ARMI | MBH
ANALYTICAL LTD

ISO Certified · 9001:2015 · 17025:2017 · 17043:2010 · 17034:2016

Certificate of Analysis

IARM Cu360-18

Copper Alloy, CDA 360 / UNS 36000

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Ag	**0.011** ± 0.001	**Al**	**0.010** ± 0.002	**As**	**0.026** ± 0.007	**Bi**	**0.0023** ± 0.0009
C	**0.003** ± 0.001	**Cd**	**0.0034** ± 0.0007	**Co**	**0.0010** ± 0.0002	**Cr**	**0.003** ± 0.001
Cu	**61.6** ± 0.4	**Fe**	**0.27** ± 0.01	**Mn**	**0.0131** ± 0.0005	**Ni**	**0.120** ± 0.005
P	**0.003** ± 0.001	**Pb**	**2.73** ± 0.08	**Sb**	**0.012** ± 0.002	**Si**	**0.010** ± 0.002
Sn	**0.29** ± 0.02	**Zn**	**35.1** ± 0.4				

Indicative Values listed in ppm

B (20)	H (<10)	Mg (0.7)	Mo (<1)	N (<10)	Nb (<10)	O (10)
Pd (1)	S (<5)	Se (<30)	Te (3)	Ti (<20)	V (<100)	

Description and Intended Use

This **Certified Reference Material** is covered under the scope of accreditation to **ISO 17034** by LGC Standards - Manchester, NH. As an ISO 17034 certified reference material, appropriate use of this material will fulfill the certified reference material and traceability requirements for use in **ISO 17025** certified laboratories. This CRM may come in the form of a solid disk, chips, or powder. The intended use of this CRM may include, but is not limited to, the calibration of instruments and the validation of analytical methods.

Instructions for Use

1. The test surface is on the opposite side of the labeled surface, which includes the material identification. The entire thickness of the unit is certified. However, the user is cautioned not to measure disks less than 2 mm thick when using X-ray fluorescence spectrometry. Each packaged disk has been prepared by finishing the test surface using a lathe. The user must determine the correct surface preparation procedure for each analytical technique. The user is cautioned to use care when either resurfacing the disk or performing additional polishing, as these processes may contaminate the surface.
2. The minimum sample size for chips should be individually evaluated based on the analytical technique used; this would typically be greater than 0.1 grams.
3. The material should be stored in a cool, dry location when not in use.
4. Chips are not recommended for gas analysis.

The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

	Ag	Al	As	B	Bi	C	Cd	Co	Cr	Cu	Fe	H	Mg	Mn	Mo	N
1	0.0089	0.0074	0.0050	0.0000	0.0015	0.0018	0.0015	0.0006	0.0015	61.010	0.2380	0.0001	0.00001	0.0122	0.00001	0.00002
2	0.0105	0.0075	0.0144	0.0001	0.0015	0.0022	0.0020	0.0009	0.0019	61.200	0.2400	<0.001	0.0001	0.0125	<0.0001	<0.001
3	0.0117	0.0079	0.0234	0.0060	0.0015	0.0025	0.0027	0.0010	0.0022	61.316	0.2551		0.0001	0.0130	<0.001	<0.001
4	0.0120	0.0084	0.0264	<0.00005	0.0016	0.0033	0.0034	0.0010	0.0027	61.442	0.2650		0.0001	0.0130	<0.005	
5	0.0120	0.0091	0.0300	<0.0001	0.0020	0.0036	0.0039	0.0010	0.0030	61.632	0.2680		<0.0001	0.0130	<0.005	
6	0.0120	0.0100	0.0301	<0.0005	0.0030	0.0044	0.0039	0.0011	0.0037	61.970	0.2682		<0.0005	0.0132		
7	0.0121	0.0110	0.0313	<0.005	0.0032		0.0039	0.0014	0.0051	62.030	0.2700		<0.001	0.0134		
8	<0.005	0.0111	0.0325	<0.005	0.0040		0.0040	<0.001	0.0059	62.140	0.2731		<0.005	0.0137		
9		0.0112	0.0345		<0.005		0.0041	<0.005	<0.0001		0.2780			0.0140		
10		0.0135	0.0360				0.0043	<0.005	<0.001		0.2840					
11		0.0140					<0.005		<0.005		0.2870					
12																
13																
14																
15																
Mean	0.0113	0.0101	0.0264	0.0020	0.0023	0.0030	0.0034	0.0010	0.0033	61.5925	0.2660	0.0001	0.00007	0.0131	0.00001	0.00002
STDV.	0.0012	0.0023	0.0098	0.0034	0.0010	0.0010	0.0010	0.0002	0.0016	0.4188	0.0160		0.00004	0.0006		
Certified	**0.011**	**0.010**	**0.026**	**(0.002)**	**0.0023**	**0.003**	**0.0034**	**0.0010**	**0.003**	**61.6**	**0.27**	**(<0.001)**	**(0.00007)**	**0.0131**	**(<0.0001)**	**(<0.001)**
U_{CRM}	0.001	0.002	0.007		0.0009	0.001	0.0007	0.0002	0.001	0.4	0.01			0.0005		
Methods	IM,I,X	IM,I,X	IM,A,I,X	IM,I	IM,A,I	C	IM,I,X	IM,I	IM,I,X	I,X	IM,I,X	F	IM,I	IM,I,X	IM,I	F

