in cooperation with the WG 'Precious Metals'
of the Committee of Chemists of GDMB

European Reference Materials

CERTIFICATE OF ANALYSIS

ERM®-EZ505

Electronic Scrap Melted with Pyrite			
	Certified value [1]	Uncertainty [2]	
Element	Mass fraction in %		
Cu	15.10	±	0.11
Ni	0.470	±	0.008
Element	Mass fraction in mg/kg		
Ag	692	±	13
Au	292	±	4
Be	68.8	±	2.3
In	91	±	7
Pd	90.5	±	2.4
Pt	8.5	±	0.8

[1] Unweighted mean value of the means of accepted sets of data, each set being obtained in a different laboratory and/or with a different method of measurement. The values are traceable to the SI (Système International d'Unités) via calibration using pure metals or substances of known stoichiometry.

[2] Estimated expanded uncertainty U with a coverage factor of $k = 2$, corresponding to a level of confidence of approx. 95 %, as defined in the Guide to the expression of uncertainty in measurement, ISO, 1993.

This certificate is valid until 01/2021; this validity may be extended as further evidence of stability becomes available.
The minimum sample size for analysis is 5 g.

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NOTE

European Reference Material ERM®-EZ505 was certified under the responsibility of BAM Federal Institute for Materials Research and Testing in cooperation with the Committee of Chemists of the GDMB, Gesellschaft für Bergbau, Metallurgie, Rohstoff- und Umwelttechnik according to the principles laid down in the technical guidelines of the European Reference Materials® co-operation agreement between BAM-LGC-IRMM. Information on these guidelines is available on the Internet (http://www.erm-crm.org).

DESCRIPTION OF THE SAMPLE

The material is a mixture of used printed circuit boards, doped with Be, In and Pt, ashed and melted with pyrite (FeS_2). After milling and grinding the material was sieved to a particle size below 150 µm and homogenised thoroughly before filling in 200 g units in screw cap amber glass bottles.

INTENDED USE

This material is intended for use as a reference material in the development, validation or quality control of analytical methods for the determination of precious metals and other elements in electronic scrap.

Information on how to compare an analytical result with the certified value can be found in ERM Application Note 1; www.erm-crm.org

INSTRUCTIONS FOR USE AND STORAGE

Prior to use, the material should be thoroughly mixed by several inversions of the bottle. To make sure that the powder is free of moisture, the material has to be dried for 8 h at 105 °C before weighing. The material should be stored at room temperature in a dry and clean environment.

MEANS OF ACCEPTED DATA SETS

	Mass fraction in %		Mass fraction in mg/kg					
Line No.	**Cu**	**Ni**	**Ag**	**Au**	**Be**	**In**	**Pd**	**Pt**
1	14.90	0.453	673	285	63.3	77.7	86.0	7.48
2	14.98	0.456	681	286	65.9	79.5	86.2	7.61
3	15.01	0.461	683	287	66.4	81.1	86.4	7.73
4	15.04	0.467	683	289	67.0	81.7	86.5	7.98
5	15.06	0.467	684	291	67.4	81.7	87.8	8.18
6	15.09	0.468	689	291	69.0	81.7	89.0	8.25
7	15.10	0.470	695	292	69.5	90.0	89.4	8.43
8	15.13	0.471	698	292	69.6	92.0	90.4	8.44
9	15.15	0.472	701	293	70.1	94.5	90.9	8.58
10	15.19	0.474	702	293	74.6	97.8	91.3	8.65
11	15.20	0.475	703	295		102.1	91.7	8.78
12	15.20	0.477	715	295		104.0	91.8	9.23
13	15.30	0.480		298			92.7	9.33
14		0.493		299			93.1	9.36
15							96.4	9.67
16							98.4	< 10
M :	15.10	0.470	692	292	68.8	90.7	90.5	8.51
s_M:	0.11	0.010	13	5	3.1	8.9	3.6	0.67
$\overline{s_i}$:	0.04	0.004	11	2.1	1.0	1.5	2.0	0.57

The laboratory mean values have been examined statistically to eliminate outlying values. As no technical reasons could be identified for “suspicious” data sets (none of them was flagged as a statistical outlier with a level of confidence of 99 %), all data sets were retained for further data processing.

