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Sicherheit in Technik und Chemie

CERTIFIED REFERENCE MATERIALS

CATALOGUE 2021

Certified
Reference Materials
Catalogue

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Certified Reference Materials, as defined in the ISO Guide 30 and the International Vocabular of Metrology (VIM), can act as traceability links to the International System of Measurement (SI). By application, e.g. of a CRM whose matrix and analyte levels match those of the samples under investigation as closely as possible, the analyst is able to assure himself that his measurements have been properly carried out to the required level of accuracy.

The BAM Federal Institute for Materials Research and Testing has a long tradition in the production of Certified Reference Materials. Starting in 1912 with a "Normal Steel" for the determination of carbon, the development of new CRMs has increased continuously. One year later 8 steel samples with different carbon contents were available. The development continued with the participation of regional German material research and testing institutes as well as industry (1957). In 1968 within the framework of EURONORM, the first European CRMs in the field of iron and steel were issued (see page 10). In 2003 the European Reference Materials (ERM®) initiative was launched by BAM together with EUROPEAN COMMISSION JRC and LGC to create a European brand of CRMs of high metrological quality.

Since 2016 BAM is accredited by DAkkS as a producer of RM in accordance with ISO 17034 (General requirements for the competence of reference material producers). The scope of accreditation comprises certified reference materials in the form of non-ferrous metals and alloys, ceramics and glass, soils and sediments, food, ethanol/water solutions, aqueous solutions of stable isotopes, lubricants and fuels as well as porous materials.

Today a large range of ferrous and non-ferrous CRMs together with environmental CRMs and CRMs for engineering materials are offered in our new catalogue.

The catalogue provides technical and general ordering information for the CRMs currently available from the BAM Federal Institute for Materials Research and Testing.

BAM holds an accreditation as a reference material producer according to ISO 17034. This accreditation is valid only for the scope as specified in the certificate D-RM-11075-01-00. DAkkS is a signatory of the multilateral agreement (MLA) between EA, ILAC and IAF for mutual acceptance.	DAkkS Deutsche Akkreditierungsstelle D-RM-11075-01-00

Reference material (RM): material, sufficiently homogeneous and stable with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process

Note 1 RM is a generic term.

Note 2 Properties can be quantitative or qualitative, e.g. identity of substances or species.

Note 3 Uses may include the calibration of a measurement system, assessment of a measurement procedure, assigning values to other materials, and quality control.

Note 4 A single RM cannot be used for both calibration and validation of results in the same measurement procedure.

Note 5 VIM has an analogous definition (ISO/IEC Guide 99:2007, 5.13), but restricts the term "measurement" to apply to quantitative values and not to qualitative properties. However, Note 3 of ISO/IEC Guide 99:2007, 5.13, specifically includes the concept of qualitative attributes, called "nominal properties".

Certified reference material (CRM): reference material characterized by a metrologically valid procedure for one or more specified properties, accompanied by a certificate that provides the value of the specified property, its associated uncertainty, and a statement of metrological traceability

Note 1 The concept of value includes qualitative attributes such as identity or sequence. Uncertainties for such attributes may be expressed as probabilities.

Note 2 Metrologically valid procedures for the production and certification of reference materials are given in, among others, ISO Guides 34 and 35.

Note 3 ISO Guide 31 gives guidance on the contents of certificates.

Note 4 VIM has an analogous definition (ISO/IEC Guide 99:2007, 5.14).

Note: In this document the comma (and not the dot) is used as a decimal separator.

Ordering BAM reference materials

General

Purchase orders for BAM-CRMs should be directed to:

Bundesanstalt für Materialforschung
und –pruefung (BAM)
Fachbereich 1.6 Anorganische Referenzmaterialien
Richard-Willstaetter-Str. 11
12489 Berlin, Germany

Phone: **+49 30 8104-2061**
Fax: **+49 30 8104-72061**

Email: sales.crm@bam.de
Webshop: https://www.webshop.bam.de

Terms of delivery:
Prices include transport service by mail.

Terms of delivery: free delivery:
BAM usually delivers via DHL.
If another courier or carrier etc. is desired, then the customer bears the costs at the point of destination. BAM will assume no further costs.

Orders shipping to destinations outside Europe or bulky parcels is charged additionally (flat rate is deducted).

Your products will be packed and shipped asap. Shipment will be performed by standard mail service. Duration of mail delivery cannot be guaranteed by BAM because of different national delivery services.

Iron and steel products

EURONORM certified reference materials for the chemical analysis of iron and steel products

EURONORM certified reference materials are prepared under the auspices of the European Committee for Iron and Steel Standardization (ECISS) in a collaboration between the producing organizations in:

France: ArcelorMittal Maizières (Institute de Recherches de la Sidérurgie (IRSID)), Centre de Dévelopement des Industries de Mise en Forme des Matériaux (CTIF),

the Federal Republic of Germany: Iron and Steel CRM Working Group comprising Bundesanstalt für Materialforschung und –prüfung (BAM), Max-Planck-Institut für Eisenforschung, Stahlinstitut VDEh,

Sweden/Finland: Jernkontoret, Oy Narema Ab.

Starting in 1968 EURONORM-CRMs have been analysed by laboratories in the European Community (EC) and further European countries. These samples are indicated by an asterisk in the tables. A number of former national CRMs are also listed in the tables. After examination by laboratories in the EC they have been accepted as EURONORM-CRMs.

Approximately 20 laboratories take part in the analysis. Each laboratory is requested to analyse the elements to be determined four times. A statistical evaluation of the laboratory mean values is carried out with respect to their normal distribution and the identification of any outlying values.

The finely divided EURONORM-CRMs are supplied in glass bottles containing 100 g. Some EURONORM-CRMs are also available in solid form (discs). Samples in the form of chips, pins and balls with certified oxygen and nitrogen content are also available.

This catalogue represents European CRMs of German origin. For CRMs of British, Swedish and French origin please contact the above mentioned producers. Details of all ECRMs are given in CEN-Report CR 10317 and CEN TR 10350 (ECSC), both of which are available from the national standards body in your country.

Types of material

The following types of material are available as EURONORM-CRM:

Unalloyed steels (0), alloyed steels (1), highly alloyed steels (2), special alloys (3), cast iron (4), ferro-alloys (5), ores (6), ceramics (7) and slags (8).

Our system of numbering of the samples allows an easy orientation about the type of material. The first digit of the sample number shows the type of material (0 - unalloyed steel, 1 - low alloyed steel, 2 - highly alloyed steel etc.). The second and third digit characterizes the single sample. Another digit, separated by a hyphen gives the number of editions of the material.

Content of the certificate

On the head of the certificate the EURONORM-number and the type of material of the sample is given. The mean values of the laboratories involved in the certification campaign are given in a table together with indicative values. The mean values of the accepted data sets, their standard deviations and the standard deviations of the laboratories are also given in the table. The sign "-" in the table stands for an outlier pointed out by statistical tests. The certified values are given in a second table together with their uncertainties (95%-level) or standard deviations. Additionally the following information are given: The owner of the material, a characterization of the sample (e.g. grain size, dimensions of compact samples), the laboratories involved in the certification campaign, the analytical methods used for element determination, sources for getting additional information published by ECISS/EGKS.

The following information are given in the tables:

Indicative values (not certified) are given in parentheses.

Authentic for the certified element contents are only the values given in the certificates, not the values given in this catalogue.

Samples for the determination of nitrogen and oxygen (N-O-materials)

Two different types of material are available:

Unalloyed steel: the pin-shaped material (100 mm long, 8 mm in diameter) forms an iron oxide coating. Before analysis this layer has to be removed by turning and care has to be taken to prevent a reoxidation of the cleaned surface.

Highly alloyed stainless steel: after formation of a reproducible and constant oxide layer the chipped material is protected (passivated) against further oxidation. There is no need for sample pretreatment.

Samples for optical emission and X-ray fluorescence spectrometry

The samples are in form of discs (cylinders of 36 to 41 mm diameter and 20 to 35 mm height) and normally also available in form of chips. The samples 035-2, 284-3, and 290-1/291-1 are prepared by hot isostatic pressing (HIP) of powder which was atomized from the melt and solidified in inert gas giving a material of high homogeneity.

Unalloyed steels

Mass fraction in % ± standard deviation

CRM-No.	D 030-4	D 031-3	D 032-2	D 035-2[1)]	D 036-1
Year of issue	1973	1972	1968	1998	1968
Chips, powder	•	•	•	•	•
Disc				•	
C	0,456 ± 0,004	0,055 ± 0,002	0,271 ± 0,007	1,277 ± 0,005	0,858 ± 0,008
Si	0,318 ± 0,007	0,037 ± 0,004	0,282 ± 0,007	0,216 ± 0,004	0,194 ± 0,005
Mn	0,603 ± 0,004	0,329 ± 0,007	0,556 ± 0,008	0,305 ± 0,002	0,327 ± 0,010
P	0,018 ± 0,002	0,014 ± 0,001	0,0129 ± 0,0007	0,0038 ± 0,0003	0,0074 ± 0,0009
S	0,021 ± 0,002	0,021 ± 0,001	0,0254 ± 0,0010	0,0111 ± 0,0003	0,0095 ± 0,0009
Cr	0,117 ± 0,004	–	(0,088)	0,0104 ± 0,0003	(0,091)
Mo	–	–	–	0,0056 ± 0,0002	–
Ni	0,042 ± 0,002	–	(0,040)	0,0190 ± 0,0004	(0,058)
Al_{total}	0,042 ± 0,006	0,054 ± 0,002	–	0,0193 ± 0,0005	(0,015)
$Al_{insol.}$	–	–	–	–	–
$Al_{acid\text{-}sol.}$	–	–	–	0,0177 ± 0,0004	–
As	0,012 ± 0,002	0,013 ± 0,002	0,020 ± 0,002	0,0017 ± 0,0001	0,0233 ± 0,0007
Cu	0,061 ± 0,002	0,020 ± 0,002	0,085 ± 0,002	0,0085 ± 0,0002	0,065 ± 0,005
N	0,0051 ± 0,0003	0,0050 ± 0,0004	0,0044 ± 0,0009	0,0230 ± 0,0004	0,0100 ± 0,0008
Nb	–	–	–	–	–
Pb	–	–	–	–	–
Sn	0,0055 ± 0,0007	–	(0,006)	–	(0,006)
Ti	–	–	–	0,0030 ± 0,0001	–
V	–	–	–	–	(0,019)
Te	–	–	–	–	–

(Values in parentheses are indicative values)

- continued -

1) Powdered material, produced by atomization of the melt

Unalloyed steels (continued)

CRM-No.	D 042-1	D 079-2	D 082-1	D 083-1	D 083-2
Year of issue	1972	1989	1976	1978	2017
Chips, powder	•	•	•	•	•
Disc					•
C	0,108 ± 0,003	0,596 ± 0,006	0,415 ± 0,003	0,0262R ± 0,0004⁺	0,0315 ± 0,0006
Si	0,037 ± 0,005	0,247 ± 0,006	0,235 ± 0,005	–	0,00747 ± 0,00023
Mn	0,666 ± 0,010	0,743 ± 0,013	0,769 ± 0,008	0,289 ± 0,004	0,2160 ± 0,0014
P	0,0057R ±0,0004	0,0234 ± 0,0012	0,013 ± 0,001	0,0076 ± 0,0010	0,0106 ± 0,0003
S	0,024 ± 0,024	0,192 ± 0,006	0,030 ± 0,001	0,0100 ± 0,0005	0,00561 ± 0,00021
Cr	0,016 ± 0,004	0,0382 ± 0,0023	0,018 ± 0,001	(0,0129)	0,0219 ± 0,0003
Mo	–	–	–	–	–
Ni	0,029 ± 0,002	0,0219 ± 0,0010	0,027 ± 0,001	0,014 ± 0,001	0,0116 ± 0,0003
Al	0,010 ± 0,001	0,0209 ± 0,0017	0,032 ± 0,002	(0,0044)	0,0784 ± 0,0012
As	–	0,0040 ± 0,0007	(0,029)	(0,0043)	0,00177 ± 0,00009
Co					0,00236 ± 0,00009
Cu	0,041 ± 0,002	0,0462 ± 0,0010	0,025 ± 0,001	0,016 ± 0,001	0,0127 ± 0,0002
N	0,0078 ± 0,0007	0,0074 ± 0,0005	0,0046 ± 0,0004	0,00189 ± 0,00011	0,00157 ± 0,00010
Nb	0,054 ± 0,005	–	–	–	–
Pb	–	–	0,149 ± 0,004	–	–
Sn	–	0,0037 ± 0,0008	–	–	–
Ti	–	(0,0021)	–	–	–
V	–	–	–	–	–
Te	–	–	0,030 ± 0,001	–	–
Zn	–	–	–	–	0,00439 ± 0,00015

CRM-No.	D 049-1	D 077-3
Year of issue	2020	2017
Chips, powder	•	•
C	0,701 ± 0,004⁺	0,1650 ± 0,0016⁺
S	0,00404 ± 0,00017⁺	0,0162 ± 0,0003
N	0,00317 ± 0,00015⁺	1,274 ± 0,014

(Values in parentheses are indicative values) R: revised value ⁺ 95%-confidence interval

Pure iron

Disc

Mass fraction in µg/g

± 95%-confidence interval

CRM-No.	D 098-1
Year of issue	1993
C	5,1 ± 1,3
Si	4,8 ± 1,1
Mn	0,8 ± 0,4
P	(0,6)
S	3,1 ± 0,5
Cr	57,1 ± 2,4
Mo	8,5 ± 0,8
N	2,4 ± 0,7

(Values in parentheses are indicative values)

Alloy steels

Mass fraction in % ± standard deviation

CRM-No.	D 126-1	D 128-1	D 129-3	D 130-1	D 179-2
Year of issue	1963	1972	2008	1968	1990
Chips, powder	•	•	•	•	•
Disc			•		•
C	0,841 ± 0,008	0,085 ± 0,003	0,3684 ± 0,0017⁺	0,546 ± 0,005	0,598 ± 0,009
Si	(0,241)	0,949 ± 0,010	0,2087 ± 0,0020⁺	0,313 ± 0,006	0,579 ± 0,011
Mn	1,817 ± 0,009	0,839 ± 0,010	0,371 ± 0,004⁺	1,593 ± 0,009	0,539 ± 0,010
P	0,0092 ± 0,0011	0,007 ± 0,001	0,0110 ± 0,0003⁺	0,0209 ± 0,0017	0,0267 ± 0,0024
S	0,0050 ± 0,0007	0,007 ± 0,001	0,0165 ± 0,0003⁺	0,0158 ± 0,0011	(0,0006)
Cr	0,317 ± 0,009	0,108 ± 0,003	1,702 ± 0,008⁺	(0,032)	1,08 ± 0,03
Mo	–	–	0,206 ± 0,003⁺	–	0,070 ± 0,006
Ni	(0,038)	0,046 ± 0,006	1,022 ± 0,007⁺	(0,031)	0,0741R ± 0,0008
Al	–	0,286 ± 0,010	1,016 ± 0,006⁺	0,0037 ± 0,0005	–
$Al_{acid\ soluble}$	–	–	–	0,0019 ± 0,0006	–
As	–	–	0,0049 ± 0,0003⁺	0,0167 ± 0,0011	–
B	–	–	(0,0012)	–	–
Co	–	–	0,0148 ± 0,0002⁺	–	(0,015)
Cu	(0,098)	0,055 ± 0,003	0,0804 ± 0,0007⁺	0,072 ± 0,003	0,111 ± 0,004
N	–	(0,0024)	0,0046 ± 0,0002⁺	0,0093 ± 0,0008	0,0068 ± 0,0003⁺
Nb	–	–	(0,0007)	–	0,00144 ± 0,00013⁺
Pb	–	–	–	–	0,00013 ± 0,00002⁺
Sn	–	–	0,0067 ± 0,0002⁺	(0,006)	–
Ti	–	0,890 ± 0,013	0,0030 ± 0,0002⁺	–	(0,0014)
V	0,143 ± 0,004	(0,008)	(0,0045)	(0,003)	0,188 ± 0,007
W	–	–	(0,0052)	–	1,87 ± 0,05
Bi	–	–	–	–	< 0,00003
Ca	–	–	–	–	–
Cd	–	–	–	–	< 0,00003
Ga	–	–	–	–	0,00129 ± 0,00012⁺
Hg	–	–	–	–	(< 0,00001)
Mg	–	–	–	–	–
Sb	–	–	0,00059 ± 0,00008⁺	–	0,00175 ± 0,00010⁺
Se	–	–	–	–	(< 0,00020)
Te	(0,0002)	–	–	–	< 0,00020
Tl	–	–	–	–	(< 0,000035)
Zn	–	–	(0,0030)	–	0,00023 ± 0,00004⁺

(Values in parentheses are indicative values) ⁺ 95%-confidence interval R: revised value - continued -

Alloy steels (continued)

CRM-No.	D 180-1	D 181-1	D 182-1	D 183-1
Year of issue	1973	1973	1974	1973
Chips, powder	•	•	•	•
Disc				
C	0,197 ± 0,005	0,590 ± 0,005	0,790 ± 0,008	0,083 ± 0,002
Si	0,362 ± 0,007	1,054 ± 0,015	0,368 ± 0,014	0,421 ± 0,006
Mn	1,286 ± 0,015	1,047 ± 0,008	0,389 ± 0,007	0,354 ± 0,004
P	0,0174 ± 0,0010	0,018 ± 0,001	0,0076R± 0,0005	0,089 ± 0,002
S	0,0249 ± 0,0010	0,035 ± 0,001	0,011 ± 0,001	0,031 ± 0,001
Cr	1,250 ± 0,018	0,126 ± 0,004	0,591 ± 0,012	0,670 ± 0,013
Mo	–	–	–	–
Ni	0,096 ± 0,008	0,070 ± 0,004	0,152 ± 0,005	0,073 ± 0,004
Al	–	0,022 ± 0,004	0,020 ± 0,003	0,027 ± 0,002
$Al_{acid\ soluble}$	–	–	–	–
As	0,030 ± 0,002	(0,026)	(0,0202)	(0,013)
B	–	–	–	–
Co	–	–	–	–
Cu	0,115 ± 0,004	0,174 ± 0,005	0,141 ± 0,004	0,445 ± 0,010
N	0,0068 ± 0,0009	0,0068 ± 0,0005	0,0102 ± 0,0004	0,0064 ± 0,0006
Nb	–	–	–	–
Pb	–	–	0,0039 ± 0,0003	–
Sn	–	(0,015)	(0,0135)	–
Ti	–	–	–	–
V	–	–	0,177 ± 0,010	–
W	–	–	–	–
Ca	–	–	–	–
Mg	–	–	(0,0005)	–
Sb	–	(0,004)	0,0042 ± 0,0005	–
Te	–	–	–	–
Zn	–	–	0,0015 ± 0,0002	–

(Values in parentheses are indicative values) R: revised value - continued -

Alloy steels (continued)

CRM-No.	D 187-1	D187-2	D 191-2	D 192-1
Year of issue	1982	2010	2006	1994
Chips,powder	•	•	•	•
Disc		•		•
C	0,195 ± 0,003	0,2038 ± 0,0012	0,0043 ± 0,0002+	0,1875 ± 0,0009
Si	0,026 ± 0,002	0,2110 ± 0,0029	3,267 ± 0,012+	0,219 ± 0,004
Mn	1,354 ± 0,011	1,257 ± 0,006	0,1334 ± 0,0019+	1,377 ± 0,006
P	0,014 ± 0,001	0,0066 ± 0,0002	0,0087 ± 0,0004+	0,0029 ± 0,0002
S	0,025 ± 0,001	0,0300 ± 0,0006	0,0029 ± 0,0002+	0,0010 ± 0,0001
Cr	1,186 ± 0,015	1,132 ± 0,007	0,0314 ± 0,0006+	0,0717 ± 0,0018
Mo	0,035 ± 0,002	0,0623 ± 0,0008	0,0020 ± 0,0002+	0,482 ± 0,004
Ni	0,096 ± 0,003	0,1755 ± 0,0013	0,0224 ± 0,0004+	0,755 ± 0,004
Al	0,046 ± 0,002	0,0223 ± 0,0006	0,985 ± 0,006+	0,0308 ± 0,0008
$Al_{acid\ soluble}$	–	–	–	0,0285 ± 0,0008
As	0,018 ± 0,002	0,0057 ± 0,0003	0,0018 ± 0,0003+	(0,003)
B	0,0004 ± 0,0002	0,00048 ± 0,00006	–	(0,00016)
Co	0,014 ± 0,001	0,0112 ± 0,0003	–	
Cu	0,161 ± 0,003	0,1288 ± 0,0012	0,0165 ± 0,0003+	0,0453 ± 0,0008
N	0,014 ± 0,001	0,0105 ± 0,0004	0,00105 ± 0,00009+	0,0118 ± 0,0002
Nb	–	–	–	–
Pb	–	–	–	–
Sn	0,011 ± 0,001	0,0237 ± 0,0006	0,0050 ± 0,0005+	(0,0030)
Ti	–	(0,00075)	0,0024 ± 0,0002+	(0,0009)
V	–	0,0122 ± 0,0003	–	(0,003)
W	–	–	–	–
Ca	–	–	–	–
Mg	–	–	–	–
Sb	–	(0,0018)	(0,0007)	–
Te	–	–	–	–
Zn	–	–	–	–

(Values in parentheses are indicative values) R: revised value + 95%-confidence interval

Alloy steels (continued)

CRM-No.	D 193-1	D 194-1	D 194-2
Year of issue	1990	1993	2015
Chips,powder	•	•	•
Disc	•		•
C	0,139 ± 0,004	0,1532 ± 0,0011+	0,1694 ± 0,0010+
Si	0,404 ± 0,006	0,431 ± 0,004+	0,2974 ± 0,0029+
Mn	0,972 ± 0,017	1,188 ± 0,004+	1,282 ± 0,009+
P	0,0063 ± 0,0006	0,0097 ± 0,0006+	0,0137 ± 0,0003+
S	0,0086 ± 0,0006	0,000059R ± 0,00005+	0,00049 ± 0,00009+
Cr	0,182 ± 0,006	0,733 ± 0,006+	0,760 ± 0,006+
Mo	0,347 ± 0,011	0,2857 ± 0,0026+	0,402 ± 0,004+
Ni	1,178 ± 0,019	0,3417 ± 0,0027+	0,3316 ± 0,0023+
Al	0,0257 ± 0,0015	0,0837 ± 0,0020+	0,0669 ± 0,0009+
$Al_{acid\ soluble}$	–	–	–
As	0,0062 ± 0,0007	0,0042 ± 0,0004+	0,00208 ± 0,00011+
B	(0,0002)	0,0020 ± 0,0002+	0,00155 ± 0,00016+
Co	0,0073 ± 0,0007	–	0,00328 ± 0,00011+
Cu	0,598 ± 0,009	0,0751 ± 0,0011+	0,0313 ± 0,0004+
N	0,0108 ± 0,0004	0,0115 ± 0,0002+	0,00319 ± 0,00014+
Nb	0,0232 ± 0,0019	–	0,0290 ± 0,0007+
Pb	(0,0002)	–	–
Sn	–	–	(0,00036)
Ti	(0,0013)	–	0,00322 ± 0,00015+
V	(0,0019)	0,0243 ± 0,0009+	0,00161 ± 0,00010+
W	–	–	–
Ca	–	0,0026 ± 0,0002+	–
Mg	–	–	–
Sb	–	–	(0,00030)
Te	–	–	–
Zn	–	–	–

(Values in parentheses are indicative values) R: revised value + 95%-confidence interval

Highly alloyed steels

Mass fraction in % ± standard deviation

CRM-No.	D 226-1		D 227-1		D 231-2		D 235-1		D 237-1	
Year of issue	1967		1971		2002		1972		1973	
Chips	•		•		•		•		•	
Disc										
C	0,416	± 0,007	0,950	± 0,013	0,0140	± 0,0003⁺	0,912	± 0,014	0,068	± 0,002
Si	0,514	± 0,007	0,272	± 0,013	0,368	± 0,006⁺	0,094	± 0,010	0,482	± 0,013
Mn	0,434	± 0,013	0,236	± 0,007	1,263	± 0,009⁺	12,73	± 0,07	1,443	± 0,018
P	0,0207	± 0,0012	0,016	± 0,001	0,0179	± 0,0007⁺	0,045	± 0,002	0,032	± 0,002
S	0,0094	± 0,0014	0,022	± 0,002	0,0250	± 0,0007⁺	0,0072	± 0,0007	0,012	± 0,001
Cr	13,67	± 0,06	4,25	± 0,02	18,071	± 0,018⁺	0,354	± 0,014	17,24	± 0,04
Mo	0,024	± 0,006	2,64	± 0,05	0,301	± 0,004⁺	0,032	± 0,003	0,306	± 0,006
Ni	0,139	± 0,014	0,114	± 0,008	10,105	± 0,021⁺	(0,08)		10,32	± 0,04
Al	–		–		0,0032	± 0,0004⁺	–		–	
As	(0,0256)		–		0,0048	± 0,0003⁺	–		–	
B	–		–		0,0020	± 0,0002⁺	–		–	
Co	(0,0246)		–		0,0402	± 0,0011⁺	–		0,221	± 0,006
Cu	–		0,124	± 0,005	0,0941	± 0,0009⁺	0,073	± 0,002	0,123	± 0,005
N	0,0362	± 0,0017	0,040	± 0,002	0,0444	± 0,0004⁺	0,020	± 0,0008	0,035	± 0,002
Nb	–		–		–		–		0,660	± 0,023
Pb	–		–		(0,00007)		–		–	
Sn	(0,0068)		0,0251	± 0,0024	0,0043	± 0,0003⁺	–		–	
Ti	–		–		0,0007	± 0,0002⁺	–		–	
V	0,022	± 0,003	2,44	± 0,03	0,0708	± 0,0008⁺	(0,012)		0,057	± 0,005
W	–		3,03	± 0,06	0,0141	± 0,0010⁺	–		–	
Zr	–		–		–		–		–	
Ag	–		(0,000064)		–		–		–	
O	–		–		–		–		–	
Sb	–		0,0035	± 0,0005	0,0011	± 0,0001⁺	–		–	
Ta	–		–		–		–		–	
Ca	–		–		0,00074	± 0,00014⁺	–		–	

