

CERTIFICATE OF ANALYSIS

31X 7835.1 (batch U)

Certified Reference Material Information

Type: LEADED BRASS (CHILL CAST)
Form and Size: Disc ~40mm diameter
Manufactured by: Maybrey Reliance, UK
Certified and Supplied by: MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Ni	Al	Mn	Si	P
Value ¹	0.446	2.78	33.42	0.173	0.120	0.0187	0.0105	0.0218	0.0493
Uncertainty ²	0.005	0.02	0.05	0.005	0.003	0.0009	0.0005	0.0014	0.0013

Element	Co	Bi	Sb	As	Cr	Cd	Ag	Te	Cu
Value ¹	0.0091	0.0089	0.0156	0.0138	0.0028	0.0037	0.0083	0.0015	62.90
Uncertainty ²	0.0003	0.0008	0.0009	0.0009	0.0002	0.0003	0.0004	0.0001	0.08

Definitions

- ¹ The certified values are the present best estimates of the true content for each element. Each value is a panel consensus, based on the averaged results of an interlaboratory testing programme, detailed on page 3.
- ² The uncertainty values are generated from the 95% confidence interval derived from the wet analysis results, in combination with a statistical assessment of the homogeneity data, as described on page 2.

Certified by:

MBH ANALYTICAL LIMITED _____
C Eveleigh

on 30th June 2019

Method of Preparation

This reference material was produced from commercial-grade metals, binaries and master alloys. The discs are the product of one melt poured into a sequence of multiple chill moulds with feeding systems designed to ensure sound discs. Approximately 2mm has been removed from the chill-cast faces of the discs to minimise surface effects.

Sampling

Samples for chemical analysis were taken from various positions throughout the casting process. Approximately 10% of all discs were selected for non-destructive homogeneity testing.

Homogeneity

Samples representative of the batch were checked for uniformity using an optical emission spectrometer.

For all accepted material, through-batch variation values were derived for each element as an indicator of any minor compositional variation (as determined for the specific sample size and other limitations of the spectrometer).

Chemical Analysis

Analysis was carried out on millings taken from samples representative of the product. It was performed by a panel of laboratories mostly operating within the terms of EN ISO/IEC 17025, using documented standard reference methods and validated by appropriate reference materials. The individual values listed overpage are the average of each analyst's results.

Estimation of Uncertainties

Each element certified has been analysed by several laboratories, and 95% half-width confidence intervals ($C_{(95\%)}$) for the resultant mean values have been derived by the method shown on page 3.

As a separate exercise, the degree of non-homogeneity of the batch for each element has been quantified by a programme of non-destructive application testing, discussed above.

The final certified uncertainty for each element has been derived by combining these two factors, using the square-root of the summed squares.

Traceability

Much of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to ISO 17025. It is an implicit requirement for this accreditation that analytical work should be performed with due traceability, via an unbroken chain of comparisons, each with stated uncertainty, to primary standards such as the mole, or to nationally- or internationally-recognised reference materials.

Of the individual results herein, some have traceability (to the mole) via primary analytical methods. Some are traceable to substances of known stoichiometry. Most have traceability via commercial solutions. Furthermore, some results have additional traceability to NIST standards, as part of the analytical calibration or process control.

Usage

Intended use: With optical emission and X-ray fluorescence spectrometers.

Recommended method of use: Copper alloys are generally prepared by machining on a mill or a lathe. However, users are recommended to follow the calibration and sample preparation procedures specified by the relevant instrument manufacturer.

Preparation should be the same for reference materials and the samples for test.

A minimum of five consistent replicate analyses is recommended to provide the necessary sample size. Users are advised to check against possible bias between reference materials and production samples due to differences in metallurgical history, and be aware of possible inter-element effects.

