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ISO Certified · 9001 · 17025 · 17043 · 17034

Certificate of Analysis
IARM Cu544-18

Phosphor Bronze B-2 / CDA 544 / UNS C54400

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Cu	88.0 ± 0.2	**Fe**	0.010 ± 0.002	**Ni**	0.019 ± 0.002	**P**	0.069 ± 0.004
Pb	3.92 ± 0.13	**Sn**	4.14 ± 0.05	**Zn**	3.80 ± 0.07		

Indicative Values listed in ppm

Ag (15)	Al (18)	As (11)	B (<50)	Be (<50)	Bi (14)	C (15)
Cd (<50)	Co (8)	Cr (56)	H (<10)	Mg (<50)	Mn (45)	Mo (50)
N (<10)	Nb (<50)	O (14)	S (<110)	Sb (9)	Se (24)	Si (12)
Ta (<10)	Ti (<50)	V (<50)	Zr (<50)			

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 or chips. 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.

	Cu	Fe	Ni	P	Pb	Sn	Zn	Ag	Al	As	B	Be	Bi	C	Cd	Co
1	87.713	0.0040	0.0150	0.0540	3.470	3.980	3.513	0.0010	0.0008	0.0008	<0.001	<0.001	0.0010	0.0010	0.00004	0.0005
2	87.800	0.0060	0.0156	0.0608	3.637	4.040	3.731	0.0014	0.0020	0.0008	<0.001	<0.005	0.0010	0.0010	0.0003	0.0010
3	87.913	0.0093	0.0165	0.0644	3.650	4.060	3.732	0.0020	0.0026	0.0010	<0.005		0.0013	0.0012	<0.001	0.0010
4	87.927	0.0095	0.0180	0.0656	3.853	4.090	3.732		<0.001	0.0020			0.0023	0.0028	<0.001	<0.001
5	88.190	0.0100	0.0180	0.0660	3.960	4.107	3.768		<0.001	<0.005			<0.001	<0.005	<0.005	<0.001
6	88.214	0.0100	0.0182	0.0675	3.973	4.139	3.780		<0.005				<0.005			<0.005
7	88.364	0.0106	0.0190	0.0700	4.013	4.140	3.810									
8		0.0107	0.0190	0.0700	4.027	4.170	3.830									
9		0.0120	0.0217	0.0710	4.040	4.200	3.835									
10		0.0130	0.0260	0.0730	4.057	4.218	3.890									
11		0.0180		0.0740	4.080	4.220	3.900									
12				0.0781	4.101	4.229	3.901									
13				0.0831	4.116	4.252	4.020									
14																
15																
Mean	88.017	0.0103	0.0187	0.0690	3.921	4.142	3.803	0.0015	0.0018	0.0011			0.0014	0.0015	0.0002	0.0008
STDV.	0.241	0.0036	0.0032	0.0074	0.207	0.083	0.121	0.0005	0.0009	0.0006			0.0006	0.0009	0.0002	0.0003
Certified	**88.0**	**0.010**	**0.019**	**0.069**	**3.92**	**4.14**	**3.80**	**(0.0015)**	**(0.0018)**	**(0.0011)**	**(<0.005)**	**(<0.005)**	**(0.0014)**	**(0.0015)**	**(<0.005)**	**(0.0008)**
U_{CRM}	0.2	0.002	0.002	0.13	0.05	0.07										
Methods	O,I	O,X,IM,I	O,X,IM,I	O,X,I,IM	O,X,I	O,X,I	O,X,I	O,I	O,IM,I	O,IM	IM,I	I	O,IM,I	O,C	O,IM,I	IM,I

	Cr	H	Mg	Mn	Mo	N	Nb	O	S	Sb	Se	Si	Ta	Ti	V	Zr
1	0.0030	0.0002	0.0001	0.0010	0.0050	0.0002	<0.001	0.0010	0.0020	0.0005	0.0014	0.0010	<0.001	0.0030	<0.001	<0.001
2	0.0082	0.0002	<0.001	0.0019	<0.001	0.0010	<0.001	0.0012	0.0020	0.0009	0.0019	0.0010	<0.001	<0.001	<0.001	<0.001
3	<0.001	<0.001	<0.001	0.0050	<0.005	<0.001	<0.005	0.0014	0.0110	0.0010	0.0040	0.0017		<0.005	<0.005	<0.005
4	<0.001		<0.005	0.0100		<0.001		0.0016	<0.001	0.0010	<0.001	<0.005				
5	<0.005			<0.001				0.0020		0.0011	<0.005	<0.005				
6				<0.001							<0.005					
7				<0.005												
8																
9																
10																
11																
12																
13																
14																
15																
Mean	0.0056	0.0002		0.0045		0.0006		0.0014	0.0050	0.0009	0.0024	0.0012				
STDV.	0.0037	0.0000		0.0041		0.0005		0.0004	0.0052	0.0003	0.0014	0.0004				
Reference	**(0.0056)**	**(<0.001)**	**(<0.005)**	**(0.0045)**	**(0.005)**	**(<0.001)**	**(<0.005)**	**(0.0014)**	**(<0.011)**	**(0.0009)**	**(0.0024)**	**(0.0012)**	**(<0.001)**	**(<0.005)**	**(<0.005)**	**(<0.005)**
Methods	O,IM,I	F	IM,I	O,X,IM,I	IM,I	F	IM,I	F	O,C	O,IM,I	O,IM,I	O,IM,I	IM	IM,I	IM,I	IM,I

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

Certification Laboratories

ConCast Metal Products Co.	Mars, PA	Laboratorio Prove Materiali S. Marco srl	Schio, Italy
Laboratory Testing, Inc.	Hatfield, PA	AY Mc Donald Mfg. Co.	Dubuque, IA
Anderson Laboratories, Inc.	Greendale, WI	California Metal-X	Los Angeles, CA
LGC Standards	Manchester, NH	NSL Analytical Services	Cleveland, OH
IMR Test Labs	Lansing, NY	Dirats Laboratories	Westfield, MA
Applied Technical Services	Marietta, GA	EAG Laboratories	Liverpool, NY

Certification laboratories have demonstrated performance and traceability by utilizing a variety of test methods under the scope of ISO 17025 or have demonstrated equivalent performance. Some of the specific CRMs and SRMs used in the analysis of the material covered by this certificate are:

NIST 872   NIST 63C   IARM 86D   MBH 33X 54400 A   LECO 502-102
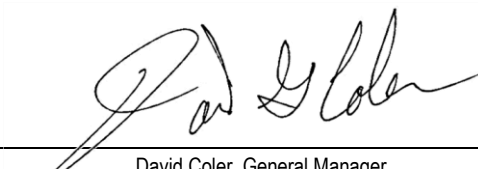
Homogeneity and Uncertainty

"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.

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

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

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.

David Coler, General Manager

Analytical Reference Materials International

ACCREDITED