on all relevant alloying elements.

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
CRM BAM-376 – Cu110 (pure & low alloyed copper)

Element %	Zn	Pb	Sn	P	Mn	Fe	Ni	Si	Mg	Cr	Al	S	As
MEAN ¹⁾	0.0218	0.0239	0.0248	0.0206	0.0208	0.0236	0.0207	0.0278	0.0124	0.0399	0.0181	0.0134	0.0199
STD ²⁾	0.0005	0.0012	0.0004	0.0009	0.0008	0.0002	0.0017	0.0010	0.0005	0.0012	0.0005	0.0007	0.0005
1	0.0215	0.0239	0.0249	0.0213	0.0198	0.0238	0.0204	0.0271	0.0130	0.0394	0.0179	0.0126	0.0202
2	0.0223	0.0219	0.0246	0.0193	0.0210	0.0233	0.0200	0.029	0.0128	0.0412	0.0179	0.0136	0.0193
3	0.0213	0.0244	0.0248	0.0210	0.0216	0.0237	0.0189	0.0283	0.0122	0.0405	0.0185	0.0142	0.0201
4	0.0222	0.0253	0.0243	0.0202	0.0200	0.0238	0.0209	0.0279	0.0120	0.0380	0.0175	0.0128	0.0193
5	0.0215	0.0238	0.0255	0.0212	0.0215	0.0234	0.0234	0.0266	0.0121	0.0405	0.0186	0.0137	0.0205
Certified Values													
Value	0.0217	0.0236	0.0247	0.0203	0.0206	0.0235	0.0209	-	0.0124	0.0400	0.0182	0.0133	0.0200
Error ³⁾	0.0003	0.0004	0.0003	0.0005	0.0003	0.0003	0.0006	-	0.0019	0.0060	0.0010	0.0019	0.0003

Element %	Be	Ag	Co	Bi	Cd	Sb	Zr	Ti	Au	Se	Te	B	O
MEAN ¹⁾	0.0039	0.0164	0.0200	0.0197	0.0185	0.0205	0.0045	<0.0006	<0.0015	0.0214	0.0215	0.0028	<0.0700
STD ²⁾	0.0001	0.0004	0.0021	0.0053	0.0004	0.0021	0.0005			0.0011	0.0029	0.0002	
1	0.0040	0.0160	0.0175	0.0198	0.0189	0.0231	0.0042	<0.0006	<0.0015	0.0199	0.0215	0.0028	<0.0700
2	0.0040	0.0171	0.0215	0.0198	0.0188	0.0182	0.0052	<0.0006	<0.0015	0.0219	0.0167	0.0030	<0.0700
3	0.0038	0.0164	0.0220	0.0202	0.0181	0.0200	0.0045	<0.0006	<0.0015	0.0222	0.0244	0.0028	<0.0700
4	0.0039	0.0163	0.0179	0.0188	0.0181	0.0190	0.0040	<0.0006	<0.0015	0.0206	0.0227	0.0025	<0.0700
5	0.0039	0.0162	0.0212	0.0199	0.0186	0.0223	0.0044	<0.0006	<0.0015	0.0223	0.0221	0.0029	<0.0700
Certified Values													
Value	0.0041	0.0163	0.0208	0.0200	0.0186	0.0202	0.0042	0.0005	-	0.0210	0.0215	-	-
Error ³⁾	0.0006	0.0003	0.0002	0.0005	0.0003	0.0005	0.0002	0.0002	-	0.0004	0.0007	-	-

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 3
CRM IMN WN1 – Cu120 (Cu-Zn alloys, brass)

Element %	Zn	Pb	Sn	P	Mn	Fe	Ni	Si	Cr	Al
MEAN ¹⁾	38.28	0.509	1.008	0.033	0.576	0.237	0.290	0.161	0.0009	0.331
STD ²⁾	0.138	0.0082	0.0075	0.0023	0.0062	0.0018	0.0072	0.0034	0.0001	0.0015
1	38.36	0.511	0.997	0.033	0.578	0.239	0.289	0.162	0.0008	0.330
2	38.23	0.517	1.013	0.030	0.570	0.235	0.285	0.167	0.0009	0.334
3	38.09	0.517	1.015	0.036	0.582	0.238	0.281	0.158	0.0008	0.330
4	38.26	0.499	1.003	0.033	0.582	0.238	0.298	0.159	0.0007	0.331
5	38.45	0.503	1.013	0.031	0.569	0.235	0.296	0.159	0.0010	0.331
Certified Values										
Value	38.28	0.51	1.000	0.031	0.57	0.23	0.29	-	-	0.33
Error ³⁾		0.0072	0.018	0.0007	0.0072	0.01	0.0072			0.0058