	Nb	Ni	O	P	Pb	Pd	S	Sb	Se	Si	Sn	Te	Ti	V	Zn	
1	0.0004	0.1090	0.0003	0.0011	2.5580	0.0001	0.0004	0.0050	0.0021	0.0040	0.2520	0.0003	0.000001	0.0080	34.317	
2	<0.00005	0.1100	0.0003	0.0020	2.5620		<0.0001	0.0072	<0.0001	0.0080	0.2553		0.0010	<0.005	34.644	
3	<0.001	0.1110	0.0003	0.0024	2.6618		<0.0005	0.0102	<0.001	0.0082	0.2700		<0.005	<0.005	34.750	
4	<0.002	0.1170	0.0010	0.0027	2.6660		<0.0005	0.0102		0.0089	0.2730		<0.005		34.834	
5	<0.005	0.1180	0.0010	0.0035	2.6920		<0.001	0.0120		0.0093	0.2740				35.000	
6		0.1199	0.0017	0.0038	2.7470		<0.001	0.0126		0.0098	0.2795				35.024	
7		0.1221	0.0022	0.0040	2.7830		<0.001	0.0130		0.0098	0.2803				35.026	
8		0.1254	<0.0005	0.0041	2.7833			0.0133		0.0119	0.2833				35.190	
9		0.1270	<0.001	0.0051	2.7863			0.0138		0.0125	0.2890				35.823	
10		0.1294		<0.005	2.8330			0.0152		0.0160	0.3450				35.954	
11		0.1300			2.9800			0.0170		<0.005	0.3500					
12																
13																
14																
15																
Mean	0.0004	0.1199	0.0010	0.0032	2.7320	0.0001	0.0004	0.0118	0.0021	0.0098	0.2865	0.0003	0.0005	0.0080	35.056	
STDV.		0.0077	0.0007	0.0012	0.1225			0.0035		0.0032	0.0321		0.0007		0.5028	
Certified	**(<0.001)**	**0.120**	**(0.001)**	**0.003**	**2.73**	**(0.0001)**	**(<0.0005)**	**0.012**	**(<0.0030)**	**0.010**	**0.29**	**(0.0003)**	**(<0.0020)**	**(<0.010)**	**35.1**	
U_{CRM}		0.005	0.0009	0.001	0.08			0.002		0.002	0.02				0.4	
Methods	IM,I	IM,I,X	F,I	IM,I,F,X	I,X	IM	C,X	IM,I,A,X	IM,I	IM,I,X	IM,I,X		IM,I	IM,I	I	

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP, IM=ICP-MS, D = DC Arc, O = Spark OES, X = XRF, G = GDAES or GDMS, H = Hollow Cathode AES, BAL=Difference

Certification Laboratories

Laboratory Testing, Inc.	Hatfield, PA	NSL Analytical Services	Cleveland, OH
IMR Test Labs	Lansing, NY	Dirats Laboratories	Westfield, MA
Applied Technical Services	Marietta, GA	EAG Laboratories	Liverpool, NY
LGC Standards	Manchester, NH	Luvak Laboratories Inc.	Boylston, MA
Massachusetts Materials Research Inc.	West Boylston, MA	SGS MSi	Melrose Park, IL

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.

Homogeneity and Uncertainty

"Uncertainty" values, as reported adjacent to certified concentration values, are based on a 95% Confidence Interval. These estimated uncertainties include the combined effects of method imprecision, material inhomogeneity, and any bias between methods. Homogeneity data from experimental XRF results are reflected in both the overall statistics and certified data. Homogeneity samples are selected by a systematic sampling procedure. The number of samples may be determined by equation 1, where N_{prod} is the number of units produced and N_{min} is the number of samples used for homogeneity testing. These samples are arranged in a simple randomized design such that each sample is analyzed multiple times by XRF. Homogeneity may also be determined within sample using an applied version of ASTM E826. A single factor ANOVA is used to calculated uncertainty due to inhomogeneity (U_{hom}). Uncertainty of the material is calculated by equation 2, where H=U_{hom}, S= Standard deviation, t= t-value at 95% CI, and n= number of observations.

1. $$N_{min} = \max(10, \sqrt[3]{N_{prod}})$$

2. $$U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

Expiration

The certification of this material is valid indefinitely, within the uncertainty specified, provided the material is handled and stored in accordance with the instructions stated on this certificate. The certification is nullified if the material is damaged, contaminated, otherwise modified, or used in a manner for which it was not intended.

Kimberly Halkiotis, Global Product Manager

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