(Values in parentheses are indicative values) ⁺95%-confidence interval

- continued -

Highly alloyed steels (continued)

CRM-No.	D 271-1	D 278-1	D 283-1	D 284-2	D 284-3
Year of issue	2007	1973	1985	2000	2016
Chips	•	•	•	•	•
Disc	•				•
C	0,3698 ± 0,0021^{+}	0,903 ± 0,019	1,219 ± 0,009	0,0201 ± 0,0005^{+}	0,0025 ± 0,0003^{+}
Si	0,923 ± 0,006^{+}	0,336 ± 0,008	0,345 ± 0,017	0,537 ± 0,008^{+}	0,0442 ± 0,0017^{+}
Mn	0,437 ± 0,004^{+}	0,405 ± 0,006	0,217 ± 0,010	1,745 ± 0,009^{+}	0,0615 ± 0,0012^{+}
P	0,0120 ± 0,0004^{+}	0,0154 ± 0,0014	0,022 ± 0,002	0,0258 ± 0,0008^{+}	0,0049 ± 0,0003^{+}
S	0,00045 ± 0,00008^{+}	0,0052 ± 0,0011	0,029 ± 0,002	0,0237 ± 0,0005^{+}	0,0066 ± 0,0003^{+}
Cr	5,002 ± 0,019^{+}	18,11 ± 0,08	4,15 ± 0,06	16,811 ± 0,019^{+}	17,37 ± 0,04^{+}
Mo	1,247 ± 0,006^{+}	1,040 ± 0,030	3,41 ± 0,09	2,111 ± 0,010^{+}	2,236 ± 0,012^{+}
Ni	0,1552 ± 0,0020^{+}	0,236 ± 0,024	–	10,72 ± 0,05^{+}	12,09 ± 0,04^{+}
Al	0,0234 ± 0,0011^{+}	–	0,0099 ± 0,0014	0,0027 ± 0,0004^{+}	(0,0471)
As	0,0057 ± 0,0004^{+}	–	(0,0096)	0,0063 ± 0,0003^{+}	0,00131 ± 0,00011^{+}
B	(0,0003)	–	0,0003 ± 0,0001	0,0026 ± 0,0001^{+}	0,00020 ± 0,00004^{+}
Co	0,0139 ± 0,0005^{+}	–	10,27 ± 0,17	0,0525 ± 0,0011^{+}	0,0366 ± 0,0007^{+}
Cu	0,1371 ± 0,0015^{+}	0,077 ± 0,008	–	0,1831 ± 0,0014^{+}	0,0105 ± 0,0004^{+}
N	0,0137 ± 0,0003^{+}	–	0,033 ± 0,002	0,0151 ± 0,0002^{+}	0,0418 ± 0,0008^{+}
Nb	(0,0009)	–	–	(0,0028)	(0,0129)
Pb	(0,0005)	–	(< 0,0005)	–	(0,0003)
Sn	0,0084 ± 0,0002^{+}	–	(0,0065)	0,0047 ± 0,0002^{+}	0,00074 ± 0,00009^{+}
Ti	0,0020 ± 0,0002^{+}	–	–	0,191 ± 0,004^{+}	0,0050 ± 0,0004^{+}
V	0,850 ± 0,007^{+}	0,077 ± 0,008	3,28 ± 0,03	0,0425 ± 0,0016^{+}	(0,0947)
W	0,0054 ± 0,0005^{+}	–	9,66 ± 0,12	(0,0183)	0,0039 ± 0,0003^{+}
Zr	(0,00013)	–	–	(0,0005)	(0,00353)
Ag	–	–	–	–	–
Ca	0,0009 ± 0,0002^{+}	–	–	–	–
Mg	(0,00013)	–	–	–	–
O	0,0020 ± 0,0002$^{+1)}$	–	–	0,0099 ± 0,0007$^{+2)}$	–
Sb	(0,0017)	–	–	–	(0,000365)
Ta	–	–	–	(0,0013)	–
Ga	–	–	–	–	(0,0016)
Ir					(0,000005)
Re	–	–	–	–	(0,0005)

(Values in parentheses are indicative values)

1) Oxygen certified only for disc
2) Oxygen certified only for chips

$^{+}$95%-confidence interval

- continued-

Highly alloyed steels (continued)

CRM-No.	D 286-1	D 288-1	D 289-1	D 290-1[1)]	D 291-1[1)]
Year of issue	1985	1986	1990	1990	1990
Chips	•	•	•	•	•
Disc		•	•	•	•
C	0,100 ± 0,005	2,08 ± 0,02	0,0489 ± 0,0022	0,911 ± 0,010	0,903 ± 0,008
Si	–	0,260 ± 0,012	0,531 ± 0,013	0,072 ± 0,007	0,907 ± 0,018
Mn	1,92 ± 0,03	0,292 ± 0,008	1,016 ± 0,016	0,244 ± 0,010	0,808 ± 0,011
P	0,026 ± 0,002	0,024 ± 0,002	0,0114 ± 0,0010	0,0160 ± 0,0005	0,0168 ± 0,0016
S	0,280 ± 0,014	(0,0012)	0,0027 ± 0,0004	0,0160 ± 0,0008	0,0087 ± 0,0007
Cr	18,13 ± 0,08	12,00 ± 0,08	14,63 ± 0,11	4,18 ± 0,06	17,10 ± 0,10
Mo	0,329 ± 0,009	0,103 ± 0,007	1,102 ± 0,015	4,83 ± 0,09	2,10 ± 0,06
Ni	8,54 ± 0,04	0,298 ± 0,007	24,68 ± 0,19	0,329 ± 0,018	0,563 ± 0,011
Al	(0,0023)	0,012 ± 0,002	0,199 ± 0,011	–	0,0030 ± 0,0006
As	–	(0,0065)	(0,0056)	–	–
B	(0,0003)	–	0,0044 ± 0,0004	–	–
Co	0,150 ± 0,008	0,018 ± 0,002	0,065 ± 0,006	5,12 ± 0,12	0,0233 ± 0,0022
Cu	–	0,060 ± 0,004	–	0,081 ± 0,004	0,0711 ± 0,0019
N	0,043 ± 0,002	0,0151 ± 0,0004	–	0,0325 ± 0,0012	0,1142 ± 0,0038
Nb	–	–	–	–	(0,0057)
Pb	(0,0003)	–	(0,0008)	–	–
Sn	0,0084 ± 0,0009	(0,0043)	0,111 ± 0,010	–	–
Ti	–	0,020 ± 0,002	2,01 ± 0,05	–	–
V	–	0,055 ± 0,004	0,260 ± 0,015	1,91 ± 0,04	0,388 ± 0,016
W	–	(0,682)	–	6,27 ± 0,14	–
Zr	–	–	–	–	–
Ag	–	–	–	–	–
Ca	–	–	–	–	–
O	–	–	–	–	–
Sb	–	(0,0014)	(0,0013)	–	–
Ta	(0,0315)	–	–	–	–
Te	0,0014 ± 0,0004	–	–	–	–

(Values in parentheses are indicative values) ⁺95%-confidence interval

- continued-

1) Powdered material, produced by atomization of the melt

Highly alloyed steels (continued)

CRM-No.	D 294-1	D 297-1	D 299-1
Year of issue	2005	2005	2009
Chips	•	•	•
Disc	•	•	•
C	0,0657 ± 0,0010⁺	0,0223 ± 0,0004⁺	0,0154 ± 0,0006⁺
Si	0,283 ± 0,005⁺	0,344 ± 0,006⁺	0,299 ± 0,005⁺
Mn	18,68 ± 0,04⁺	0,897 ± 0,007⁺	0,2678 ± 0,0026⁺
P	0,0273 ± 0,0013⁺	0,0135 ± 0,0004⁺	0,0152 ± 0,0006⁺
S	0,00031 ± 0,00009⁺	0,0101 ± 0,0003⁺	0,00022 ± 0,00006⁺
Cr	17,98 ± 0,05⁺	18,37 ± 0,03⁺	22,32 ± 0,05⁺
Mo	0,0861 ± 0,0022⁺	0,290 ± 0,005⁺	0,0186 ± 0,0010⁺
Ni	0,427 ± 0,006⁺	12,33 ± 0,02⁺	0,172 ± 0,004⁺
Al	(0,0095)	0,0195 ± 0,0009⁺	5,33 ± 0,04⁺
As	0,00365 ± 0,00029⁺	0,0040 ± 0,0005⁺	0,0054 ± 0,0004⁺
B	(<0,00005)	1,146 [1)] ± 0,009⁺	0,0002 ± 0,0001⁺
Co	0,0288 ± 0,0009	0,0413 ± 0,0007⁺	0,0187 ± 0,0010⁺
Cu	0,0242 ± 0,0007⁺	0,204 ± 0,004⁺	0,0382 ± 0,0008⁺
N	0,566 ± 0,011⁺	0,0152 ± 0,0007⁺	0,0198 ± 0,0008⁺
Nb	(0,00117)	(0,0089)	(0,0043)
Pb	(0,000128)	–	(0,0018)
Sn	(0,0014)	–	(0,0079)
Ti	(0,0008)	0,0072 ± 0,0004⁺	0,1289 ± 0,0018⁺
V	0,0694 ± 0,0021⁺	0,0535 ± 0,0008⁺	0,0333 ± 0,0015⁺
W	(0,00114)	(0,0057)	(0,0017)
Zr	(0,0001)	(0,0002)	0,1775 ± 0,0025⁺
Ag	–	–	–
Ca	(0,00026)	(0,0002)	–
O	–	–	–
Sb	(0,00053)	–	(0,0005)
Ta	–	–	–
Te	(<0,00008)	–	–

(Values in parentheses are indicative values) ⁺95%-confidence interval

1) Boron isotope ratio $^{10}B/^{11}B$ (0,24811)

Special alloys

Chips

Mass fraction in % ± standard deviation

CRM-No.	D 326-1	D 327-2	D 328-1
Year of issue	1972	1972	1973
C	0,092 ± 0,002	0,152 ± 0,003	0,390 ± 0,005
Si	1,46 ± 0,025	2,052 ± 0,028	0,629 ± 0,014
Mn	0,406 ± 0,008	1,289 ± 0,018	1,395 ± 0,012
P	0,0093 ± 0,0009	0,0228 ± 0,0014	0,005 ± 0,001
S	0,0028 ± 0,0006	0,0046 ± 0,0012	0,003 ± 0,001
Cr	16,37 ± 0,05	24,35 ± 0,08	20,54 ± 0,07
Mo	(0,025)	0,174 ± 0,009	4,41 ± 0,07
Ni	61,16 ± 0,16	19,72 ± 0,08	20,38 ± 0,19
Al_{total}	(0,79)	0,070 ± 0,006	0,070 ± 0,006
Co	0,223 ± 0,011	0,159 ± 0,010	41,65 ± 0,24
Cu	(0,027)	0,060 ± 0,003	0,013 ± 0,003
N	(0,0359)	0,059 ± 0,0024	0,027 ± 0,002
Nb	–	–	3,61 ± 0,22
V	(0,024)	0,044 ± 0,004	–
W	–	–	4,16 ± 0,04
Zr	0,129 ± 0,008	–	–
Fe	–	–	2,40 ± 0,06
Ta	–	–	0,18 ± 0,02

(Values in parentheses are indicative values)

Cast irons

Mass fraction in % ± standard deviation

CRM-No.	D 428-2[1)]	D 476-3	D 478-2	D 479-1[1)]	D 480-1[1)]
Year of issue	1998	1996	1996	1978	1979
Chips, powder	•	•	•	•	•
Disc					
C_{total}	2,747 ± 0,009⁺	3,390 ± 0,011⁺	4,003 ± 0,013⁺	2,86 ± 0,04	3,03 ± 0,02
Si	1,752 ± 0,007⁺	1,813 ± 0,005⁺	2,411 ± 0,021⁺	2,02 ± 0,02	2,41 ± 0,02
Mn	0,750 ± 0,05⁺	0,987 ± 0,008⁺	0,321 ± 0,005⁺	0,136 ± 0,008	0,151 ± 0,005
P	0,0691 ± 0,0011⁺	0,0908 ± 0,0023⁺	0,201 ± 0,006⁺	0,076 ± 0,003	0,0021R ± 0,0005
S	0,1105 ± 0,0018⁺	0,0493 ± 0,0009⁺	0,0460 ± 0,0015⁺	0,089 ± 0,003	0,0086 ± 0,0010
Cr	0,0366 ± 0,0017⁺	0,0648 ± 0,0012⁺	0,251 ± 0,005⁺	1,00 ± 0,02	(0,0164)
Mo	(0,0014)	–	–	0,196 ± 0,005	–
Ni	0,0358 ± 0,0005⁺	0,0549 ± 0,0014⁺	0,151 ± 0,007⁺	1,012 ± 0,015	0,483 ± 0,007
Al	–	–	–	0,014 ± 0,002	0,016 ± 0,001
As	0,0156 ± 0,0005⁺	0,0145 ± 0,0007⁺	(0,0018)	–	–
B	–	–	0,0006 ± 0,0001⁺	–	–
Cu	0,0996 ± 0,0014⁺	0,2445 ± 0,0025⁺	0,1276 ± 0,0019⁺	–	(0,0052)
N	–	0,0038 ± 0,0001⁺	0,0023 ± 0,0002⁺	–	–
Ti	0,0311 ± 0,0005⁺	0,0222 ± 0,0005⁺	0,0328 ± 0,0007⁺	–	–
V	0,0120 ± 0,0003⁺	0,0115 ± 0,0002⁺	0,0113 ± 0,0003⁺	–	–
Mg	–	–	–	–	0,017 ± 0,001

(Values in parentheses are indicative values) R: revised value ⁺ 95%-confidence interval

1) Powdered material, produced by atomization of the melt

Ferro alloys

Powder

Mass fraction in % ± standard deviation

CRM-No.	D 502-2	D 529-1
Description	FeMn	FeSi
Year of issue	2004	1975
C	6,94 ± 0,02⁺	0,10 ± 0,01
Si	(0,092)	91,11 ± 0,33
Mn	77,87 ± 0,11⁺	0,04 ± 0,005
P	0,148 ± 0,003⁺	0,013 ± 0,001
S	(0,0024)	–
Cr	0,0265 ± 0,0006⁺	–
Mo	–	–
Ni	0,0384 ± 0,0011⁺	–
Al	–	0,86 ± 0,02
As	–	–
B	(0,0006)	–
Co	(0,048)	–
Cu	0,0370 ± 0,0007⁺	0,01 ± 0,001
N	(0,017)	–
Sn	–	–
Ti	0,0034 ± 0,0003⁺	0,09 ± 0,004
V	–	–
Zr	–	–
Ca	–	0,46 ± 0,04
Fe	(14,6)	6,15 ± 0,08
Mg	–	0,04 ± 0,006
O	–	–
Zn	–	–
Pb	0,0179 ± 0,0011⁺	–

(Values in parentheses are indicative values) ⁺ 95%-confidence interval

Ores, iron oxide

Powder

Mass fraction in % ± standard deviation

CRM-No.	D 627-2		D 630-1		D 631-1		D 633-1	
Description	Iron ore		Iron ore		Iron ore		Manganese ore	
Year of issue	1966		1969		1969		1967	
Fe_{total}	31,77	± 0,12	65,63	± 0,17	61,09	± 0,09	1,64	± 0,04
Si	–		–		–		–	
SiO_2	9,24	± 0,08	5,88	± 0,07	3,20	± 0,06	10,39	± 0,15
Al	–		–		–		–	
Al_2O_3	4,49	± 0,12	0,88	± 0,038	1,06	± 0,05	1,64	± 0,12
Ca	–		–		–		–	
CaO	15,67	± 0,21	0,10	± 0,017	0,75	± 0,038	2,02	± 0,12
Mg	–		–		–		–	
MgO	1,57	± 0,08	0,47	± 0,046	0,54	± 0,059	0,58	± 0,10
Mn	0,250	± 0,012	0,060	± 0,005	0,044	± 0,006	47,85	± 0,21
P	0,661	± 0,014	0,043	± 0,003	0,114	± 0,005	0,170	± 0,007
S	0,114	± 0,009	0,032	± 0,004	0,033	± 0,006	0,227	± 0,009
Na	–		–		–		–	
Na_2O	–		–		(0,04)		–	
K	–		–		–		–	
K_2O	–		–		(0,04)		–	
As	0,020	± 0,001	–		–		(0,0040)	
BaO	–		–		–		1,13	± 0,08
Cr	0,018	± 0,003	–		–		–	
Cu	(0,002)		–		–		–	
F	–		–		–		–	
Ni	–		–		–		–	
Pb	–		–		–		–	
Ti	–		–		–		–	
TiO_2	0,225	± 0,014	0,066	± 0,013	0,109	± 0,006	0,079	± 0,009
V	–		–		–		–	
Zn	–		–		–		–	

(Values in parentheses are indicative values)

- continued-

Ores, iron oxide (continued)

CRM-No.	D 680-1	D 686-1	D 687-1
Description	Iron ore	Iron oxide	Iron oxide
Year of issue	1977	2002	2009
Fe_{total}	59,98 ± 0,08	69,44 ± 0,11⁺	69,66 ± 0,14⁺
Fe(II)	–	(0,0484)	(0,076)
Si	4,20 ± 0,02	0,0083 ± 0,0005⁺	0,0157 ± 0,0011⁺
SiO_2	8,98 ± 0,04	–	–
Al	0,66 ± 0,02	0,0407 ± 0,0012⁺	0,0356 ± 0,0012⁺
Al_2O_3	1,23 ± 0,04	–	–
Ca	0,45 ± 0,02	0,0097 ± 0,0007⁺	0,0113 ± 0,0012⁺
CaO	0,63 ± 0,03	–	–
Mg	0,14 ± 0,01	0,0027 ± 0,0002⁺	0,0018 ± 0,0002⁺
MgO	0,23 ± 0,02	–	–
Mn	0,025 ± 0,002	0,231 ± 0,004⁺	0,1658 ± 0,0027⁺
P	0,018 ± 0,002	0,0078 ± 0,0001⁺	0,0120 ± 0,0004⁺
P_2O_5	–	–	–
S	0,544 ± 0,017	–	–
Na	0,128 ± 0,004	0,0058 ± 0,0005⁺	0,0030 ± 0,0003⁺
Na_2O	–	–	–
K	0,078 ± 0,003	0,0024 ± 0,0004⁺	0,0011 ± 0,0002⁺
K_2O	–	–	–
As	0,057 ± 0,003	–	–
Cr	0,005 ± 0,001	0,0182 ± 0,0006⁺	0,0227 ± 0,0008⁺
Cu	0,063 ± 0,003	0,0038 ± 0,0003⁺	0,0030 ± 0,0003⁺
F	–	–	–
Ni	0,007 ± 0,001	0,0127 ± 0,0004⁺	0,0122 ± 0,0006⁺
Pb	0,317 ± 0,008	–	(0,0004)
Ti	0,045 ± 0,003	0,0014 ± 0,0001⁺	0,0303 ± 0,0005⁺
TiO_2	0,08 ± 0,005	–	–
V	–	–	–
Zn	0,165 ± 0,004	0,0004 ± 0,0001⁺	0,0051 ± 0,0003⁺
Cl	–	0,095 ± 0,006⁺	0,0173 ± 0,0018⁺
Co	–	0,0019 ± 0,0001⁺	(0,0016)
Mo	–	0,0007 ± 0,0001⁺	0,0020 ± 0,0002⁺
Sn	–	0,0025 ± 0,0002⁺	0,0006 ± 0,0001⁺

(Values in parentheses are indicative values)

⁺ 95%-confidence interval

Ceramic materials

Powder

Mass fraction in % ± standard deviation

CRM-No.	D 777-1	D 779-1
Description	Silica brick	Magnesite, low boron
Year of issue	1984	1991
Si	44,44 ± 0,15	0,182 ± 0,015
SiO_2	95,06 ± 0,32	–
Ca	2,02 ± 0,08	1,691 ± 0,023
CaO	2,83 ± 0,10	–
Mg	0,043 ± 0,007	(54,57)
MgO	0,071 ± 0,012	–
Al	0,42 ± 0,02	0,105 ± 0,007
Al_2O_3	0,80 ± 0,04	–
B	–	0,0116 ± 0,0012
Cr	–	(0,0030)
Fe	0,23 ± 0,03	3,73 ± 0,06
Fe_2O_3	0,33 ± 0,04	–
K	0,13 ± 0,02	(0,0020)
K_2O	0,15 ± 0,02	–
Mn	–	0,503 ± 0,017
Na	(0,02)	(0,0058)
P	–	0,0267 ± 0,0026
Ti	0,27 ± 0,02	0,0081 ± 0,0012

(Values in parentheses are indicative values)

Molybdenum oxide

Powder

CRM-No.	D 784-1
Description	Molybdenum oxide
Year of issue	2018
Ca	0,888 ± 0,008
Mg	0,0883 ± 0,0019
Ti	0,0223 ± 0,0010
P	0,0113 ± 0,0008
Bi	0,00326 ± 0,00020
Cu	0,390 ± 0,005
Fe	1,870 ± 0,021
Pb	0,0216 ± 0,0009
K	0,164 ± 0,007
Al	0,468 ± 0,010
As	0,0126 ± 0,0003
Mo	(57,87)
Si	(2,65)
S	(0,0088)
Na	(0,040)
C	(0,0103)
W	(0,015)
Ba	(0,006)
Co	(0,0045)
Ni	(0,0019)
Rb	(0,0006)
Sb	(0,0007)
Sr	(0,0041)
V	(0,127)
Zr	(0,0012)

Slags

Powder

Mass fraction in % ± standard deviation

CRM-No.	D 826-1	D 827-1
Description	Basic slag	Basic slag
Year of issue	1976	1976
SiO_2	8,96 ± 0,15	6,21 ± 0,15
Al	0,696 ± 0,008	–
Al_2O_3	–	(0,57)
CaO	46,48 ± 0,54	47,38 ± 0,49
MgO	(2,46)	(3,70)
P_2O_5	14,65 ± 0,15	20,70 ± 0,16
P_2O_5 citric acid sol.	10,73 ± 0,14	18,79 ± 0,22
B	(0,0029)	–
Cr	0,182 ± 0,005	–
Cr_2O_3	–	(0,14)
Cu	(0,0019)	–
F	(0,3667)	–
Fe total	(20,73)	(15,72)
K	0,0278 ± 0,0017	–
Mn total	(3,46)	(2,34)
Mo	(0,0011)	–
Na	0,375 ± 0,009	–
Ni	(0,0017)	–
Pb	(0,0049)	–
V	0,503 ± 0,008	–
V_2O_5	(0,89)	(1,15)

(Values in parentheses are indicative values)

Steels with certified oxygen and nitrogen content

Mass fraction in % ± standard deviation

CRM-No.	D 026-1	D 026-2	D 027-1	D 028-1
Description	Unalloyed steel	Unalloyed steel	Unalloyed steel	Unalloyed steel
Year of issue	1969	1973	1970	1970
Shape	Rods	Rods	Rods	Rods
O	0,0031 ± 0,0003	0,0025 ± 0,0004	0,0084 ± 0,0006	0,0113 ± 0,0007
N	0,0053 ± 0,0004	0,0042 ± 0,0003	0,0157 ± 0,0010	0,0029 ± 0,0005

CRM-No.	D 029-1	D 271-1	D 284-2	D 286-1
Description	Unalloyed steel	Stainless steel	Stainless steel	Stainless steel
Year of issue	1970	2007	2000	1985
Shape	Rods	Disc	Chips	Chips
O	0,0312 ± 0,0010	0,0020 ± 0,0002^{+}	0,0099 ± 0,0007^{+}	(0,0315)
N	0,0083 ± 0,0008	0,0137 ± 0,0003^{+}	0,0151 ± 0,0002^{+}	0,043 ± 0,002

(Values in parentheses are indicative values)

$^{+}$ 95%-confidence interval

Setting-up sample for spectrometric analysis of low alloyed steels

BAM SUS-1 R

The setting-up sample is suitable for direct reading spark emission and X-ray fluorescence spectrometers analysing low alloyed steels.

The material was prepared by hot isostatic pressing (HIP) of powder which was atomised from the melt of the alloy and solidified in inert gas. Therefore it is of particular high homogeneity. Analysis of the sample was carried out in BAM.

Dimensions: cylinder, 50 mm in diameter, 42 mm high

Analyte	Uncertified mass fraction in %
C	0,9
Si	0,8
Mn	1,1
P	0,02
S	0,017
Cr	1,7
Mo	0,9
Ni	2,9
V	0,5
W	0,7
Cu	0,7
Co	0,3
Nb	0,55

Steel with certified hydrogen content

Mass fraction in mg/kg ± 95%-confidence interval

CRM-No.	CRM Steel-H1
Description	Alloyed steel, 1.4546.9
Year of issue	2011
Shape	Pins
H	0,97 ± 0,05

Non ferrous metals and alloys

The **aluminium, copper, lead and zinc based samples** were produced and certified by BAM in collaboration with the Working Groups „Aluminium", „Copper" and „Lead/Zinc" of the Committee of Chemists of the Society of Metallurgists und Miners (GDMB).

The analyses were carried out in BAM and in laboratories of the non ferrous metals industry. The finely divided samples are supplied in glass bottles containing 100 g each.

Cylindrical samples in block form have been especially designed for spark emission and X-ray fluorescence spectrometers.

The **aluminium discs** are 2,5 to 5 cm high and 4 to 6 cm in diameter and have been analysed by 10 to 15 industrial laboratories (depending on the element) involved in an interlaboratory comparison organized by BAM.

The **copper blocks** of cylindrical shape have an approximate height of 3 cm and a diameter of about 4 cm.
Lead blocks of cylindrical shape have a height of 3 - 4 cm and a diameter of 4 - 5 cm.
Zinc blocks of cylindrical shape have a height of 3 cm and a diameter of about 4,5 cm.

The granulated **tin solder** was certified in a German-French collaboration by the Bureau National de Métrologie, involving several industrial laboratories of both countries. The sieved material (fraction 40 to 200 µm) is available from BAM in glass bottles containing 100 g each.

Each sample is distributed together with a certificate which contains the certified values together with their uncertainties and the indicative values. The mean values of the accepted data sets, their standard deviations and the standard deviations of the laboratories are also given in the certificate together with the laboratories participating in the certification campaign and the analytical methods used for element determination.