Element %	S	As	Be	Ag	Co	Bi	Cd	Sb	Se	B	Cu
MEAN ¹⁾	<0.0008	0.036	0.0013	<0.0005	<0.0035	0.022	<0.0015	0.096	0.0038	0.0026	58.42
STD ²⁾		0.0009	0.00006			0.0005		0.0072	0.0004	0.0003	0.126
1	<0.0008	0.037	0.0013	<0.0005	<0.0035	0.022	<0.0015	0.090	0.0042	0.0025	58.36
2	<0.0008	0.037	0.0013	<0.0005	<0.0035	0.022	<0.0015	0.089	0.0037	0.0025	58.47
3	<0.0008	0.037	0.0013	<0.0005	<0.0035	0.022	<0.0015	0.107	0.0041	0.0021	58.58
4	<0.0008	0.035	0.0014	<0.0005	<0.0035	0.022	<0.0015	0.095	0.0032	0.0026	58.43
5	<0.0008	0.037	0.0014	0.0006	<0.0035	0.021	<0.0015	0.097	0.0039	0.0030	58.24
Certified Values											
Value	-	0.035	-	-	-	0.023	-	0.099	-	-	58.44
Error ³⁾		0.001				0.001		0.0043			0.069

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 4

Production Sample: CuSn12, 2.1052 - Cu160 (Cu-Sn alloys, bronze)

Element %	Zn	Pb	Sn	P	Mn	Fe	Ni	Si
MEAN ¹⁾	0.171	0.575	11.74	0.018	<0.0005	0.013	1.208	0.0059
STD ²⁾	0.0075	0.0095	0.092	0.0005		0.0004	0.0087	0.0001
1	0.173	0.574	11.76	0.018	<0.0005	0.014	1.202	0.0059
2	0.169	0.574	11.72	0.018	<0.0005	0.014	1.215	0.0061
3	0.175	0.567	11.78	0.018	<0.0005	0.013	1.213	0.0059
4	0.176	0.560	11.70	0.018	<0.0005	0.013	1.206	0.0061
5	0.176	0.566	11.64	0.017	<0.0005	0.013	1.195	0.0058
6	0.179	0.588	11.80	0.018	<0.0005	0.013	1.201	0.0058
7	0.177	0.576	11.60	0.018	<0.0005	0.013	1.213	0.0057
8	0.160	0.592	11.73	0.018	<0.0005	0.014	1.225	0.0060
9	0.162	0.573	11.93	0.018	<0.0005	0.013	1.210	0.0060
10	0.159	0.577	11.77	0.018	<0.0005	0.013	1.203	0.0059

Typical Chemical Composition of BS EN 1982-2008 CC483K - DIN CuSn12 - Sn Bronze - UNS C90800

Element %	Zn	Pb	Sn	P	Mn	Fe	Ni	Si
Min	-	-	11.20	-	-	-	-	-
Max	0.40	0.60	13.00	0.20	0.02	0.15	2.00	0.01

Element %	Mg	Al	S	As	Ag	Sb	Cu
MEAN ¹⁾	<0.00010	<0.0006	0.011	<0.0040	0.048	0.098	86.11
STD ²⁾			0.0003		0.0004	0.0023	0.09
1	<0.00010	<0.0006	0.011	<0.0040	0.049	0.099	86.09
2	<0.00010	<0.0006	0.011	<0.0040	0.049	0.096	86.13
3	<0.00010	<0.0006	0.011	<0.0040	0.048	0.094	86.08
4	<0.00010	<0.0006	0.010	<0.0040	0.048	0.099	86.16
5	<0.00010	<0.0006	0.010	<0.0040	0.048	0.097	86.23
6	<0.00010	<0.0006	0.011	<0.0040	0.049	0.098	86.04
7	<0.00010	<0.0006	0.010	<0.0040	0.048	0.097	86.24
8	<0.00010	<0.0006	0.011	<0.0040	0.049	0.101	86.09
9	<0.00010	<0.0006	0.011	<0.0040	0.049	0.099	85.93
10	<0.00010	<0.0006	0.010	<0.0040	0.049	0.102	86.09