M: mean of means of data sets $\overline{s_i}$: mean of standard deviations of individual data sets
s_M: standard deviation of means of data sets (calculated of at least 3 but normally 6 single values)

PARTICIPANTS

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ANALYTICAL METHODS USED FOR CERTIFICATION

Element	Line no.	Method
Cu	1	ICP-OES, dissolution with HNO_3
	2	FAAS, decomposition with $Na_2O_2/Na_2CO_3/K_2CO_3$
	3, 5, 13	ICP-OES, extraction with aqua regia
	4	Electrogravimetry, decomposition with $HNO_3/H_2SO_4/Br_2$/HBr
	6	Electrogravimetry/XRF, extraction with aqua regia
	7	Electrogravimetry, dissolution with HNO_3/HCl/HF/H_2SO_4
	8	ICP-OES, decomposition with HCl/aqua regia/Na_2O_2
	9, 11	Electrogravimetry
	10	Electrogravimetry, decomposition with aqua regia/ H_2SO_4/Na_2O_2
	12	ICP-OES
Ni	1	ICP-OES, dissolution with HNO_3
	2	ICP-OES, dissolution with $HNO_3/H_2SO_4/Br_2$/HBr
	3	FAAS, decomposition with $Na_2O_2/Na_2CO_3/K_2CO_3$
	4, 5	ICP-OES, dissolution with acid
	6, 10	ICP-OES, decomposition with HCl/aqua regia/Na_2O_2
	7, 13, 14	ICP-OES, extraction with aqua regia
	8, 11	ICP-OES
	9	XRF
	12	FAAS, dissolution with acid
Ag	1	ICP-OES, extraction with aqua regia
	2, 5, 8, 10, 12	ICP-OES, after collection with lead
	3	FAAS, decomposition with $Na_2O_2/Na_2CO_3/K_2CO_3$
	4	FAAS, dissolution with acid
	6	ICP-OES
	7	SOES, after collection with lead
	11	ICP-OES, decomposition with HCl/aqua regia/Na_2O_2
Au	1, 3, 8, 10, 11, 13, 14	ICP-OES, after collection with lead
	2	ICP-OES, after collection with copper oxide
	4	Gravimetry, after lead collection
	5	ICP-OES, after collection with silver
	6	ICP-OES, decomposition with HCl/aqua regia/Na_2O_2
	7	ICP-OES
	9	SOES, after collection with lead
	12	ICP-OES, decomposition with nitrate melt

Element	Line no.	Method
Be	1	ICP-OES, decomposition with aqua regia/H_2SO_4/Na_2O_2
	2	ETAAS, dissolution with HNO_3/HF
	3	ICP-OES, dissolution with HNO_3
	4, 8	ICP-OES
	5, 6, 9	ICP-OES, extraction with aqua regia
	7	ICP-OES, dissolution with acid
	10	ICP-OES, decomposition with acid, alkaline melt
In	1	ETAAS, dissolution with HNO_3/HF
	2, 4	ICP-OES, extraction with aqua regia
	3	INAA
	5	ICP-OES
	6, 9	ICP-MS, dissolution with HCl/HNO_3/HF
	7	ICP-OES, dissolution with HCl/HNO_3/HF
	8, 10, 12	ICP-OES, dissolution with acid
	11	ICP-OES, decomposition with aqua regia/ H_2SO_4/Na_2O_2
Pd	1	ICP-OES, after collection with silver
	2, 5, 6, 7, 8, 10, 12, 14, 15	ICP-OES, after collection with lead
	3	ICP-OES, decomposition with nitrate melt
	4	ICP-OES, after collection with copper oxide
	9	ICP-OES
	11	ICP-OES, decomposition with HCl/aqua regia/Na_2O_2
	13	SOES, after collection with lead
	16	ICP-OES, after collection with copper
Pt	1, 2, 4, 6, 8, 9, 10, 13, 14, 15	ICP-OES, after collection with lead
	3	ICP-OES, decomposition with nitrate melt
	5	ICP-OES, after collection with silver
	7	SOES, after collection with lead
	11	ICP-OES
	12	ICP-OES, decomposition with HCl/aqua regia/Na_2O_2
	16	ICP-OES, after collection with copper oxide

Abbreviations:

ETAAS	Electrothermal atomic absorption spectrometry
FAAS	Flame atomic absorption spectrometry
ICP-MS	Inductively coupled plasma – mass spectrometry
ICP-OES	Inductively coupled plasma – optical emission spectrometry
INAA	Instrumental neutron activation analysis
SOES	Spark optical emission spectrometry
XRF	X-ray fluorescence spectrometry

TECHNICAL REPORT

A detailed technical report describing the analysis procedures and the treatment of the analytical data used to certify ERM®-EZ505 is available on request or can be downloaded from BAM website (http://www.bam.de/de/fachthemen/referenzmaterialien/index.htm).

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