Certified Reference Materials

BAM
Federal Institute for Materials Research and Testing

Catalogue 2014

Safety in technology and chemistry

Our Mission

As a Federal Institute for materials technology and chemical engineering we ensure ongoing safety in technology and chemistry through
– research and development
– testing, analysis, approval and certification
– consultation, information and advice

within our objective of promoting German industrial development.

Our Guideline

Safety in technology and chemistry

Our Responsibilities

- Statutory functions relating to technical safety in the public domain, especially as regards dangerous materials and substances
- Collaboration in developing statutory regulations, for example on safety standards and threshold values
- Advising the Federal Government and industry on safety aspects of materials and chemical technology
- The development and supply of reference materials and methods, in particular for chemical analysis and materials testing
- Assisting in the development of standards and technical regulations for the evaluation of substances, materials, structures and processes with reference to damage prediction and prevention, environmental protection and preservation of national economic values
- Enhancement of safety and reliability in chemical and materials technologies

Our National and international cooperation

The tasks of BAM for technology, science, economy and society require interdisciplinary cooperation. BAM collaborates closely with technological institutions in Germany and abroad, especially with national institutes. It gives advice to Federal Ministries, economy associations, industrial enterprises and consumer organisations. It provides expertise to administrative authorities and law-courts. In the area of measurement, standardisation, testing and quality assurance BAM is the competent national authority for testing techniques. BAM is cooperating with numerous technical, legislative and standardisation bodies in order to develop technical rules and safety regulations and represents the Federal Republic of Germany both on the national and international level.

Our Status

BAM is a senior scientific and technical Federal Institute with responsibility to the Federal Ministry for Economic Affairs and Energy. It is the successor of the Public Materials Testing Office (Staatliches Materialprüfungsamt) founded in 1871 and of the Chemical-Technical State Institute (Chemisch-Technische Reichsanstalt) set up in 1920. BAM has a staff of about 1800, including over 1000 natural scientists and engineers working at the main grounds of Berlin-Lichterfelde and at the extensions at Berlin-Steglitz and Berlin-Adlershof.

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Foreword

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 IRMM and LGC (www.erm-crm.org) to create a European brand of CRMs of high metrological quality.

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.

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:

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

Phone: **+49 30 8104-2061**
Fax: **+49 30 8104-1117**

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

Terms and conditions:

For prices see separate price list, which is also available on our homepage.

http://www.bam.de/en/fachthemen/referenzmaterialien/index.htm

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: 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 BAM Bundesanstalt für Materialforschung und -prüfung, Max-Planck-Institut für Eisenforschung, Stahlinstitut VDEh,

the United Kingdom: Bureau of Analysed Samples Limited,

Sweden/Finland: Jernkontoret, Corrosion and Metals Institute (Swerea KIMAB).

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 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:

* - analysed by 20 to 25 European laboratories

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)

Three 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.

Ball-bearing steel: The surfaces of the balls are protected against oxidation by a layer of gold. The diameter of the balls is kept constant with high reproducibility resulting in masses of 1,00050 g ± 0,00015 g. Weighing of the material is not necessary.

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 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-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 039-2**	**D 042-1**	**D 079-2***	**D 082-1***	**D 083-1***
Year of issue	1971	1972	1989	1976	1978
Chips, powder	•	•	•	•	•
Disc					
C	0,107 ± 0,003	0,108 ± 0,003	0,596 ± 0,006	0,415 ± 0,003	0,0262**R** ± 0,0004+
Si	0,011 ± 0,002	0,037 ± 0,005	0,247 ± 0,006	0,235 ± 0,005	—
Mn	1,274 ± 0,014	0,666 ± 0,010	0,743 ± 0,013	0,769 ± 0,008	0,289 ± 0,004
P	0,083 ± 0,004	0,0057**R** ±0,0004	0,0234 ± 0,0012	0,013 ± 0,001	0,0076 ± 0,0010
S	0,310 ± 0,005	0,024 ± 0,024	0,192 ± 0,006	0,030 ± 0,001	0,0100 ± 0,0005
Cr	0,048 ± 0,003	0,016 ± 0,004	0,0382 ± 0,0023	0,018 ± 0,001	(0,0129)
Mo	—	—	—	—	—
Ni	0,051 ± 0,003	0,029 ± 0,002	0,0219 ± 0,0010	0,027 ± 0,001	0,014 ± 0,001
Al	—	0,010 ± 0,001	0,0209 ± 0,0017	0,032 ± 0,002	(0,0044)
As	0,018 ± 0,001	—	0,0040 ± 0,0007	(0,029)	(0,0043)
Cu	0,117 ± 0,006	0,041 ± 0,002	0,0462 ± 0,0010	0,025 ± 0,001	0,016 ± 0,001
N	0,0113 ± 0,0004	0,0078 ± 0,0007	0,0074 ± 0,0005	(0,0047)	0,00189 ± 0,00011
Nb	—	0,054 ± 0,005	—	—	—
Pb	0,207 ± 0,005	—	—	0,149 ± 0,004	—
Sn	0,016 ± 0,001	—	0,0037 ± 0,0008	—	—
Ti	—	—	(0,0021)	—	—
V	—	—	—	—	—
Te	—	—	—	0,030 ± 0,001	—

(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)	0,078 ± 0,007
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

- continued -

Alloy steels (continued)

CRM-No.	**D 180-1***	**D 181-1***	**D 182-1***	**D 183-1***	**D 184-1***
Year of issue	1973	1973	1974	1973	1978
Chips, powder	•	•	•	•	•
Disc					
C	0,197 ± 0,005	0,590 ± 0,005	0,790 ± 0,008	0,083 ± 0,002	0,333 ± 0,003
Si	0,362 ± 0,007	1,054 ± 0,015	0,368 ± 0,014	0,421 ± 0,006	0,218 ± 0,005
Mn	1,286 ± 0,015	1,047 ± 0,008	0,389 ± 0,007	0,354 ± 0,004	0,528 ± 0,006
P	0,0174 ± 0,0010	0,018 ± 0,001	0,0076**R** ± 0,0005	0,089 ± 0,002	0,0047**R** ± 0,0003
S	0,0249 ± 0,0010	0,035 ± 0,001	0,011 ± 0,001	0,031 ± 0,001	0,0032 ± 0,0003
Cr	1,250 ± 0,018	0,126 ± 0,004	0,591 ± 0,012	0,670 ± 0,013	1,287 ± 0,011
Mo	—	—	—	—	0,457 ± 0,009
Ni	0,096 ± 0,008	0,070 ± 0,004	0,152 ± 0,005	0,073 ± 0,004	3,318 ± 0,015
Al	—	0,022 ± 0,004	0,020 ± 0,003	0,027 ± 0,002	0,0052 ± 0,0007
Al acid soluble	—	—	—	—	—
As	0,030 ± 0,002	(0,026)	(0,0202)	(0,013)	0,0180 ± 0,0011
B	—	—	—	—	—
Co	—	—	—	—	0,0560 ± 0,0019
Cu	0,115 ± 0,004	0,174 ± 0,005	0,141 ± 0,004	0,445 ± 0,010	0,060 ± 0,002
N	0,0068 ± 0,0009	0,0068 ± 0,0005	0,0102 ± 0,0004	0,0064 ± 0,0006	0,0051 ± 0,0004
Nb	—	—	—	—	—
Pb	—	—	0,0039 ± 0,0003	—	—
Sn	—	(0,015)	(0,0135)	—	0,0044 ± 0,0004
Ti	—	—	—	—	—
V	—	—	0,177 ± 0,010	—	0,108 ± 0,006
W	—	—	—	—	—
Ca	—	—	—	—	—
Mg	—	—	(0,0005)	—	—
Sb	—	(0,004)	0,0042 ± 0,0005	—	(0,0015)
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***	**D 193-1***	**D 194-1***
Year of issue	1982	2010	2006	1994	1990	1993
Chips, powder	•	•	•	•	•	•
Disc		•	•	•	•	
C	0,195 ±0,003	0,2038 ±0,0012	0,0043 ±0,0002$^+$	0,1875 ±0,0009	0,139 ±0,004	0,1532 ±0,0011$^+$
Si	0,026 ±0,002	0,2110 ±0,0029	3,267 ±0,012$^+$	0,219 ±0,004	0,404 ±0,006	0,431 ±0,004$^+$
Mn	1,354 ±0,011	1,257 ±0,006	0,1334 ±0,0019$^+$	1,377 ±0,006	0,972 ±0,017	1,188 ±0,004$^+$
P	0,014 ±0,001	0,0066 ±0,0002	0,0087 ±0,0004$^+$	0,0029 ±0,0002	0,0063 ±0,0006	0,0097 ±0,0006$^+$
S	0,025 ±0,001	0,0300 ±0,0006	0,0029 ±0,0002$^+$	0,0010 ±0,0001	0,0086 ±0,0006	0,00059**R** ±0,00005$^+$
Cr	1,186 ±0,015	1,132 ±0,007	0,0314 ±0,0006$^+$	0,0717 ±0,0018	0,182 ±0,006	0,733 ±0,006$^+$
Mo	0,035 ±0,002	0,0623 ±0,0008	0,0020 ±0,0002$^+$	0,482 ±0,004	0,347 ±0,011	0,2857 ±0,0026$^+$
Ni	0,096 ±0,003	0,1755 ±0,0013	0,0224 ±0,0004$^+$	0,755 ±0,004	1,178 ±0,019	0,3417 ±0,0027$^+$
Al	0,046 ±0,002	0,0223 ±0,0006	0,985 ±0,006$^+$	0,0308 ±0,0008	0,0257 ±0,0015	0,0837 ±0,0020$^+$
Al $_{\text{acid soluble}}$	—	—	—	0,0285 ±0,0008	—	—
As	0,018 ±0,002	0,0057 ±0,0003	0,0018 ±0,0003$^+$	(0,003)	0,0062 ±0,0007	0,0042 ±0,0004$^+$
B	0,0004 ±0,0002	0,00048 ±0,00006	—	(0,00016)	(0,0002)	0,0020 ±0,0002$^+$
Co	0,014 ±0,001	0,0112 ±0,0003	—	0,0055 ±0,0002	0,0073 ±0,0007	—
Cu	0,161 ±0,003	0,1288 ±0,0012	0,0165 ±0,0003$^+$	0,0453 ±0,0008	0,598 ±0,009	0,0751 ±0,0011$^+$
N	0,014 ±0,001	0,0105 ±0,0004	0,00105 ±0,00009$^+$	0,0118 ±0,0002	0,0108 ±0,0004	0,0115 ±0,0002$^+$
Nb	—	—	—	—	0,0232 ±0,0019	—
Pb	—	—	—	—	(0,0002)	—
Sn	0,011 ±0,001	0,0237 ±0,0006	0,0050 ±0,0005$^+$	(0,0030)	—	—
Ti	—	(0,00075)	0,0024 ±0,0002$^+$	(0,0009)	(0,0013)	—
V	—	0,0122 ±0,0003	—	(0,003)	(0,0019)	0,0243 ±0,0009$^+$
W	—	—	—	—	—	—
Ca	—	—	—	—	—	0,0026 ±0,0002$^+$
Mg	—	—	—	—	—	—
Sb	—	(0,0018)	(0,0007)	—	—	—
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
Year of issue	1967	1971	2002	1972
Chips	•	•	•	•
Disc				
C	0,416 ± 0,007	0,950 ± 0,013	0,0140 ± 0,0003⁺	0,912 ± 0,014
Si	0,514 ± 0,007	0,272 ± 0,013	0,368 ± 0,006⁺	0,094 ± 0,010
Mn	0,434 ± 0,013	0,236 ± 0,007	1,263 ± 0,009⁺	12,73 ± 0,07
P	0,0207 ± 0,0012	0,016 ± 0,001	0,0179 ± 0,0007⁺	0,045 ± 0,002
S	0,0094 ± 0,0014	0,022 ± 0,002	0,0250 ± 0,0007⁺	0,0072 ± 0,0007
Cr	13,67 ± 0,06	4,25 ± 0,02	18,071 ± 0,018⁺	0,354 ± 0,014
Mo	0,024 ± 0,006	2,64 ± 0,05	0,301 ± 0,004⁺	0,032 ± 0,003
Ni	0,139 ± 0,014	0,114 ± 0,008	10,105 ± 0,021⁺	(0,08)
Al	—	—	0,0032 ± 0,0004⁺	—
As	(0,0256)	—	0,0048 ± 0,0003⁺	—
B	—	—	0,0020 ± 0,0002⁺	—
Co	(0,0246)	—	0,0402 ± 0,0011⁺	—
Cu	—	0,124 ± 0,005	0,0941 ± 0,0009⁺	0,073 ± 0,002
N	0,0362 ± 0,0017	0,040 ± 0,002	0,0444 ± 0,0004⁺	0,020 ± 0,0008
Nb	—	—	—	—
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)
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 237-1**	**D 271-1***	**D 278-1***	**D 283-1***	**D 284-2***
Year of issue	1973	2007	1973	1985	2000
Chips	•	•	•	•	•
Disc		•			
C	0,068 ± 0,002	0,3698 ± 0,0021[+]	0,903 ± 0,019	1,219 ± 0,009	0,0201 ± 0,0005[+]
Si	0,482 ± 0,013	0,923 ± 0,006[+]	0,336 ± 0,008	0,345 ± 0,017	0,537 ± 0,008[+]
Mn	1,443 ± 0,018	0,437 ± 0,004[+]	0,405 ± 0,006	0,217 ± 0,010	1,745 ± 0,009[+]
P	0,032 ± 0,002	0,0120 ± 0,0004[+]	0,0154 ± 0,0014	0,022 ± 0,002	0,0258 ± 0,0008[+]
S	0,012 ± 0,001	0,00045 ± 0,00008[+]	0,0052 ± 0,0011	0,029 ± 0,002	0,0237 ± 0,0005[+]
Cr	17,24 ± 0,04	5,002 ± 0,019[+]	18,11 ± 0,08	4,15 ± 0,06	16,811 ± 0,019[+]
Mo	0,306 ± 0,006	1,247 ± 0,006[+]	1,040 ± 0,030	3,41 ± 0,09	2,111 ± 0,010[+]
Ni	10,32 ± 0,04	0,1552 ± 0,0020[+]	0,236 ± 0,024	—	10,72 ± 0,05[+]
Al	—	0,0234 ± 0,0011[+]	—	0,0099 ± 0,0014	0,0027 ± 0,0004[+]
As	—	0,0057 ± 0,0004[+]	—	(0,0096)	0,0063 ± 0,0003[+]
B	—	(0,0003)	—	0,0003 ± 0,0001	0,0026 ± 0,0001[+]
Co	0,221 ± 0,006	0,0139 ± 0,0005[+]	—	10,27 ± 0,17	0,0525 ± 0,0011[+]
Cu	0,123 ± 0,005	0,1371 ± 0,0015[+]	0,077 ± 0,008	—	0,1831 ± 0,0014[+]
N	0,035 ± 0,002	0,0137 ± 0,0003[+]	—	0,033 ± 0,002	0,0151 ± 0,0002[+]
Nb	0,660 ± 0,023	(0,0009)	—	—	(0,0028)
Pb	—	(0,0005)	—	(< 0,0005)	—
Sn	—	0,0084 ± 0,0002[+]	—	(0,0065)	0,0047 ± 0,0002[+]
Ti	—	0,0020 ± 0,0002[+]	—	—	0,191 ± 0,004[+]
V	0,057 ± 0,005	0,850 ± 0,007[+]	0,077 ± 0,008	3,28 ± 0,03	0,0425 ± 0,0016[+]
W	—	0,0054 ± 0,0005[+]	—	9,66 ± 0,12	(0,0183)
Zr	—	(0,00013)	—	—	(0,0005)
Ag	—	—	—	—	—
Ca	—	0,0009 ± 0,0002[+]	—	—	—
Mg	—	(0,00013)	—	—	—
O	—	0,0020 ± 0,0002[+1)]	—	—	0,0099 ± 0,0007[+2)]
Sb	—	(0,0017)	—	—	—
Ta	—	—	—	—	(0,0013)

