ARMI | MBH ANALYTICAL LTD

276 Abby Road, Manchester, NH 03103 USA
Tel: 1+ 603.935.4100
Email: ARMI@lgcgroup.com | Online: ARMI.com

Certified Reference Material — Certificate of Analysis

ISO 17034:2016 | ISO/IEC 17025:2017 | ISO 9001:2015

Product ID: MBH-84X BA22 C

Product Description: Pb/Sn/Ca Battery Alloy

Revision No.: 001
Revision Date: 05/26/2022

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** accredited 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.

Certified Values listed in wt.% with associated uncertainties

Ag	**0.0049**	±0.0004	**Al**	**0.055**	±0.002	**Bi**	**0.0168**	±0.0008	**Ca**	**0.82**	± 0.03
Cd	**0.0020**	±0.0003	**Mg**	**0.0044**	±0.0004	**Sb**	**0.0009**	±0.0003	**Sn**	**0.093**	± 0.006
Zn	**0.0049**	±0.0005									

Indicative Values listed in ppm

Cu (7)

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.

$$1.\ N_{MIN} = \max\left(10, \sqrt[3]{N_{PROD}}\right) \qquad 2.\ U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

Certification Laboratories: 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.

- American Iron and Metal - Montreal, Canada
- Alpha Assembly Solutions - Altoona, PA
- Dirats Laboratories - Westfield, MA
- Instytut Metali Niezelaznych - Gliwice, Poland
- Inppamet Anodos - Calama, Chile
- LGC Standards - Manchester, NH
- Scrooby's Laboratory Services - Benoni, South Africa
- Universal Scientific Laboratory - Revesby NSW, Australia
- Sheffield Analytical Services - Sheffield, UK
- AnchorCert Analytical - Birmingham, UK
- IMNR - Pantelimon, Romania
- Mineral & Metallurgical Laboratories - Bangalore, India
- TEC-Eurolab - Campogalliano, Italy
- Genitest Inc. - Montreal, Canada
- AMG Superalloys UK Limited - Rotherham, UK

Instructions for Use: The test surface is on the opposite side of the labeled surface, which includes the material identification. This material is individually chill cast per piece. This manner of casting can cause the formation of inhomogeneous segregates in the upper, engraved portion of the disk. Therefore, the certification information above is not applicable to within 3mm of the engraved surface. 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. 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. The material should be stored in a cool, dry location when not in use.
Chips are not recommended for gas analysis.

Period of Validity: 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.

Chuck Goudreau

Chuck Goudreau, Certifying Officer

26 May 2022
Certification Date

ACCREDITED

ISO 17034 Accredited: Reference Materials Producer, Certificate # 2848.02
ISO/IEC 17025 Accredited: Chemical Testing, Certificate # 2848.01

LGC

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

	Ag	Al	Bi	Ca	Cd	Cu	Mg	Sb	Sn	Zn
1	0.0034	0.0491	0.0138	0.7230	0.0016	0.0007	0.0034	0.0004	0.0806	0.0032
2	0.0042	0.0507	0.0150	0.7895	0.0017		0.0040	0.0005	0.0806	0.0034
3	0.0044	0.0515	0.0153	0.7950	0.0018		0.0040	0.0007	0.0807	0.0045
4	0.0044	0.0526	0.0154	0.7970	0.0018		0.0041	0.0007	0.0838	0.0046
5	0.0045	0.0537	0.0154	0.7970	0.0018		0.0042	0.0007	0.0866	0.0047
6	0.0046	0.0558	0.0162	0.8090	0.0019		0.0042	0.0008	0.0878	0.0047
7	0.0047	0.0559	0.0164	0.8103	0.0019		0.0043	0.0009	0.0879	0.0049
8	0.0048	0.0559	0.0164	0.8175	0.0019		0.0043	0.0011	0.0900	0.0049
9	0.0049	0.0560	0.0170	0.8330	0.0019		0.0049	0.0014	0.0911	0.0049
10	0.0050	0.0568	0.0170	0.8512	0.0019		0.0050	0.0014	0.0935	0.0050
11	0.0050	0.0577	0.0171	0.8530	0.0020		0.0052	0.0018	0.0983	0.0050
12	0.0051	0.0580	0.0171	0.8680	0.0020		0.0054	<0.0005	0.0988	0.0050
13	0.0052	0.0590	0.0175	0.9049	0.0022		<0.005	<0.0005	0.1010	0.0052
14	0.0055	0.0592	0.0187		0.0022			<0.001	0.1050	0.0062
15	0.0056	0.0595	0.0188		0.0034			<0.002	0.1080	0.0072
16	0.0060		0.0190		<0.002			<0.002	0.1160	<0.005
17	0.0061		0.0192		<0.002					
Mean	0.0049	0.0554	0.0168	0.8191	0.0020	0.0007	0.0044	0.0009	0.0931	0.0049
STDV	0.0007	0.0032	0.0015	0.0447	0.0004		0.0006	0.0004	0.0106	0.0009
Certified	**0.0049**	**0.055**	**0.0168**	**0.82**	**0.0020**	**(0.0007)**	**0.0044**	**0.0009**	**0.093**	**0.0049**
U_{CRM}	0.0004	0.002	0.0008	0.03	0.0003		0.0004	0.0003	0.006	0.0005
Methods	IM,O,I,A,X	IM,I,A,W,X	IM,O,I,A,X,W	I,A,W	IM,O,I,A,X	I	IM,I,A,X	IM,O,I,A,X	I,O,A,W,X	IM,I,A,X

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