Authentic for the certified element contents are only the values given in the certificates, not the values given in this catalogue.

Aluminium

Chips, powder

Mass fraction in %

CRM-No.	201	300	301	BAM-M319[◻]
Description	GAlSi12	AlMg3	Al99,8	AlMgSc
Year of issue	1963	1959	1961	2019
Al	(matrix)	(matrix)	(matrix)	(matrix)
Si	13,20	0,14	0,061	0,1043
Mg	0,0024	2,67	0,0008	4,96
Cu	0,009	0,046	0,0016	0,0015
Fe	0,18	0,198	0,054	0,291
Mn	0,38	0,018	0,001	0,371
Sc	–	–	–	0,847
Cr	–	0,23	–	(0,060)
Ga	–	–	–	(0,015)
Ni	–	–	–	(0,037)
Pb	–	0,016	–	(< 0,001)
Sn	–	(< 0,0005)	(< 0,0005)	(< 0,001)
Ti	0,011	0,011	0,005	0,0030
V	–	–	0,0018	(0,0093)
Zn	0,038	0,128	0,033	0,0073
Zr	–	–	–	0,324

(Values in parentheses are indicative values)

◻) Accredited by DAkkS as a producer of RM according to ISO 17034

Aluminium

Discs

Mass fraction in µg/g (bold in %) ± 95%-confidence interval

CRM-No.	ERM®-EB307a^{+}	BAM-M308a$^{\Delta+}$	BAM-310	BAM-311	ERM®-EB312a$^{\Delta+}$
Description	AlMg4,5Mn	AlZnMgCu1,5	Al99,85Mg1	AlCuMg2	AlMgSi0,5
Year of issue	2016	2018	1993	1993	2017
Si	**0,152 ± 0,005**	**0,072 ± 0,003**	**0,0797 ± 0,0012**	**0,2040 ± 0,0029**	**0,403 ± 0,008**
Fe	**0,345 ± 0,007**	**0,164 ± 0,005**	**0,0705 ± 0,0012**	**0,310 ± 0,006**	**0,198 ± 0,004**
Cu	**0,0939 ± 0,0026**	**1,36 ± 0,03**	16,9 ± 0,9	**4,653 ± 0,028**	**0,0509 ± 0,0014**
Mn	**0,811 ± 0,010**	**0,0343 ± 0,0005**	30,7 ± 1,1	**0,694 ± 0,006**	**0,0488 ± 0,0011**
Mg	**4,80 ± 0,09**	**2,28 ± 0,05**	**0,994 ± 0,015**	**1,567 ± 0,014**	**0,379 ± 0,004**
Cr	**0,1536 ± 0,0026**	**0,192 ± 0,004**	0,90 ± 1,2	**0,1037 ± 0,0014**	**0,0320 ± 0,0009**
Ni	**0,0097 ± 0,0005**	147 ± 3	24,4 ± 1,4	**0,0519 ± 0,0009**	40,7 ± 2,4
Zn	**0,0690 ± 0,0016**	**5,61 ± 0,08**	86 ± 4	**0,2005 ± 0,0022**	**0,0297 ± 0,0008**
Ti	**0,0595 ± 0,0016**	257 ± 7	30,1 ± 1,1	**0,0562 ± 0,0006**	**0,0291 ± 0,0011**
Al	(matrix)	(matrix)	(matrix)	(matrix)	(matrix)
As	–	–	–	–	–
B	–	–	(6)	–	(2,7 ± 1,0)
Be	5,37 ± 0,16	1,8 ± 0,1	1,28 ± 0,14	5,2 ± 0,4	–
Bi	–	–	–	500 ± 30	18,0 ± 1,8
Ag	–	6,5 ± 0,6	–	–	–
Ca	19,2 ± 2,8	–	7,3 ± 0,4	(6)	(16,9 ± 2,5)
Cd	32,6 ± 1,4	–	23,7 ± 0,7	12,7 ± 0,5	16,7 ± 1,3
Co	5,1 ± 0,5	–	(9)	11,5 ± 1,0	–
Ga	**0,0124 ± 0,0005**	–	115,2 ± 2,4	159 ± 5	**0,0129 ± 0,0003**
In	–	–	–	–	–
Hg	(34 ± 5)	–	–	–	–
Li	8,1 ± 0,5	–	3,66 ± 0,12	5,3 ± 0,5	6,0 ± 1,1
Mo	–	–	–	–	–
Na	(8,4 ± 2,4)	15,8 ± 2,2	(3)	(18)	(4,0 ± 1,8)
P	–	–	(3)	–	–
Pb	**0,0084 ± 0,0004**	43,6 ± 2,7	34,7 ± 2,5	504 ± 11	49,7 ± 2,1
Sb	46 ± 6	–	–	–	–
Sn	**0,0075 ± 0,0004**	–	23,8 ± 1,8	127 ± 12	–
Sr	–	–	–	–	11,1 ± 0,7
Tl	–	–	–	–	–
V	**0,0119 ± 0,0004**	–	44,4 ± 2,3	240 ± 8	67,3 ± 1,4
Zr	31,9 ± 1,2	87,3 ± 2,6	13,5 ± 1,9	**0,140 ± 0,005**	8,5 ± 0,7

(Values in parentheses are indicative values)

- continued -

$^{+}$ Estimated expanded uncertainty with a coverage factor of k=2

$^{\Delta)}$ Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025

Aluminium, discs (continued)
Mass fraction in µg/g (bold in %) ± 95%-confidence interval

CRM-No.	BAM-M313a[□)]	ERM®-EB314a	ERM®-EB315a[Δ+]	ERM®-EB316	ERM®-EB317[+]
Description	AlMg3	AlSi11Cu2Fe	AlSi9Cu3	AlSi12	AlZn6CuMgZr
Year of issue	2021	2016	2017	2009	2013
Si	**0,346 ± 0,012**	**11,51 ± 0,15**	**9,88 ± 0,18**	**11,98 ± 0,20[+]**	271 ± 22
Fe	**0,388 ± 0,010**	**0,992 ± 0,017**	**0,621 ± 0,014**	**0,1054 ± 0,0021[+]**	**0,112 ± 0,003**
Cu	**0,0932 ± 0,0027**	**2,08 ± 0,07**	**2,46 ± 0,08**	**0,0297 ± 0,0008[+]**	**1,77 ± 0,06**
Mn	**0,486 ± 0,006**	**0,404 ± 0,008**	**0,311 ± 0,009**	**0,204 ± 0,004[+]**	912 ± 19
Mg	**3,35 ± 0,08**	**0,196 ± 0,004**	**0,446 ± 0,023**	**0,045 ± 0,004[+]**	**2,39 ± 0,07**
Cr	**0,117 ± 0,004**	**0,0574 ± 0,0012**	**0,0274 ± 0,0004**	59,3 ± 2,6[+]	**0,141 ± 0,003**
Ni	**0,0296 ± 0,0007**	**0,242 ± 0,006**	**0,955 ± 0,0022**	**0,0235 ± 0,0011[+]**	359 ± 14
Zn	**0,1481 ± 0,0026**	**1,100 ± 0,015**	**0,801 ± 0,010**	**0,0611 ± 0,0012[+]**	**6,93 ± 0,26**
Ti	**0,099 ± 0,006**	**0,188 ± 0,004**	**0,142 ± 0,006**	**0,0790 ± 0,0015[+]**	952 ± 156
Al	**(matrix)**	**(matrix)**	**(matrix)**	**(matrix)**	**(matrix)**
As	(3,8 ± 1,4)	28 ± 7	–	–	–
B	–	–	(2,1 ± 2,0)	(< 1,5)	(37 ± 32)
Be	5,4 ± 0,3	4,65 ± 0,22	4,33 ± 0,16	2,95 ± 0,17[+]	10,1 ± 0,8
Bi	92 ± 5	92 ± 6	36 ± 4	140 ± 7[+]	41 ± 6
Ag	–	–	–	(183 ± 10[+])	73 ± 5
Ca	10,4 ± 1,2	–	–	(11,3 ± 1,4[+])	(6,0 ± 2,7)
Cd	4,7 ± 0,6	5,2 ± 1,0	7,9 ± 1,0	20,8 ± 1,5[+]	–
Co	–	74 ± 4	(1,4 ± 0,7)	(< 1,5)	–
Ga	106,7 ± 2,2	164 ±4	**0,0089 ± 0,0003**	105 ± 5[+]	183 ± 12
In	–	–	–	–	162 ± 11
Hg	3,7 ± 0,7	–	(22 ± 6)	(35 ± 7[+])	–
Li	11,3 ± 0,4	–	–	(1,00 ± 0,03[+])	–
Mo	4,8 ± 0,8	–	–	–	–
Na	25 ± 5	–	–	–	–
P	–	–	(7 ± 4)	–	(27 ± 15)
Pb	38,0 ± 1,4	**0,189 ± 0,010**	**0,077 ± 0,003**	87 ± 7[+]	48,1 ± 2,3
Sb	6,1 ± 1,0	102 ± 19	51 ± 10	(56 ± 5[+])	–
Sn	193 ± 6	**0,201 ± 0,004**	**0,0764 ± 0,0020**	(106 ± 11[+])	237 ± 18
Sr	–	–	–	260 ± 7[+]	–
Tl	(5,1 ± 0,6)	–	–	–	–
V	308 ± 8	277 ±7	47,0 ± 2,3	98 ± 7[+]	105 ± 7
Zr	355 ± 10	103 ±3	31,0 ± 1,9	32,8 ± 0,7[+]	**0,130 ± 0,008**

(Values in parentheses are indicative values)

[+] Estimated expanded uncertainty with a coverage factor of *k*=2
[Δ)] Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025
[□)] Accredited by DAkkS as a producer of RM according to ISO 17034

Aluminium, discs (continued)

Mass fraction in µg/g (bold in %) ± 95%-confidence interval

CRM-No.	BAM-M318[□+]	BAM-M320[□+]	BAM-M321[□+]
Description	AlSi1,2Mg0,4	AlMgSc	AlCu4Mg1
Year of issue	2019	2020	2020
Si	**1,211 ± 0,017**	**0,197 ± 0,007**	**0,0490 ± 0,0022**
Fe	**0,246 ± 0,008**	**0,206 ± 0,006**	**0,0495 ± 0,0017**
Cu	**0,0908 ± 0,0025**	**0,147 ± 0,005**	**4,38 ± 0,06**
Mn	**0,0985 ± 0,0017**	**0,699 ± 0,008**	**0,808 ± 0,010**
Mg	**0,356 ± 0,009**	**3,98 ± 0,08**	**1,51 ± 0,04**
Cr	**0,0208 ± 0,0004**	**0,1044 ± 0,0023**	**0,0558 ± 0,0013**
Ni	50,0 ± 1,9	20,9 ± 1,3	**0,0504 ± 0,0007**
Zn	**0,0486 ± 0,0011**	**0,252 ± 0,006**	**0,147 ± 0,003**
Ti	**0,0238 ± 0,0010**	**0,102 ± 0,004**	**0,0436 ± 0,0022**
Al	**(matrix)**	**(matrix)**	**(matrix)**
As	–	–	–
B	(<2)	–	–
Be	4,7 ± 0,3	22,4 ± 0,7	4,9 ± 0,2
Bi	–	–	323 ± 14
Ag	–	–	–
Ca	9,1 ± 1,6	11,7 ± 2,2	5,2 ± 0,8
Cd	9,6 ± 1,2	15,2 ± 1,9	30 ± 4
Co	–	20,9 ± 1,2	–
Ga	**0,0189 ± 0,0005**	**0,0208 ± 0,0008**	87,9 ± 2,0
In	–	–	–
Hg	7,6 ± 1,1	–	–
Li	6,0 ± 0,7	9,1 ± 0,4	5,8 ± 0,4
Mo	–	–	–
Na	(3,7 ± 1,3)	6,4 ± 1,3	2,9 ± 0,9
P	–	–	–
Pb	56 ± 3	44,8 ± 2,4	99 ± 6
Sb	–	–	–
Sc	–	**0,282 ± 0,007**	**0,0502 ± 0,0020**
Sn	20,6 ± 1,1	45,6 ± 2,9	**0,0286 ± 0,0010**
Sr	–	–	–
Tl	–	–	–
V	**0,0104 ± 0,0003**	75,9 ± 2,5	**0,0105 ± 0,0003**
Zr	32,9 ± 1,4	**0,102 ± 0,005**	**0,1554 ± 0,0026**

(Values in parentheses are indicative values)

[+] Estimated expanded uncertainty with a coverage factor of k=2

[□)] Accredited by DAkkS as a producer of RM according to ISO 17034

Copper

Chips

Mass fraction in % ± standard deviation

CRM-No.	223	224	227
Description	CuZn39Pb2	CuZn40MnPb	Rg7
Year of issue	1974	1975	1979
Cu	58,74 ± 0,02	57,40 ± 0,02	85,57 ± 0,03
Sn	0,089 ± 0,004	0,066 ± 0,003	6,01 ± 0,07
Zn	38,82 ± 0,09	39,40 ± 0,04	3,46 ± 0,03
Pb	2,13 ± 0,02	1,13 ± 0,04	4,12 ± 0,04
Fe	0,091 ± 0,002	0,136 ± 0,002	0,129 ± 0,002
Ni	0,0214 ± 0,0005	0,038 ± 0,001	0,284 ± 0,003
Mn	(< 0,001)	1,70 ± 0,03	–
Al	(< 0,002)	0,0012 ± 0,0002	(< 0,0001)
Ag	–	–	–
As	0,0084 ± 0,0005	0,0025 ± 0,0002	0,081 ± 0,002
Bi	0,0018 ± 0,0001	0,0006 ± 0,0001	0,0088 ± 0,0002
Cd	–	–	–
Co	–	–	–
P	0,0003 ± 0,00015	0,0112 ± 0,0002	(0,0002)
S	0,0011 ± 0,0001	0,0004 ± 0,0001	0,122 ± 0,005
Sb	0,0040 ± 0,0002	0,0026 ± 0,0001	0,160 ± 0,002
Se	(< 0,0001)	–	0,0028 ± 0,0002
Si	(< 0,003)	(0,002)	(< 0,01)
Te	–	–	0,0012 ± 0,0003

(Values in parentheses are indicative values)

- continued -

Copper, chips (continued)
Mass fraction in µg/g (**bold in %**) ± 95%-confidence interval

CRM-No.	228		BAM-229		BAM-M365a[Δ]	
Description	Rg10		CuZn37		Pure copper	
Year of issue	1979		1996		2017	
Cu	**85,34**	**± 0,03**	**63,334%**	**± 0,007 %**	**99,73 %**	**± 0,07 %**
Zn	**9,76**	**± 0,05**	**36,63 %**	**± 0,04 %**	30	± 4
Sn	**3,32**	**± 0,05**	48,5	± 1,1		–
Pb	**1,24**	**± 0,03**	192	± 5	141	± 4
Fe	**0,036**	**± 0,002**	106,1	± 2,1	6,1	± 1,3
Ni	**0,109**	**± 0,005**	111,4	± 0,9	235	± 5
Mn	**(< 0,001)**		–		–	
Al	**(0,0001)**		–		–	
Ag	–		–		159	± 5
As	**0,024**	**± 0,001**	21,7	± 0,8	40,4	± 0,8
Bi	**0,0086**	**± 0,0003**	–		30,0	± 1,2
Cd	–		–		–	
Co	–		–		2,13	± 0,14
P	**0,019**	**± 0,001**	(10,6	± 1,6)	–	
S	**0,036**	**± 0,002**	–		–	
Sb	**0,078**	**± 0,001**	7,2	± 0,7	12,1	± 1,0
Se	**0,0012**	**± 0,0001**	34	± 4	179	± 12
Si	–		–		–	
Te	–		–		1,27	± 0,12

(Values in parentheses are indicative values)
Δ) Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025

Copper

Discs

Mass fraction in µg/g (bold in %) ± 95%-confidence interval

CRM-No.	BAM-368	BAM-369	BAM-370	BAM-371	BAM-372	ERM®-EB374 (BAM-374)
Description	CuZn20Al2	OF-Cu	OF-Cu	OF-Cu	OF-Cu	CuSn8
Year of issue	1993	1993	1993	1995	1995	1999
Cu	**77,049 ± 0,018**	(matrix)	(matrix)	(matrix)	(matrix)	**92,22 ± 0,05**
Al	**1,972 ± 0,014**	–	12,6 ± 0,8	–	–	(< 1)
Ni	258 ± 4	–	–	–	11,66 ± 0,24	32,7 ± 1,3
Fe	192,7 ± 2,9	–	–	18,3 ± 0,7	–	40 ± 4
Mn	202,8 ± 2,4	–	–	–	11,4 ± 0,4	4,3 ± 0,3
Zn	(matrix)	22,0 ± 0,6	–	–	–	40,4 ± 1,9
Ag	–	–	–	–	9,01 ± 0,29	12,1 ± 1,3
As	246 ± 9	–	–	–	10,3 ± 0,6	(4,3 ± 1,2)
Be	–	–	–	11,5 ± 0,6	–	–
Bi	–	9,7 ± 0,4	–	–	–	(2,2 ± 1,3)
C	–	–	–	–	–	–
Cd	–	–	–	1,63 ± 0,08	–	(< 1)
Co	–	10,42 ± 0,29	–	–	–	(< 1)
Cr	–	9,2 ± 0,5	–	–	–	(< 1)
Mg	62,1 ± 1,5	3,60 ± 0,18	–	–	–	(< 1)
P	89,9 ± 1,6	–	11,7 ± 0,7	–	–	**0,170 ± 0,008**
Pb	131,3 ± 2,4	–	15,8 ± 1,1	–	–	8,3 ± 0,9
S	(18,5 ± 2,9)	–	–	12,1 ± 0,9	–	(13 ± 5)
Sb	–	–	15,6 ± 1,3	–	–	(6,3 ± 1,4)
Se	–	–	–	–	(8,4 ± 0,6)	(< 2)
Si	130 ± 7	–	18,7 ± 3,0	–	–	(< 10)
Sn	147 ± 4	–	16,8 ± 0,9	–	–	**7,60 ± 0,13**
Te	–	–	–	14,4 ± 0,6	–	(< 1)
Ti	–	–	–	12,9 ± 0,7	–	(< 1)
Zr	–	–	–	–	5,8 ± 0,4	(< 1)

(Values in parentheses are indicative values)

- continued -

Copper, discs (continued)
Mass fraction in µg/g (bold in %) ± 95%-confidence interval

CRM-No.	ERM®-EB375 (BAM-375)	BAM-M376a	ERM®-EB377 (BAM-377)	ERM®-EB378 (BAM-378)	BAM-M381
Description	CuZn39Pb3	Pure copper	CuSn6	CuSn6	Pure copper
Year of issue	1999	2016	1999	2000	2006
Cu	**58,32 ± 0,05**	(matrix)	**94,04 ± 0,05**	**94,13 ± 0,04**	(matrix)
Al	270 ± 5	(182 ± 10)	45,1 ± 1,2	(< 1)	(< 1)
Ni	**0,1053 ± 0,0015**	209 ± 6	107,4 ± 1,5	18,3 ± 0,9	0,7 ± 0,2
Fe	**0,207 ± 0,004**	235 ± 3	104,2 ± 2,7	182 ± 7	3,3 ± 0,2
Mn	222 ± 3	206 ± 3	92,1 ± 2,1	(0,74 ± 0,24)	0,22 ± 0,03
Zn	**38,02 ± 0,08**	217 ± 3	100,6 ± 3,0	(7,4 ± 1,0)	5,3 ± 0,3
Ag	166 ± 4	163 ± 3	64,4 ± 1,1	26,6 ± 1,3	< 1
As	231 ± 4	200 ± 3	(< 10)	99,5 ± 2,5	< 0,5
Be	–	(41 ± 6)	–	–	–
Bi	68,6 ± 2,5	200 ± 5	42,2 ± 1,5	(< 1)	< 0,3
C	–	–	–	–	–
Cd	85,9 ± 2,1	186,1 ± 3	(< 1)	100,7 ± 2,2	< 0,4
Co	196,4 ± 2,8	208 ± 2	(< 2)	89 ± 5	< 0,3
Cr	–	(400 ± 60)	66,9 ± 2,1	311 ± 5	< 0,4
Ge	(15 ± 5)	–	–	–	–
In	(104 ± 13)	–	–	–	–
Mg	–	(124 ± 19)	(< 1)	28,7 ± 0,8	< 0,6
P	(8,6 ± 1,2)	203 ± 5	(< 10)	602 ± 23	–
Pb	**2,90 ± 0,03**	236 ± 4	44,9 ± 2,3	4,2 ± 0,7	0,59 ± 0,07
S	–	(133 ± 19)	(6,8 ± 0,8)	9,1 ± 1,9	(3,2 ± 1,3)
Sb	122 ± 4	202 ± 5	13,0 ± 1,3	86,1 ± 2,6	< 1
Se	–	210 ± 4	55 ± 4	(< 2)	(< 1)
Si	211 ± 14	–	(134)	(< 10)	(< 3)
Sn	**0,2090 ± 0,0024**	247 ± 3	**5,92 ± 0,13**	**5,74 ± 0,21**	3,86 ± 0,25
Te	53,8 ± 2,4	215 ± 7	(< 1)	85,0 ± 2,6	(< 0,3)
Ti	–	(4,5 ± 1,7)	(< 1)	(29,4 ± 4)	(< 0,3)
Zr	–	42,2 ± 1,9	–	(1,7 ± 0,09)	< 6

(Values in parentheses are indicative values)

- continued -

Copper, discs (continued)
Mass fraction in µg/g (± 95%-confidence interval

CRM-No.	BAM-M383b	BAM-M384a	BAM-M384b	BAM-M385a$^{\Delta}$
Description	Pure copper	Pure copper	Pure copper	Pure copper
Year of issue	2014	2014	2014	2017
Cu	(matrix)	(matrix)	(matrix)	(matrix)
Al	(<1,2)	(< 1,5)	(2,9 ± 0,8)	13,3 ± 3,2
Ni	1,43 ± 0,18	6,1 ± 0,5	4,7 ± 0,6	10,8 ± 0,6
Fe	3,6 ± 0,6	2,7 ± 0,5	(5,1 ± 1,2)	44,2 ± 1,2
Mn	0,18 ± 0,03	0,22 ± 0,03	8,1 ± 0,9	9,9 ± 0,9
Zn	9,3 ± 0,4	5,3 ± 0,5	2,6 ± 0,5	9,2 ± 0,7
Ag	10,6 ± 0,4	10,7 ± 0,4	11,3 ± 0,4	25,4 ± 0,5
As	2,8 ± 0,4	5,4 ± 0,8	6,6 ± 1,1	9,4 ± 2,0
Be	–	–	–	–
Bi	1,85 ± 0,21	6,16 ± 0,25	6,81 ± 0,23	5,64 ± 0,28
C	–	–	–	–
Cd	0,93 ± 0,05	4,1 ± 0,2	4,0 ± 0,2	2,75 ± 0,28
Co	1,02 ± 0,05	3,64 ± 0,16	10,4 ± 0,5	7,4 ± 0,4
Cr	(< 1)	(< 0,2)	(2,3 ± 0,6)	10,4 ± 0,8
Mg	(< 1)	(< 0,2)	3,3 ± 0,5	(32 ± 7)
P	(< 1)	(< 1,5)	(< 2)	10,0 ± 1,3
Pb	1,01 ± 0,17	11,7 ± 1,1	1,6 ± 0,4	10,8 ± 1,0
S	(3,6 ± 1,5)	(4,6 ± 1,4)	(3,8 ± 1,4)	(34,4 ± 2,5)
Sb	1,69 ± 0,16	5,4 ± 0,5	5,8 ± 0,4	14,9 ± 0,8
Se	1,17 ± 0,28	5,8 ± 0,6	(2,9 ± 0,7)	5,0 ± 0,7
Si	(< 2)	(< 2,5)	(<2,5)	7,3 ± 0,8
Sn	0,8 ± 0,4	2,6 ± 0,5	2,1 ± 0,4	16,1 ± 1,1
Te	5,7 ± 0,9	9,3 ± 0,5	7,2 ± 0,7	8,1 ± 1,2
Ti	(< 1)	(< 1)	2,9 ± 0,6	6,6 ± 1,1
Zr	(< 1)	(0,1 ± 0,07)	1,3 ± 0,4	(18 ± 7)
O	–	–	–	–

(Values in parentheses are indicative values)

- continued -

$^{\Delta)}$ Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025

Copper, discs (continued)
Mass fraction in µg/g (bold in %) ± 95%-confidence interval

CRM-No.	ERM®-EB387 (BAM-M387)		ERM®-EB388 (BAM-M388)		ERM®-EB389		ERM®-EB393a	
Description	CuZn20Ni5		CuAl5Zn5Sn		CuNi25		CuZn21Si3P	
Year of issue	2004		2004		2007		2016	
Cu	**75,18**	**± 0,04**	**89,27**	**± 0,05**	**74,3**	**± 0,5**	**75,8**	**± 0,3**
Al		–	**4,972**	**± 0,024**	(123	± 10)	2,1	± 0,4
Ni	**5,020**	**± 0,025**	73,6	± 2,0	**24,7**	**± 0,5**	29,7	± 1,5
Fe	617	± 10	303	± 9	**0,107**	**± 0,006**	143	± 5
Mn	796	± 6	512	± 6	**0,415**	**± 0,011**	18,5	± 0,6
Zn	**19,57**	**± 0,06**	**4,81**	**± 0,03**	**0,1125**	**± 0,0026**	**(20,8)**	
Ag		–		–		–		–
As		–		–		–	1,34	± 0,16
B		–		–	(23	±6)		–
Be		–		–		–		–
Bi		–		–	44	± 10	(0,19	± 0,05)
C		–		–	(216	± 24)		–
Cd		–		–	16	± 3	0,61	± 0,17
Co		–		–	770	± 28		–
Cr		–		–	153	± 6	1,56	± 0,28
Mg		–		–	**0,067**	**±0,009**		–
P		–		–	93	± 17	**0,0454**	**± 0,0012**
Pb	10,8	± 0,8	9,69	± 0,83	98	± 23	104	± 4
S		–		–	(308	± 23)		–
Sb		–		–	46	± 5	(0,93	± 0,29)
Se		–		–		–	(0,47	± 0,15)
Si		–		–	(349	± 37)	**3,35**	**±0,06**
Sn	30,1	± 1,2	**0,857**	**± 0,011**	262	± 34	39,0	± 0,9
Te		–		–		–		–
Ti		–		–	660	± 18		–
Zr		–		–	**0,098**	**± 0,011**		–