(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

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	0,0021**R** ± 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**	**D 591-1***
Description	FeMn	FeSi	FeV
Year of issue	2004	1975	1996
C	6,94 ± 0,02^{+}	0,10 ± 0,01	0,141 ± 0,004
Si	(0,092)	91,11 ± 0,33	0,847 ± 0,012
Mn	77,87 ± 0,11^{+}	0,04 ± 0,005	0,307 ± 0,004
P	0,148 ± 0,003^{+}	0,013 ± 0,001	0,0299 ± 0,0017
S	(0,0024)	—	0,0153 ± 0,0008
Cr	0,0265 ± 0,0006^{+}	—	—
Mo	—	—	—
Ni	0,0384 ± 0,0011^{+}	—	0,0141 ± 0,0014
Al	—	0,86 ± 0,02	3,19 ± 0,05
As	—	—	0,0022 ± 0,0002
B	(0,0006)	—	(0,0018)
Co	(0,048)	—	—
Cu	0,0370 ± 0,0007^{+}	0,01 ± 0,001	0,0596 ± 0,0016
N	(0,017)	—	(0,308)
Sn	—	—	—
Ti	0,0034 ± 0,0003^{+}	0,09 ± 0,004	(0,044)
V	—	—	79,72 ± 0,14
Zr	—	—	—
Ca	—	0,46 ± 0,04	(0,0328)
Fe	(14,6)	6,15 ± 0,08	14,59 ± 0,10
Mg	—	0,04 ± 0,006	(0,044)
O	—	—	(0,516)
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)

Ores, iron oxide (continued)

CRM-No.	**D 686-1***	**D 687-1***
Description	Iron oxide	Iron oxide
Year of issue	2002	2009
Fe total	69,44 ± 0,11+	69,66 ± 0,14+
Fe(II)	(0,0484)	(0,076)
Si	0,0083 ± 0,0005+	0,0157 ± 0,0011+
SiO_2	—	—
Al	0,0407 ± 0,0012+	0,0356 ± 0,0012+
Al_2O_3	—	—
Ca	0,0097 ± 0,0007+	0,0113 ± 0,0012+
CaO	—	—
Mg	0,0027 ± 0,0002+	0,0018 ± 0,0002+
MgO	—	—
Mn	0,231 ± 0,004+	0,1658 ± 0,0027+
P	0,0078 ± 0,0001+	0,0120 ± 0,0004+
P_2O_5	—	—
S	—	—
Na	0,0058 ± 0,0005+	0,0030 ± 0,0003+
Na_2O	—	—
K	0,0024 ± 0,0004+	0,0011 ± 0,0002+
K_2O	—	—
As	—	—
Cr	0,0182 ± 0,0006+	0,0227 ± 0,0008+
Cu	0,0038 ± 0,0003+	0,0030 ± 0,0003+
F	—	—
Ni	0,0127 ± 0,0004+	0,0122 ± 0,0006+
Pb	—	(0,0004)
Ti	0,0014 ± 0,0001+	0,0303 ± 0,0005+
TiO_2	—	—
V	—	—
Zn	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)

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

CRM Stahl-H1

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“, “Lead” and „Zinc“ of the Committee of Chemists of the Gesellschaft für Bergbau, Metallurgie, Rohstoff- und Umwelttechnik (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 cm high and 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.

Potassiumdicyanoaurate(I) is provided for wet chemical analysis. It was certified by BAM in collaboration with the Working Group „Precious Metals“ of the Committee of Chemists of the GDMB. It is available in glass bottles containing 6 g each.

Each sample is distributed together with a certificate which contains the certified values together with their uncertainties (95%-level) 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

Mass fraction in %

CRM-No.	**201**	**300**	**301**
Description	GAlSi12	AlMg3	Al99,8
Year of issue	1963	1959	1961
Al	**(matrix)**	**(matrix)**	**(matrix)**
Si	13,20	0,14	0,061
Mg	0,0024	2,67	0,0008
Cu	0,009	0,046	0,0016
Fe	0,18	0,198	0,054
Mn	0,38	0,018	0,001
Cr	—	0,23	—
Ni	—	—	—
Pb	—	0,016	—
Sn	—	(< 0,0005)	(< 0,0005)
Ti	0,011	0,011	0,005
V	—	—	0,0018
Zn	0,038	0,128	0,033

(Values in parentheses are indicative values)

Aluminium

Discs

Mass fraction in % ± 95%-confidence interval

CRM-No.	BAM-308		BAM-310		BAM-311	
Description	AlZnMgCu1,5		Al99,85Mg1		AlCuMg2	
Year of issue	1990		1993		1993	
Si	0,0707	± 0,0024	0,0797	± 0,0012	0,2040	± 0,0029
Fe	0,1634	± 0,0027	0,0705	± 0,0012	0,310	± 0,006
Cu	1,315	± 0,011	0,00169	± 0,00009	4,653	± 0,028
Mn	0,0342	± 0,0009	0,00307	± 0,00011	0,694	± 0,006
Mg	2,290	± 0,013	0,994	± 0,015	1,567	± 0,014
Cr	0,1962	± 0,0024	0,00090	± 0,00012	0,1037	± 0,0014
Ni	0,0122	± 0,0004	0,00244	± 0,00014	0,0519	± 0,0009
Zn	5,67	± 0,04	0,0086	± 0,0004	0,2005	± 0,0022
Ti	0,0285	± 0,0009	0,00301	± 0,00011	0,0562	± 0,0006
Al	**(matrix)**		**(matrix)**		**(matrix)**	
As	—		—		—	
B	—		(0,0006)		—	
Be	0,00022	± 0,00001	0,000128	± 0,000014	0,00052	± 0,00004
Bi	—		—		0,0500	± 0,0030
Ca	—		0,00073	± 0,00004	(0,0006)	
Cd	—		0,00237	± 0,00007	0,00127	± 0,00005
Co	—		(0,0009)		0,00115	± 0,00010
Ga	—		0,01152	± 0,00024	0,0159	± 0,0005
Hg	—		—		—	
Li	—		0,000366	± 0,000012	0,00053	± 0,00005
Mo	—		—		—	
Na	—		(0,0003)		(0,0018)	
P	—		(0,0003)		—	
Pb	—		0,00347	± 0,00025	0,0504	± 0,0011
Sb	—		—		—	
Sn	—		0,00238	± 0,00018	0,0127	± 0,0012
Sr	—		—		—	
Tl	—		—		—	
V	—		0,00444	± 0,00023	0,0240	± 0,0008
Zr	0,0078	± 0,0004	0,00135	± 0,00019	0,140	± 0,005