Analytical Data

Percentage element by weight

Sample	Sn	Pb	Zn	Fe	Ni	Al	Mn	Si	P
1	0.4351	2.723	33.32	0.1592	0.1112	0.0166	0.0089	0.0186	0.0459
2	0.4387	2.736	33.35	0.1638	0.1125	0.0168	0.0090	0.0187	0.0470
3	0.4410	2.759	33.39	0.1659	0.1132	0.0169	0.0093	0.0197	0.0481
4	0.4420	2.760	33.41	0.1705	0.1160	0.0173	0.0094	0.0197	0.0482
5	0.4428	2.768	33.41	0.1710	0.1180	0.0174	0.0096	0.0204	0.0486
6	0.4436	2.780	33.41	0.1710	0.1180	0.0182	0.0100	0.0209	0.0488
7	0.4460	2.780	33.43	0.1711	0.1184	0.0186	0.0106	0.0209	0.0502
8	0.4480	2.784	33.43	0.1742	0.1185	0.0187	0.0108	0.0228	0.0507
9	0.4485	2.785	33.45	0.1755	0.1188	0.0189	0.0109	0.0230	0.0513
10	0.4490	2.787	33.51	0.1778	0.1198	0.0190	0.0111	0.0233	0.0514
11	0.4490	2.788	33.53	0.1800	0.1199	0.0193	0.0112	0.0238	0.0520
12	0.4534	2.805		0.1810	0.1200	0.0193	0.0113	0.0238	
13	0.4540	2.810		0.1815	0.1260	0.0204	0.0113	0.0241	
14	0.4593	2.830		0.1850	0.1262	0.0216	0.0114	0.0254	
15		2.842			0.1288	0.0222	0.0115		
16					0.1290		0.0116		
Mean	0.4464	2.782	33.42	0.1734	0.1196	0.0187	0.0105	0.0218	0.0493
Std Dev	0.0065	0.032	0.06	0.0073	0.0054	0.0017	0.0010	0.0022	0.0020
C_(95%)	0.0038	0.018	0.04	0.0042	0.0029	0.0009	0.0005	0.0013	0.0013

Sample	Co	Bi	Sb	As	Cr	Cd	Ag	Te	Cu
1	0.0078	0.0073	0.0142	0.0112	0.0022	0.0031	0.0071	0.00128	62.80
2	0.0085	0.0076	0.0145	0.0119	0.0025	0.0032	0.0076	0.00130	62.81
3	0.0086	0.0077	0.0148	0.0119	0.0026	0.0033	0.0078	0.00130	62.81
4	0.0087	0.0078	0.0149	0.0120	0.0027	0.0035	0.0079	0.00140	62.89
5	0.0089	0.0081	0.0150	0.0132	0.0027	0.0036	0.0079	0.00147	62.89
6	0.0091	0.0082	0.0150	0.0135	0.0027	0.0036	0.0080	0.00147	62.90
7	0.0091	0.0086	0.0154	0.0135	0.0028	0.0036	0.0084	0.00150	62.93
8	0.0091	0.0089	0.0157	0.0136	0.0028	0.0037	0.0084	0.00154	62.93
9	0.0092	0.0090	0.0169	0.0142	0.0030	0.0037	0.0084	0.00160	62.95
10	0.0093	0.0092	0.0173	0.0145	0.0035	0.0038	0.0085	0.00170	63.06
11	0.0093	0.0094	0.0176	0.0146		0.0039	0.0088		
12	0.0094	0.0098		0.0155		0.0040	0.0092		
13	0.0097	0.0103		0.0157		0.0040	0.0092		
14	0.0102	0.0106		0.0160		0.0041	0.0093		
15		0.0107		0.0164		0.0042			
Mean	0.0091	0.0089	0.0156	0.0138	0.0028	0.0037	0.0083	0.00146	62.90
Std Dev	0.0006	0.0011	0.0012	0.0016	0.0003	0.0003	0.0007	0.00014	0.08
C_(95%)	0.0003	0.0006	0.0008	0.0009	0.0002	0.0002	0.0004	0.00010	0.06

Note: C_(95%) is the 95% half-width confidence interval derived from the equation:

$$C_{(95\%)} = (t \times SD) / \sqrt{n}$$

where n is the number of available values, t is the Student's t value for n-1 degrees of freedom, and SD is the standard deviation of the test results.