(Values in parentheses are indicative values)

CRM-No.	BAM-M390	BAM-M391	BAM-M392
Description	Pure copper	Pure copper	Pure copper
Year of issue	2010	2010	2010
Fe	0,79 ± 0,20	0,90 ± 0,21	0,80 ± 0,17
P	1,3 ± 0,4	3,3 ± 0,5	7,0 ± 0,5
Sn	(< 0,1)	(< 0,1)	(< 0,1)

(Values in parentheses are indicative values)

Copper, discs (continued)
Mass fraction in µg/g (bold in %) ± 95%-confidence interval

CRM-No.	BAM-M394[Δ]		BAM-M394a[Δ]		BAM-M396[□]		BAM-M397[□]		BAM-M397a[□]	
Description	CuZn40Pb2		CuZn40Pb2		CuZn33Pb1AlSiAs		CuSn4Zn2PS		CuSn4Zn2PS	
Year of issue	2017		2017		2019		2019		2019	
Cu	**57,70**	**± 0,19**	**57,64**	**± 0,17**	**65,49**	**± 0,12**	–		–	
Al	(1,0	± 1,1)	(7,9	± 1,4)	**0,223**	**± 0,010**	–		–	
Ni	399	± 8	386	± 7	143	± 17	**0,336**	**± 0,006**	**0,337**	**± 0,007**
Fe	**0,1191**	**± 0,0024**	**0,1323**	**± 0,0026**	**0,0235**	**± 0,0012**	–		–	
Mn	14,1	± 0,7	12,5	± 0,7	44,5	±1 ,9	–		–	
Zn	–		–		–		**1,96**	**± 0,05**	**1,87**	**± 0,06**
Ag	–		–		–		–		–	
As	100,1	± 2,6	95,9	± 1,6	**0,0590**	**± 0,0016**	(2,9	± 0,3)	(2,9	± 0,2)
B	–		–		–		–		–	
Be	–		–		–		–		–	
Bi	8,1	± 0,9	8,3	± 1,0	3,2	± 0,03	–		–	
C	–		–		–		–		–	
Cd	7,0	± 0,4	7,3	± 0,6	2,2	± 0,2	–		–	
Co	–		–		1,2	± 0,1	–		–	
Cr	(< 2)		1,3	± 0,3	7,9	± 0,7	–		–	
Mg	–		–		–		–		–	
P	15,7	± 1,2	17,2	± 1,6	8,9	± 1,0	–		–	
Pb	**1,93**	**± 0,04**	**1,92**	**± 0,04**	**0,592**	**± 0,014**	**0,229**	**± 0,008**	**0,227**	**± 0,008**
S	–		–		–		**0,459**	**± 0,029**	**0,45**	**± 0,04**
Sb	23,8	± 1,3	24,1	± 1,0	6,1	± 0,7	**0,097**	**± 0,004**	**0,097**	**± 0,004**
Se	–		–		(< 10)		(<1)		(<1)	
Si	(5,5	± 5,2)	(5,8	± 4,1)	**0,187**	**± 0,008**	–		(<1)	
Sn	**0,232**	**± 0,006**	**0,174**	**± 0,006**	**0,0367**	**± 0,0011**	**3,99**	**± 0,08**	**3,98**	**± 0,10**
Te	–		–		–		–		–	
Ti	–		–		–		(<1)		–	
Zr	–		–		–		–		–	

(Values in parentheses are indicative values)
□) Accredited by DAkkS as a producer of RM according to ISO 17034
Δ) Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025

Oxygen in copper

Discs

Mass fraction in µg/g ± uncertainty

CRM-No.	BAM-379/1	BAM-379/2	BAM-379/3
Description	Pure copper	Pure copper	Pure copper
Cu	(matrix)	(matrix)	(matrix)
O	38 ± 4	212 ± 8	378 ± 12

(Values in parentheses are indicative values)

The samples 379/1 to 379/3 (year of issue: 2000) are available individually as well as in a set of all three samples. Each cylinder is 3 cm high and about 4 cm in diameter.

These samples are not certified reference materials as defined in the relevant standards because during certification analysis calibration was done using existing reference materials instead of pure chemicals or stoichiometric compounds.

Tin-lead solder –

Granulated powder

Mass fraction in % ± 95%-confidence interval

CRM-No.	BNM 010
Description	Sn63Pb37
Year of issue	1991
Sn	63,40 ± 0,07
Pb	36,47 ± 0,17
Bi	0,0245 ± 0,0010
Cd	0,0016 ± 0,0002
Cu	0,0417 ± 0,0014
Ni	0,0021 ± 0,0002
Sb	0,0488 ± 0,0008
Ag	(0,014)
As	(0,012)
Au	(< 0,001)
Fe	(0,0020)
In	(< 0,001)
Zn	(< 0,0001)

(Values in parentheses are indicative values)

Precious metal alloys

Slices

Mass fraction in % ± estimated expanded uncertainty (k=2,5)

CRM-No.	ERM®-EB506	ERM®-EB507	ERM®-EB508
Description	rose gold	white gold	yellow gold
Year of issue	2014	2014	2014
Au	58,56 ± 0,06	75,10 ± 0,11	75,12 ± 0,11
Ag	3,90 ± 0,05	3,02 ± 0,05	24,90 ± 0,05
Cu	35,65 ± 0,06	14,69 ± 0,05	–
Ni	–	4,99 ± 0,04	–
Zn	1,891 ± 0,018	2,107 ± 0,016	–

Zinc

Disc

Mass fraction in mg/kg ± 95%-confidence interval

CRM-No.	BAM-M601
Description	Pure zinc
Year of issue	2005
Cd	0,55 ± 0,06
Fe	2,20 ± 0,09
Cu	1,89 ± 0,11
Tl	2,25 ± 0,09
Pb	15,7 ± 0,3
Al	< 0,5
In	< 0,05

Zinc-alloy

Disc

Mass fraction in mg/kg (bold in %)
± estimated expanded uncertainty (k=2) (Fe: k=3)

CRM-No.	ERM®-EB602
Description	ZnAl4Cu1
Year of issue	2014
Al	**4,08 ± 0,11**
Cu	**0,812 ± 0,017**
Mg	**0,0415 ± 0,0020**
Pb	19,5 ± 3,0
Cd	1,1 ± 0,5
Fe	7,3 ± 1,6
Sn	1,0 ± 0,5
Ni	2,5 ± 0,4
Si	11,4 ± 1,9
Ti	4,8 ± 0,4

Zinc powder

BAM-M603[□]

Year of issue: 2019

Element	Certified values		Element	Informative values	
	Mass fraction in mg/kg	Uncertainty in mg/kg		Mass fraction in mg/kg	Uncertainty in mg/kg
Pb	15,8	0,5	Al	0,22	0,15
Ag	1,00	0,09	Bi	0,102	0,002
Cd	1,69	0,12	Co	0,041	0,004
Cu	3,69	0,21	Sb	0,04	0,02
Fe	2,18	0,14	As	<1	–
Ni	0,43	0,05	In	<0,5	–
Tl	3,81	0,23	Sn	<1	–
			V	<0,2	–

□) Accredited by DAkkS as a producer of RM according to ISO 17034

Zinc/Aluminum alloys, discs

for the determination of chemical composition and sputter factor (GDOES); Year of issue: 2020

Mass fraction in % (bold in mg/kg) ± estimated expanded uncertainty (*k* = 2)

CRM-No.	AlZn-G1	AlZn-G2	AlZn-G3	AlZn-G4	AlZn-G5	AlZn-G6
Description	Zn99.95	Zn99.9	Zn99.7	Zn99.7	Zn99	Zn97
Al	**494 ± 24**	0,101 ± 0,004	0,151 ± 0,004	0,198 ± 0,004	0,264 ± 0,011	0,894 ± 0,023
Fe	**71 ± 4**	0,0222 ± 0,0006	0,0416 ± 0,0003	0,0732 ± 0,0006	0,0907 ± 0,0023	0,146 ± 0,004
Si	–	–	–	–	–	–
Pb	**21,2 ± 1,2**	0,00218 ± 0,00017	0,00214 ± 0,00012	0,00197 ± 0,00014	0,053 ± 0,004	–
Mg	–	–	–	–	0,43 ± 0,03	1,83 ± 0,18
Zn	–	–	–	–	–	–
Sputter factor	(7,21)	(6,25)	(6,08)	(5,77)	(4,97)	(4,48)
Density/g cm^{-3}	(7,13)	(7,12)	(7,12)	(7,11)	(7,01)	(6,70)

CRM-No.	AlZn-G7	AlZn-G8	AlZn-G9	AlZn-G10	AlZn-11
Description	Zn93Al4Mg3	Zn95Al5	Zn80Al20	Zn48Al50	Zn44Al55
Al	3,91 ± 0,07	4,85 ± 0,16	19,5 ± 0,4	49,5 ± 1,3	55,2 ± 1,1
Fe	0,0057 ± 0,0003	0,0074 ± 0,0007	0,082 ± 0,005	0,594 ± 0,011	0,502 ± 0,011
Si	–	–	(0,246)	(1,463)	0,99 ± 0,09
Pb	–	0,100 ± 0,005	0,00214 ± 0,00012	–	–
Mg	3,28 ± 0,11	–	–	–	1,83 ± 0,18
Zn	–	–	–	(48,4)	(43,3)
Sputter factor	(3,80)	(3,52)	(1,97)	(0,81)	(0,72)
Density/g cm^{-3}	(6,19)	(6,59)	(5,36)	(3,87)	(3,70)

(Values in parentheses are indicative values)

Lead-alloys, discs

Mass fraction in mg/kg (bold in %) ± estimated expanded uncertainty (*k*=2)

CRM-No.	ERM®-EB101a	ERM®-EB102a	ERM®-EB103
Description/ year of issue	PbCaSnAl/ 2009	PbCaSn/ 2009	PbSb1,6/ 2006
Ca	**0,136 % ± 0,007 %**	**0,0635% ± 0,0022%**	–
Sn	**0,294 % ± 0,006 %**	**1,01 % ± 0,05 %**	**0,183% ± 0,026%**
Al	**0,0227% ± 0,0009%**	124 ± 11	–
Ag	29,0 ± 1,1	170 ± 6	66 ± 6
Bi	165 ± 7	73,7 ± 2,6	158 ± 4
Cu	24,3 ± 1,1	1,3 ± 0,4	9,7 ± 0,9
Sb	(< 1,2)	(4 ± 4)	**1,64 % ± 0,06 %**
As	(< 2)	(< 2)	**0,097% ± 0,004%**
Se	–	–	180 ± 10
Tl	10,2 ± 0,6	30,2 ± 1,5	15,2 ± 0,7
Ni	(< 0,6)	–	3,02 ± 0,27
P	(< 3)	–	–
Cd	(< 2)	–	0,20 ± 0,08
S	(< 3)	(< 3)	(5,4 ± 1,2)
In	–	(< 2)	–
Te	(< 3)	(< 1,1)	(1,9 ± 0,6)
Zn	1,0 ± 0,8	(< 0,5)	–
Fe	(< 2)	(< 2)	–
Mg	(9 ± 1)	(< 1)	–
Na	(4 ± 1)	(4 ± 1)	–

(Values in parentheses are indicative values)

Lead, lead alloys, discs

Mass fraction in mg/kg (bold in %) ± estimated expanded uncertainty (*k*=2)

CRM-No.	ERM®-EB104	ERM®-EB105	ERM®-EB106
Description	PbCaSn	PbCaSn	PbCaSn
Year of issue	2011	2011	2011
Ca	**0,0530% ± 0,0018%**	**0,0595% ± 0,0016%**	**0,0782% ± 0,0026%**
Sn	**1,27 % ± 0,007 %**	**1,43 % ± 0,07 %**	**1,72 % ± 0,05 %**
Ag	(29,3)	32,1 ± 0,9	(32,3)
Bi	(126)	133 ± 5	(135)

(Values in parentheses are indicative values)

Mass fraction in mg/kg ± estimated expanded uncertainty (*k*=2)

CRM-No.	ERM®-EB107	ERM®-EB108
Description	Pure lead	Pure lead
Year of issue	2015	2015
Cd	26,1 ± 1,1	26,0 ± 1,3
Hg	11,3 ± 0,9	8,3 ± 0,9

Mass fraction in mg/kg (bold in %) ± estimated expanded uncertainty (*k*=2)

CRM-No.	BAM-M109^Δ	BAM-M110^Δ	BAM-M112^Δ
Description	Refined lead	PbSb3	Pure lead
Year of issue	2018	2018	2020
As	**0,0113 ± 0,0006**	**0,107 ± 0,008**	–
Bi	**0,0193 ± 0,0006**	**0,0126 ± 0,0004**	(70)
Sb	**0,0098 ± 0,0003**	**3,08 ± 0,08**	–
Se	–	**0,0106 ± 0,0014**	–
Sn	**0,115 ± 0,004**	**0,131 ± 0,004**	5,2 ± 0,4
Ag	45,1 ± 1,0	22,6 ± 1,7	(8)
Cd	35,3 ± 0,9	–	–
Cu	19,6 ± 0,7	6,4 ± 0,4	8,2 ± 0,6
Ni	3,5 ± 0,3	–	5,3 ± 0,4
Te	30,6 ± 1,5	3,8 ± 0,9	5,3 ± 0,3
Tl	3,0 ± 0,5	–	(13)
Zn	31,8 ± 2,1	(<1)	–
Al	(<2,1)	–	–
In	(<0,5)	–	–
Pt	–	–	5,4 ± 0,5

(Values in parentheses are indicative values)
Δ) Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025

Special materials

The CRMs in the field of **high tech ceramics** and of **refractory metals** were produced and certified by BAM in collaboration with the Working Group "Special Materials" of the Committee of Chemists of the Gesellschaft für Bergbau, Metallurgie, Rohstoff- und Umwelttechnik (GDMB). The analyses were carried out in BAM and in national and international laboratories of producers and users of these materials and of research institutes. The powder samples are supplied in tightly closed glass bottles containing 50 g or 100 g each.

The **glass** CRMs were produced and certified by BAM in collaboration with the Technical Committee 2 of the International Commission on Glass (ICG, TC-2). The analyses were carried out in BAM and in the laboratories of international members of ICG, TC-2 and some other laboratories. All laboratories are from glass making industry or from glass research institutes. The crushed glass sample (BAM-S004) is supplied in glass bottles containing 50 g each.

The **pure substances** are intended for analyte calibration and matrix simulation of atomic spectrometric methods, especially for X-ray fluorescence analysis (XRF). The samples were prepared and certified by Arbeitsgemeinschaft "Zertifiziertes Referenzmaterial Eisen und Stahl" (BAM, VDEh, MPI für Eisenforschung), Working Group "Primary substances for calibration". They can be ordered in polyethylene bottles with a unit size of 100 g. Each sample is distributed together with a certificate which contains the certified values together with their uncertainties (95%-level, if necessary extended by contributions from sample inhomogeneity) and the indicative values. The mean values of the accepted data sets, their standard deviations and the standard deviations of the mean values of laboratories are also given in the certificate together with the laboratories participating in the certification campaign and the analytical methods used for determination of element mass fractions or other parameters.

The material **BAM-H010** intended for use in quality assurance of measurements of elements in polymers and related matrices in order to support e.g. the EU directive 2002/95/EG (RoHS). The development and production of the acrylonitrile-butadiene-styrene terpolymer (ABS) has been carried by the Fachhochschule Münster. The certification process has been carried out by BAM. The reference material is available in form of granulate (100 g) or as discs with a diameter of 4 cm and a thickness of 1, 2 or 6 mm.

High tech ceramics

Boron carbide powder

ERM®-ED102

Analyte	Certified value	Uncertainty *	Unit of mass fraction
Al	157	5	mg/kg
Ca	97	8	mg/kg
Co	0,39	0,09	mg/kg
Cr	5,6	1,2	mg/kg
Cu	2,2	0,4	mg/kg
Fe	686	22	mg/kg
Mn	10,4	0,5	mg/kg
Na	6,3	0,9	mg/kg
Ni	8,0	1,6	mg/kg
Si	268	22	mg/kg
Ti	96	5	mg/kg
Zr	48,9	2,3	mg/kg
C_{total}	21,01	0,28	%
O	0,10	0,04	%
N	0,209	0,026	%
B_{total}	78,47	0,31	%
$B_{soluble}$	0,116	0,013	%
B_2O_3	0,075	0,023	%
^{10}B 1)	19,907	0,014	Isotopic abundance in %
	Indicative value	Uncertainty *	Unit of mass fraction
Mg	3,2	1,0	mg/kg
W	3,6	2,1	mg/kg
C_{free}	0,51	0,12	%

* The uncertainty is the expanded uncertainty estimated in accordance with the Guide to the Expression of Uncertainty in Measurements (GUM) with a coverage factor of *k*=2.

1) Isotopic abundance (amount fraction) of ^{10}Boron related to total amount of Boron.

Boron nitride powder

ERM®-ED103

Analyte	Certified value 1)	Uncertainty 2)	Unit of mass fraction
Al	7,0	1,4	mg/kg
Ca	273	16	mg/kg
Cr	4,7	1,1	mg/kg
Fe	15,0	2,2	mg/kg
Mg	56	5	mg/kg
Na	12,3	1,0	mg/kg
Si	17	4	mg/kg
Ti	4,9	0,7	mg/kg
Co	(<0,1)	–	mg/kg
O	0,68	0,19	%
N	55,6	0,6	%
B_{total}	43,5	0,5	%
B_2O_3 adherent	0,070	0,014	%
C	(0,018)	(0,009)	%
H_2O	(<0,1)	–	%

(Values in parentheses are indicative values)

1) The certified values are the means of 5 - 13 series of results (depending on the parameter) obtained by different laboratories. Up to 6 different analytical methods were used for the measurement of each parameter. The calibration of the methods applied for determination of element mass fractions were carried out by using pure substances of definite stoichiometry or solutions prepared from them, thus, ensuring traceability to SI units.

2) The certified uncertainty is the expanded uncertainty estimated in accordance with the Guide to the Expression of Uncertainty in Measurements (GUM) with a coverage factor *k* = 2. It includes contributions from sample inhomogeneity and sample stability.

Yttrium stabilized zirconium oxide

ERM®-ED105

Analyte	Certified value [1)]	Uncertainty [2)]	Unit of mass fraction
Al	660	15	mg/kg
Ca	242	9	mg/kg
Fe	95	9	mg/kg
Mg	12,9	1,7	mg/kg
Si	195	40	mg/kg
Th	112	17	mg/kg
Ti	497	11	mg/kg
U	292	19	mg/kg
Hf	1,535	0,024	%
Y	6,11	0,09	%
P	(< 75)	–	mg/kg
ZrO_2 (monoclinic)	(1,94)	–	%

(Values in parentheses are indicative values)

[1)] The certified values are the means of 11-20 series of results (depending on the parameter) obtained by different laboratories. Up to 7 different analytical methods were used for the measurement of each parameter. The methods applied for determination of element mass fractions were calibrated using pure substances of definite stoichiometry or solutions prepared from them, thus achieving traceability to the International System of Units (SI).

[2)] The uncertainty of the certified value is the expanded uncertainty estimated in accordance with the Guide to the Expression of Uncertainty in Measurement (GUM) with a coverage factor *k* = 2. It includes contributions from sample inhomogeneity.

Silicon carbide powder

Analyte	BAM-S003a (green micro F 800)		BAM-S008 (transparent 200/F)	
	Mass fraction mg/kg	Uncertainty mg/kg	Mass fraction mg/kg	Uncertainty mg/kg
Al	372	20	47	7
B	63	7	3,0	1,2
Ca	29,4	2,7	0,25	0,6
Cr	3,5	0,4	0,16	0,05
Cu	1,5	0,4	0,10	0,05
Fe	149	15	4,8	0,8
Mg	6,3	0,9	0,07	0,07
Mn	1,44	0,25	0,05	0,02
Na	17,7	0,8	0,17	0,09
Ni	32,9	2,7	0,9	0,5
Ti	79	4	67	6
V	41	5	275	18
Zr	25,2	2,0	4,4	1,2
C_{free}	493	79	–	–
O	(910)	(53)	146	36
N	(93)	(22)	18	4
$SiO_{2\,free}$	(600)	(148)	–	–
Si_{free}	(481)	(223)	–	–
	Mass fraction %	Uncertainty %	Mass fraction %	Uncertainty %
C_{total}	29,89	0,07	29,9	0,1
C_{free}	–	–	0,045	0,010

(Values in parentheses are indicative values)

Refractory metals,Tungsten metal powder
BAM-S002

Analyte	Mass fraction mg/kg	Uncertainty mg/kg
Al	29,4	0,9
Ca	46	4
Co	45	6
Cr	47,0	1,4
Cu	28,4	2,9
Fe	53	5
K	40,0	1,8
Mg	38,8	2,7
Mn	16,7	1,9
Mo	59	4
Na	41	5
Ni	29	4
P	(7,2)	(1,3)
Si	106	10
Sn	42	6

(Values in parentheses are indicative values)

Glass containing hexavalent chromium
BAM-S004

Analyte	Mass fraction	Uncertainty mg/kg
Mass fraction in mg/kg		
Cr-(VI)	94	5
Cr-total	471	25
Mass fraction in %		
SiO_2	(70,9)	
Na_2O	(14,5)	
CaO	(9,4)	
Al_2O_3	(2,15)	
BaO	(1,2)	
MgO	(0,90)	
ZnO	(0,33)	
SO_2	(0,17)	
K_2O	(0,16)	
Cr_2O_3	(0,07)	
Fe_2O_3	(0,06)	
CuO	(0,04)	

(Values in parentheses are informative values)

Multielement-glass
BAM-S005c

Element		Mass fraction [1] in %		Uncertainty [2] in %
Al	(Al_2O_3)	0.587	(1.109)	0.018
Ca	(CaO)	7.43	(10.39)	0.12
K	(K_2O)	0.595	(0.717)	0.014
Mg	(MgO)	1.37	(2.28)	0.04
Na	(Na_2O)	10.33	(13.92)	0.24
Si	(SiO_2)	33.1	(70.8)	0.5
		in mg/kg		in mg/kg
As	(As_2O_3)	81	(107)	4
Ba	(BaO)	102	(114)	4
Cd	(CdO)	47	(54)	4
Ce	(CeO_2)	80	(98)	5
Co	(CoO)	33.2	(42.3)	1.9
Cr	(Cr_2O_3)	10.8	(15.8)	1.0
Cu	(CuO)	86	(107)	5
Fe	(Fe_2O_3)	295	(422)	7
Mn	(MnO)	69.6	(89.9)	2.5
Mo	(MoO_3)	215	(323)	7
Ni	(NiO)	41.3	(52.6)	1.7
Pb	(PbO)	182	(196)	8
Sb	(Sb_2O_3)	103	(123)	4
Sn	(SnO_2)	72.9	(92.5)	2.3
Sr	(SrO)	134	(158)	6
Ti	(TiO_2)	101	(169)	6
V	(V_2O_5)	189	(337)	8
Zn	(ZnO)	157	(196)	6
Zr	(ZrO_2)	544	(735)	26

(Values in parenthesis are calculated using the molar masses)

Titanium diboride powder

BAM-S012

Parameter	Certified values		Parameter	Informative values	
	Mass fraction in %	Uncertainty in %		Mass fraction in %	Uncertainty in %
Ti	68,3	0,8	C	0,169	0,008
B	30,71	0,15	N	0,120	0,007
B_2O_3	0,359	0,024	O	0,48	0,08
			R_{acid}	0,22	0,03
	in mg/kg			in mg/kg	
Al	12,0	1,3	Si	11	5
Ca	44	4	Na	< 10	–
Cr	97	4	Nb	1700	–
Fe	640	40	S	2	–
Mg	1,6	0,4	W	114	–
Mn	3,8	0,4	Particle size distribution determined by laser light diffraction method		
Mo	11,7	0,7			
Ni	23,5	1,1	D_{97}	33,8 µm	
V	10,2	0,8	D_{50}	12,3 µm	
Zr	121	4	D_{06}	2,3 µm	

Iron in flat glass

BAM-S050, BAM-S051, BAM-S052

CRM	Parameter	Mass fraction in %	Uncertainty in %	Element	Mass fraction in %	Uncertainty in %
	Certified values				Values for information	
BAM-S050	Fe(II)	0,0026	0,0004	Fe(III), calculated	0,0058	0,0012
BAM-S050	Fe(total)	0,0084	0,0012	Fe(II), calculated as Fe_2O_3	0,0037	0,0007
BAM-S051	Fe(II)	0,0155	0,0013	Fe(III), calculated	0,0326	0,0021
BAM-S051	Fe(total)	0,0481	0,0017	Fe(II), calculated as Fe_2O_3	0,0226	0,0022
BAM-S052	Fe(II)	0,160	0,005	Fe(III), calculated	0,437	0,011
BAM-S052	Fe(total)	0,597	0,011	Fe(II), calculated as Fe_2O_3	0,229	0,008

Borosilicate glass

BAM-S053

Hydrolytic resistance of borosilicate glass,
Glass grains tests (ISO 720, USP<660>, Ph.Eur. 3.2.1, ISO 719)

Acid consumption according to	Consumption of 0,02M HCl per g in mL	Uncertainty in mL
ISO 720	0,0422	0,0030
USP<660>	0,0428	0,0025
Ph.Eur. 3.2.1	0,0429	0,0026
	Values for information	
	Consumption of 0,01M HCl per g in mL	Uncertainty in mL
ISO 719	0,036	0,006

Medium purity graphite powder

BAM-S009

Certified values

Parameter	Mass fraction in mg/kg	Uncertainty in mg/kg
Al	0,27	0,08
B	0,83	0,18
Ba	0,80	0,09
Be	0,00050	0,00027
Ca	5,1	1,1
Co	0,143	0,017
Cr	1,39	0,20
Cu	0,067	0,012
Fe	28	4
K	1,04	0,20
Li	0,022	0,007
Mg	0,135	0,030
Mn	0,094	0,015
Mo	0,20	0,04
Na	0,32	0,08
Ni	5,6	0,6
P	0,26	0,06
Pb	0,052	0,028
S	10,7	1,8
Si	41	6
Sr	0,32	0,05
Ti	8,6	1,6
V	1,30	0,17
W	3,0	0,6
Y	0,049	0,011
Zn	0,070	0,018
Zr	0,81	0,19

Values for information

Parameter	Mass fraction in mg/kg	Uncertainty in mg/kg
Ag	0,0018	0,0010
As	0,016	0,007
Bi	0,016	0,012
Cd	0,0022	0,0019
Eu	0,0021	0,0010
Sb	0,022	0,015
Sc	0,012	0,010
Sn	0,16	0,05
Ta	0,018	0,014
B_{ETV}	0,22 [4)]	0,09
Si_{ETV}	12,8 [4)]	2,4

Further informative values (laboratory mean values without statistical evaluation)

Mass fraction in mg/kg

Line no.	Au	Cs	Dy	Ga	Gd	Hg	In	La	Nb	Rb
1	< 0,00005	0,0038	0,010	< 0,02	0,021	0,0089	< 0,026	0,103	0,11	< 0,02
2	< 0,0032	0,0038	0,012		0,025	0,0089	< 0,05			
3	< 0,07		< 0,07		< 0,1	< 0,031				
4						< 0,06				

(continued)

Line no.	Re	Rh	Se	Sm	Tb	Te	Th	U		Ash
1	< 0,0006	< 0,0055	0,011	0,012	0,0034	0,015	0,011	0,022		202
2	< 0,0086	< 0,4		0,014	0,0037	0,026	0,030	0,037		
3				< 0.3				< 0,1		

Niobium pentoxide

BAM-S011

Parameter	Mass fraction mg/kg	Uncertainty mg/kg
F	128	13
Al	(0,29)	(0,16)
Cr	(0,031)	(0,005)
Cu	(0,040)	(0,009)
Fe	(0,26)	(0,08)
Ta	(8)	(6)
Mo	(< 0,05)	–
Ni	(< 0,3)	–
Particle size	**Value in µm**	
d_{10}	(0,87)	–
d_{50}	(2,2)	–
d_{90}	(18,1)	–

(Values in parentheses are informative values)

Acrylonitrile-butadiene-styrene copolymerisate (ABS)

BAM-H010

Analyte	Mass fraction µg/g	Uncertainty * µg/g
Pb	479	17
Br	240	21
Cd	93	5
Cr	470	36
Hg	(415)	–

(Value in parentheses an indicative value)

* The uncertainty is the expanded uncertainty with a coverage factor of k=2 and was determined according to the Guide to the Expression of Uncertainty in Measurement (GUM, ISO) 1993.