(Values in parentheses are indicative values)

- continued -

Aluminium, discs (continued)

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

CRM-No.	**ERM®-EB313 (BAM-313)**	**BAM-M315**	**ERM®-EB316**	**ERM®-EB317**
Description	AlMg3	AlSi9Cu3	AlSi12	AlZn6CuMgZr
Year of issue	1997	2006	2009	2013
Si	**0,363% ± 0,007%**$^{+}$	**9,18% ± 0,21%**$^{+}$	**11,98% ± 0,20%**$^{+}$	271 ± 22
Fe	**0,391% ± 0,003%**$^{+}$	**0,59% ± 0,02%**$^{+}$	**0,1054% ± 0,0021%**$^{+}$	**0,112% ± 0,003%**
Cu	**0,0931% ± 0,0014%**$^{+}$	**2,51% ± 0,09%**$^{+}$	**0,0297% ± 0,0008%**$^{+}$	**1,77% ± 0,06%**
Mn	**0,495% ± 0,003%**$^{+}$	**0,314% ± 0,007%**$^{+}$	**0,204% ± 0,004%**$^{+}$	912 ± 19
Mg	**3,40% ± 0,04%**$^{+}$	**0,422% ± 0,012%**$^{+}$	**0,045% ± 0,004%**$^{+}$	**2,39% ± 0,07%**
Cr	**0,1224% ± 0,0012%**$^{+}$	**0,0311% ± 0,0007%**$^{+}$	59,3 ± 2,6^{+}	**0,141% ± 0,003%**
Ni	**0,0278% ± 0,0006%**$^{+}$	**0,096% ± 0,003%**$^{+}$	**0,0235% ± 0,0011%**$^{+}$	359 ± 14
Zn	**0,158% ± 0,002%**$^{+}$	**0,77% ± 0,02%**$^{+}$	**0,0611% ± 0,0012%**$^{+}$	**6,93% ± 0,26%**
Ti	**0,0947% ± 0,0014%**$^{+}$	**0,143% ± 0,005%**$^{+}$	**0,0790% ± 0,0015%**$^{+}$	952 ± 156
Al	**(matrix)**	**(matrix)**	**(matrix)**	**(matrix)**
As	7,2 ± 0,7^{+}	—	—	—
B	—	(< 3)	(**< 1,5**)	(37 ± 32)
Be	5,5 ± 0,2^{+}	5 ± 2^{+}	2,95 ± 0,17^{+}	10,1 ± 0,8
Bi	95 ± 8^{+}	41 ± 7^{+}	140 ± 7^{+}	41 ± 6
Ag	—	—	(183 ± 10^{+})	73 ± 5
Ca	5,7 ± 0,8^{+}	(~ 15*)	(11,3 ± 1,4^{+})	(6,0 ± 2,7)
Cd	7,4 ± 0,4^{+}	11 ± 4^{+}	20,8 ± 1,5^{+}	—
Co	—	(< 3)	(< 1,5)	—
Ga	121 ± 5^{+}	101 ± 5^{+}	105 ± 5^{+}	183 ± 12
In	—	—	—	162 ± 11
Hg	4,1 ± 0,4^{+}	(33 ± 2^{+})	(35 ± 7^{+})	—
Li	6,04 ± 0,12^{+}	(~ 7*)	(1,00 ± 0,03^{+})	—
Mo	5,3 ± 1,9^{+}	—	—	—
Na	37 ± 2,4^{+}	(~ 15*)	—	—
P	—	**(13 ± 7^{+})**	—	(27 ± 15)
Pb	43,3 ± 2,8^{+}	**0,079% ± 0,004%**$^{+}$	87 ± 7^{+}	48,1 ± 2,3
Sb	8,7 ± 1,9^{+}	**(32 ± 24^{+})**	(56 ± 5^{+})	—
Sn	197 ± 6^{+}	**0,0771% ± 0,0025%**$^{+}$	(106 ± 11^{+})	237 ± 18
Sr	—	(~ 70*)	260 ± 7^{+}	—
Tl	6,4 ± 0,4^{+}	—	—	—
V	299 ± 6^{+}	54 ± 2,5^{+}	98 ± 7^{+}	105 ± 7
Zr	359 ± 19^{+}	30 ± 7^{+}	32,8 ± 0,7^{+}	**0,130% ± 0,008%**

(Values in parentheses are indicative values)

* The given values are average values, the exact value must be calculated for each single sample

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

Copper
Chips

Mass fraction in % ± standard deviation

CRM-No.	**223**	**224**	**227**	**228**
Description	CuZn39Pb2	CuZn40MnPb	Rg7	Rg10
Year of issue	1974	1975	1979	1979
Cu	58,74 ± 0,02	57,40 ± 0,02	85,57 ± 0,03	85,34 ± 0,03
Sn	0,089 ± 0,004	0,066 ± 0,003	6,01 ± 0,07	9,76 ± 0,05
Zn	38,82 ± 0,09	39,40 ± 0,04	3,46 ± 0,03	3,32 ± 0,05
Pb	2,13 ± 0,02	1,13 ± 0,04	4,12 ± 0,04	1,24 ± 0,03
Fe	0,091 ± 0,002	0,136 ± 0,002	0,129 ± 0,002	0,036 ± 0,002
Ni	0,0214 ± 0,0005	0,038 ± 0,001	0,284 ± 0,003	0,109 ± 0,005
Mn	(< 0,001)	1,70 ± 0,03	—	(< 0,001)
Al	(< 0,002)	0,0012 ± 0,0002	(< 0,0001)	(0,0001)
Ag	—	—	—	—
As	0,0084 ± 0,0005	0,0025 ± 0,0002	0,081 ± 0,002	0,024 ± 0,001
Bi	0,0018 ± 0,0001	0,0006 ± 0,0001	0,0088 ± 0,0002	0,0086 ± 0,0003
Cd	—	—	—	—
Co	—	—	—	—
P	0,0003 ± 0,00015	0,0112 ± 0,0002	(0,0002)	0,019 ± 0,001
S	0,0011 ± 0,0001	0,0004 ± 0,0001	0,122 ± 0,005	0,036 ± 0,002
Sb	0,0040 ± 0,0002	0,0026 ± 0,0001	0,160 ± 0,002	0,078 ± 0,001
Se	(< 0,0001)	—	0,0028 ± 0,0002	0,0012 ± 0,0001
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.	**BAM-229**	**BAM-365**
Description	CuZn37	Refined copper
Year of issue	1996	1996
Cu	**63,334% ± 0,007%**	**99,937% ± 0,012%**
Zn	**36,63% ± 0,04%**	—
Sn	48,5 ± 1,1	(< 5)
Pb	192 ± 5	28,8 ± 1,3
Fe	106,1 ± 2,1	22,3 ± 1,3
Ni	111,4 ± 0,9	175,3 ± 1,5
Mn	—	(< 1)
Al	—	—
Ag	—	102,7 ± 1,7
As	21,7 ± 0,8	29,8 ± 1,0
Bi	—	29,4 ± 1,4
Cd	—	—
Co	—	23,6 ± 1,4
P	(10,6 ± 1,6)	—
S	—	(7,7 ± 1,4)
Sb	7,2 ± 0,7	8,8 ± 0,3
Se	34 ± 4	120 ± 4
Si	—	—
Te	—	4,6 ± 0,6

(Values in parentheses are indicative values)

Copper

Discs

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

CRM-No.	**BAM-367**	**BAM-368**	**BAM-369**	**BAM-370**	**BAM-371**	**BAM-372**
Description	CuNi10Fe1Mn	CuZn20Al2	OF-Cu	OF-Cu	OF-Cu	OF-Cu
Year of issue	1995	1993	1993	1993	1995	1995
Cu	**87,88% ± 0,04%**	**77,049% ± 0,018%**	**(matrix)**	**(matrix)**	**(matrix)**	**(matrix)**
Al	—	**1,972% ± 0,014%**	—	12,6 ± 0,8	—	—
Ni	**9,72% ± 0,05%**	258 ± 4	—	—	—	11,66 ± 0,24
Fe	**1,443% ± 0,012%**	192,7 ± 2,9	—	—	18,3 ± 0,7	—
Mn	**0,723% ± 0,005%**	202,8 ± 2,4	—	—	—	11,4 ± 0,4
Zn	715 ± 9	**(matrix)**	22,0 ± 0,6	—	—	—
Ag	—	—	—	—	—	9,01 ± 0,29
As	—	246 ± 9	—	—	—	10,3 ± 0,6
Be	—	—	—	—	11,5 ± 0,6	—
Bi	—	—	9,7 ± 0,4	—	—	—
C	28,7 ± 0,6	—	—	—	—	—
Cd	—	—	—	—	1,63 ± 0,08	—
Co	498 ± 3	—	10,42 ± 0,29	—	—	—
Cr	—	—	9,2 ± 0,5	—	—	—
Mg	347 ± 13	62,1 ± 1,5	3,60 ± 0,18	—	—	—
P	124 ± 6	89,9 ± 1,6	—	11,7 ± 0,7	—	—
Pb	298 ± 6	131,3 ± 2,4	—	15,8 ± 1,1	—	—
S	162 ± 9	(18,5 ± 2,9)	—	—	12,1 ± 0,9	—
Sb	—	—	—	15,6 ± 1,3	—	—
Se	—	—	—	—	—	(8,4 ± 0,6)
Si	—	130 ± 7	—	18,7 ± 3,0	—	—
Sn	105 ± 4	147 ± 4	—	16,8 ± 0,9	—	—
Te	—	—	—	—	14,4 ± 0,6	—
Ti	—	—	—	—	12,9 ± 0,7	—
Zr	—	—	—	—	—	5,8 ± 0,4

(Values in parentheses are indicative values)

- continued -

Copper, discs (continued)