Typical Chemical Composition of BS EN 1982-2008 CC483K - DIN CuSn12 - Sn Bronze - UNS C90800

Element %	Mg	Al	S	As	Ag	Sb	Cu
Min	-	-	-	-	-	-	85.50
Max		0.01	0.05			0.15	88.50

¹⁾ MEAN = arithmetic average²⁾ STD = absolute standard deviation (1σ)**Table 5**

Production Sample: CuSn7Zn4Pb7, 2.1090, CC493K - Cu150 (Gunmetal alloys)

Element %	Zn	Pb	Sn	P	Mn	Fe	Ni	Si	Cr
MEAN ¹⁾	4.075	5.854	6.884	0.030	<0.0004	0.069	1.083	0.0006	0.0007
STD ²⁾	0.019	0.063	0.023	0.0009		0.0005	0.0087	0.0001	0.00004
1	4.082	5.832	6.913	0.031	<0.0004	0.069	1.088	0.0006	0.0007
2	4.073	5.797	6.887	0.030	<0.0004	0.069	1.090	0.0006	0.0008
3	4.099	5.951	6.880	0.029	<0.0004	0.069	1.064	0.0006	0.0007
4	4.088	5.907	6.863	0.031	<0.0004	0.069	1.090	0.0006	0.0007
5	4.100	5.786	6.894	0.030	<0.0004	0.069	1.080	0.0007	0.0007
6	4.046	5.802	6.875	0.029	<0.0004	0.068	1.088	0.0007	0.0008
7	4.069	5.774	6.837	0.031	<0.0004	0.069	1.077	0.0006	0.0007
8	4.076	5.914	6.877	0.029	<0.0004	0.069	1.089	0.0007	0.0007
9	4.044	5.875	6.914	0.031	<0.0004	0.069	1.087	0.0006	0.0008
10	4.074	5.897	6.895	0.030	<0.0004	0.068	1.074	0.0007	0.0007

Typical Chemical Composition of Lead Gunmetal - CuSn7Zn4Pb7 - BS EN 1982-2008 CC493K - RG7 - DIN 1705 2.1090

Element %	Zn	Pb	Sn	P	Mn	Fe	Ni	Si	Cr
Min	2.30	5.20	6.20	-	-	-	-	-	-
Max	5.00	8.00	8.00	0.03		0.20	2.00	0.01	

Element %	Al	S	As	Ag	Bi	Sb	Se	Cu
MEAN ¹⁾	0.0004	0.034	0.028	0.019	<0.0020	0.123	0.016	81.78
STD ²⁾		0.0009	0.0005	0.0002		0.0049	0.0004	0.075
1	<0.0004	0.034	0.027	0.019	<0.0020	0.113	0.015	81.78
2	<0.0004	0.034	0.028	0.019	<0.0020	0.129	0.016	81.83
3	<0.0004	0.035	0.028	0.019	<0.0020	0.124	0.016	81.68
4	<0.0004	0.034	0.027	0.019	<0.0020	0.119	0.016	81.73
5	<0.0004	0.033	0.028	0.019	<0.0020	0.126	0.016	81.82
6	<0.0004	0.036	0.028	0.019	<0.0020	0.122	0.016	81.87
7	<0.0004	0.034	0.027	0.019	<0.0020	0.118	0.015	81.93
8	<0.0004	0.033	0.028	0.019	<0.0020	0.127	0.016	81.72
9	<0.0004	0.033	0.029	0.019	<0.0020	0.125	0.016	81.76
10	<0.0004	0.033	0.028	0.019	<0.0020	0.125	0.016	81.74

Typical Chemical Composition of Lead Gunmetal - CuSn7Zn4Pb7 - BS EN 1982-2008 CC493K - RG7 - DIN 1705 2.1090

Element %	Al	S	As	Ag	Bi	Sb	Se	Cu
Min	-	-	-	-	-	-	-	81.00
Max	0.01	0.08				0.30		84.50

¹⁾ MEAN = arithmetic average²⁾ STD = absolute standard deviation (1σ)