Pure substances

Mass fraction in µg/g (bold in %) ± 95%-confidence interval

CRM-No.	RS 1	RS 2	RS 3	RS 4	RS 5	RS 6A	RS 6B
Type	SiO_2[1)] >99,99 %	Al_2O_3[2)] 99,76 %	$CaCO_3$[3)] 99,79 %	Ni[4)] 99,995 %	NiO[5)]	MgO[6)] 100-350 µm	MgO[6)] 50-100 µm
Year	1991	1994	1994	1996	1996	1998	1998
CO_2	–	–	**43,95%**	–	–	–	–
H_2O	–	**0,22%**	**0,13%**	–	**0,015%**	110	283
Ag	–	–	–	< 1	< 1	–	–
Al	8,7 ± 0,7	–	(< 5)	< 1	(< 15)	45 ± 9	49 ± 8
As	< 0,1	(< 0,5)	–	< 0,5	< 0,2	–	–
B	–	(< 5)	(< 0,2)	(< 2)	–	–	–
Ba	–	–	45,3 ± 1,7	–	< 1	(< 10)	(< 20)
Be	–	(< 0,2)	–	–	–	–	–
C	–	–	–	9,4 ± 2,0	14 ± 8	(< 50)	(< 210)
Ca	0,42 ± 0,09	3,1 ± 0,4	–	< 1	2,2 ± 0,9	994 ± 93	956 ± 149
Cd	< 0,05	(< 0,5)	(< 0,5)	< 0,2	< 0,2	–	–
Ce	–	(< 0,1)	–	–	–	–	–
Cl	–	(< 10)	–	–	–	–	–
Co	–	< 1	–	< 1	< 2	(< 5)	(< 5)
Cr	0,062 ±0,021	< 1,5	< 1	< 0,5	16,1 ± 2,0	9,2	8,1
Cu	< 0,1	< 2,5	< 1	< 2	1,53 ± 0,18	(< 6)	(< 6)
Fe	0,62 ± 0,12	3,3 ± 1,6	< 5	4,2 ± 1,6	41 ± 7	72	71
Ga	–	(< 2)	(< 1,5)	< 0,2	< 0,5	–	–
Ge	< 1	–	–	–	–	–	–
Hg	< 0,05	–	–	(< 1)	–	–	–
In	–	(< 0,5)	–	(< 0,2)	(< 1)	–	–
K	0,48 ± 0,27	(< 5)	(< 30)	–	< 2	–	–
La	–	(< 0,3)	(< 0,5)	–	–	–	–
Li	0,25 ± 0,14	< 1	–	–	(< 2)	–	–
Mg	< 0,5	< 3	183 ± 5	< 0,8	< 1	**60,19%**	**60,17%**
Mn	< 0,2	< 1,5	3,0 ± 0,5	< 0,5	< 1	5,4	5,2
Mo	–	(< 1)	–	(< 0,2)	< 5	(< 10)	(< 10)
N	–	–	–	2,5 ± 1,0	–	–	–
Na	< 2	< 15	47,5 ± 2,7	(< 1)	< 2	–	–
Ni	< 0,2	< 10	(< 3)	**99,995%±0,003%**	**78,57% ± 0,06%**	3,9	3,3
O	–	–	–	(29)	**21,41% ± 0,06%**	–	–
Pb	< 0,15	–	(< 0,1)	< 1	< 2	(< 5)	(< 5)
S	–	–	–	(< 2)	(4)	–	–
Sb	–	–	–	< 0,2	(< 0,1)	–	–
Se	–	–	–	< 1	< 1	–	–
Si	–	< 20	(< 20)	(< 2)	(< 5)	–	–

(Values in parentheses are indicative values)

- continued -

Pure substances (continued)

CRM-No.	RS 1	RS 2	RS 3	RS 4	RS 5	RS 6A	RS 6B
Type	SiO_2 1) > 99,99 %	Al_2O_3 2) 99,76 %	$CaCO_3$ 3) 99,79 %	Ni 4) 99,995 %	NiO 5)	MgO 6) 100-350 µm	MgO 6) 50-100 µm
Year	1991	1994	1994	1996	1996	1998	1998
Sn	–	(< 1)	(< 1)	< 0,3	(< 1)	–	–
Sr	–	–	173 ± 8	–	(< 1)	2,0	2,1
Te	–	–	–	(< 0,2)	(< 0,2)	–	–
Ti	1,3 ± 0,4	< 2	(< 0,5)	–	(< 2)	1,3	1,2
Tl	–	–	–	< 0,2	(< 0,5)	–	–
V	–	(< 1)	–	(< 0,2)	< 1	8,4	7,8
W	–	–	–	(< 0,1)	(< 1)	–	–
Zn	< 1,3	< 2	< 2	< 4	3,4 ± 0,7	(< 6)	(< 6)
Zr	< 0,1	3,2 ± 1,3	(< 0,2)	–	(< 1)	(< 20)	(< 105)

(Values in parentheses are indicative values)

1) α-quartz, mean particle size: 150 µm

2) α-aluminium oxide, average surface: 5,6 m^2/g, bulk density: ca. 1,1 kg/L

3) Pure calcite, the CO_2-content is given for the water free sample. It is 99,96 % of the theoretical value.

4) Pure electrolytic nickel, the weight of one particle after milling is about 2 – 4 mg.

5) Powdered nickel(II)oxide made by oxidation of powdered nickel (made by thermal decomposition of nickel carbonyl) with a particle size of 5 – 20 µm.

6) Crystalline magnesium oxide with two different particle sizes

Platinum group elements (PGE) in used automobile catalyst

ERM®-EB504a Δ)

Element	Certified value	Uncertainty
	Mass fraction in mg/kg	
Pt	1414	9
Pd	1596	11
Rh	210,0	2,2

Δ) Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025

Electronic scrap

BAM-M505a

Element	Mass fraction in %	Uncertainty in %
Cu	16,76	0,04
Ni	0,694	0,006
Ag	0,0633	0,0009
Pb	1,13	0,05
Cr	0,980	0,017
Sn	0,468	0,015
	in mg/kg	in mg/kg
Au	52,4	0,9
Pd	48,0	0,8
Pt	5,7	0,4
As	372	20
Be	6,8	0,9
Cd	16,4	0,7
	Informative value	
	Mass fraction in mg/kg	Uncertainty in mg/kg
In	43	6
Hg	< 5	–

Environment

Calibration standards “Ethanol in Water”

The certified reference materials are solutions of ethanol in water, prepared gravimetrically in units of about 4 L. The ethanol concentration at 20 °C is certified.

Application: Calibration of breath alcohol analysers according to DIN VDE 0405-4; validation of methods for the analysis of ethanol in aqueous samples

Identifier	Concentration g/L	Expanded Uncertainty g/L
BAM-K001	1,0292	± 0,0010
BAM-K002	0,0000	± 0,0001
BAM-K003	0,6100	± 0,0006
BAM-K004	1,2100	± 0,0012
BAM-K005	1,4500	± 0,0014
BAM-K006	1,8200	± 0,0018
BAM-K007	3,3900	± 0,0033

Currently, the calibration standards are only sold to customers in Germany. Certificates are only available in German. To customers outside of Germany the standards may be sold on request. Please pay attention to the delivery notes given in our webshop [https://webshop.bam.de]!

Calibration standard for the determination of mineral oil hydrocarbons in environmental matrices using gas chromatography

BAM-K010g Diesel oil/lubricating oil (1:1)

Certified parameter	Value in g/g	Uncertainty *U* in g/g
Mass ratio of diesel oil/lubricating oil	1,000028	0,000014

Sulfur in petrol

ERM®-EF213

This material is a petroleum product containing sulfur (S) in its natural forms, closely matching commercial petrol fuels at a sulfur concentration slightly lower than actual legal limits in Germany and EU. The absence of artificially added sulfur species avoids any effects arising from species specific analytical methods. A suitable supply of petrol was obtained in bulk from ESSO Deutschland GmbH, Ingolstadt, Germany. The main purpose of the materials is to assess method performance, i.e. for checking accuracy of analytical results. As any reference material, it can also be used for control charts or validation studies.

Certified property	Mass fraction	
	Certified value 1) mg/kg	Uncertainty 2) mg/kg
S	9,1	0,8

1) Unweighted mean of three sets of results obtained using isotope-dilution mass spectrometry applied as primary method of measurement. The value is traceable to the International System of Units (SI).

2) The certified uncertainty is the expanded uncertainty estimated in accordance with the Guide to the Expression of Uncertainty in Measurement (GUM) with a coverage factor of k=2, corresponding to a level of confidence of about 95%

Organochloropesticides (OCP) in soil

ERM®-CC007a

Certification of the content of six DDT, DDE and HCH isomers in industrial soil.

Use of CRM for the validation and checking of the accuracy of analytical procedures for the quantitative determination of the contents of selected relevant organochloropesticides in soil by gas chromatography.

Compound	Certified value 1)	Uncertainty 2)
α-HCH	219	23
β-HCH	1570	210
γ-HCH	21,4	2,6
p,p‘-DDE	380	60
o,p‘-DDT	340	50
p,p‘-DDT	960	140

All values are given in µg/kg

1) The certified value is the mean of 7-8 laboratory means using GC-ECD and GC-MS including IDMS. The values are traceable to the SI (Système International d’Unités) via calibration using substances with certified purity.

2) Estimated expanded uncertainty with a coverage factor of k=2, corresponding to a level of confidence of 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement, (GUM, ISO), 1993.

Pentachlorophenol (PCP) in soil

ERM®-CC008 (BAM-U008), ERM®-CC009 (BAM-U009)

Certification of the content of PCP in two industrial soils.

Use of CRMs for the validation and checking of the accuracy of analytical procedures for the quantitative determination of the content of pentachlorophenol in soil.

CRM-No.	Compound	Certified value 1)	Uncertainty 2)
ERM®-CC008	Pentachlorophenol (PCP)	2,04	0,18
ERM®-CC009	Pentachlorophenol (PCP)	2,91	0,23

All values are given in mg/kg

1) Unweighted mean value of 5 laboratory means using three different chromatographic methods combined with four detection principles (see below). The values are traceable to the SI (Système International d’Unités) via calibration using sufficiently pure substances.

2) Estimated expanded uncertainty with a coverage factor of k=2, corresponding to a level of confidence of about 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM, ISO), 1995.

Polycyclic aromatic hydrocarbons in soil

BAM-U013c[Δ)]

Certified properties: Contents of 15 [1)] of priority pollutant polycyclic aromatic hydrocarbons (PAH) according to EPA and the sum of the 15 listed PAH in industrial soil

Application: Validation and checking of the accuracy of analytical procedures for the quantitative determination of the contents of PAH in soil or similar solid matrices

Compound	Certified value [2)]	Uncertainty [3)]
Naphthalene	1,9	0,4
Acenaphthene	0,69	0,14
Fluorene	0,98	0,09
Phenanthrene	7,0	0,5
Anthracene	2,38	0,12
Fluoranthene	14,2	0,7
Pyrene	9,7	0,6
Benzo[a]anthracene	9,6	0,6
Chrysene	10,6	0,6
Benzo[b]fluoranthene	11,3	1,2
Benzo[k]fluoranthene	4,7	0,3
Benzo[a]pyrene	8,1	0,8
Dibenz[a,h]anthracene	2,02	0,26
Benzo[ghi]perylene	5,5	0,4
Indeno[1,2,3-cd]pyrene	5,5	0,5
PAH sum	94,2	4,0

All values are given as mass fractions in mg/kg

1) The mass fractions of Acenaphthylene (0,65 mg/kg) are given as not certified indicative values.

2) The certified values are the unweighted mean value of 16 laboratory means using HPLC/DAD/F or GC/MS. The values are traceable to the SI (Système International d'Unités) via calibration using sufficiently pure substances.

3) Estimated expanded uncertainty with a coverage factor of *k*=2, corresponding to a confidence level of approximately 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM), ISO, 2008.

Δ) Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025

Mineral oil contaminated sediment and soil

BAM-U015b, BAM-U021a and BAM-U022

Certified properties: Mineral oil content or total hydrocarbon (TPH) in sediment or soil to be determined by GC/FID

Application: Validation and checking of the accuracy of analytical procedures for the quantitative determination of mineral oil in sediment by gas chromatography (GC-FID) according to ISO 16703:2004 (soil quality)

CRM-No.	Measurand	Certified value [1)]	Uncertainty [2)]
BAM-U015b sediment	Total petrol hydrocarbon (TPH)	920	100
BAM-U021a soil	Total petrol hydrocarbon (TPH)	2801	204
BAM-U022 sediment	Total petrol hydrocarbon (TPH)	8270	550

All values are given in mg/kg.

1) Unweighted mean value of 11-14 laboratory means using gas chromatography with flame ionisation detection (GC/FID) according to ISO 16703:2005.

2) Estimated expanded uncertainty with a coverage factor of *k* =2, corresponding to a confidence level of approximately 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM), ISO, 2008

Polychlorinated biphenyls in soil

BAM-U019a

Measurand	Certifies values [1)]	Uncertainty [2)]
PCB-28	0,157	0,021
PCB-52	1,67	0,23
PCB-101	1,8	0,4
PCB-118	1,48	0,16
PCB-138	1,02	0,13
PCB-153	0,84	0,19
PCB-180	0,213	0,030

All values are given in mg/kg.

1) Unweighted mean value of 10 laboratory means

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, (GUM, ISO/IEC Guide 98-3:2008) [1].

Trace elements in contaminated sandy soil and river sediment

ERM®-CC020

Certified properties: Aqua regia extractable (ISO 11466) mass fractions

The material is intended for the verification of analytical results obtained by standardised procedures as well as for the validation of modified or new analytical procedures.

CRM-No.	ERM®-CC020 River sediment	
Analyte	Aqua regia extractable mass fractions	
	Certified value	Uncertainty [1]
As	56,6	2,6
Cd	20,8	0,5
Co	290	8
Cr	32,8	1,5
Cu	560	11
Hg	255	11
Ni	27,4	0,6
Pb	158	6
V	53	4
Zn	2030	40

All values are given in mg/kg.

[1] Estimated expanded uncertainty with a coverage factor of *k*=2,5, corresponding to a level of confidence of about 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM), ISO, 1995.

Trace elements in contaminated soils

BAM-U110

Certified properties: Total and aqua regia extractable (ISO 11466) mass fractions

The material is intended for the verification of analytical results obtained by standardised procedures as well as for the validation of modified or new analytical procedures. Furthermore, it can be used for quality control or calibration purposes if X-ray fluorescence spectrometry or other methods of direct solid state analysis are applied.

Analyte	Total mass fractions		Aqua regia extractable mass fractions	
	Certified value	Uncertainty [1]	Certified value	Uncertainty [1]
As	15,8	1,4	13,0	1,1
Cd	7,3	0,6	7,0	0,4
Co	16,2	1,6	14,5	0,8
Cr	230	13	190	9
Cu	263	12	262	9
Hg	51,5	4,1	49,3	2,9
Mn	621	20	580	19
Ni	101	5	95,6	4,0
Pb	197	14	185	8
Zn	1000	50	990	40

All values are given in mg/kg.

[1] Estimated expanded uncertainty with a coverage factor of *k*=2, corresponding to a level of confidence of about 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM), ISO, 1995.

Trace elements in contaminated soils

BAM-U115

Certified properties: Aqua regia extractable (EN 16174) mass fractions

The material is intended for the verification of analytical results obtained by standardised procedures as well as for the validation of modified or new analytical procedures.

Analyte	BAM-U115 [Δ]			
	Extraction according to EN 16174, Method A [1] (open vessel, reflux conditions)		Extraction according to EN 16174, Method B (microwave-assisted, 175 °C)	
	Mass fraction in mg/kg	Uncertainty [2] in mg/kg	Mass fraction in mg/kg	Uncertainty [2] in mg/kg
As	27,7	0,9	27,9	1,1
Cd	4,52	0,17	4,65	0,16
Co	7,35	0,28	7,3	0,4
Cr	96,9	2,7	99,6	2,9
Cu	167	5	171	6
Hg	4,00	0,17	4,07	0,14
Ni	29,3	1,1	29,9	1,0
Pb	164	6	169	5
V	22,4	1,1	23,5	1,1
Zn	342	9	349	12

The certified values are corrected to the dry mass content of the material determined according to ISO 11465. They are operationally defined by the analytical protocols given in EN 16174.

[1] Extraction procedure according to EN 16174, Method A, is identical to the analytical protocol given in ISO 11466.

[2] Estimated expanded uncertainty with a coverage factor of k = 2, corresponding to a level of confidence of approximately 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM, ISO/IEC Guide 98-3:2008).

[Δ] Accredited by DAkkS as a producer of RM in accordance with ISO Guide 34 in combination with ISO/IEC 17025

Total cyanide in soil

BAM-U116/CGL306

Certified property: Mass fraction of total cyanide

The material is intended for the verification of analytical results obtained when applying the standardised procedure ISO 11262:2011 for the determination of total cyanide in soils and soil-like materials. As any reference material, it can also be used for routine performance checks (quality control charts).

The reference material was certified in cooperation with Central Geological Laboratory (CGL), Ulaanbaatar/Mongolia.

Analyte	Certified value [1]	Uncertainty [2]
Total cyanide according to ISO 11262:2011	12,0	0,8

All values are given in mg/kg.

[1] Unweighted mean value of 14 laboratory means which were corrected to the dry mass content of the material after drying to constant mass at (105 ± 2) °C.

[2] Estimated expanded uncertainty with a coverage factor of k = 2, corresponding to a level of confidence of approximately 95%, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM, ISO/IEC Guide 98-3:2008).

Food

Acrylamide in crispbread

ERM®-BD272

Compound	Certified value	Uncertainty
Acrylamide	0,98 mg/kg	0,09 mg/kg

Acrylamide in rusk

ERM®-BD274

Compound	Certified value	Uncertainty
Acrylamide	74 µg/kg	7 µg/kg

Fusarium mycotoxins in wheat flour

ERM®-BC600

Compound [1]	Certified value	Uncertainty
Deoxynivalenol (DON)	102 µg/kg	11 µg/kg
Nivalenol (NIV)	1000 µg/kg	130 µg/kg
Zearalenone (ZON)	90 µg/kg	8 µg/kg

1) DON, NIV and ZON as measured by using appropriate sample preparation techniques (e.g. solvent extraction, clean-up, derivatisation), instrumental separation (HPLC, GC) and detection techniques corrected for extraction efficiency/recovery.

Zearalenone in maize germ oil

ERM®-BC715

Compound	Certified value	Uncertainty
Zearalenone (ZON)	362 µg/kg	22 µg/kg

T-2 and HT-2 toxin in oat flakes

ERM®-BC720

Compound [1]	Certified value	Uncertainty
T-2 toxin [CAS number: 21259-20-1]	82 µg/kg	4 µg/kg
HT-2 toxin [CAS number: 26934-87-2]	81 µg/kg	4 µg/kg

1) T-2 and HT-2 toxin measured using sample preparation, instrumental separation (HPLC) and mass spectrometric detection as specified on page 3 of the certificate.

Cadmium and Acrylamide in Cocoa

	Certified mass fraction of Cd in mg/kg	Uncertainty in mg/kg	Mass fraction of Acrylamide in mg/kg (for information)	Uncertainty in mg/kg (for information)
ERM®-BD513	0,181	0,009	0,051	0,018
ERM®-BD514	0,541	0,024	0,101	0,026
ERM®-BD515	0,690	0,029	0,095	0,025

Consumer products

Polycyclic aromatic hydrocarbons in rubber toy

BAM-B001

Measurand [1)]	Mass fraction [2)] in mg kg-1	Uncertainty [3)] in mg kg-1
Fluorene	1,71	0,22
Phenanthrene	15,4	1,2
Anthracene	2,9	1,1
Fluoranthene	4,3	0,5
Pyrene	11,4	1,1
Benz[*a*]anthracene	2,17	0,22
Chrysene	2,08	0,15
Benzo[*b*]fluoranthene	0,57	0,05
Benzo[*k*]fluoranthene	0,213	0,022
Benzo[*j*]fluoranthene	0,40	0,04
Benzo[*e*]pyrene	1,21	0,16
Benzo[*a*]pyrene	1,41	0,10
Indeno[1,2,3-*cd*]pyrene	0,28	0,06
Benzo[*ghi*]perylene	1,43	0,09
Naphthalene	(0,09)	(0,08)
Acenaphthylene	(1,6)	(1,6)
Acenaphthene	(0,63)	(0,28)
Dibenz[*a,h*]anthracene	(0,118)	(0,020)

(Values in brackets are for information only)

Gas mixtures

Certified reference gas mixtures

Certified reference gas mixtures (CRGM) are provided by BAM with compositions and expanded relative uncertainties (k = 2) according to GUM [1] as given in the tables below.

The customer has to provide the starting material and has to demonstrate that the starting material has been synthetically prepared according to ISO 6142 [2] or ISO 6144 [3].

The composition (i.e., amount of substance fractions of the specified analytes) of the starting material is certified with small uncertainty using a measurement procedure according to ISO 12963 [4] or ISO 6143 [5].

Certification of the starting material is carried out against primary standards prepared at BAM according to ISO 6142-1 [2]. By designation from PTB [6, 7], these primary standards are the National Standards of Germany for gas analysis, providing traceability to the International System of Units (SI).

The accordingly certified starting material becomes a measurement standard with transparent SI traceability.

Due to limited preparation capacity, BAM provides gas mixtures according to ISO 6142-1 [2] to customers only in exclusive cases and liable to charges.

Even though the described work on CRGMs at BAM is carried out at BAM in accordance with ISO 17025 [8] and ISO 17034 [9], it is not covered by formal accreditation (yet).

Validity of the issued certificates is usually for a period of two years; exceptions apply for unstable mixtures.