CRM-No.	**ERM®-EB374 (BAM-374)**	**ERM®-EB375 (BAM-375)**	**BAM-376**	**ERM®-EB377 (BAM-377)**	**ERM®-EB378 (BAM-378)**
Description	CuSn8	CuZn39Pb3	Pure copper	CuSn6	CuSn6
Year of issue	1999	1999	1996	1999	2000
Cu	**92,22%± 0,05%**	**58,32% ± 0,05%**	**(matrix)**	**94,04% ± 0,05%**	**94,13% ± 0,04%**
Al	(< 1)	270 ± 5	(181,5 ± 10)	45,1 ± 1,2	(< 1)
Ni	32,7 ± 1,3	**0,1053% ± 0,0015%**	209 ± 6	107,4 ± 1,5	18,3 ± 0,9
Fe	40 ± 4	**0,207% ± 0,004%**	234,6 ± 2,7	104,2 ± 2,7	182 ± 7
Mn	4,3 ± 0,3	222 ± 3	205,9 ± 2,5	92,1 ± 2,1	(0,74 ± 0,24)
Zn	40,4 ± 1,9	**38,02% ± 0,08%**	217,3 ± 2,7	100,6 ± 3,0	(7,4 ± 1,0)
Ag	12,1 ± 1,3	166 ± 4	163,0 ± 2,4	64,4 ± 1,1	26,6 ± 1,3
As	(4,3 ± 1,2)	231 ± 4	199,9 ± 2,5	(< 10)	99,5 ± 2,5
Be	—	—	40,6 ± 0,9	—	—
Bi	(2,2 ± 1,3)	68,6 ± 2,5	200 ± 5	42,2 ± 1,5	(< 1)
C	—	—	—	—	—
Cd	(< 1)	85,9 ± 2,1	186,1 ± 2,5	(< 1)	100,7 ± 2,2
Co	(< 1)	196,4 ± 2,8	207,9 ± 1,8	(< 2)	89 ± 5
Cr	(< 1)	—	(400 ± 9)	66,9 ± 2,1	311 ± 5
Mg	(< 1)	—	124 ± 4	(< 1)	28,7 ± 0,8
P	**0,170%± 0,008%**	(8,6 ± 1,2)	203 ± 5	(< 10)	602 ± 23
Pb	8,3 ± 0,9	**2,90% ± 0,03%**	236 ± 4	44,9 ± 2,3	4,2 ± 0,7
S	(13 ± 5)	—	133 ± 5	(6,8 ± 0,8)	9,1 ± 1,9
Sb	(6,3 ± 1,4)	122 ± 4	202 ± 5	13,0 ± 1,3	86,1 ± 2,6
Se	(< 2)	—	210 ± 4	55 ± 4	(< 2)
Si	(< 10)	211 ± 14	—	(134)	(< 10)
Sn	**7,60%± 0,13%**	**0,2090% ± 0,0024%**	247,3 ± 2,9	**5,92% ± 0,13%**	**5,74% ± 0,21%**
Te	(< 1)	53,8 ± 2,4	215 ± 7	(< 1)	85,0 ± 2,6
Ti	(< 1)	—	(4,5 ± 1,7)	(< 1)	(29,4 ± 4)
Zr	(< 1)	—	42,2 ± 1,9	—	(1,7 ± 0,09)

(Values in parentheses are indicative values)

- continued -

Copper, discs (continued)

CRM-No.	BAM-M381	BAM-M382	BAM-M383a	BAM-M383b	BAM-M383c	BAM-M384a	BAM-M384b
Description	Pure copper	Pure copper	Pure copper	Pure copper	Pure copper	Pure copper	Pure copper
Year of issue	2006	2006	2014	2014	2014	2014	2014
Cu	**(matrix)**	**(matrix)**	**(matrix)**	**(matrix)**	**(matrix)**	**(matrix)**	**(matrix)**
Al	(< 1)	< 2,5	(< 1,5)	(<1,2)	(1,6 ± 0,6)	(< 1,5)	(2,9 ± 0,8)
Ni	0,7 ± 0,2	1,7 ± 0,2	1,13 ± 0,11	1,43 ± 0,18	4,2 ± 0,4	6,1 ± 0,5	4,7 ± 0,6
Fe	3,3 ± 0,2	6,0 ± 0,4	(3,1 ± 0,8)	3,6 ± 0,6	(1,4 ± 0,5)	2,7 ± 0,5	(5,1 ± 1,2)
Mn	0,22 ± 0,03	0,76 ± 0,06	0,34 ± 0,07	0,18 ± 0,03	1,52 ± 0,28	0,22 ± 0,03	8,1 ± 0,9
Zn	5,3 ± 0,3	6,0 ± 0,5	17,1 ± 0,9	9,3 ± 0,4	2,5 ± 0,5	5,3 ± 0,5	2,6 ± 0,5
Ag	< 1	1,8 ± 0,2	11,1 ± 0,5	10,6 ± 0,4	10,6 ± 0,4	10,7 ± 0,4	11,3 ± 0,4
As	< 0,5	(0,6 ± 0,2)	2,5 ± 0,4	2,8 ± 0,4	1,54 ± 0,28	5,4 ± 0,8	6,6 ± 1,1
Be	—	—	—	—	—	—	—
Bi	< 0,3	0,53 ± 0,03	2,7 ± 0,4	1,85 ± 0,21	1,01 ± 0,18	6,16 ± 0,25	6,81 ± 0,23
C	—	—	—	—	—	—	—
Cd	< 0,4	0,90 ± 0,09	1,16 ± 0,04	0,93 ± 0,05	2,06 ± 0,06	4,1 ± 0,2	4,0 ± 0,2
Co	< 0,3	0,73 ± 0,07	0,96 ± 0,06	1,02 ± 0,05	1,21 ± 0,11	3,64 ± 0,16	10,4 ± 0,5
Cr	< 0,4	0,56 ± 0,06	(<1)	(< 1)	(<1,5)	(< 0,2)	(2,3 ± 0,6)
Mg	< 0,6	(1,4 ± 0,3)	(<1)	(< 1)	1,11 ± 0,28	(< 0,2)	3,3 ± 0,5
P	—	—	(<1)	(< 1)	(< 1)	(< 1,5)	(< 2)
Pb	0,59 ± 0,07	1,0 ± 0,2	1,09 ± 0,22	1,01 ± 0,17	3,0 ± 0,5	11,7 ± 1,1	1,6 ± 0,4
S	(3,2 ± 1,3)	(3,2 ± 1,4)	(3,2 ± 1,5)	(3,6 ± 1,5)	(4,6 ± 1,0)	(4,6 ± 1,4)	(3,8 ± 1,4)
Sb	< 1	0,7 ± 0,2	1,91 ± 0,20	1,69 ± 0,16	2,13 ± 0,10	5,4 ± 0,5	5,8 ± 0,4
Se	(< 1)	0,6 ± 0,1	1,34 ± 0,27	1,17 ± 0,28	2,5 ± 0,5	5,8 ± 0,6	(2,9 ± 0,7)
Si	(< 3)	< 6	(<1)	(< 2)	(< 2,5)	(< 2,5)	(<2,5)
Sn	3,86 ± 0,25	4,29 ± 0,21	1,01 ± 0,28	0,8 ± 0,4	1,9 ± 0,4	2,6 ± 0,5	2,1 ± 0,4
Te	(< 0,3)	0,61 ± 0,06	1,77 ± 0,22	5,7 ± 0,9	4,6 ± 0,9	9,3 ± 0,5	7,2 ± 0,7
Ti	(< 0,3)	(0,6 ± 0,2)	(<2)	(< 1)	(2,6 ± 1,2)	(< 1)	2,9 ± 0,6
Zr	< 6	< 3	(<1)	(< 1)	(2,9 ± 1,2)	(0,1 ± 0,07)	1,3 ± 0,4

(Values in parentheses are indicative values)

- continued -

Copper, discs (continued)

CRM-No.	**ERM®-EB385 (BAM-M385)**	**ERM®-EB386 (BAM-M386)**	**ERM®-EB387 (BAM-M387)**	**ERM®-EB388 (BAM-M388)**	**ERM®-EB389**
Description	Pure copper	Pure copper	CuZn20Ni5	CuAl5Zn5Sn	CuNi25
Year of issue	2003	2003	2004	2004	2007
Cu	**(matrix)**	**(matrix)**	**75,18% ± 0,04%**	**89,27% ± 0,05%**	**74,3% ± 0,5%**
Al	28,6 ± 2,5	36,5 ± 2,5	—	**4,972% ± 0,024%**	(123 ± 10)
Ni	11,9 ± 0,8	25,0 ± 1,0	**5,020% ± 0,025%**	73,6 ± 2,0	**24,7% ± 0,5%**
Fe	45,4 ± 1,4	64,7 ± 1,8	617 ± 10	303 ± 9	**0,107% ± 0,006%**
Mn	10,1 ± 0,2	13,3 ± 0,2	796 ± 6	512 ± 6	**0,415% ± 0,011%**
Zn	57,9 ± 4,0	49,5 ± 1,6	**19,57% ± 0,06%**	**4,81% ± 0,03%**	**0,1125% ± 0,0026%**
Ag	28,6 ± 0,8	47,4 ± 1,2	—	—	—
As	11,4 ± 0,8	24,2 ± 1,0	—	—	—
B	—	—	—	—	(23 ± 6)
Be	—	—	—	—	—
Bi	5,81 ± 0,17	9,6 ± 0,5	—	—	44 ± 10
C	—	—	—	—	(216 ± 24)
Cd	5,8 ± 0,3	7,8 ± 0,4	—	—	16 ± 3
Co	6,93 ± 0,15	5,20 ± 0,14	—	—	770 ± 28
Cr	9,81 ± 0,20	12,4 ± 0,7	—	—	153 ± 6
Mg	29,1 ± 1,3	36,1 ± 1,2	—	—	**0,067% ± 0,009%**
P	12,9 ± 1,0	7,2 ± 0,7	—	—	93 ± 17
Pb	11,3 ± 0,5	23,4 ± 1,2	10,8 ± 0,8	9,69 ± 0,83	98 ± 23
S	31,3 ± 1,5	21,9 ± 2,1	—	—	(308 ± 23)
Sb	19,9 ± 0,8	31,2 ± 1,1	—	—	46 ± 5
Se	7,2 ± 0,5	11,6 ± 0,3	—	—	—
Si	(7,2 ± 1,5)	(14,3 ± 4,3)	—	—	(349 ± 37)
Sn	18,0 ± 0,9	28,3 ± 0,8	30,1 ± 1,2	**0,857% ± 0,011%**	262 ± 34
Te	10,0 ± 0,4	38,3 ± 0,9	—	—	—
Ti	3,83 ± 0,17	33,1 ± 1,3	—	—	660 ± 18
Zr	(< 7)	(8,9 ± 1,7)	—	—	**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

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

CRM-No.	**BAM-373/1**	**BAM-373/2**	**BAM-373/3**
Description	E-Cu	E-Cu	E-Cu
Year of issue	1995	1995	1995
Cu	**(matrix)**	**(matrix)**	**(matrix)**
P	33,8 ± 1,2	226,5 ± 1,7	455,7 ± 1,7

(Values in parentheses are indicative values)

The samples 373/1, 373/2 and 373/3 are only available in a set of all three samples. The cylinders are 3 cm high and about 5 cm in diameter.

