

CERTIFICATE OF ANALYSIS

38X C1 (batch C)

Certified Reference Material Information

Type: PURE COPPER
Form and Size: Wire, 2.84mm diameter
Produced by: Sterlite Industries (India) Limited
Certified and supplied by: MBH Analytical Limited

Certified Analysis

Composition $\mu\text{g/g}$ (ppm)

Element	Sn	Pb	Zn	Fe	Ni	Si	As	Mn	Bi
Value ¹	(0.01)	(0.05)	<0.1	1.7	0.27	<0.1	0.19	(0.005)	0.10
Uncertainty ²	-	-	-	0.4	0.06	-	0.02	-	0.04

Element	Sb	P	Cr	Ag	S	Cd	Te	Se	O
Value ¹	0.10	<0.05	<0.005	11	2.0	<0.01	(0.21)	(0.25)	266
Uncertainty ²	0.03	-	-	2	0.8	-	-	-	13

Note: values given in parentheses are not certified - they are provided for information only.

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 analysis results (page 3). When appropriate, these values have been modified to account for additional information from the material homogeneity checks.

Certified by:

MBH ANALYTICAL LIMITED _____

on 15th August 2002



Method of Preparation

This reference material was produced from high-purity continuous-cast copper bar, cold drawn to wire of 2.84mm nominal diameter.

Sampling

Ten samples for homogeneity checks, plus all the samples necessary for chemical analysis, were taken from random positions within the bulk coil.

Homogeneity

Samples representative of the batch were checked for uniformity using a DC arc spectrometer.

The mean value of the material was then calculated from the multiple measurements.

For each of the samples checked, the difference between the individual result and the overall mean value were evaluated to ensure that the homogeneity of the material satisfied the acceptance criteria defined in ISO guide 30 - 1992.

Using the individual data from each check, standard deviation values were derived for each element. These values were combined with the 95% half-width confidence intervals ($C_{(95\%)}$) obtained from the analysis programme, using the square-root of the summed squares, to derive the final uncertainty values.

Chemical Analysis

Analysis was carried out on pieces representative of the product. It was performed by participating laboratories using documented methods of analysis.

The individual values listed overpage are the average of each analyst's results.

Usage

Intended use: With glow discharge and DC arc spectrometers.

Recommended method of use: 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 three consistent replicate analyses is recommended to optimise precision and accuracy. 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

Composition $\mu\text{g/g}$ (ppm)

Sample	Sn	Pb	Zn	Fe	Ni	Si	As	Mn	Bi
1	0.01	0.03	<0.01	1.17	0.20	0.03	0.167	0.004	0.056
2	0.01	0.032	<0.01	1.24	0.21	0.034	0.17	0.005	0.063
3	0.013	0.033	<0.05	1.4	0.214	0.10	0.173	0.006	0.064
4	<0.01	0.05	0.07	1.78	0.24	<1	0.18	<0.1	0.09
5	<0.1	0.10	<0.1	1.8	<0.25		0.20	<1	<0.1
6	<0.1	<0.1	<1	2.0	0.33		0.20		0.11
7		<1		2.2	0.33		0.21		0.15
8					0.36		<0.5		0.17
Mean	(0.01)	(0.05)	<0.1	1.66	0.27	<0.1	0.19	(0.005)	0.10
Std Dev	-	-	-	0.39	0.07	-	0.02	-	0.05
C_(95%)	-	-	-	0.36	0.06	-	0.02	-	0.04

Composition $\mu\text{g/g}$ (ppm)

Sample	Sb	P	Cr	Ag	S	Cd	Te	Se	O
1	0.062	<0.001	<0.001	7.75	0.816	<0.001	0.130	0.06	243
2	0.08	<0.001	<0.005	7.9	1.02	<0.01	0.19	0.15	248
3	0.088	0.004	<0.005	9.25	1.18	<0.01	0.21	<0.2	255
4	<0.1	<0.05	<0.1	11	1.3	<0.05	<0.2	0.30	267
5	0.1	<0.1	<1.0	11.59	1.7	<0.1	0.32	0.32	270
6	0.11	<0.1		11.83	2.1	<0.1	<0.5	<0.4	280
7	0.16			11.9	3			0.442	283
8	<0.5			12	3.1			<0.5	284
9				13	3.8				
10				13.2					
11				14					
Mean	0.10	<0.05	<0.005	11.2	2.0	<0.01	(0.21)	(0.25)	266
Std Dev	0.03	-	-	2.1	1.1	-	-	-	16
C_(95%)	0.03	-	-	1.4	0.8	-	-	-	13

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.

