



TAZ GMBH



Certificate

Certified Reference Material (CRM)

TAZ-029

PbSb1AgSe

Certified Values

Element	Mass fraction ¹⁾	Uncertainty ²⁾	Unit ³⁾	Element	Mass fraction ¹⁾	Uncertainty ²⁾	Unit
Sb	1.038	0.022	%	Cu	7.5	0.7	µg/g
Ag	0.0304	0.0012	%	Ni	1.70	0.22	µg/g
Se	0.0212	0.0010	%	S	2.8	1.2	µg/g
Bi	0.0165	0.0003	%	Te	4.9	0.8	µg/g
As	0.0110	0.0009	%	Zn	1.1	0.6	µg/g

¹⁾ Unweighted mean values of the accepted data set mean values, whereby the data sets either originate from different laboratories or were determined using different methods.

²⁾ Expanded uncertainty U_{CRM} corresponding to a confidence level of 95 %.

³⁾ Although widely accepted in the industry, the "mass fraction in %" is neither an SI- nor an IUPAC-supported unit. Multiplying the certified values and uncertainties by 10^4 yields the values in µg/g.

This certificate is valid until November 2055.

Information Values ⁴⁾

Element	Mass fraction	Unit
Sn	<15	µg/g
Cd	<1,2	µg/g
In	<1	µg/g
Pd	<0,5	µg/g
Pb	98.93	%

⁴⁾ The values were not certified, but given for information if the number of accepted data sets was less than five, the uncertainty of the characterisation was significantly larger than expected or there were indications of inhomogeneities.

Description of the Material

The reference material is available in the form of cylinders with a diameter of 38 mm and a height of approx. 20 mm.

Intended Use

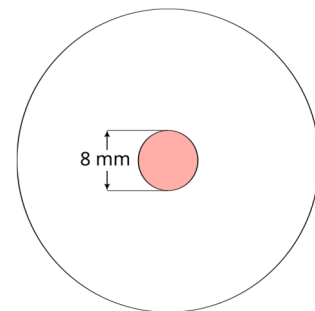
The reference material is intended for establishing and checking calibrations for X-ray fluorescence analysis and optical emission spectrometry for the analysis of samples of similar composition. The minimum sample size for wet chemical analysis is 0.2 g.



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Instructions for Use

As significant segregation can occur in the centre of cast disc samples, an area of 8 mm diameter in the centre of the sample should not be used. The surface of the sample to be analysed should not be used as delivered, but only after the surface has been prepared so that any protective layers are removed. Preparation should be carried out by turning or milling. At least three individual sparks should be used for an analysis. For wet chemical analysis chips have to be prepared by turning or milling of the sample surface.



Transport and Storage

The material must be stored in a dry and clean environment at room temperature. Transportation must be carried out under normal ambient conditions. The sample remains stable as long as it is not exposed to extreme heat (e.g. during surface treatment).

Homogeneity

A homogeneity assessment according to ASTM E826-14 and ISO 33405:2024 was carried out by TAZ GmbH using Spark-Optical Emission Spectrometry (OES) to determine the batch inhomogeneity.

Estimation of Uncertainty

The estimation of uncertainty takes into account the results of the homogeneity assessment and the characterisation study. u_{hom} is obtained from the contributions of the homogeneity assessment between the units u_{bu} and within the units u_{wu} . u_{char} is the standard uncertainty of the characterisation study, which results from the standard deviation s_{char} and the number n of accepted data set mean values. u_{CRM} is the combined uncertainty of the homogeneity assessment and the characterisation study. The coverage factor $t_{(n-1)}$ is the two-sided quantile of the Student t -distribution and U_{CRM} is the expanded uncertainty. The reported uncertainties and the certified values have been rounded according to DIN 1333:1992.

$$u_{\text{hom}} = \sqrt{u_{\text{bu}}^2 + u_{\text{wu}}^2}$$

$$u_{\text{char}} = \frac{s_{\text{char}}}{\sqrt{n}}$$

$$u_{\text{CRM}} = \sqrt{u_{\text{char}}^2 + u_{\text{hom}}^2}$$

$$U_{\text{CRM}} = t_{(n-1)} \cdot u_{\text{CRM}}$$

Metrological Traceability

The analytical values are traceable to the SI (Système International d'Unités) via calibration using pure metals, substances of known stoichiometry, certified reference materials or traceable standard solutions.