Certified reference gas mixtures comprise:

1. Certified reference gas mixtures for vehicle exhaust emission measurements
   - especially as defined in PTB-A 18.10 [10]
   - especially as defined in [11]
   - related to OIML [12]
2. Certified reference gas mixtures for energy gases
   - especially as defined in PTB-A 7.63 [13]
3. Binary mixtures
4. Multicomponent certified reference gas mixtures

References:

[1] JCGM 100:2008 "Evaluation of measurement data – Guide to the expression of uncertainty in measurement" (GUM)

[2] ISO 6142-1:2015 "Gas analysis – Preparation of calibration gas mixtures – Part 1: Gravimetric method for Class I mixtures" or upcoming ISO 6142-2

[3] ISO 6144:2003 "Gas analysis – Preparation of calibration gas mixtures – Static volumetric method"

[4] ISO 12963:2017 "Gas analysis – Comparison methods for the determination of the composition of gas mixtures based on one- and two-point calibration"

[5] ISO 6143:2001 "Gas analysis – Comparison methods for determining and checking the composition of calibration gas mixtures"

[6] https://www.bipm.org/en/about-us/member-states/de/cipm-mra.html (accessed June 2020)

[7] PTB Physikalisch-Technische Bundesanstalt is the National Metrology Institute of Germany within the Metre Convention

[8] ISO/IEC 17025:2017 "General requirements for the competence of testing and calibration laboratories"

[9] ISO 17034:2016 "General requirements for the competence of reference material producers"

[10] PTB-Anforderung (Technical Requirement) PTB-A 18.10 „Messgeräte im Straßenverkehr; Abgasmessgeräte für Fremdzündungsmotoren", PTB, January 2004, DOI: 10.7795/510.20150728T, Section 6.3.3

[11] Section 3.3.3.6 in „Richtlinie zur Kalibrierung von Abgasmessgeräten, die für die Untersuchung der Abgase von Kraftfahrzeugen nach Nummer 6.8.2 der Anlage VIIIa StVZO eingesetzt werden (AU-Geräte

Kalibrierrichtlinie)“, rendered on 2018-05-23, Bundesministerium für Verkehr und digitale Infrastruktur, Verkehrsblatt Straßenverkehr Ausgabe Nr. 11/2018
[12] International Recommendation OIML R 99-1 & 2 “Instruments for measuring vehicle exhaust emissions”, International Organization of Legal Metrology (OIML), 2008, Annex B4 and others
[13] PTB-Anforderung (Technical Requirement) PTB-A 7.63 „Messgeräte für Gas; Anforderungen an Kalibriergase für Brennwert- und Gasbeschaffenheitsmessgeräte“, PTB, May 2011, DOI: 10.7795/510.20151109H, addendum published January 2018

Certified reference gas mixtures for vehicle exhaust emission measurements

CRM-No.	Main component	Analyte	Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G030-10+90 (PTB AU Q)	Nitrogen (N_2)	Oxygen (O_2)	10	0,5
BAM-G040-5+95 (PTB AU T)	Nitrogen (N_2)	Carbon monoxide (CO)	5	0,5
BAM-G040-0,1+99,9 (PTB AU T1)	Nitrogen (N_2)	Carbon monoxide (CO)	0,1	0,4
BAM-G040-0,01+99,99 (PTB AU T2)	Nitrogen (N_2)	Carbon monoxide (CO)	0,01	0,6
BAM-G050-14+86 (PTB AU S)	Nitrogen (N_2)	Carbon dioxide (CO_2)	14	0,3
BAM-G070-0,2+99,8 (PTB AU N)	Nitrogen (N_2)	Propane (C_3H_8)	0,2	0,8
BAM-G070-0,02+99,98 (PTB AU M)	Nitrogen (N_2)	Propane (C_3H_8)	0,02	0,8
BAM-G100-0,1+99,9 (PTB AU P)	Nitrogen (N_2)	Hexane (C_6H_{14})	0,1	0,3
BAM-G100-0,01+99,99 (PTB AU O)	Nitrogen (N_2)	Hexane (C_6H_{14})	0,01	0,8
BAM-G200 (PTB AU IIA1)	Nitrogen (N_2)	Carbon monoxide (CO)	2	0,5
BAM-G210 (PTB AU IIA2)	Nitrogen (N_2)	Carbon monoxide (CO)	4,5	0,5
BAM-G220 (PTB AU IB)	Nitrogen (N_2)	Carbon monoxide (CO) Carbon dioxide (CO_2) Propane (C_3H_8)	0,5 6 0,02	0,5 0,3 0,8
BAM-G221 (PTB AU E) (OIML E)	Nitrogen (N_2)	Carbon monoxide (CO) Carbon dioxide (CO_2) Propane (C_3H_8) Oxygen (O_2)	0,5 6 0,02 0,5	0,5 0,3 0,8 0,5
BAM-G225	Nitrogen (N_2)	Carbon monoxide (CO) Carbon dioxide (CO_2) Propane (C_3H_8)	1,5 11 0,06	0,5 0,3 0,5
BAM-G226 (PTB AU F) (OIML F)	Nitrogen (N_2)	Carbon monoxide (CO) Carbon dioxide (CO_2) Propane (C_3H_8) Oxygen (O_2)	1 10 0,06 10	0,5 0,3 0,5 0,5
BAM-G227 (PTB AU C)	Nitrogen (N_2)	Carbon monoxide (CO) Carbon dioxide (CO_2) Propane (C_3H_8)	0,1 3 0,008	0,5 0,6 1,0
BAM-G230 (PTB AU D) (OIML D)	Nitrogen (N_2)	Carbon monoxide (CO) Carbon dioxide (CO_2) Propane (C_3H_8)	3,5 14 0,2	0,5 0,3 0,5
BAM-G231 (PTB AU G)	Nitrogen (N_2)	Carbon monoxide (CO) Carbon dioxide (CO_2) Propane (C_3H_8) Oxygen (O_2)	3,5 14 0,2 20	0,5 0,3 0,5 0,5

Certified reference gas mixtures for vehicle exhaust emission measurements (continued)

CRM-No.	Main component	Analyte	Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G232 (PTB AU J) (OIML J)	Nitrogen (N_2)	Carbon monoxide (CO)	3,5	0,3
		Carbon dioxide (CO_2)	14	0,3
		Propane (C_3H_8)	0,2	0,5
		Oxygen (O_2)	10	0,5
BAM-G233 (PTB AU A) (OIML A)	Nitrogen (N_2)	Carbon monoxide (CO)	0,5	0,5
		Carbon dioxide (CO_2)	14	0,3
		Propane (C_3H_8)	0,02	0,8
		Oxygen (O_2)	0,5	0,5
BAM-G234 (PTB AU A1)	Nitrogen (N_2)	Carbon monoxide (CO)	0,1	0,5
		Carbon dioxide (CO_2)	14	0,3
		Propane (C_3H_8)	0,02	0,8
		Oxygen (O_2)	0,5	0,5
BAM-G235 (PTB AU K) (OIML K)	Nitrogen (N_2)	Carbon monoxide (CO)	3,5	0,5
		Carbon dioxide (CO_2)	14	0,3
		Propane (C_3H_8)	0,2	0,5
		Hydrogen (H_2)	5	0,5
BAM-G236 (PTB AU I) (OIML I)	Nitrogen (N_2)	Carbon monoxide (CO)	3,5	0,5
		Propane (C_3H_8)	0,2	0,5
BAM-G237 (PTB AU L)	Nitrogen (N_2)	Carbon monoxide (CO)	0,25	0,5
		Carbon dioxide (CO_2)	3	0,6
		Propane (C_3H_8)	0,01	0,8
BAM-G238 (PTB AU B) (OIML B)	Nitrogen (N_2)	Carbon monoxide (CO)	0,5	0,5
		Carbon dioxide (CO_2)	14	0,3
		Propane (C_3H_8)	0,02	0,8
BAM-G239 (PTB AU G1)	Nitrogen (N_2)	Carbon dioxide (CO_2)	14	0,3
		Propane (C_3H_8)	0,2	0,5
		Oxygen (O_2)	20,9	0,5
BAM-G240 (PTB AU H) (OIML H)	Nitrogen (N_2)	Carbon monoxide (CO)	5	0,5
		Carbon dioxide (CO_2)	14	0,3
		Propane (C_3H_8)	0,2	0,5
		Oxygen (O_2)	20,9	0,5

Certified reference gas mixtures for energy gases

Certified reference gas mixtures for gas calorimeters

CRM-No.	Main component	Analyte	Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G300 (2H)	Methane (CH_4)	Ethane (C_2H_6)	12,3	0,3
BAM-G310 (2HL)	Methane (CH_4)	Ethane (C_2H_6)	6,5	0,3
BAM-G320 (2LH)	Methane (CH_4)	Nitrogen (N_2)	7	0,3
BAM-G330 (2LHL)	Methane (CH_4)	Nitrogen (N_2)	8,7	0,3
BAM-G340 (2L)	Methane (CH_4)	Nitrogen (N_2)	11,7	0,3
BAM-G350 (2LL)	Methane (CH_4)	Nitrogen (N_2)	17,5	0,3
BAM-G360 (3S)	Methane (CH_4)	Nitrogen (N_2)Hydrogen (H_2)	17 49	0,3 0,5

(The "CRM-No." in parentheses corresponds to the name used in technical requirement "PTB-A 7.63" by PTB [13].)

Certified reference gas mixtures for process gas chromatographs

CRM-No.	Main component	Analyte	Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G400 (6H)	Methane (CH_4)	Nitrogen (N_2) Carbon dioxide (CO_2) Ethane (C_2H_6) Propane (C_3H_8) n-Butane (C_4H_{10}) Methane (CH_4)	0,4 1,8 9,4 3,4 1 84	0,5 0,6 0,3 0,3 0,5 0,05
BAM-G401 (6L)	Methane (CH_4)	Nitrogen (N_2) Carbon dioxide (CO_2) Ethane (C_2H_6) Propane (C_3H_8) n-Butane (C_4H_{10}) Methane (CH_4)	14,4 1 3 0,5 0,1 81	0,3 0,6 0,4 0,8 0,5 0,05
BAM-G410 (L1-8K)	Methane (CH_4)	Nitrogen (N_2) Carbon dioxide (CO_2) Ethane (C_2H_6) Propane (C_3H_8) n-Butane (C_4H_{10}) 2-Methyl-propane (C_4H_{10}) 2-Methyl-butane (C_5H_{12}) Methane (CH_4)	12 4,5 0,75 0,3 0,2 0,2 0,05 82	0,3 0,6 0,8 0,8 0,5 0,5 0,5 0,05

(The "CRM-No." in parentheses corresponds to the name used in technical requirement "PTB-A 7.63" by PTB [13].)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	Main component	Analyte		Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G411 (L2-8K)	Methane (CH_4)	Nitrogen	(N_2)	10,3	0,3
		Carbon dioxide	(CO_2)	1	0,6
		Ethane	(C_2H_6)	4	0,4
		Propane	(C_3H_8)	1,25	0,4
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		Methane	(CH_4)	83	0,05
BAM-G412 (H1-8K)	Methane (CH_4)	Nitrogen	(N_2)	1	0,5
		Carbon dioxide	(CO_2)	0,9	0,6
		Ethane	(C_2H_6)	1	0,4
		Propane	(C_3H_8)	0,25	0,8
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		Methane	(CH_4)	96,4	0,05
BAM-G413 (H2-8K)	Methane (CH_4)	Nitrogen	(N_2)	4	0,3
		Carbon dioxide	(CO_2)	1,5	0,6
		Ethane	(C_2H_6)	8,2	0,4
		Propane	(C_3H_8)	2	0,3
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		Methane	(CH_4)	83,85	0,05
BAM-G420 (11M)	Methane (CH_4)	Oxygen	(O_2)	0,5	0,5
		Nitrogen	(N_2)	4	0,3
		Carbon dioxide	(CO_2)	1,5	0,6
		Ethane	(C_2H_6)	4	0,4
		Propane	(C_3H_8)	1	0,4
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,05	0,5
		Methane	(CH_4)	88,45	0,05
BAM-G422 (P1-11K)	Methane (CH_4)	Nitrogen	(N_2)	8	0,3
		Carbon dioxide	(CO_2)	3	0,6
		Ethane	(C_2H_6)	6,5	0,3
		Propane	(C_3H_8)	2	0,3
		n-Butane	(C_4H_{10})	0,5	0,5
		2-Methyl-propane	(C_4H_{10})	0,5	0,5
		n-Pentane	(C_5H_{12})	0,1	0,5
		2-Methyl-butane	(C_5H_{12})	0,1	0,5
		2,2-Dimethyl-propane	(C_5H_{12})	0,025	0,8
		n-Hexane	(C_6H_{14})	0,025	0,8
		Methane	(CH_4)	79,25	0,05

(The "CRM-No." in parentheses corresponds to the name used in technical requirement "PTB-A 7.63" by PTB [13].)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	Main component	Analyte	Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G430 (11D)	Methane (CH_4)	Nitrogen (N_2)	4	0,3
		Carbon dioxide (CO_2)	1,5	0,6
		Ethane (C_2H_6)	4	0,4
		Propane (C_3H_8)	1	0,4
		n-Butane (C_4H_{10})	0,2	0,5
		2-Methyl-propane (C_4H_{10})	0,2	0,5
		n-Pentane (C_5H_{12})	0,05	0,5
		2-Methyl-butane (C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane (C_5H_{12})	0,05	0,5
		n-Hexane (C_6H_{14})	0,05	0,5
		Methane (CH_4)	88,9	0,05
BAM-G431 (H1-11K)	Methane (CH_4)	Nitrogen (N_2)	1,35	0,4
		Carbon dioxide (CO_2)	0,35	0,6
		Ethane (C_2H_6)	0,4	0,8
		Propane (C_3H_8)	0,2	0,8
		n-Butane (C_4H_{10})	0,1	0,5
		2-Methyl-propane (C_4H_{10})	0,1	0,5
		n-Pentane (C_5H_{12})	0,05	0,5
		2-Methyl-butane (C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane (C_5H_{12})	0,05	0,5
		n-Hexane (C_6H_{14})	0,05	0,5
		Methane (CH_4)	97,3	0,05
BAM-G432 (H2-11K)	Methane (CH_4)	Nitrogen (N_2)	0,95	0,5
		Carbon dioxide (CO_2)	1,45	0,6
		Ethane (C_2H_6)	9	0,3
		Propane (C_3H_8)	3	0,3
		n-Butane (C_4H_{10})	0,2	0,5
		2-Methyl-propane (C_4H_{10})	0,2	0,5
		n-Pentane (C_5H_{12})	0,05	0,5
		2-Methyl-butane (C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane (C_5H_{12})	0,05	0,5
		n-Hexane (C_6H_{14})	0,05	0,5
		Methane (CH_4)	85	0,05
BAM-G433 (H3-11K)	Methane (CH_4)	Nitrogen (N_2)	2,5	0,3
		Carbon dioxide (CO_2)	1	0,6
		Ethane (C_2H_6)	6,5	0,3
		Propane (C_3H_8)	1,3	0,4
		n-Butane (C_4H_{10})	0,2	0,5
		2-Methyl-propane (C_4H_{10})	0,25	0,5
		n-Pentane (C_5H_{12})	0,05	0,5
		2-Methyl-butane (C_5H_{12})	0,025	0,8
		2,2-Dimethyl-propane (C_5H_{12})	0,05	0,5
		n-Hexane (C_6H_{14})	0,05	0,5
		Methane (CH_4)	88,075	0,05
BAM-G434 (L1-11K)	Methane (CH_4)	Nitrogen (N_2)	11	0,3
		Carbon dioxide (CO_2)	1,55	0,6
		Ethane (C_2H_6)	0,75	0,8
		Propane (C_3H_8)	0,3	0,8
		n-Butane (C_4H_{10})	0,1	0,5
		2-Methyl-propane (C_4H_{10})	0,1	0,5
		n-Pentane (C_5H_{12})	0,05	0,5
		2-Methyl-butane (C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane (C_5H_{12})	0,05	0,5
		n-Hexane (C_6H_{14})	0,05	0,5
		Methane (CH_4)	86	0,05

(The "CRM-No." in parentheses corresponds to the name used in technical requirement "PTB-A 7.63" by PTB [13].)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	Main component	Analyte		Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G435	Methane (CH_4)	Nitrogen	(N_2)	1,2	0,5
		Carbon dioxide	(CO_2)	0,8	0,6
		Ethane	(C_2H_6)	11	0,3
		Propane	(C_3H_8)	4,5	0,3
		n-Butane	(C_4H_{10})	0,1	0,5
		2-Methyl-propane	(C_4H_{10})	0,1	0,5
		n-Pentane	(C_5H_{12})	0,035	0,8
		2-Methyl-butane	(C_5H_{12})	0,035	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,02	0,8
		Methane	(CH_4)	82,16	0,05
BAM-G436 (L2-11K)	Methane (CH_4)	Nitrogen	(N_2)	9,2	0,3
		Carbon dioxide	(CO_2)	1,8	0,6
		Ethane	(C_2H_6)	3	0,4
		Propane	(C_3H_8)	0,5	0,8
		n-Butane	(C_4H_{10})	0,1	0,5
		2-Methyl-propane	(C_4H_{10})	0,1	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,05	0,5
		Methane	(CH_4)	85,1	0,05
BAM-G437	Methane (CH_4)	Nitrogen	(N_2)	0,8	0,5
		Carbon dioxide	(CO_2)	1	0,6
		Ethane	(C_2H_6)	1	0,8
		Propane	(C_3H_8)	0,5	0,8
		n-Butane	(C_4H_{10})	0,1	0,5
		2-Methyl-propane	(C_4H_{10})	0,1	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,1	0,5
		Methane	(CH_4)	96,25	0,05
BAM-G440 (16M)	Methane (CH_4)	Helium	(He)	0,5	1,0
		Oxygen	(O_2)	0,5	0,5
		Nitrogen	(N_2)	5	0,3
		Carbon dioxide	(CO_2)	1	0,6
		Carbon monoxide	(CO)	0,5	0,5
		Hydrogen	(H_2)	1	0,8
		Ethene	(C_2H_4)	0,5	0,8
		Ethane	(C_2H_6)	2,5	0,4
		Propene	(C_3H_6)	0,5	0,8
		Propane	(C_3H_8)	1	0,5
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,06	0,5
		Methane	(CH_4)	86,44	0,05

(The "CRM-No." in parentheses corresponds to the name used in technical requirement "PTB-A 7.63" by PTB [13].)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	Main component	Analyte		Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G441 (12M)	Methane (CH_4)	Oxygen	(O_2)	0,5	0,5
		Nitrogen	(N_2)	4	0,3
		Carbon dioxide	(CO_2)	1,5	0,6
		Hydrogen	(H_2)	1	0,8
		Ethane	(C_2H_6)	4	0,4
		Propane	(C_3H_8)	1	0,5
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,05	0,5
		Methane	(CH_4)	87,45	0,05
BAM-G442 (13K)	Methane (CH_4)	Oxygen	(O_2)	0,5	0,5
		Nitrogen	(N_2)	4	0,3
		Carbon dioxide	(CO_2)	1,5	0,6
		Hydrogen	(H_2)	1	0,8
		Ethane	(C_2H_6)	4	0,4
		Propane	(C_3H_8)	1	0,5
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,05	0,5
		Methane	(CH_4)	87,40	0,05
BAM-G443 (P1-13K)	Methane (CH_4)	Helium	(He)	0,25	1,0
		Oxygen	(O_2)	0,3	0,5
		Nitrogen	(N_2)	4	0,3
		Carbon dioxide	(CO_2)	4	0,6
		Hydrogen	(H_2)	7	0,5
		Ethane	(C_2H_6)	5,5	0,3
		Propane	(C_3H_8)	2	0,3
		n-Butane	(C_4H_{10})	0,5	0,5
		2-Methyl-propane	(C_4H_{10})	0,3	0,5
		n-Pentane	(C_5H_{12})	0,1	0,5
		2-Methyl-butane	(C_5H_{12})	0,1	0,5
		n-Hexane	(C_6H_{14})	0,06	0,8
		Methane	(CH_4)	75,89	0,05
BAM-G444 (P-3K)	Methane (CH_4)	Nitrogen	(N_2)	3	0,3
		Hydrogen	(H_2)Methane	4,5	0,5
		(CH_4)		92,5	0,05
BAM-G446 (B-5K)	Methane (CH_4)	Oxygen	(O_2)	1	0,5
		Nitrogen	(N_2)	2	0,3
		Carbon dioxide	(CO_2)	5,5	0,6
		Hydrogen	(H_2)	2	0,8
		Methane	(CH_4)	89,5	0,05
BAM-G449 (B3-5K)	Methane (CH_4)	Oxygen	(O_2)	1	0,5
		Nitrogen	(N_2)	18	0,3
		Carbon dioxide	(CO_2)	2,5	0,6
		Hydrogen	(H_2)	15	0,5
		Methane	(CH_4)	63,5	0,07

(The "CRM-No." in parentheses corresponds to the name used in technical requirement "PTB-A 7.63" by PTB [13].)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	Main component	Analyte		Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G450 (17K)	Methane (CH_4)	Helium	(He)	0,5	1,0
		Oxygen	(O_2)	0,5	0,5
		Nitrogen	(N_2)	5	0,3
		Carbon dioxide	(CO_2)	1	0,6
		Carbon monoxide	(CO)	0,5	0,5
		Hydrogen	(H_2)	1	0,8
		Ethene	(C_2H_4)	0,5	0,8
		Ethane	(C_2H_6)	2,5	0,4
		Propene	(C_3H_6)	0,5	0,8
		Propane	(C_3H_8)	1	0,5
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,06	0,5
		Methane	(CH_4)	86,39	0,05
BAM-G451	Methane (CH_4)	n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,05	0,5
		Methane	(CH_4)	99,80	0,05
BAM-G452	Methane (CH_4)	Helium	(He)	0,5	1,0
		Nitrogen	(N_2)	12	0,3
		Carbon dioxide	(CO_2)	4	0,6
		Hydrogen	(H_2)	3	0,5
		Ethane	(C_2H_6)	0,75	0,8
		Propane	(C_3H_8)	0,3	0,8
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,05	0,5
		Methane	(CH_4)	78,85	0,05
BAM-G460	Methane (CH_4)	Helium	(He)	0,5	1,0
		Nitrogen	(N_2)	12	0,3
		Carbon dioxide	(CO_2)	4	0,6
		Ethane	(C_2H_6)	0,75	0,8
		Propane	(C_3H_8)	0,3	0,8
		n-Butane	(C_4H_{10})	0,2	0,5
		2-Methyl-propane	(C_4H_{10})	0,2	0,5
		n-Pentane	(C_5H_{12})	0,05	0,5
		2-Methyl-butane	(C_5H_{12})	0,05	0,5
		2,2-Dimethyl-propane	(C_5H_{12})	0,05	0,5
		n-Hexane	(C_6H_{14})	0,05	0,5
		Methane	(CH_4)	81,85	0,05

(The "CRM-No." in parentheses corresponds to the name used in technical requirement "PTB-A 7.63" by PTB [13].)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	Main component	Analyte	Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G471 (9M)	Methane (CH_4)	Oxygen (O_2)	0,4	0,5
		Nitrogen (N_2)	4	0,3
		Carbon dioxide (CO_2)	2,5	0,6
		Hydrogen (H_2)	0,2	1,0
		Ethane (C_2H_6)	2,5	0,3
		Propane (C_3H_8)	1	0,5
		n-Butane (C_4H_{10})	0,2	0,5
		2-Methyl-propane (C_4H_{10})	0,2	0,5
		Methane (CH_4)	89	0,05
BAM-G472 (9E)	Methane (CH_4)	Oxygen (O_2)	2	0,3
		Nitrogen (N_2)	8	0,3
		Carbon dioxide (CO_2)	2	0,6
		Hydrogen (H_2)	1	0,8
		Ethane (C_2H_6)	4	0,4
		Propane (C_3H_8)	3	0,3
		n-Butane (C_4H_{10})	0,5	0,5
		2-Methyl-propane (C_4H_{10})	0,5	0,5
		Methane (CH_4)	79	0,05
BAM-G473 (P1-9K)	Methane (CH_4)	Oxygen (O_2)	0,3	0,5
		Nitrogen (N_2)	3	0,3
		Carbon dioxide (CO_2)	3,5	0,6
		Hydrogen (H_2)	0,3	1,0
		Ethane (C_2H_6)	0,35	0,8
		Propane (C_3H_8)	4,75	0,3
		n-Butane (C_4H_{10})	0,3	0,5
		2-Methyl-propane (C_4H_{10})	0,3	0,5
		Methane (CH_4)	87,2	0,05
BAM-G474	Methane (CH_4)	Nitrogen (N_2)	0,12	0,5
		Carbon dioxide (CO_2)Ethane	0,02	0,6
		(C_2H_6)	10	0,3
		Propane (C_3H_8)	2	0,3
		n-Butane (C_4H_{10})	0,15	0,5
		2-Methyl-propane (C_4H_{10})	0,15	0,5
		n-Pentane (C_5H_{12})	0,02	0,8
		2-Methyl-butane (C_5H_{12})	0,02	0,8
		Methane (CH_4)	87,52	0,05
BAM-G494	Methane (CH_4)	Nitrogen (N_2)	4	0,3
		Carbon dioxide (CO_2)	1,5	0,6
		n-Butane (C_4H_{10})	3	0,5
		n-Pentane (C_5H_{12})	0,3	0,5
		2-Methyl-butane (C_5H_{12})	0,3	0,5
		2,2-Dimethyl-propane (C_5H_{12})	0,3	0,5
		n-Hexane (C_6H_{14})	0,3	0,5
		Methane (CH_4)	90,3	0,05
BAM-G901	Natural gas	Carbon dioxide (CO_2)	0,2 to 20	0,5 to 0,3

(The "CRM-No." in parentheses corresponds to the name used in technical requirement "PTB-A 7.63" by PTB [13].)

Binary certified reference gas mixtures

CRM-No.	Main component	Analyte	Range of amount of substance fraction cmol/mol	Range of relative expanded uncertainty %
BAM-G010	Nitrogen (N_2)	Helium (He)	1 to 50	0,8 to 0,5
BAM-G012	Synth. air	Helium (He)	0,5 to 50	2,0 to 0,5
BAM-G014	Argon (Ar)	Helium (He)	1 to 50	0,5
BAM-G020	Nitrogen (N_2)	Hydrogen (H_2)	1 to 20	0,8 to 0,5
BAM-G022	Helium (He)	Hydrogen (H_2)	0,1 to 20	1,0 to 0,3
BAM-G024	Argon (Ar)	Nitrogen (N_2)	1 to 50	0,5
BAM-G025-0,1+99,9	Methane (CH_4)	Hydrogen (H_2)	0,1	0,5
BAM-G030	Nitrogen (N_2)	Oxygen (O_2)	1 to 20	0,5
BAM-G037	Helium (He)	Nitrogen (N_2)	0,001 to 0,1	1,0 to 0,5
BAM-G038	Helium (He)	Argon (Ar)	0,0005 to 0,2	1,0 to 0,3
BAM-G039	Helium (He)	Oxygen (O_2)	1 to 20	1,0 to 0,5
BAM-G040	Nitrogen (N_2)	Carbon monoxide (CO)	0,001 to 10	1,0 to 0,3
BAM-G042	Synth. air	Carbon monoxide (CO)	0,01 to 1	1,0 to 0,5
BAM-G050	Nitrogen (N_2)	Carbon dioxide (CO_2)	0,001 to 50	0,5 to 0,3
BAM-G052	Synth. air	Carbon dioxide (CO_2)	0,01 to 20	1,0 to 0,3
BAM-G055	Methane (CH_4)	Carbon dioxide (CO_2)	0,5 to 10	0,5
BAM-G060	Nitrogen (N_2)	Methane (CH_4)	0,001 to 50	1,0 to 0,3
BAM-G062	Synth. air	Methane (CH_4)	0,01 to 0,1	1,0 to 0,5
BAM-G070	Nitrogen (N_2)	Propane (C_3H_8)	0,005 to 1	1,0 to 0,5
BAM-G072	Synth. air	Propane (C_3H_8)	0,01 to 0,1	1,0 to 0,5
BAM-G100	Nitrogen (N_2)	n-Hexane (C_6H_{14})	0,01 to 0,1	0,8 to 0,3

For binary certified reference gas mixtures only a limited amount of calibration gases is actually on stock. Hence, certification of starting materials with specific values for the amount of substance fraction might require additional time.