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)

Potassiumdicyanoaurate(I)

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

CRM-No.	**BAM-501**
Description	$K[Au(CN)_2]$
Year of issue	1997
Au	682,23 ± 0,25

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

Discs

Mass fraction in g/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

Discs

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

Lead-alloys

Discs

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

CRM-No.	**ERM®-EB101a**	**ERM®-EB102a**	**ERM®-EB103**
Description	PbCaSnAl	PbCaSn	PbSb1,6
Year of issue	2009	2009	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)

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)

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 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.

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 materials **ERM®-EB504** and **ERM®-EZ505** are intended for use as reference materials in the development, validation or quality control of analytical methods for the determination of Platinum group elements (PGE) in automobile catalysts (ERM®-EB504) resp. of precious metals and impurities in electronic scrap (ERM®-EZ505). Both materials were produced and certified by BAM in collaboration with the Working Group "Precious Metals" of the Committee of Chemists of the Gesellschaft für Bergbau, Metallurgie, Rohstoff- und Umwelttechnik (GDMB).
The powder samples are supplied in tightly closed glass bottles containing 250 g of powder (ERM®-EB504) resp. 200 g of powder (ERM®-EZ505).

High tech ceramics

Silicon nitride powder

ERM®-ED101 (BAM-S001)

Analyte	Certified value	Uncertainty	Unit of mass fraction
Al	469	12	mg/kg
Ca	14,1	0,5	mg/kg
Co	43,5	0,8	mg/kg
Fe	79,5	1,3	mg/kg
Mg	4,3	0,4	mg/kg
Na	7,59	0,27	mg/kg
W	41,3	1,3	mg/kg
C	0,162	0,024	%
N	38,1	0,2	%
O	(1,91)	(0,07)	%
ß-phase	7,43	0,09	%

(Values in parentheses are indicative values)

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 U [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.

Silicon carbide powder

	BAM-S003 (green micro F 800)		BAM-S008 (transparent 200/F)	
Analyte	**Mass fraction in mg/kg**	**Uncertainty in mg/kg**	**Mass fraction in mg/kg**	**Uncertainty in mg/kg**
Al	372	20	47	7
B	63	7	3,0	1,2
Ca	29,4	1,8	0,25	0,6
Cr	3,5	0,4	0,16	0,05
Cu	1,5	0,4	0,10	0,05
Fe	149	10	4,8	0,8
Mg	6,3	0,6	0,07	0,07
Mn	1,44	0,17	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	41,4	2,8	275	18
Zr	25,2	2,0	4,4	1,2
C_{free}	493	79	—	—
O	910	35	146	36
N	(93)	(22)	18	4
$SiO_{2\ free}$	(600)	(148)	—	—
Si_{free}	(481)	(223)	—	—
	Mass fraction in %	**Uncertainty in %**	**Mass fraction in %**	**Uncertainty in %**
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 in mg/kg**	**Uncertainty in 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 in 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)

Niobium pentoxide

BAM-S011

Parameter	Mass fraction in mg/kg	Uncertainty in 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 in µg/g	Uncertainty * in µg/g
Pb	479	17
Br	240	21
Cd	93	5
Cr	470	36
Hg	(415)	—

(Value in parentheses an indicative value)

* The uncertainty *U* 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®-EB504

Analyte	Certified value [1)]	Uncertainty [2)]
	Mass fraction in mg/kg	
Pt	1777	15
Pd	279	6
Rh	338	4

Electronic scrap melted with pyrithe

ERM®-EZ505

Analyte	Certified value [1)]	Uncertainty [2)]
	Mass fraction in %	
Cu	15,10	0,11
Ni	0,470	0,008
	Mass fraction in mg/kg	
Ag	692	13
Au	292	4
Be	68,8	2,3
In	91	7
Pd	90,5	2,4
Pt	8,5	0,8

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

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 (1995) ISO, Geneva.

Primary pure substances

By agreement with Physikalisch Technische Bundesanstalt (PTB) the materials in this group are the National Standards for Element Analysis in Germany. They are available only to the signatories (National Measurement Institutes) and designated laboratories as listed in the Mutual Recognition Arrangement MRA [http://www.bipm.org/en/cipm-mra/].

The substances are of high purity, and certified for the mass fraction of the matrix element by considering all possible impurities with other chemical elements. They are intended for gravimetrical preparation of calibration solutions for analyte calibration with small combined uncertainty and enable to establish traceability to the international system of units (SI).

The material is supplied in glass bottles together with the certificate, which includes the prescribed procedure for etching before use and the informative values for the individual impurities. The certification reports are available on request.

Identifier	**Description**	**Mass fraction *w***	**Uncertainty *U* (with *k*=2)**	**Unit**	**Form**	**Unit size**
BAM-Y001	high purity copper	0,999 970	0,000 010	kg/kg	compact material	0,5 g
BAM-Y002	high purity iron	0,999 862	0,000 044	kg/kg	compact material	0,5 g
BAM-Y003	high purity silicon	0,999 91	0,000 07	kg/kg	cubes 3×3×3 mm	0,5 g
BAM-Y004	high purity lead	0,999 92	0,000 06	kg/kg	compact material	0,5 g
BAM-Y005	high purity tin	0,999 91	0,000 06	kg/kg	compact material	0,5 g
BAM-Y006	high purity tungsten	0,999 81	0,000 10	kg/kg	compact material	0,5 g
BAM-Y007	high purity bismuth	0,999 90	0,000 07	kg/kg	compact material	0,5 g
BAM-Y008	high purity gallium	0,999 92	0,000 07	kg/kg	compact material	0,5 g
BAM-Y009	high purity sodium chloride	0,999 84	0,000 09	kg/kg	crystalline powder	0,5 g
BAM-Y010	high purity potassium chloride	0,999 83	0,000 10	kg/kg	crystalline powder	0,5 g

Environment

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

BAM-K009
Lubricating oil

Certified property	**Certified value** **g/g**	**Expanded uncertainty*** **g/g**	**Relative expanded uncertainty** **%**
Mass fraction of the boiling range C_{10} –C_{40}	0,995	+ 0,005 - 0,006	+ 0,53 - 0,61

* *k*=2

Application range: Calibration standard (type B) for the determination of mineral oil hydrocarbons in water, soil and waste by gas chromatography (GC-FID) according to:

ISO 9377-2:2000 (water quality); ISO 16703:2004 (soil quality); EN 14039:2004 (characterization of waste)

BAM-K010e
Diesel oil / lubricating oil (1:1)

Certified property	**Certified value** **g/g**	**Expanded uncertainty*** **g/g**	**Relative expanded uncertainty** **%**
Mass ratio of components – diesel oil and lubricating base oil (both additive free)	1,00003	0,00006	0,006
Mass fraction of the boiling range C_{10} –C_{40}	0,967	0,018	1,83

* *k*=2

Application range: Calibration standard for the determination of mineral oil hydrocarbons in water, soil and waste by gas chromatography (GC-FID) according to:

ISO 9377-2:2000 (water quality); ISO 16703:2004 (soil quality); EN 14039:2004 (characterization of waste)

BAM-K011
Mineral oil calibration standard in n-heptane

Certified property	**Certified value** **mg/g**	**Expanded uncertainty*** **mg/g**
Mass fraction of the boiling range C_{10} –C_{40}	14,71	0,32

* *k*=2

Application range: Calibration standard for the determination of mineral oil hydrocarbons in water, soil and waste by gas chromatography (GC-FID) according to:

ISO 9377-2:2000 (water quality); ISO 16703:2004 (soil quality); EN 14039:2004 (characterization of waste)

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, 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.

Adsorbable organically bound halogens (AOX) in soil

ERM®-CC010 (BAM-U010), ERM®-CC011 (BAM-U011)

Certified properties: Content of AOX in industrial soil

Application: Validation and checking of the accuracy of analytical procedures for the quantitative determination of AOX contents in soil

CRM-No.	Compound	Certified value [1)]	Uncertainty [2)]
ERM®-CC010	Adsorbable organically bound halogens (AOX)	1349	59
ERM®-CC011	Adsorbable organically bound halogens (AOX)	80	7

All values are given in mg/kg

1) The certified value is the mean of laboratory means (analytical procedure according to DIN 38414 Teil 18, Nov 1989).

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-U013b

Certified properties: Contents of 14[1)] of priority pollutant polycyclic aromatic hydrocarbons (PAH) according to EPA and the sum of the 14 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	0,73	0,21
Fluorene	0,45	0,07
Phenanthrene	8,4	0,7
Anthracene	1,45	0,14
Fluoranthene	14,0	1,3
Pyrene	11,3	1,1
Benzo[a]anthracene	6,0	0,5
Chrysene	5,4	1,2
Benzo[b]fluoranthene	6,5	1,0
Benzo[k]fluoranthene	3,16	0,24
Dibenz[a,h]anthracene	6,6	0,4
Benzo[a]pyrene	1,03	0,15
Benzo[ghi]perylene	5,0	0,6
Indeno[1,2,3-cd]pyrene	4,5	0,6
PAH sum	75,4	6,0

All values are given as mass fractions in mg/kg

1) The mass fractions of Acenaphthene (0,148 mg/kg) and Acenaphthylene (0,66 mg/kg) are given as not certified indicative values.

2) The certified values are the unweighted mean value of 8-10 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 U 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, ISO, 2008.

Mineral oil contaminated sediment and soil

BAM-U015b, BAM-U021 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-U021 soil	Total petrol hydrocarbon (TPH)	3560	260
BAM-U022 sediment	Total petrol hydrocarbon (TPH)	8270	550

All values are given in mg/kg.

1) Unweighted mean value of 13-14 laboratory means using gas chromatography with flame ionisation detection (GC/FID) according to ISO 16703:2005.

2) Estimated expanded uncertainty *U* 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, ISO, 2008

Polychlorinated biphenyls in soil

BAM-U019

Certified properties: Content of selected PCB congeners in soil to be determined by GC-ECD of GC-MS

Application: Validation and checking of the accuracy of analytical procedures for the quantitative determination of PCB in soil by gas chromatography (GC-ECD or GC-MS)

Compound	**Certified value [1)]**	**Uncertainty [2)]**
PCB 28	0,50	0,13
PCB 44	2,04	0,29
PCB 52	2,96	0,62
PCB 101	2,90	0,68
PCB 118	2,58	0,75
PCB 138	1,81	0,50
PCB 149	1,20	0,21
PCB 153	1,38	0,37
PCB 170	0,264	0,063
PCB 180	0,39	0,08

All values are given in mg/kg.

1) Unweighted mean value of 7 - 11 laboratory means using GC/MS or GC/ECD.

2) Estimated expanded uncertainty *U* 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, ISO, 2008.