Laboratories involved in characterisation

Aurubis AG Hamburg, Hamburg, DE

Clarios Germany GmbH & Co KG, Hannover, DE

Clarios VARTA Hannover GmbH, Hannover, DE

Clarios Recycling GmbH, Buchholz, DE

Clarios Zwickau GmbH & Co.KG, Zwickau, DE

Ecobat Resources Freiberg GmbH, Freiberg, DE

Łukasiewicz Research Network - Institute of Non-Ferrous Metals, Gliwice, PL

Nyrstar Stolberg GmbH, Stolberg, DE

Thyssenkrupp Steel Europe AG, Duisburg, DE



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Mean values of accepted data sets

	Sb		Ag		Bi		As		Se		Cu		Ni		S		Te		Zn		Sn		Cd	
No.	%	M	%	M	%	M	%	M	%	M	µg/g	M	µg/g	M	µg/g	M	µg/g	M	µg/g	M	µg/g	M	µg/g	M
1	---	a	0.0276	a	0.0156	a	0.0096	a	---	c	6.2	a	---	c	1.1	a	3.2	a	0.6	a	0	a	0.0	a
2	0.996	c	0.0276	a	0.0156	c	0.0098	a	---	c	6.5	c	1.35	a	1.8	a	4.1	a	0.8	a	<0.7	c	<0.1	c
3	1.003	a	0.0285	c	0.0158	a	0.0102	a	0.0196	c	6.8	c	1.36	a	2.3	a	4.1	a	0.9	c	1	c	<0.1	a
4	1.004	a	0.0295	a	0.0160	c	0.0104	c	0.0196	a	6.9	a	1.42	a	<2.7	c	4.3	c	1.1	a	1	a	0.1	c
5	1.019	c	0.0297	a	0.0161	a	0.0105	b	0.0198	c	7.0	c	1.48	a	3.3	a	4.5	a	1.3	b	1	a	0.6	a
6	1.021	a	0.0297	a	0.0164	a	0.0106	a	0.0200	c	7.1	a	1.50	a	3.5	a	4.6	c	1.9	c	2	b	<1	c
7	1.028	a	0.0299	a	0.0164	a	0.0109	c	0.0200	b	7.2	c	1.62	a	3.7	a	5.1	b	---	a	2	a	1.2	c
8	1.031	c	0.0302	a	0.0165	c	0.0109	a	0.0203	c	7.2	a	1.70	a	4.0	a	5.2	c			2	a		
9	1.032	a	0.0303	c	0.0166	c	0.0110	a	0.0209	a	7.5	a	1.77	c			5.3	a			4	c		
10	1.036	c	0.0307	c	0.0167	a	0.0112	a	0.0213	a	7.5	a	1.77	c			5.4	c			6	a		
11	1.049	c	0.0309	c	0.0167	b	0.0112	c	0.0214	a	7.6	c	1.84	c			6.2	a			12	a		
12	1.051	c	0.0309	b	0.0168	c	0.0114	a	0.0220	c	7.9	a	1.90	a			6.5	a			12	c		
13	1.055	c	0.0315	a	0.0168	c	0.0116	a	0.0220	a	8.0	c	1.92	b							13	a		
14	1.060	c	0.0315	c	0.0169	a	0.0116	c	0.0223	a	8.0	a	2.02	c										
15	1.071	a	0.0317	c	0.0169	a	0.0117	c	0.0228	a	9.1	c	2.19	c										
16	1.075	a	0.0319	c	0.0170	c	0.0117	c	0.0230	a	9.7	b												
17	1.081	a	0.0324	a	0.0172	a	0.0118	c	0.0231	c														
18	---	b	0.0329	c	---	c	0.0125	c																
<i>M</i>	1.038		0.0304		0.0165		0.0110		0.0212		7.5		1.70		2.8		4.9		1.1		5		0.5	
<i>s_M</i>	0.027		0.0015		0.0006		0.0008		0.0013		0.9		0.26		1.1		1.0		0.5		5		0.6	
<i>s_i</i>	0.025		0.0013		0.0002		0.0004		0.0006		0.4		0.08		0.3		0.2		0.1		1		0.0	

	Pd		In		Pb	
No.	µg/g	M	µg/g	M	%	M
1	0.07	c	<0.1	c	98.89	a
2	<0.1	a	0.15	a	98.90	a
3	0.10	a	0.38	c	98.92	a
4	0.10	a	<1	a	98.92	a
5	0.25	a			99.05	d
6	0.30	a				
7	0.48	a				
8	---	b				
<i>M</i>	0.22		0.27		98.93	
<i>s_M</i>	0.16		0.17		0.07	
<i>s_i</i>	0.09		0.05		0.04	

The laboratory values were analysed statistically in order to eliminate outliers. If "----" appears in the table, this means that an outlier has been excluded. A data set consists of at least 5 individual values. Figures in italics are non-certified values for information purposes.

M: mean value of the data set values

s_M: Standard deviation of the data set mean values

s_i: averaged standard deviation of repeatability (square root of the mean value of the data set variances)

Analytical methods used for certification (M)

a Spark excitation - optical emission spectrometry

b Inductively coupled plasma - mass spectrometry

c Inductively coupled plasma - optical emission spectrometry

d Titration



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Accepted as TAZ CRM (Rev. 0) on 17 November 2025

Moritz Winter, M.Sc.

Head of Reference Materials Production

This certified reference material was manufactured in accordance with DIN EN ISO 17034 in combination with DIN EN ISO/IEC 17025. TAZ GmbH is accredited as a reference material producer according to DIN EN ISO 17034. The accreditation is valid for the scope specified in the annex to the accreditation certificate D-RM-11169-02-00. The Deutsche Akkreditierungsstelle (DAkkS) is a signatory of the Multilateral Agreement (MLA) between EA, ILAC and IAF for mutual recognition.

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- End of the Certificate -