Multicomponent certified reference gas mixtures

CRM-No.	Main component	Analyte	Amount of substance fraction cmol/mol	Relative expanded uncertainty %
BAM-G501	Nitrogen (N_2)	Oxygen (O_2)Argon (Ar)	20 1	0,5 0,5
BAM-G510	Nitrogen (N_2)	Carbon monoxide (CO) Methane (CH_4)	0,3 0,3	0,5 0,5
BAM-G530	Nitrogen (N_2)	Oxygen (O_2) Hydrogen (H_2)	1,5 10	0,5 0,5

Elastomeric materials

Standard reference elastomers (SRE) from vulcanized rubbers

Standard Reference Elastomers (SRE) are characterized by standardized and controlled properties. One application area is the calibration of scientific and technical test apparatuses and methods (E001 and E003). They enable the exact determination of material data if the method of measuring by itself cannot give absolute measured values. They can further be used as part of a measuring device (E002, E004 to E007). The SRE E001, E003 to E007 consist of natural rubber (NR).

SRE made from nitrile rubber (NBR), hydrogenated nitrile rubber (HNBR), ethylene-propylene diene rubber (EPDM), polyacrylate rubber (ACM), silicone rubber (MVQ) , fluoropolymer rubber (FKM) and chloroprene rubber (CR) are meant to determine the effect of mineral oils, lubricants, hydraulic liquids and other service fluids on vulcanizates made from the mentioned rubbers which are used for seals, hoses etc. They are different in their degree of swelling (E008 to E021). In most cases the physical properties of the elastomers such as density, hardness, compression set and tensile stress-strain are also specified.

The following SRE from vulcanized rubbers and for testing of vulcanized rubber products (E002) are produced and offered:

BAM-E001	Rubber test sheet for determination of abrasion resistance of vulcanized rubber according to DIN 53516 and ISO 4649 standard reference compound no. 1
BAM-E002	Abrasive paper sheet - according to DIN 53516 and ISO 4649; Annex A
BAM-E003	Rubber test sheet for determination of abrasion resistance of vulcanized rubber according to ISO 4649 standard reference compound no. 2
BAM-E004	Rubber sole sheet for measuring the electrostatic charging of floor by a walking test
BAM-E005	Rubber base ring for the portable tester for measuring the surface roughness of streets (Efflux meter in accordance with MOORE) according to EN 13036-3
BAM-E006/ BAM-E007	Rubber slider for the pendulum tester for measuring the surface grip property of streets (skid resistance test; SRT) according to EN 13036-4: 2003; CEN rubber and for the pendulum tester for the determination of the PSV-value (polished stone value) according to EN 1097-8
BAM-E008	Elastomer ISO 13226 SRE-NBR 28/PX designated for hydraulic area (vulcanized with peroxide, low elongation at break)
BAM-E009	Elastomer ISO 13226 SRE-NBR 28/SX designated for automotive area (vulcanized with thiurame, high elongation at break)
BAM-E010	Elastomer ISO 13226 SRE-NBR 34/SX designated for automotive area (vulcanized with thiurame, high elongation at break)
BAM-E011	Elastomer ISO 13226 SRE-HNBR/1X designated for hydraulic and automotive area (vulcanized with peroxide)
BAM-E012	Elastomer ISO 13226 SRE-ACM/1X designated for hydraulic and automotive area
BAM-E013	Elastomer ISO 13226 SRE-VMQ/1X designated for hydraulic and automotive area (vulcanized with peroxide)
BAM-E014	Elastomer ISO 13226 SRE-FKM/2X / ISO 6072 FKM 2 designated for hydraulic and automotive area
BAM-E015	Elastomer ISO 6072 NBR 1 designated for hydraulic and automotive area
BAM-E016	Elastomer ISO 6072 NBR 2 designated for hydraulic and automotive area
BAM-E017	Elastomer ISO 13226 SRE-NBR L designated for hydraulic and automotive area (vulcanized with thiurame, low content of acrylonitrile)
BAM-E018	Elastomer ISO 13226 SRE-NBR M designated for hydraulic and automotive area (vulcanized with thiurame, medium content of acrylonitrile)
BAM-E019	Elastomer ISO 6072 EPDM 1 designated for hydraulic and automotive area
BAM-E020	Elastomer ISO 6072 HNBR 1 designated for hydraulic and automotive area
BAM-E021	Elastomer ISO 13226 SRE-CR/1 designated for hydraulic and automotive area

BAM-E022	**Rubber Slider** for the pendulum tester (Skid Resistance Test, SRT) according to EN 13036-4: 2011; slider 57
BAM-E023	**Rubber Slider Pad** for the pendulum tester (SRT) according to EN 13036-4:2003; CEN rubber
BAM-E024	**Rubber Slider Pad** for the pendulum tester (SRT) according to EN 13036-4:2011; slider 57
BAM-E025	**Reference Material** for the determination of rebound resilience according to ISO 4662
BAM-E026	**Rubber Slider** for the pendulum tester according to EN 1436:2009, annex D
BAM-E027	**Rubber Slider** for the pendulum tester according to EN 1338:2003/AC:2006, annex I

In addition to the described applications, these SRE can generally be used in all cases in which elastomers with defined and reproducible properties are needed.

Optical properties

X-ray film step tablet

BAM-X001

Calibrated X-ray film step tablet of 15 steps

Covered optical density range: 0,25 – 5,0

Film type: Agfa - Gevaert Structurix D4

Calibration kit

Spectral fluorescence standards

BAM-F001b, BAM-F002b, BAM-F003b, BAM-F004b, BAM-F005b

For the determination of the relative spectral responsivity of fluorescence instruments, the control of the long-term stability of fluorescence instruments, and for the determination of corrected, i.e., instrument-independent emission spectra.

Five spectral fluorescence standards ready made by SIGMA-ALDRICH GmbH (now part of Merck KGaA), which cover the spectral region of 300 nm to 770 nm as a set.

This Reference Material is issued by BAM and distributed by SIGMA-ALDRICH GmbH.

Catalog Keyword: Spectral fluorescence standard kit (Product number: 75255)

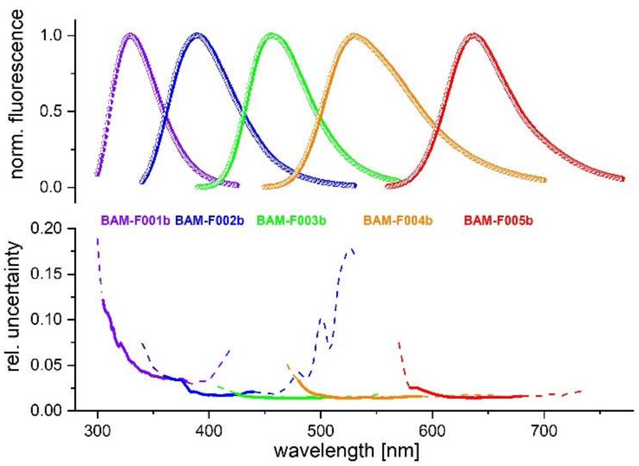
Addition of aliquots of 10 mL of ethanol to each solid standard yields a solution that can be measured without additional dilution steps.

Corrected emission spectra of BAM-F001b - BAM-F005b certified with a calibrated reference spectrofluorometer and the corresponding wavelength-dependent expanded relative uncertainties. Certification was performed according to ISO Guide 35 and the Guide to the Expression of Uncertainty in Measurement (GUM).

CD with the Certificate, the data evaluation software *LINKCORRWin1.3* including the certificate file BAM1808M6.CTF developed by BAM, and instructions for use of BAM-F001b - BAM-F005b and *LINKCORRWin1.3*.

Certified properties

Normalized corrected fluorescence emission spectra of BAM-F001b - BAM-F005b in ethanol for T = 25 °C. The emission spectra are traceable to the spectral photon radiance scale realized and disseminated in Germany by the Physikalisch-Technische Bundesanstalt (PTB) Berlin.



Certified normalized corrected fluorescence emission spectra of

← BAM-F001b – BAM-F005b

and

← expanded relative uncertainties

Porous reference materials

CRMs for the gas adsorption method

CRM-No.	BAM-PM-101	BAM-PM-102	ERM®-FD107
Description	SiO_2 Powder	alpha-Al_2O_3 Powder	Faujasite type zeolite Pellets
Adsorptive	Krypton	Nitrogen	Nitrogen
Year of issue	1996	1996	2000
BET Specific surface area (m^2/g)	0,177 ± 0,014	5,41 ± 0,24	–
Specific pore volume (cm^3/g) p/p_0=0,99	–	–	–
Mean pore diameter (nm)	–	–	–
Most frequent pore diameter (nm)	–		–
Specific micropore volume (cm^3/g)	–	–	0,217 ± 0,002
Median pore width (nm)	–	–	0,86 ± 0,02

CRM-No.	BAM-P109	BAM-P110	BAM-P116□
Description	Nanoporous carbon Beads	Titanium dioxide (Anatase)	Titanium dioxide (Anatase)
Adsorptive	Nitrogen	Nitrogen	Nitrogen
Year of issue	2010	2016	2020
BET Specific surface area (m^2/g)	1396 ± 24	107,8 ± 1,6	324 ± 11
Specific pore volume (cm^3/g) p/p_0=0,99	–	–	–
Mean pore diameter (nm)	–	–	–
Most frequent pore diameter (nm)	–	–	–
Specific micropore volume (cm^3/g)	–	–	–
Median pore width (nm)	–	–	–

1) calculated from the desorption branch of the isotherm

2) calculated from the adsorption branch of the isotherm

Note: The uncertainty given here is ± 1 s (standard deviation of the laboratory means) for BAM-PM-101 to 102. In the case of BAM-P109 to 116 and ERM®-FD107 it is the expanded uncertainty with a coverage factor of k=2.

The reference materials are intended for checking the performance of instruments used for the determination of BET specific surface area, specific pore volume, and the pore diameter (pore width) by means of the gas adsorption methods according to DIN 66131 (replaced by DIN ISO 9277), DIN 66134, DIN 66135-4, ISO 9277, ISO 15901-2 and ISO 15901-3.

□) Accredited by DAkkS as a producer of RM according to ISO 17034

CRMs for the mercury intrusion method

High pressure range between 0,1 and 400 MPa

Certified properties:

A) Pressure-volume curve (mercury intrusion curve) between 0,1 MPa and 400 MPa
B) Diameter-volume curve (cumulative pore volume curve) between 3,7 nm and 14708 nm
(for A and B see certificate)
C) (i) Pore volume values at selected intrusion pressure points;
(ii) Values for the pore diameter (see the table below)

CRM-No.	ERM®-FD120 (BAM-PM-120)	ERM®-FD121 (BAM-PM-121)	ERM®-FD122 (BAM-PM-122)	BAM-P127*
Description	alpha-Alumina Beads	Porous glass Beads	Porous glass Beads	Alumina Beads
Year of issue	2000	2000	2000	2002
Pore volume (in mm³/g) at 50 MPa	–	–	–	69,4 ± 8,0
Pore volume (in mm³/g) at 100 MPa	545,0 ± 12,2	425,0 ± 47,1	919,7 ± 16,8	625,4 ± 13,6
Pore volume (in mm³/g) at 195 MPa	546,7 ± 12,7	621,9 ± 12,9	922,5 ± 17,5	637,1 ± 14,4
Pore volume (in mm³/g) at 200 MPa	546,8 ± 12,7	621,9 ± 12,9	922,6 ± 17,5	–
Pore volume (in mm³/g) at 395 MPa	548,1 ± 13,1	624,6 ± 13,4	924,4 ± 17,2	638,6 ± 21,6
Mean pore diameter d_{50} (nm)	228,0 ± 5,9	15,1 ± 0,2	139,0 ± 3,7	24,2 ± 1,0
Most frequent pore diameter $d_{p,m}$ (nm)	232,2 ± 8,8	15,3 ± 0,2	140,2 ± 3,9	23,9 ± 2,8

* 1st CRM jointly developed by NIST and BAM (identical with NIST SRM 1917)

Note: All certified pore volumes are normalized values $V'_p = V_p(p_{Hg}) - V_p(0{,}1\ \text{MPa})$

The uncertainty is the expanded uncertainty for the selected intrusion pressure points for ERM®-FD120, ERM®-FD121, ERM®-FD122 and for BAM-P127

These reference materials are intended for the calibration and checking of porosimeters by means of the whole pressure volume curves of the Hg intrusion method.

ERM®-FD123

Mercury intrusion curve between 0,28 MPa and 1,41 MPa

Ceramic filter tubes

Pressure-volume curve characteristics

Quantity	Certified value 1)	Uncertainty 2)	Unit
y_1 3)	99,52	3,44	mm^3g^{-1}
y_2 4)	0,4966	0,0180	MPa
y_3 5)	0,2151	0,0156	MPa
p_{50}	0,4829	0,0239	MPa
d_{50}	3,0520	0,1533	µm

1) Pressure volume curves from designed round robins are analysed by means of a multivariate variance components model for the curves characteristics y_1, y_2 and y_3. The results are mean curve characteristics (certified values) and confidence intervals for the curve characteristics. Adjusted curves and statistics from the variance components model are used to create a certified pressure volume curve with confidence bands and prediction bands.

2) Half-width of the confidence interval resulting from the variance analytical investigation of the pressure volume curve characteristics y_1, y_2, and y_3 at the significance level 0,95.

3) y_1: Intruded volume at the saturation point 1,41 MPa (saturation value).

4) y_2: Pressure at 57,5 % of the saturation value. This value has been determined by local polynomial estimation (Epanechnikov kernel with band width h = 0,035 MPa).

5) y_3: Difference of the pressures at which the intrusion curve has got 87,5 % and 25 % respectively of the saturation value.

BAM-P124

Mercury intrusion curve between 0,24 MPa and 1,55 MPa

Flat membrane

Mercury intrusion curve characteristics

Quantity	Certified value [1)]	Uncertainty [2)]	Unit
y_1 [3)]	158,1	7,3	mm^3g^{-1}
y_2 [4)]	0,5021	0,028	MPa
y_3 [5)]	0,2616	0,039	MPa
p_{50}	0,4795	0,029	MPa
d_{50}	3,074	0,19	µm

1) Mercury intrusion curves from the designed interlaboratory testing were analysed by means of a multivariate variance components model for the curve characteristics y_1, y_2 and y_3. The results were mean curve characteristics (certified values) and prediction intervals for the curve characteristics. Adjusted curves and statistics from the variance components model were used to create a certified pressure volume curve with a prediction band.

2) Half-width of the prediction interval resulting from the variance analytical investigation of the pressure volume curve characteristics y_1, y_2, and y_3 at the significance level 0,95.

3) y_1: Intruded volume at the saturation point 1,55 MPa (saturation value).

4) y_2: Pressure at 57,5 % of the saturation value. This value has been determined by local polynomial estimation (Epanechnikov kernel with band width h = 0,025 MPa).

5) y_3: Difference of the pressures at which the intrusion curve has got 87,5 % and 25 % respectively of the saturation value.

BAM-P125

Mercury intrusion curve between 0,12 MPa and 0,88 MPa

Flat membrane

Mercury intrusion curve characteristics

Quantity	Certified value [1)]	Uncertainty [2)]	Unit
y_1 [3)]	207,9	10,1	mm^3g^{-1}
y_2 [4)]	0,2646	0,0136	MPa
y_3 [5)]	0,1366	0,0179	MPa
p_{50}	0,2554	0,0095	MPa
d_{50}	5,797	0,216	µm

1) Mercury intrusion curves from the designed interlaboratory testing were analysed by means of a multivariate variance components model for the curve characteristics y_1, y_2 and y_3. The results were mean curve characteristics (certified values) and prediction intervals for the curve characteristics. Adjusted curves and statistics from the variance components model were used to create a certified pressure volume curve with a prediction band.

2) Half-width of the prediction interval resulting from the variance analytical investigation of the pressure volume curve characteristics y_1, y_2, and y_3 at the significance level 0,95.

3) y_1: Intruded volume at the saturation point 0,88 MPa (saturation value).

4) y_2: Pressure at 57,5 % of the saturation value. This value has been determined by local polynomial estimation (Epanechnikov kernel with band width h = 0,025 MPa).

5) y_3: Difference of the pressures at which the intrusion curve has got 87,5 % and 25 % respectively of the saturation value.

BAM-P126

Mercury intrusion curve between 0,55 MPa and 2,1 MPa

Flat membrane

Mercury intrusion curve characteristics

Quantity	Certified value [1)]	Uncertainty [2)]	Unit
y_1 [3)]	110,9	8,5	mm^3g^{-1}
y_2 [4)]	0,8682	0,0408	MPa
y_3 [5)]	0,2965	0,0305	MPa
p_{50}	0,8441	0,0416	MPa
d_{50}	1,746	0,086	µm

[1)] Mercury intrusion curves from the designed interlaboratory testing were analysed by means of a multivariate variance components model for the curve characteristics y_1, y_2 and y_3. The results were mean curve characteristics (certified values) and prediction intervals for the curve characteristics. Adjusted curves and statistics from the variance components model were used to create a certified pressure volume curve with a prediction band.

[2)] Half-width of the prediction interval resulting from the variance analytical investigation of the pressure volume curve characteristics y_1, y_2, and y_3 at the significance level 0,95.

[3)] y_1: Intruded volume at the saturation point 2,1 MPa (saturation value).

[4)] y_2: Pressure at 57,5 % of the saturation value. This value has been determined by local polynomial estimation (Epanechnikov kernel with band width h = 0,05 MPa).

[5)] y_3: Difference of the pressures at which the intrusion curve has got 87,5 % and 25 % respectively of the saturation value.

BAM-P128

Porosity properties of macroporous alumina ceramic calculated from the mercury intrusion up to a maximum pressure between 0,2 and 0,4 MPa

Property		Certified value [a)]	Uncertainty [b)]	Unit
Specific pore volume [c)]	V_p	220	6	mm^3g^{-1}
Median pore diameter [d)]	d_{50}	27,6	1,0	µm
		Informative value		
Density	ρ_s	3,6405	0,0019	g/cm^3

[a)] Mean value of the means of accepted data sets each derived from at least 19 single values.

[b)] Uncertainty $U = k \cdot u_c$ calculated according to ISO Guide 35 and ISO/IEC Guide 98 with the coverage factor k=2 (giving a level of confidence of approximately 95 %). The combined standard uncertainty u_c of each certified property includes uncertainty contributions resulting from the interlaboratory testing, the study of inhomogeneities and stability of the material.

[c)] Specific pore volume V_p calculated from the mercury intrusion with maximum pressure in a low-pressure device. Described in ISO 15901-1 and DIN 66133.

[d)] Median pore diameter d50 calculated according to the Washburn equilibrium model as described in ISO 15901-1 and DIN 66133.

Layer and surface reference materials

Nanoscale stripe pattern for testing of lateral resolution and calibration of length scale

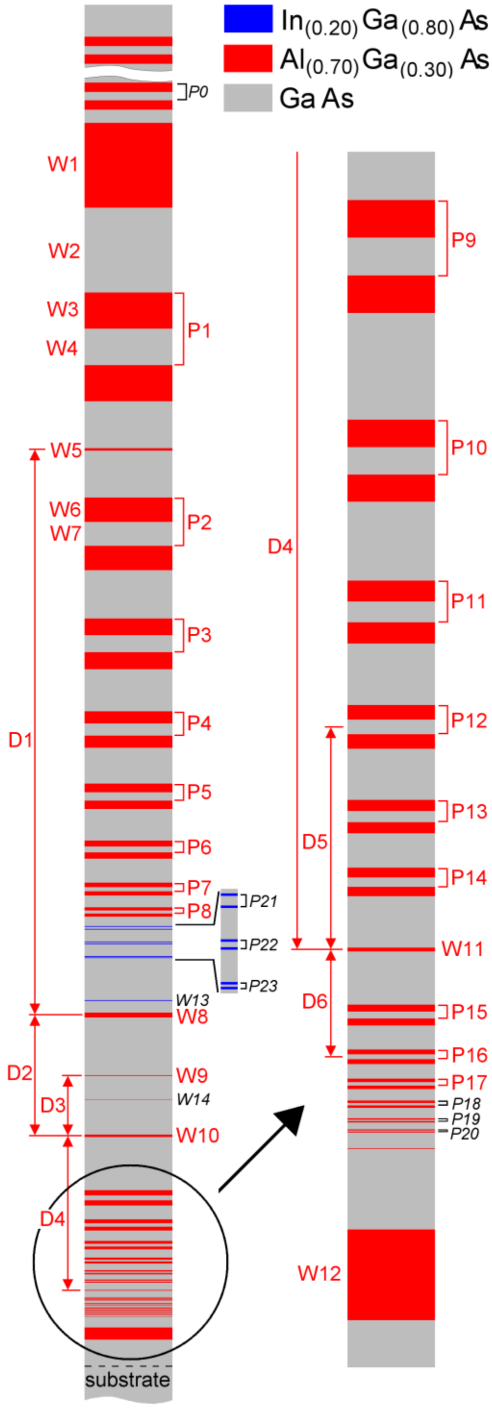
BAM-L200

BAM-L200 is a certified reference material for determination and control of lateral resolution in surface chemical analysis by SIMS, AES or XPS and covers the range from 2 nm to 600 nm. The cross section of a semiconductor layer stack is conductive, suitable for ultra high vacuum applications and can be used by all methods of surface analysis which are sensitive to a material contrast between $Al_{0.7}Ga_{0.3}As$ and GaAs.

Characteristic	Certified value nm	Expanded (*k*=2) uncertainty nm
W1	691	23
W2	691	23
W3	293	9
W4	294	9
W5	19,5	1,7
W6	195	6
W7	195	6
W8	38	2,6
W9	3,6	0,8
W10	14,2	1,5
W11	3,5	0,7
W12	96	2,6
P1	587	17
P2	389	10
P3	273	7
P4	193	5
P5	136	6
P6	97	3
P7	67,5	2,5
P8	48,5	2,6
P9	76,5	2,4
P10	57	2,2
P11	42	1,3
P12	31	1,1
P13	23	1,1
P14	17,5	1,0
P15	13,3	1,1
P16	9,4	1,4
P17	6,9	1,0
D1	4642*	24*
D2	986	22
D3	492	11,3
D4	1264	25
D5	237	8,3
D6	114	2,8

W-stripe width, P-period of a square-wave grating, D-centre to centre distance between stripes or between stripes and gratings, respectively.

Values are taken from TEM measurements.
* D1 is taken from SEM measurements.



Certified (red lettering) and non-certified (black italic lettering) characteristics

BAM-L200 (continued)

characteristic	non-certified value, for information only nm
W13	*5,0*
W14	*1,0*
P0	*147 (80 AlGaAs + 67 GaAs)*
P18	*4,6*
P19	*3,0*
P20	*2,0*
P21	*23 (5 InGaAs + 18 GaAs)*
P22	*15 (5 InGaAs + 10 GaAs)*
P23	*10 (5 InGaAs + 5 GaAs)*

EDS-TM002 test material and optional software package for the performance check of an energy dispersive X-ray spectrometer (EDS)

The test material EDS-TM002 (2nd generation) together with an accompanying software package, “EDX spectrometer check”, have been made available in 2009 by BAM [1] to be employed by EDS users to check the performance of an EDS attached to a SEM. Particularly for test laboratories operating under accreditation schemes like ISO/IEC 17025, a periodical control of the critical instrumental parameters in end-user laboratories is required.

With EDS-TM002 test material, this periodical check is simplified to the acquisition of only one 10 kV spectrum. The software “EDX spectrometer check” is destined to evaluate automatically this spectrum and determine the performance of the EDS in terms of energy resolution and calibration, as well as possible alteration of low-energy efficiency due to detector contamination. The energy resolution can be compared with the specified values according to the standard ISO 15632:2012 [2].

EDS-TM is a synthetic material consisting of a 6 µm thick layer of C, Al, Mn, Cu and Zr deposited on a silicon substrate. The chemical composition of EDS-TM was chosen such as to give nearly equal intensities of the low energy lines in a 10 kV spectrum, see Figure 1, thus, making it very sensitive against spectrometer efficiency changes. A detailed description of the test material and software together with examples of application can be found in [3,4].

When the FWHM of the X-ray lines in the EDS-TM spectrum are determined, the spectrum background must be subtracted accurately. The applied physical background subtraction procedure is robust and considers the transmission of the detector window [3]. The new software version 3.6, released in December 2018 [4], includes selection of silicon nitride window (with a transmission according to [5]) and the case of windowless detector. Moreover, the new version allows importing of spectra in Bruker spx-format and EMSA/MSA files from EDAX TEAM software.

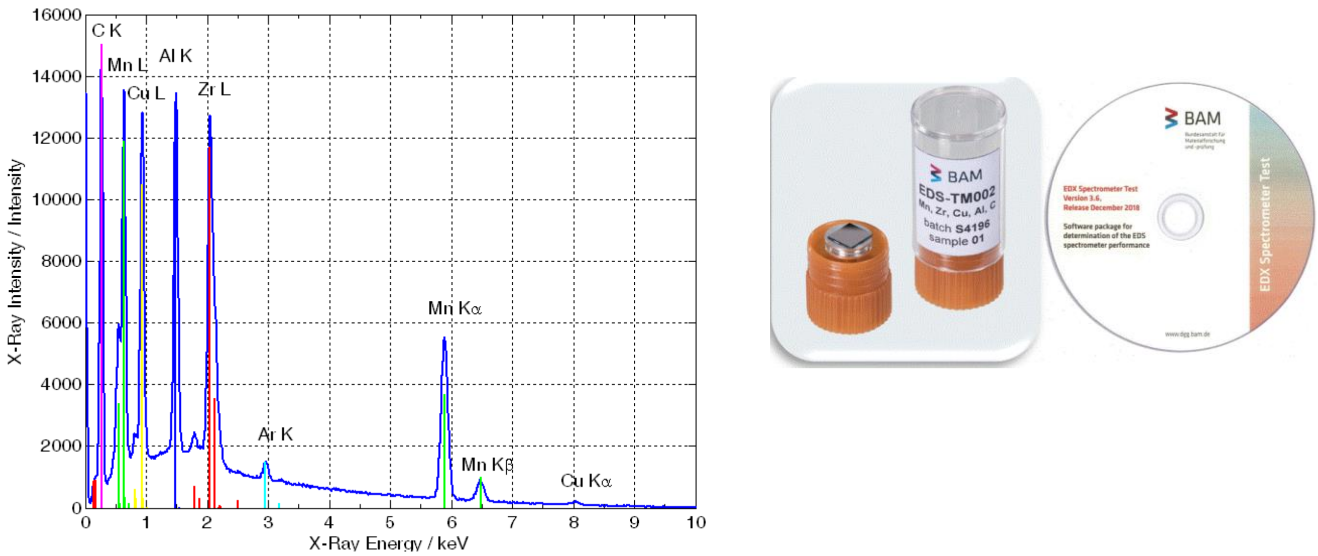


Figure 1: 10 kV X-ray spectrum of EDS-TM002, DVD with the evaluation software EDX Spectrometer Test (version 3.6, Release Dec. 2018) and photo of the test material.