Trace elements in contaminated sandy soil and river sediment

ERM®-CC018 and 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®-CC018** Sandy soil		**ERM®-CC020** River sediment	
Analyte	**Aqua regia extractable mass fractions**			
	Certified value	**Uncertainty [1)]**	**Certified value**	**Uncertainty [1)]**
As	22,9	1,3	56,6	2,6
Cd	5,4	0,5	20,8	0,5
Co	5,9	0,4	290	8
Cr	129	6	32,8	1,5
Cu	80	4	560	11
Hg	1,38	0,06	255	11
Ni	25,8	1,8	27,4	0,6
Pb	289	10	158	6
V	19,4	1,0	53	4
Zn	313	13	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-U112a

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	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 *U*** [2] in mg/kg	Mass fraction in mg/kg	Uncertainty *U* [2] in mg/kg
As	10,3	0,5	10,4	0,7
Cd	4,12	0,15	4,09	0,17
Co	5,58	0,22	3,9	0,4
Cr	80,1	2,5	81,9	2,6
Cu	75,5	3,1	75	4
Hg	16,3	1,0	15,9	1,1
Ni	10,1	0,5	11,2	0,9
Pb	198	8	199	8
V	12,7	0,8	14,0	0,9
Zn	198	6	200	7

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 *U* 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).

BAM-U113

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.

Analyte	**BAM-U113 Aqua regia extractable mass**	
	Certified value	**Uncertainty** [1]
As	41,9	2,4
Cd	3,6	0,4
Co	32,3	2,2
Cr	35,5	2,0
Cu	458	19
Hg	1,95	0,23
Ni	37,6	1,7
Pb	220	11
V	26,7	1,3
Zn	614	13

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.

Total cyanide in soil

BAM-U114

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).

Analyte	**Certified value** [1]	**Uncertainty** [2]
Total cyanide according to ISO 11262:2011	23,1	1,3

All values are given in mg/kg.

[1] Unweighted mean value of 12 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).

Trace elements and pentachlorophenol (PCP) in wood

ERM®-CD100

Certified properties: Mass fractions of trace elements and PCP in ground wood

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	**Certified value**	**Uncertainty** [1]
As	3,1	0,5
Cd	3,02	0,24
Cr	36,4	2,6
Cu	22,9	1,7
Hg	0,60	0,14
Pb	39	4
PCP	7,9	0,6

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.

Food

Acrylamide in crispbread

ERM®-BD272

Compound	Certified value 1)	Uncertainty 4)
Acrylamide	0,98 mg/kg	0,09 mg/kg

Acrylamide in rusk

ERM®-BD274

Compound	Certified value 2)	Uncertainty 4)
Acrylamide	74 µg/kg	7 µg/kg

Ochratoxin A in red wine

ERM®-BD476

Compound	Certified value 3)	Uncertainty 4)
Ochratoxin A	0,52 µg/L	0,11 µg/L

1) Unweighted mean of accepted mean values, independently obtained by 15 laboratories using different analytical methods.

2) Unweighted mean of accepted mean values, independently obtained by 8 laboratories using different analytical methods.

3) Unweighted mean of four independent results obtained by BAM using appropriate extraction, HPLC separation and MS/MS detection technique. The certified value is traceable to the SI.

4) 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.
Uncertainty contributions arising from characterisation as well as from homogeneity and stability testing were taken into account.

Fusarium mycotoxins in wheat flour

ERM®-BC600

Compound 1)	Certified value 2)	Uncertainty 3)
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.

2) Unweighted mean of accepted mean values, independently obtained in different laboratories using various methods. The certified values are traceable to the SI.

3) 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. Uncertainty contributions arising from characterisation as well as from homogeneity and stability testing were taken into account.

T-2 and HT-2 toxin in oat flakes

ERM®-BC720

Compound 1)	Certified value 2)	Uncertainty 3)
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 this certificate.

2) The value given represents the unweighted mean value of 80 results (obtained by BAM). Certified values are traceable to the SI

3) Estimated expanded uncertainty with a coverage factor of *k* = 2, corresponding to a confidence level of about 95 %, as defined in the Guide to the expression of uncertainty in measurement (GUM), ISO/IEC Guide 98-3 (2008). Uncertainty contributions arising from characterisation as well as from homogeneity and stability testing were taken into account.

Gas mixtures

Certified reference gas mixtures

The following certified reference gas mixtures (CRGMs) are prepared by BAM or industrial partners under mandate of BAM.

These CRGMs are offered and distributed by BAM exclusively.

CRGMs are prepared individually from pure gases according to ISO 6142 ”Gas analysis – Preparation of calibration gases – Gravimetric Method”.

Pre-mixtures are employed for the preparation of CRGMs with minor components. The molar fraction of the components are certified according to ISO 6143 ”Gas analysis – Determination of composition of calibration gas mixtures – Comparison methods” using primary reference gas mixtures (national primary standards of gas composition).

At request, calibration gas mixtures prepared by industrial customers and accepted by BAM can be certified by comparison with corresponding primary reference gas mixtures. These BAM-certified calibration gas mixtures are then used as reference standards, providing traceability to primary reference gas mixtures maintained at BAM. The stability is generally guaranteed over a period of two years.

Uncertainties are reported as expanded uncertainties (coverage factor *k*=2) according to GUM.

Binary certified reference gas mixtures

CRM-No.	**Main component**	**Analyte**	**Range of molar fraction mol/mol**	**Range of uncertainty % rel**
BAM-G010	Nitrogen (N_2)	Helium (He)	0,01 to 0,5	0,8 to 0,5
BAM-G012	Synth. air	Helium (He)	0,005 to 0,5	2,0 to 0,5
BAM-G014	Argon (Ar)	Helium (He)	0,01 to 0,5	0,5
BAM-G020	Nitrogen (N_2)	Hydrogen (H_2)	0,01 to 0,2	0,8 to 0,5
BAM-G022	Helium (He)	Hydrogen (H_2)	0,001 to 0,2	1,0 to 0,3
BAM-G024	Argon (Ar)	Nitrogen (N_2)	0,01 to 0,5	0,5
BAM-G025	Methane (CH_4)	Hydrogen (H_2)	0,1	0,5
BAM-G030	Nitrogen (N_2)	Oxygen (O_2)	0,01 to 0,2	0,5
BAM-G037	Helium (He)	Nitrogen (N_2)	0,00001 to 0,001	1,0 to 0,5
BAM-G038	Helium (He)	Argon (Ar)	0,000005 to 0,002	1,0 to 0,3
BAM-G039	Helium (He)	Oxygen (O_2)	0,01 to 0,2	1,0 to 0,5
BAM-G040	Nitrogen (N_2)	Carbon monoxide (CO)	0,00001 to 0,1	1,0 to 0,3
BAM-G042	Synth. air	Carbon monoxide (CO)	0,0001 to 0,01	1,0 to 0,5
BAM-G043	Nitrogen (N_2)	Nitrogen monoxide (NO)	0,0001 to 0,002	2,0 to 1,0
BAM-G050	Nitrogen (N_2)	Carbon dioxide (CO_2)	0,00001 to 0,5	0,5 to 0,3
BAM-G052	Synth. air	Carbon dioxide (CO_2)	0,0001 to 0,2	1,0 to 0,3
BAM-G055	Methane (CH_4)	Carbon dioxide (CO_2)	0,005 to 0,10	0,5
BAM-G060	Nitrogen (N_2)	Methane (CH_4)	0,00001 to 0,5	1,0 to 0,3
BAM-G062	Synth. air	Methane (CH_4)	0,0001 to 0,001	1,0 to 0,5
BAM-G070	Nitrogen (N_2)	Propane (C_3H_8)	0,00005 to 0,01	1,0 to 0,5
BAM-G072	Synth. air	Propane (C_3H_8)	0,0001 to 0,001	1,0 to 0,5
BAM-G090	Nitrogen (N_2)	Dinitrogen oxide (N_2O)	0,000005 to 0,001	2,0 to 0,5
BAM-G100	Nitrogen (N_2)	Hexane (C_6H_{14})	0,0001 to 0,001	2,0 to 0,8
BAM-G110	Nitrogen (N_2)	1-Butanol ($C_4H_{10}O$)	0,00006	2,0

Certified reference gas mixtures for vehicle exhaust emission measurements

CRM-No.	Main component		Analyte		Molar fraction mol/mol	Uncertainty % rel
BAM-G200	Nitrogen	(N_2)	Carbon monoxide	(CO)	0,02	0,5
BAM-G210	Nitrogen	(N_2)	Carbon monoxide	(CO)	0,045	0,5
BAM-G220	Nitrogen	(N_2)	Carbon monoxide Carbon dioxide Propane	(CO) (CO_2) (C_3H_8)	0,005 0,06 0,0002	0,5 0,3 0,8
BAM-G225	Nitrogen	(N_2)	Carbon monoxide Carbon dioxide Propane	(CO) (CO_2) (C_3H_8)	0,015 0,11 0,0006	0,5 0,3 0,5
BAM-G230	Nitrogen	(N_2)	Carbon monoxide Carbon dioxide Propane	(CO) (CO_2) (C_3H_8)	0,035 0,14 0,002	0,5 0,3 0,5

Certified reference gas mixtures for gas calorimeters

CRM-No.	Main component		Analyte		Molar fraction mol/mol	Uncertainty % rel
BAM-G300 (2H)	Methane	(CH_4)	Ethane	(C_2H_6)	0,123	0,3
BAM-G310 (2HL)	Methane	(CH_4)	Ethane	(C_2H_6)	0,065	0,3
BAM-G320 (2LH)	Methane	(CH_4)	Nitrogen	(N_2)	0,07	0,3
BAM-G330 (2LHL)	Methane	(CH_4)	Nitrogen	(N_2)	0,087	0,3
BAM-G340 (2L)	Methane	(CH_4)	Nitrogen	(N_2)	0,117	0,3
BAM-G350 (2LL)	Methane	(CH_4)	Nitrogen	(N_2)	0,175	0,3
BAM-G360 (3S)	Methane	(CH_4)	Nitrogen Hydrogen	(N_2) (H_2)	0,17 0,49	0,3 0,5

(The "CRM-No." in parentheses corresponds to the name used in requirement "PTB-A 7.63" by Physikalisch Technische Bundesanstalt (PTB).)