Participating Laboratories

Shiva Technologies	(Mr D Shuman)	Syracuse, NY, USA
Phelps Dodge Refining Corp	(Ms J Fernandez)	El Paso, TX, USA
Special Metals Corp	(Mr D McAnallen)	Huntington, WV, USA
Laboratory Testing Inc	(Mr L Dilks)	Hatfield, PA, USA
LECO Corporation	(Mr D Lawrenz)	St Joseph, MI, USA
Western Metals Corp Olympic Dam	(Ms R Simpson)	Roxby Downs, SA, Australia
Australian Gold Refineries	(Mr M Koch)	Perth, WA, Australia
Mount Isa Mines Copper Refineries Ltd	(Mr D Milton)	Townsville, Qld, Australia
Chinese Iron and Steel Research Institute	(Prof. W Haizou)	Beijing, China
Sterlite Industries	(Dr A K Mitra)	Silvassa, D&NH, India
Palabora Mining Co	(Mr N Rheeder)	Palabora, South Africa
University Centre for Analytical Sciences	(Mr A G Cox)	Sheffield, England

Analytical Methods Used

<u>ELEMENT</u>	<u>RESULT No. & METHOD</u>				
	GD-MS	ICP-MS	ICP-AES	DC-ARC-AES	OTHER
Tin:	2, 3, 4, 5	-	6	1	
Lead:	1, 2, 3, 5	4, 6	-	7	
Zinc:	1, 2, 3	-	4	5, 6	
Iron:	1, 2, 3, 4	-	5	6, 7	
Nickel:	1, 2, 3, 4	-	7	6, 8	5 FAAS
Silicon:	1, 2, 3	-	-	4	
Arsenic:	1, 2, 4, 5	3, 6	7, 8*	-	
Manganese:	1, 2, 3, 4	-	-	5	
Bismuth:	2, 3, 4, 5	1	7	6, 8	
Antimony:	2, 3, 4, 6	1, 5, 7	8*	-	
Phosphorus:	1, 2, 3, 5	4	6	-	
Chromium:	1, 2, 3	-	5	4	
Silver:	5, 6, 7, 11	1, 8, 9	2	3, 4, 10	
Sulfur:	1, 2, 3, 4	-	-	6, 8, 9	5, 7 combustion
Cadmium:	1, 2, 3, 5	4	-	6	
Tellurium:	1, 2, 5	-	3, 6*	-	4 AFS-hydride
Selenium:	1, 2, 4, 7	-	8*	5, 6	3 AFS-hydride
Oxygen:	6	-	-	-	others combustion

*hydride generation

Traceability

Some of the results used within this certification have traceability to nationally-recognized standards, or to pure elements with established impurity levels. However, many of the other results may not have this pedigree. Hence although the certified values are based on consensus from different analytical methods, it is appropriate to treat them with some caution.

Notes

This Certified Reference Material has been produced in accordance with the requirements of ISO Guide 34-2000, ISO Guide 31-2000, ISO Guide 35-1989, and ASTM Guides E1724 and E1831.

This certification applies to the whole of the sample.

This material will remain stable provided adequate precautions are taken to protect it from cross-contamination, extremes of temperature and atmospheric moisture. All production records will be retained for a period of 20 years from the date of this certificate. This certification will therefore expire in August 2022, although we reserve the right to make changes as issue revisions, in the intervening period.

The material to which this certificate of analysis refers is supplied subject to our general conditions of sale.