Figure 2 displays the results of the performance check of an SDD EDS spectrometer with a silicon nitride window as provided by the updated "EDS Spectrometer Test" software (version 3.6). The high Mn Lα/Mn Lα intensity ratio should be noticed.

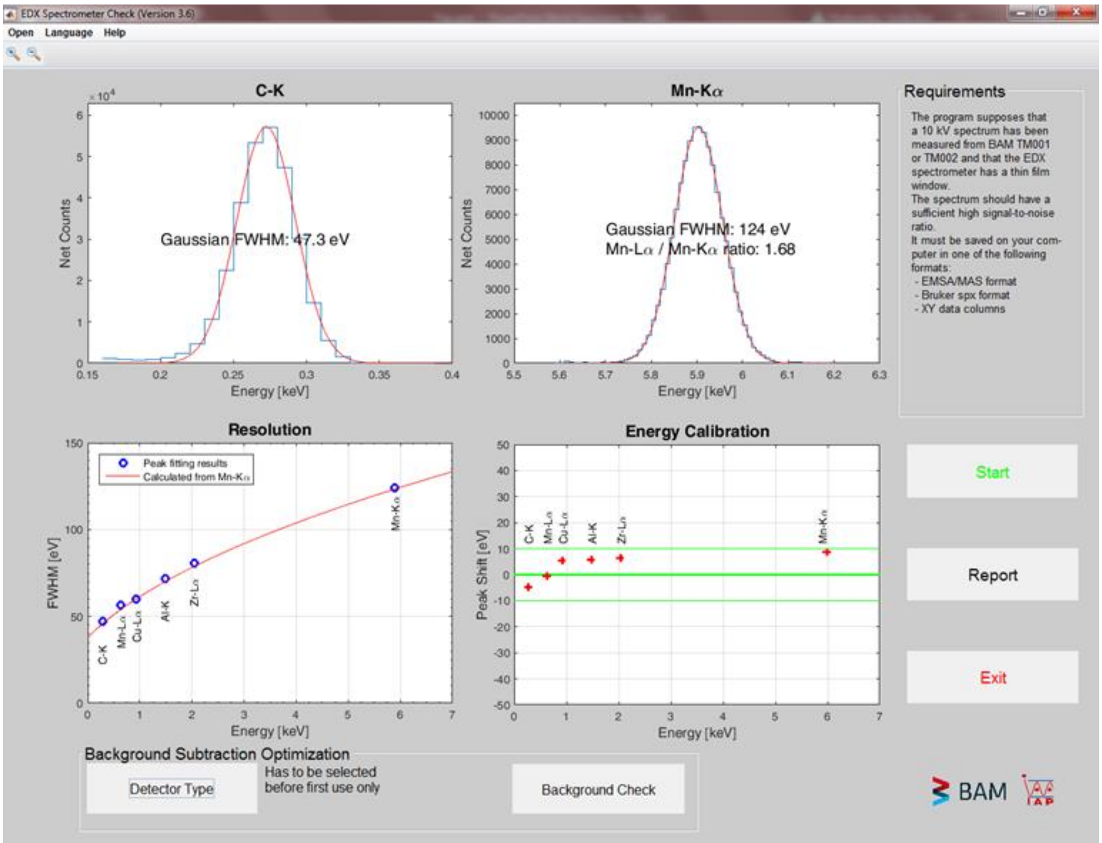


Figure 2: Result of evaluation of an SDD EDS with silicon nitride window with the updated software package "EDS Spectrometer Test", version 3.6 (release 2018).

[1] M Procop and V-D Hodoroaba, Microsc. Microanal. 15 (S2) (2009) 1120

[2] ISO 15632:2012 "Microbeam Analysis – Selected instrumental performance parameters for the specification and checking of energy-dispersive X-ray spectrometers for use in electron probe microanalysis". (Geneva, Switzerland: ISO – International Standards Organization)

[3] V-D Hodoroaba and M Procop, Microsc. Microanal. 20 (2014) 1556

[4] V-D Hodoroaba, R Terborg and M Procop, Microsc. Microanal. 24 (S1) (2018) 730

[5] http://amptek.com/products/c-series-low-energy-x-ray-windows/#4

Particle size distribution

CRM for particle size distribution by laser diffraction methods according to ISO 13320

BAM-D001

Description: hexagonal silicon carbide powder

Year of issue: 2012

Certified properties:

Specific particle diameter corresponding to the cumulative undersize volume distribution Q3	Equivalent spherical diameter [1)] µm	Uncertainty [2)] µm
d_{10}	7,02	0,25
d_{50}	12,48	0,21
d_{90}	20,8	1,1

1) The certified value is the weighted mean of 13 laboratory means which participated in the interlaboratory comparison for certification according to ISO 13320:2009.

2) Estimated expanded uncertainty with a coverage factor of k=2, corresponding to a level of confidence of about 95%, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM,ISO/IEC Guide 98-3:2008).

Values for information:

Refractive index n_p [3)]	2,645
Imaginary part k_p of particles' refractive index (absorption) [3)]	0,1
Density ρ in g/ cm³	3,205

3) Wavelength: 633 nm

Polymeric reference materials

CRMs for the determination of the molecular weight

CRM-No.	ERM®-FA001 (BAM-P001)	ERM®-FA002 (BAM-P002)	ERM®-FA003 (BAM-P003)	ERM®-FA004 (BAM-P004)	ERM®-FA005 (BAM-P005)
Description	Polystyrene	Polystyrene	Polymethyl-methacrylate	Polyethylenoxide	Polystyrene
	Amorphous material	Pellets	Crystalline material	Crystalline material	Pellets
Year of issue	2002	2002	2002	2002	2003
Weight-average molecular weight (M_w) by light scattering (LS) g/mol	87600 ± 2245	205600 ± 3075	107050 ± 2500	–	349800 ± 9700
Intrinsic viscosity by viscometry mL/g	42,37 ± 0,83	68,38 ± 0,79	31,48 ± 1,21	14,28 ± 0,54	104,28 ± 2,30
Average molecular weights (M_w and M_n) g/mol	–	–	–	6065 ± 90	–
polydispersity M_w/M_n by MALDI-TOF-mass spectrometry	–	–	–	1,02 ± 0,98	–

CRM-No.	ERM®-FA006 (BAM-P006)	ERM®-FA007 (BAM-P007)	ERM®-FA008 (BAM-P008)	BAM-P011	BAM-P012
Description	Polymethyl-methacrylate	Polymethyl-methacrylate	Polyethylenoxide	Polystyrene	Polystyrene
	Amorphous material	Crystalline material	Crystalline material	Pellets	Pellets
Year of issue	2003	2003	2003	2007	2007
Weight-average molecular weight (M_w) by light scattering (LS) g/mol	365500 ± 10800	360200 ± 9800	–	286000 ± 4000	348000 ± 8000
Weight-average molecular weight (M_w) by Size Exclusion Chromatography (SEC) g/mol	–	–	–	284000 ± 9000	343000 ± 12000
Intrinsic viscosity by viscometry mL/g	90,63 ± 1,05	84,80 ± 1,82	20,91 ± 1,12	88,73 ± 0,8	104,0 ± 1,8
Average molecular weights (M_w and M_n) g/mol	–	–	11400 ± 150	–	–
polydispersity M_w/M_n by MALDI-TOF-mass spectrometry	–	–	1,01 ± 0,0	–	–

Note: Estimated expanded uncertainty with a coverage factor of k=2.

The reference materials are intended for the calibration of instruments for the determination of the molecular weight and molecular weight distribution of polymers.

Isotopic reference materials

CRMs certified for the isotopic composition of boron

Certified quantity: Isotopic composition of boron in an aqueous solution of boric acid, certified with expanded relative uncertainties of less than 0,12 %.

Application: Calibration and validation of ICP-MS procedures used for the determination of boron isotope amount ratios. Boron isotope amount ratios have to be determined within the surveillance of the primary cooling circuit in nuclear power plants equipped with a pressurized water reactor. They also have to be determined in container materials, which are doped with boron serving as a neutron shield. ERM®-AE124 may also be used for isotope tracer studies and as spike for isotope dilution analysis. In the latter case, however, the characterization of the boron mass fraction by reverse IDMS at the time of use might be advisable, when low measurement uncertainties (<1 % relative) are aimed at.

CRM-No.	ERM®-AE102a	ERM®-AE104a	ERM®-AE123	ERM®-AE124
Isotope abundance ratio $R(^{10}B/^{11}B)$	0,4285 (6)	0,4596 (6)	0,2474 (4)	24,04 (4)
Isotope abundance ratio $R(^{11}B/^{10}B)$	2,3338 (30)	2,1758 (28)	4,042 (6)	0,04160 (6)
Isotope abundance ^{10}B ^{11}B	 0,29995 (27) 0,70005 (27)	 0,31488 (28) 0,68512 (28)	 0,19832 (22) 0,80168 (22)	 0,96006 (6) 0,03994 (6)
Molar mass $M(B)$ in $g{\cdot}mol^{-1}$	10,71044 (27)	10,69557 (28)	10,81170 (22)	10,05273 (6)
	Informative value			
Mass fraction in solution $w(B)$ in $mg{\cdot}kg^{-1}$	999 (20)	1000 (20)	1063 (20)	1002 (20)

All uncertainties indicated are expanded uncertainties $U=k{\cdot}u$ where $k=2$ and u is the combined standard uncertainty calculated according EURACHEM and ISO guidelines. They are given in parentheses and apply to the last one or two digits of the value.

CRM-No.	ERM®-AE101a	
	Certified value	Uncertainty
Isotope amount ratio $n(^{10}B)/n(^{11}B)$ in mol/mol	0,28212	0,00038
Isotope amount ratio $n(^{11}B)/n(^{10}B)$ in mol/mol	3,5446	0,0048
Isotope amount fraction $n(^{10}B)/n(B)$ in mol/mol	0,22004	0,00023
Isotope amount fraction $n(^{11}B)/n(B)$ in mol/mol	0,77996	0,00023
Mass fraction of B in solution $M(B)$ in mol/mol	10,79007	0,00023
	Informative value	
Mass fraction of B in $mg{\cdot}kg^{-1}$	1026	21

Certified quantity: $\delta^{11}B$ relative to NIST SRM 951: $\delta^{11}B$ is a measure for the isotope variation. It is expressed as the shift of the isotopic composition relative to an internationally accepted standard given in per mill. It is calculated according to the following equation, with NIST SRM 951 (isotope reference material for boron) being used as reference: $\delta^{11}B = ((R_{sample}/R_{reference})-1)$. This certified reference material is traceable to the international δ-scale for boron with the origin being represented by NIST SRM 951.

Application: Isotope reference materials are essential to enable the determination of reliable and comparable isotope data. Besides the correction of mass fractionation or mass discrimination isotope reference materials are indispensable for validation and quality control of analytical procedures. In general δ-values of specific elements express the difference of an isotope ratio of a sample relative to an international accepted standard in per mill. Such δ-values are used in science and technology to study geochemical and environmental processes and to determine the provenance of food and the origin of forensic and archaeological artefacts.

These three boron isotope reference materials are certified for their $\delta^{11}B$-values relative to NIST SRM 951 which is the internationally accepted origin of the δ-scale for boron. The certified $\delta^{11}B$ values cover about three-quarters of the known natural boron isotope variability. The $\delta^{11}B$ reference materials are primarily intended to be used for quality control and the validation of chemical and mass spectrometric procedures.

CRM-No.	ERM®-AE120	ERM®-AE122
$\delta^{11}B_{NIST\ 951}$ in ‰	-20,2 (0,6)	39,7 (0,6)
	Informative value	
Isotope abundance ratio $R(^{10}B/^{11}B)$	0,25236 (33)	0,23782 (31)
Isotope abundance ratio $R(^{11}B/^{10}B)$	3,963 (6)	4,205 (6)
Isotope abundance ^{10}B ^{11}B	0,20150 (21) 0,79850 (21)	0,19213 (20) 0,80787 (20)
Molar mass $M(B)$ in g·mol^{-1}	10,80853 (21)	10,81787 (20)
Mass fraction in solution $w(B)$ in mg·kg^{-1}	100,0 (2,0)	100,0 (2,0)

All uncertainties indicated are expanded uncertainties $U=k\cdot u$ where k=2 and u is the combined standard uncertainty calculated according EURACHEM and ISO guidelines. They are given in parentheses and apply to the last one or two digits of the value.

CRM-No.	ERM®-AE125	
	Certified value	Uncertainty
$\delta^{11}B_{NIST\ 951}$ in ‰	-124,00	0,48
	Informative value	
Isotope amount ratio $n(^{10}B)/n(^{11}B)$ in mol/mol	0,28212	0,00038
Isotope amount ratio $n(^{11}B)/n(^{10}B)$ in mol/mol	3,5446	0,0048
Isotope amount fraction $n(^{10}B)/n(B)$ in mol/mol	0,22004	0,00023
Isotope amount fraction $n(^{11}B)/n(B)$ in mol/mol	0,77996	0,00023
Molar mass of B in solution $M(B)$ in g/mol	10,79007	0,00023
Mass fraction of B in solution $M(B)$ in mol/mol	101,4	2,0

CRM certified for the isotopic composition of cadmium

Certified quantity: Primary isotopic reference material certified for the isotopic composition of cadmium in a dilute nitric acid solution with expanded relative uncertainties of less than 0,07 %.

Application: Calibration of any kind of mass spectrometric procedures used for the determination of cadmium isotope amount ratios. BAM-I012 represents the best measurement for cadmium isotope amount ratios as approved by IUPAC. Additionally, BAM-I012 defines the delta-scale for $\delta^{114/110}$Cd measurements.

CRM-No.	BAM-I012	
Isotope amount ratios in mol·mol^{-1}		
$n(^{106}Cd)/n(^{111}Cd)$	0,09751	(7)
$n(^{108}Cd)/n(^{111}Cd)$	0,06951	(3)
$n(^{110}Cd)/n(^{111}Cd)$	0,97504	(10)
$n(^{112}Cd)/n(^{111}Cd)$	1,8835	(4)
$n(^{113}Cd)/n(^{111}Cd)$	0,95479	(16)
$n(^{114}Cd)/n(^{111}Cd)$	2,2437	(7)
$n(^{116}Cd)/n(^{111}Cd)$	0,58583	(26)
Isotope amount fractions in mol·mol^{-1}		
$n(^{106}Cd)/n(Cd)$	0,012485	(9)
$n(^{108}Cd)/n(Cd)$	0,008901	(4)
$n(^{110}Cd)/n(Cd)$	0,124846	(16)
$n(^{111}Cd)/n(Cd)$	0,128043	(13)
$n(^{112}Cd)/n(Cd)$	0,24117	(4)
$n(^{113}Cd)/n(Cd)$	0,122254	(22)
$n(^{114}Cd)/n(Cd)$	0,28729	(6)
$n(^{116}Cd)/n(Cd)$	0,07501	(4)
Molar mass M(Cd) in g·mol^{-1}	112,41218	(18)
	Informative value	
Mass fraction in solution w(Cd) in mg·kg^{-1}	994	(5)

All uncertainties indicated are expanded uncertainties $U=k \cdot u$ where k=2 and u is the combined standard uncertainty calculated according EURACHEM and ISO guidelines, excepting for w(Cd), where k=4.5. They are given in parentheses and apply to the last one or two digits of the value.

CRM certified for the mass fraction and the isotopic composition of palladium

Certified quantity: Spike isotopic reference material certified for the mass fraction of ^{106}Pd and the isotopic composition of palladium in 20 % hydrochloric acid with expanded relative uncertainties of 0,24 % for the mass fraction of ^{106}Pd.

Application: The spike isotopic reference material ERM®-AE140 is a solution of isotopically enriched Pd in 20 % hydrochloric acid and filled in flame-sealed quartz ampoules containing approximately 7 mL solution. This material is designed to serve as isotopically enriched analogue or so-called spike in Isotope Dilution Mass Spectrometry (IDMS) for the quantification of Pd.

CRM-No.	ERM®-AE140
Mass fraction $w(^{106}Pd)$ in mg·kg^{-1}	20,24 (5)
Isotope amount ratios in mol·mol^{-1} $n(^{102}Pd)/n(^{106}Pd)$ $n(^{104}Pd)/n(^{106}Pd)$ $n(^{105}Pd)/n(^{106}Pd)$ $n(^{108}Pd)/n(^{106}Pd)$ $n(^{110}Pd)/n(^{106}Pd)$	 0,0000791 (11) 0,001247 (11) 0,007518 (30) 0,004785 (22) 0,001156 (11)
	Indicative values
Mass fraction $w(Pd)$ in mg·kg^{-1}	20,54 (5)
Isotope amount fractions in mol·mol^{-1} $n(^{102}Pd)/n(Pd)$ $n(^{104}Pd)/n(Pd)$ $n(^{105}Pd)/n(Pd)$ $n(^{106}Pd)/n(Pd)$ $n(^{108}Pd)/n(Pd)$ $n(^{110}Pd)/n(Pd)$	 0,0000780 (10) 0,001229 (10) 0,007408 (30) 0,98543 (5) 0,004716 (22) 0,001139 (11)
Molar mass $M(Pd)$ in g·mol^{-1}	105,907312 (75)

All uncertainties indicated are expanded uncertainties $U=k\cdot u$ where k=2 and u is the combined standard uncertainty calculated according EURACHEM and ISO guidelines. They are given in parentheses and apply to the last one or two digits of the value.

CRM certified for the mass fraction and the isotopic composition of platinum

Certified quantity: Spike isotopic reference material certified for the mass fraction of ^{194}Pt and the isotopic composition of platinum in 20 % hydrochloric acid with expanded relative uncertainties of 0,61 % for the mass fraction of ^{194}Pt.

Application: The spike isotopic reference material ERM®-AE141 is a solution of isotopically enriched Pt in 20 % hydrochloric acid and filled in flame-sealed quartz ampoules containing approximately 7 mL solution. This material is designed to serve as isotopically enriched analogue or so-called spike in Isotope Dilution Mass Spectrometry (IDMS) for the quantification of Pt.

CRM-No.	ERM®-AE141
Mass fraction $w(^{194}Pt)$ in mg·kg^{-1}	18,18 (11)
Isotope amount ratios in mol·mol^{-1} $n(^{190}Pt)/n(^{194}Pt)$ $n(^{192}Pt)/n(^{194}Pt)$ $n(^{195}Pt)/n(^{194}Pt)$ $n(^{196}Pt)/n(^{194}Pt)$ $n(^{198}Pt)/n(^{194}Pt)$	 0,0000012 (6) 0,000342 (4) 0,0739 (8) 0,01749 (21) 0,002022 (29)
	Indicative values
Mass fraction $w(Pt)$ in mg·kg^{-1}	19,90 (12)
Isotope amount fractions in mol·mol^{-1} $n(^{190}Pt)/n(Pt)$ $n(^{192}Pt)/n(Pt)$ $n(^{194}Pt)/n(Pt)$ $n(^{195}Pt)/n(Pt)$ $n(^{196}Pt)/n(Pt)$ $n(^{198}Pt)/n(Pt)$	 0,0000011 (6) 0,000312 (4) 0,9143 (8) 0,0676 (6) 0,01599 (26) 0,001849 (10)
Molar mass $M(Pt)$ in g·mol^{-1}	194,0692 (10)

All uncertainties indicated are expanded uncertainties $U=k\cdot u$ where $k=2$ and u is the combined standard uncertainty calculated according EURACHEM and ISO guidelines. They are given in parentheses and apply to the last one or two digits of the value.

CRM certified for the isotopic composition of lead

Certified quantity: isotopic reference material certified for the isotopic composition of lead in a dilute nitric acid solution and in bronze with expanded relative uncertainties of ≤ 0,1 %.

Application: Calibration and validation of any kind of mass spectrometric procedures used for the determination of lead isotope amount ratios.

Isotope reference materials are essential to enable the determination of reliable and comparable isotope data. Besides the correction of mass fractionation or mass discrimination isotope reference materials are indispensable for validation and quality control of analytical procedures. ERM®-EB400 is the first matrix reference material certified for the Pb isotopic composition. It is best suited to calibrate and validate any Pb isotope ratio determination in metals. It helps especially for validating Pb-matrix separation procedures. Fields of application are analytical chemistry, archaeometry, geochemistry and others.

CRM-No.	ERM®-AE142	ERM®-EB400
Isotope amount ratios in $mol \cdot mol^{-1}$ $n(^{206}Pb)/n(^{204}Pb)$ $n(^{207}Pb)/n(^{204}Pb)$ $n(^{208}Pb)/n(^{204}Pb)$ $n(^{206}Pb)/n(^{204}Pb)$	 21,114 (17) 15,944 (17) 39,850 (44) 1,8874 (10)	 18,072 (17) 15,578 (18) 38,075 (46) 2,1068 (14)
Isotope amount fractions in $mol \cdot mol^{-1}$ $n(^{204}Pb)/n(Pb)$ $n(^{206}Pb)/n(Pb)$ $n(^{207}Pb)/n(Pb)$ $n(^{208}Pb)/n(Pb)$	 0,012 8357 (83) 0,271 01 (23) 0,204 65 (21) 0,511 50 (32)	 0,013 7504 (98) 0,248 50 (24) 0,214 20 (24) 0,523 55 (35)
Molar mass $M(Pb)$ in $g \cdot mol^{-1}$	207,177 83 (53)	207,209 68 (57)
	Informative value	Additional material information
Mass fraction in solution $w(Pb)$ in $mg \cdot kg^{-1}$	100,0 (2,0)	44,9 (2,3)

All uncertainties indicated are expanded uncertainties $U = k \cdot u_c$ where $k=2$ and u_c is the combined standard uncertainty calculated according EURACHEM and ISO guidelines. They are given in parentheses and apply to the last one or two digits of the value.

CRM certified for the isotopic composition of magnesium

Certified quantity: Primary isotopic reference materials certified for the isotopic composition of magnesium in a dilute nitric acid solution with relative expanded uncertainties of less than 0,035 %.

Application: Calibration of any kind of mass spectrometric procedures used for the determination of magnesium isotope amount ratios. ERM-AE143, ERM-AE144 and ERM-AE145 represent the best measurement for magnesium isotope amount ratios as approved by IUPAC. ERM-AE143 additionally is designed to anchor the magnesium delta-scale at $\delta^{26/24}$Mg = 0.

CRM-No.	ERM-AE143	ERM-AE144	ERM-AE145
Isotope amount ratios in mol·mol^{-1} $n(^{25}\text{Mg})/n(^{24}\text{Mg})$ $n(^{26}\text{Mg})/n(^{24}\text{Mg})$	 0,126 590 (20) 0,139 362 (43)	 0,126 486 (22) 0,139 138 (39)	 0,126 514 (16) 0,139 185 (29)
Isotope amount fractions in mol·mol^{-1} $n(^{24}\text{Mg})/n(\text{Mg})$ $n(^{25}\text{Mg})/n(\text{Mg})$ $n(^{26}\text{Mg})/n(\text{Mg})$	 0,789 920 (46) 0,099 996 (14) 0,110 085 (28)	 0,790 124 (39) 0,099 939 (13) 0,109 936 (25)	 0,790 078 (28) 0,099 956 (10) 0,109 967 (21)
Molar mass M(Mg) in g·mol^{-1}	 24,305 017 (73)	 24,304 664 (63)	 24,304 741 (46)
	Informative value	Informative value	Informative value
Mass fraction in solution w(Mg) in mg·kg^{-1}	 50.0 (1.0)	 50.0 (1.0)	 50.0 (1.0)

All uncertainties indicated are expanded uncertainties $U = k \cdot u_c$, where k = 2 and u_c is the combined standard uncertainty calculated according EURACHEM and ISO guidelines. They are given in parentheses and apply to the last one or two digits of the value.

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CRMs under development

Metals

BAM-M313a	AlMg3, replacement of ERM-EB313
Certified property:	Mass fraction of Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, As, Be, Bi, Ca, Cd, Ga, Hg, Li, Mo, Na, Pb, Sb, Sn, Tl, V, Zr
Fields of application:	Calibration, validation and internal laboratory quality control of spark emission and X-ray fluorescence spectrometers
Completion date:	2020

BAM-M322	AlMn1Cu
Certified property:	Mass fraction of Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, B, Be, Bi, Ca, Cd, Co, Ga, Hg, Li, Na, Pb, Sb, Sn, V, Zr
Fields of application:	Calibration, validation and internal laboratory quality control of spark emission and X-ray fluorescence spectrometers
Completion date:	2021

ECRM 591-2	FeV(80), replacement of 591-1
Certified property:	Mass fraction of C, Si, Mn, P, S, Ni, Al, As, B, Bi, Cu, Ti, V, Zn, Fe
Fields of application:	Calibration, validation and internal laboratory quality control of wet chemical methods, XRF and combustion analysis
Completion date:	2021

ECRM 593-1	FeV(65)
Certified property:	Mass fraction of C, Si, Mn, P, S, Cr, Mo, Ni, Al, As, B, Bi, Cu, Sn, Ti, V, Zn, Fe, Mg
Fields of application:	Calibration, validation and internal laboratory quality control of wet chemical methods, XRF and combustion analysis
Completion date:	2021

ECRM 267-1	Highly alloyed steel, replacement of 099-1
Certified property:	Mass fraction of O, N
Fields of application:	Calibration, validation and internal laboratory quality control of carrier gas hot extraction
Completion date:	2021

Isotopic reference materials

BAM-I020	Cu solution in dilute nitric acid
Certified Properties:	Cu isotopic composition
Fields of application:	Method development, validation and quality control of analytical procedures for Cu isotope ratio determination
Completion date:	2021