Multicomponent certified reference gas mixtures

CRM-No.	Main component		Analyte		Molar fraction mol/mol	Uncertainty % rel
BAM-G501	Nitrogen	(N_2)	Oxygen Argon	(O_2) (Ar)	0,20 0,01	0,5 0,5
BAM-G510	Nitrogen	(N_2)	Carbon monoxide Methane	(CO) (CH_4)	0,003 0,003	0,5 0,5
BAM-G511	Nitrogen	(N_2)	Nitrogen monoxide Carbon monoxide	(NO) (CO)	0,00008 0,0009	1,0 1,0
BAM-G530	Nitrogen	(N_2)	Hydrogen Oxygen	(H_2) (O_2)	0,10 0,015	0,5 0,5
BAM-G810	Helium	(He)	Hydrogen Carbon monoxide Carbon dioxide Oxygen Argon Nitrogen Methane Xenon Krypton	(H_2) (CO) (CO_2) (O_2) (Ar) (N_2) (CH_4) (Xe) (Kr)	0,000005 0,000005 0,000005 0,000005 0,000005 0,000005 0,000005 0,000005 0,000005	1,0 1,0 1,0 1,0 1,0 1,0 1,0 1,0 1,0

Certified reference gas mixtures for process gas chromatographs

CRM-No.	Main component	Analyte		Molar fraction mol/mol	Uncertainty % rel
BAM-G400 **(6H)**	Methane (CH_4)	Nitrogen	(N_2)	0,004	0,5
		Carbon dioxide	(CO_2)	0,018	0,3
		Ethane	(C_2H_6)	0,094	0,3
		Propane	(C_3H_8)	0,034	0,3
		n-Butane	(C_4H_{10})	0,01	0,5
		Methane	(CH_4)	0,84	0,05
BAM-G401 **(6L)**	Methane (CH_4)	Nitrogen	(N_2)	0,14	0,3
		Carbon dioxide	(CO_2)	0,01	0,5
		Ethane	(C_2H_6)	0,03	0,4
		Propane	(C_3H_8)	0,005	0,5
		n-Butane	(C_4H_{10})	0,001	0,8
		Methane	(CH_4)	0,814	0,05
BAM-G410 **(L1-8K)**	Methane (CH_4)	Nitrogen	(N_2)	0,12	0,3
		Carbon dioxide	(CO_2)	0,045	0,3
		Ethane	(C_2H_6)	0,0075	0,5
		Propane	(C_3H_8)	0,003	0,8
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		Methane	(CH_4)	0,82	0,05
BAM-G411 **(L2-8K)**	Methane (CH_4)	Nitrogen	(N_2)	0,103	0,3
		Carbon dioxide	(CO_2)	0,01	0,5
		Ethane	(C_2H_6)	0,04	0,4
		Propane	(C_3H_8)	0,013	0,4
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		Methane	(CH_4)	0,8295	0,05
BAM-G412 **(H1-8K)**	Methane (CH_4)	Nitrogen	(N_2)	0,01	0,5
		Carbon dioxide	(CO_2)	0,009	0,5
		Ethane	(C_2H_6)	0,01	0,4
		Propane	(C_3H_8)	0,0025	0,8
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		Methane	(CH_4)	0,964	0,05
BAM-G413 **(H2-8K)**	Methane (CH_4)	Nitrogen	(N_2)	0,04	0,3
		Carbon dioxide	(CO_2)	0,015	0,3
		Ethane	(C_2H_6)	0,082	0,3
		Propane	(C_3H_8)	0,02	0,3
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		Methane	(CH_4)	0,8385	0,05
BAM-G420 **(11M)**	Methane (CH_4)	Oxygen	(O_2)	0,005	0,5
		Nitrogen	(N_2)	0,04	0,5
		Carbon dioxide	(CO_2)	0,015	0,3
		Ethane	(C_2H_6)	0,04	0,4
		Propane	(C_3H_8)	0,01	0,4
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,8845	0,05

(The "CRM-No." in parentheses corresponds to the name used in requirement "PTB-A 7.63" by Physikalisch Technische Bundesanstalt (PTB).)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	**Main component**	**Analyte**		**Molar fraction mol/mol**	**Uncertainty % rel**
BAM-G421	Methane (CH_4)	Oxygen	(O_2)	0,025	0,4
		Nitrogen	(N_2)	0,2	0,3
		Carbon dioxide	(CO_2)	0,025	0,3
		Ethane	(C_2H_6)	0,022	0,4
		Propane	(C_3H_8)	0,025	0,4
		n-Butane	(C_4H_{10})	0,007	0,6
		2-Methyl-propane	(C_4H_{10})	0,006	0,6
		Methane	(CH_4)	0,9969	0,05
BAM-G422 (P1-11K)	Methane (CH_4)	Nitrogen	(N_2)	0,08	0,3
		Carbon dioxide	(CO_2)	0,03	0,3
		Ethane	(C_2H_6)	0,065	0,4
		Propane	(C_3H_8)	0,02	0,4
		n-Butane	(C_4H_{10})	0,005	0,8
		2-Methyl-propane	(C_4H_{10})	0,005	0,8
		n-Pentane	(C_5H_{12})	0,001	0,8
		2-Methyl-butane	(C_5H_{12})	0,001	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,00025	0,8
		n-Hexane	(C_6H_{14})	0,00025	0,8
		Methane	(CH_4)	0,7925	0,05
BAM-G430 (11D)	Methane (CH_4)	Nitrogen	(N_2)	0,04	0,3
		Carbon dioxide	(CO_2)	0,015	0,3
		Ethane	(C_2H_6)	0,04	0,4
		Propane	(C_3H_8)	0,01	0,4
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,889	0,05
BAM-G431 (H1-11K)	Methane (CH_4)	Nitrogen	(N_2)	0,014	0,4
		Carbon dioxide	(CO_2)	0,0036	0,3
		Ethane	(C_2H_6)	0,004	0,5
		Propane	(C_3H_8)	0,002	0,8
		n-Butane	(C_4H_{10})	0,001	0,8
		2-Methyl-propane	(C_4H_{10})	0,001	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,9724	0,05
BAM-G432 (H2-11K)	Methane (CH_4)	Nitrogen	(N_2)	0,0095	0,5
		Carbon dioxide	(CO_2)	0,015	0,3
		Ethane	(C_2H_6)	0,09	0,3
		Propane	(C_3H_8)	0,03	0,3
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,8495	0,05

(The "CRM-No." in parentheses corresponds to the name used in requirement "PTB-A 7.63" by Physikalisch Technische Bundesanstalt (PTB).)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	Main component	Analyte		Molar fraction mol/mol	Uncertainty % rel
BAM-G433 (H3-11K)	Methane (CH_4)	Nitrogen	(N_2)	0,025	0,4
		Carbon dioxide	(CO_2)	0,01	0,5
		Ethane	(C_2H_6)	0,065	0,3
		Propane	(C_3H_8)	0,013	0,4
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,0025	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,00025	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,88075	0,05
BAM-G434 (L1-11K)	Methane (CH_4)	Nitrogen	(N_2)	0,11	0,3
		Carbon dioxide	(CO_2)	0,0155	0,3
		Ethane	(C_2H_6)	0,0075	0,5
		Propane	(C_3H_8)	0,003	0,5
		n-Butane	(C_4H_{10})	0,001	0,8
		2-Methyl-propane	(C_4H_{10})	0,001	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,86	0,05
BAM-G435	Methane (CH_4)	Nitrogen	(N_2)	0,012	0,5
		Carbon dioxide	(CO_2)	0,008	0,5
		Ethane	(C_2H_6)	0,11	0,3
		Propane	(C_3H_8)	0,045	0,4
		n-Butane	(C_4H_{10})	0,001	0,8
		2-Methyl-propane	(C_4H_{10})	0,001	0,8
		n-Pentane	(C_5H_{12})	0,00035	0,8
		2-Methyl-butane	(C_5H_{12})	0,00035	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0002	0,8
		Methane	(CH_4)	0,8216	0,05
BAM-G436 (L2-11K)	Methane (CH_4)	Nitrogen	(N_2)	0,092	0,3
		Carbon dioxide	(CO_2)	0,018	0,3
		Ethane	(C_2H_6)	0,03	0,3
		Propane	(C_3H_8)	0,005	0,5
		n-Butane	(C_4H_{10})	0,001	0,8
		2-Methyl-propane	(C_4H_{10})	0,001	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,851	0,05
BAM-G437	Methane (CH_4)	Nitrogen	(N_2)	0,008	0,5
		Carbon dioxide	(CO_2)	0,01	0,5
		Ethane	(C_2H_6)	0,01	0,5
		Propane	(C_3H_8)	0,005	0,5
		n-Butane	(C_4H_{10})	0,001	0,8
		2-Methyl-propane	(C_4H_{10})	0,001	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,001	0,8
		Methane	(CH_4)	0,9625	0,05

(The "CRM-No." in parentheses corresponds to the name used in requirement "PTB-A 7.63" by Physikalisch Technische Bundesanstalt (PTB).)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	**Main component**	**Analyte**		**Molar fraction mol/mol**	**Uncertainty % rel**
BAM-G438	Methane (CH_4)	Nitrogen	(N_2)	0,06	0,3
		Carbon dioxide	(CO_2)	0,001	0,5
		Ethane	(C_2H_6)	0,001	0,5
		Propane	(C_3H_8)	0,0005	0,8
		n-Butane	(C_4H_{10})	0,000035	0,8
		2-Methyl-propane	(C_4H_{10})	0,000035	0,8
		n-Pentane	(C_5H_{12})	0,001	0,8
		2-Methyl-butane	(C_5H_{12})	0,001	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,001	0,8
		n-Hexane	(C_6H_{14})	0,001	0,8
		Methane	(CH_4)	0,93343	0,05
BAM-G440 (16M)	Methane (CH_4)	Helium	(He)	0,005	1,0
		Oxygen	(O_2)	0,005	0,5
		Nitrogen	(N_2)	0,05	0,3
		Carbon dioxide	(CO_2)	0,01	0,4
		Carbon monoxide	(CO)	0,005	0,5
		Hydrogen	(H_2)	0,01	0,8
		Ethene	(C_2H_4)	0,005	0,8
		Ethane	(C_2H_6)	0,025	0,3
		Propene	(C_3H_6)	0,005	0,8
		Propane	(C_3H_8)	0,01	0,5
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0006	0,8
		Methane	(CH_4)	0,8644	0,05
BAM-G441 (12M)	Methane (CH_4)	Oxygen	(O_2)	0,005	0,5
		Nitrogen	(N_2)	0,04	0,3
		Carbon dioxide	(CO_2)	0,015	0,3
		Hydrogen	(H_2)	0,01	0,8
		Ethane	(C_2H_6)	0,04	0,3
		Propane	(C_3H_8)	0,01	0,5
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,8745	0,05
BAM-G442 (13K)	Methane (CH_4)	Oxygen	(O_2)	0,005	0,5
		Nitrogen	(N_2)	0,04	0,3
		Carbon dioxide	(CO_2)	0,015	0,3
		Hydrogen	(H_2)	0,01	0,8
		Ethane	(C_2H_6)	0,04	0,3
		Propane	(C_3H_8)	0,01	0,5
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,8740	0,05
BAM-G446 (B-5K)	Methane (CH_4)	Oxygen	(O_2)	0,01	0,5
		Nitrogen	(N_2)	0,02	0,3
		Carbon dioxide	(CO_2)	0,055	0,3
		Hydrogen	(H_2)	0,02	0,8
		Methane	(CH_4)	0,90	0,05

(The "CRM-No." in parentheses corresponds to the name used in requirement "PTB-A 7.63" by Physikalisch Technische Bundesanstalt (PTB).)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	**Main component**	**Analyte**		**Molar fraction mol/mol**	**Uncertainty % rel**
BAM-G450 (17K)	Methane (CH_4)	Helium	(He)	0,005	1,0
		Oxygen	(O_2)	0,005	0,5
		Nitrogen	(N_2)	0,05	0,3
		Carbon dioxide	(CO_2)	0,01	0,5
		Carbon monoxide	(CO)	0,005	0,5
		Hydrogen	(H_2)	0,01	1,0
		Ethene	(C_2H_4)	0,005	0,8
		Ethane	(C_2H_6)	0,025	0,4
		Propene	(C_3H_6)	0,005	0,8
		Propane	(C_3H_8)	0,01	0,5
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0006	0,8
		Methane	(CH_4)	0,8639	0,05
BAM-G460	Methane (CH_4)	Helium	(He)	0,005	0,8
		Nitrogen	(N_2)	0,12	0,3
		Carbon dioxide	(CO_2)	0,04	0,3
		Ethane	(C_2H_6)	0,0075	0,5
		Propane	(C_3H_8)	0,003	0,5
		n-Butane	(C_4H_{10})	0,002	0,8
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Pentane	(C_5H_{12})	0,0005	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0005	0,8
		n-Hexane	(C_6H_{14})	0,0005	0,8
		Methane	(CH_4)	0,8185	0,08
BAM-G471 (9M)	Methane (CH_4)	Oxygen	(O_2)	0,0040	0,5
		Nitrogen	(N_2)	0,040	0,5
		Carbon dioxide	(CO_2)	0,025	0,3
		Hydrogen	(H_2)	0,002	1,0
		Ethane	(C_2H_6)	0,025	0,3
		Propane	(C_3H_8)	0,01	0,5
		2-Methyl-propane	(C_4H_{10})	0,002	0,8
		n-Butane	(C_4H_{10})	0,002	0,8
		Methane	(CH_4)	0,89	0,05
BAM-G472 (9E)	Methane (CH_4)	Oxygen	(O_2)	0,02	0,3
		Nitrogen	(N_2)	0,08	0,3
		Carbon dioxide	(CO_2)	0,02	0,3
		Hydrogen	(H_2)	0,01	0,8
		Ethane	(C_2H_6)	0,04	0,3
		Propane	(C_3H_8)	0,03	0,4
		2-Methyl-propane	(C_4H_{10})	0,005	0,6
		n-Butane	(C_4H_{10})	0,005	0,6
		Methane	(CH_4)	0,79	0,05
BAM-G490	Methane (CH_4)	Nitrogen	(N_2)	0,125	0,3
		Carbon dioxide	(CO_2)	0,04	0,3
		Ethane	(C_2H_6)	0,045	0,3
		Propane	(C_3H_8)	0,022	0,3
		n-Butane	(C_4H_{10})	0,0120	0,5
		2-Methyl-propane	(C_4H_{10})	0,007	0,5
		Methane	(CH_4)	0,749	0,09
BAM-G491	Methane (CH_4)	Nitrogen	(N_2)	0,075	0,3
		Carbon dioxide	(CO_2)	0,05	0,3
		Ethane	(C_2H_6)	0,115	0,3
		Propane	(C_3H_8)	0,05	0,3
		n-Butane	(C_4H_{10})	0,006	0,6
		2-Methyl-propane	(C_4H_{10})	0,0035	0,8
		Methane	(CH_4)	0,7005	0,06

(The "CRM-No." in parentheses corresponds to the name used in requirement "PTB-A 7.63" by Physikalisch Technische Bundesanstalt (PTB).)

Certified reference gas mixtures for process gas chromatographs (continued)

CRM-No.	**Main component**	**Analyte**		**Molar fraction mol/mol**	**Uncertainty % rel**
BAM-G492	Methane (CH_4)	Nitrogen	(N_2)	0,150	0,3
		Carbon dioxide	(CO_2)	0,06	0,3
		Ethane	(C_2H_6)	0,14	0,3
		Propane	(C_3H_8)	0,005	0,5
		n-Butane	(C_4H_{10})	0,004	0,8
		2-Methyl-propane	(C_4H_{10})	0,012	0,5
		Methane	(CH_4)	0,629	0,12
BAM-G496	Methane (CH_4)	Nitrogen	(N_2)	0,005	0,5
		Carbon dioxide	(CO_2)	0,001	0,6
		Ethane	(C_2H_6)	0,001	0,6
		Propane	(C_3H_8)	0,0005	0,8
		n-Butane	(C_4H_{10})	0,0003	0,8
		2-Methyl-propane	(C_4H_{10})	0,0003	0,8
		n-Pentane	(C_5H_{12})	0,001	0,8
		2-Methyl-butane	(C_5H_{12})	0,001	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,00025	0,8
		n-Hexane	(C_6H_{14})	0,00025	0,8
		Methane	(CH_4)	0,9894	0,05
BAM-G497	Methane (CH_4)	Nitrogen	(N_2)	0,01	0,3
		Carbon dioxide	(CO_2)	0,029	0,3
		Ethane	(C_2H_6)	0,02	0,3
		Propane	(C_3H_8)	0,042	0,3
		n-Butane	(C_4H_{10})	0,008	0,5
		2-Methyl-propane	(C_4H_{10})	0,005	0,6
		n-Pentane	(C_5H_{12})	0,00025	0,8
		2-Methyl-butane	(C_5H_{12})	0,0005	0,8
		2,2-Dimethyl-propane	(C_5H_{12})	0,0001	0,8
		n-Hexane	(C_6H_{14})	0,0001	0,8
		Methane	(CH_4)	0,88505	0,05
BAM-G901	Natural gas	Carbon dioxide	(CO_2)	0,002 to 0,2	0,5 to 0,3

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

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

Materials with integral optical properties

CRM-No.	**BAM-V001**	**BAM-V002**
Optical property	specular gloss	coefficient of retroreflection
Method for estimating the certified value	DIN 67530, ISO 2318	DIN 67520, CIE-Pub. 54
Essential parameters for measurement	illumination angle: 20°, 60°, 85°	observation angle 0,1° to 2°, entrance angle: -60° to +60°, rotation angle 0° to 360°
Certified value	about 95 units	up to 900 cd/(lx*m*m) [customer defined]
Uncertainty (*k*=2)	0,3 units	5%
Validity of the certified value	1 year	1 year
Traceability to	PTB	PTB
Description of the material	polished black glass	commercial retroreflective film used for traffic signs
Size of the material	about 100 mm x 100 mm	about 100 mm x 100 mm
Delivery of the material	typically by the customer	typically by the customer

Materials with spectral optical properties

CRM-No.	**BAM-V004/5**[1]	**BAM-V006**	**BAM-V007**	**BAM-V008**
Optical property	spectral radiance factor	bispectral transition factor	spectral transmittance factor	total radiance factor
Method for estimating the certified value	DIN 5033	Two- Monochromator-Method[2]	DIN 5033	DIN 5033
Measuring geometry	0/45 (circ), 45/0, d/8, or 8/d in- or excluding specular reflection	45/0 and 0/45	0/0, 0/d	45/0
Wavelength region	250 nm - 2500 nm	300 nm - 830 nm	250 nm - 2500 nm	300 nm - 800 nm
Stepwidth and optical bandwidth	1 - 10 nm	5 nm (1 - 10 nm)	1 - 10 nm	10 nm
Calculated spectral properties		total, fluorescent, and reflected radiance factor		
Calculated colorimetric properties	*X*, *Y*, *Z* *L**,*a**,*b** or others	*X*, *Y*, *Z* *L**,*a*,**b** or others		*X*, *Y*, *Z* *L**,*a*,**b** or others
Uncertainty (*k*=2)	1%	1% to 10%	1% to 2%	2%
Validity of the certified value	1 year	1 year	1 year	1 year
Traceability to	PTB	PTB	PTB	PTB
Description of the material	reflecting non-fluorescent reference object	reflecting fluorescent reference object	transparent reference object	reflecting fluorescent reference object
Size of the material	typical 50 mm x 50 mm	typical 50 mm x 50 mm	typical 50 mm x 50 mm	typical 50 mm x 50 mm
Delivery of the material	typically by the customer	typically by the customer	typically by the customer	typically by the customer

[1] BAM-V004 is used for white reference objects, BAM-V005 is used for chromatic reference objects
[2] according to CIE 182:2007

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-F001, BAM-F002, BAM-F003, BAM-F004, BAM-F005

For the determination of the relative spectral responsivity of fluorescence instruments, and 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 from Sigma Aldrich Co (former Fluka GmbH), which cover the spectral region of 300 nm to 770 nm as a set. The corresponding product numbers from Sigma Aldrich are

97003-1KT-F for the calibration kit including solvent and software LinkCorr- GUI and

69336-1KT for the new advanced calibration kit including solvent and software LinkCorr- WIN.

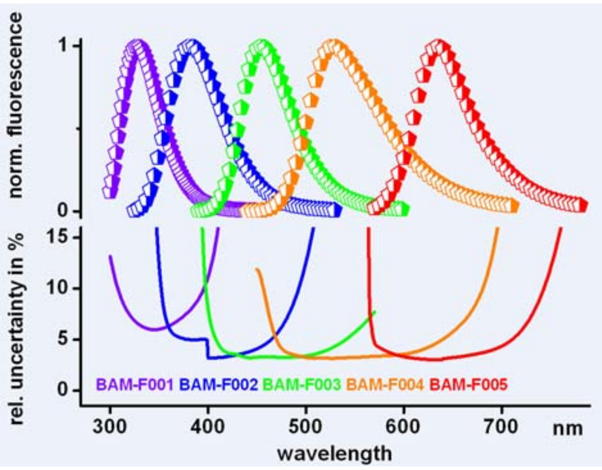
Addition of aliquots of 10 ml of ethanol to each solid dye yields a solution that can be measured without additional dilution steps.

Corrected emission spectra of BAM-F001 - BAM-F005 certified with different spectral bandpasses and the corresponding wavelength-dependent expanded relative uncertainties. Certification was performed according to ISO Guide 35 and the calculation of the wavelength-dependent uncertainties according to the guide to the expression of uncertainty (GUM).

CD with the certificate files BAM507Mx.CTF, the data evaluation software LinkCorr developed by BAM, and instructions for use of BAM-F001 - BAM-F005 and LinkCorr***.

Certified properties

Normalized corrected emission spectra of BAM-F001 - BAM-F005 in ethanol for T = 25 °C. The emission spectra are traceable to the spectral radiance scale realized and disseminated in Germany by the Physikalisch-Technische Bundesanstalt (PTB).



Certified normalized corrected emission spectra of

← BAM-F001 – BAM-F005

and

← expanded relative uncertainties

Porous reference materials

CRMs for the gas adsorption method

CRM-No.	**BAM-PM-101**	**BAM-PM-102**	**BAM-P105**
Description	SiO_2 Powder	alpha-Al_2O_3 Powder	Nanoporous glass Granular material
Adsorptive	Krypton	Nitrogen	Nitrogen
Year of issue	1996	1996	2009
BET Specific surface area (m^2/g)	0,177 ± 0,014	5,41 ± 0,24	198,5 ± 1,6
Specific pore volume (cm^3/g) *p/p₀*=0,99	—	—	0,2327± 0,0025
Mean pore radius (nm)	—	—	4,69 ± 0,06
Most frequent pore radius (nm)	—	—	4,38 ± 0,14 [1)] 5,80 ± 0,27 [2)]
Specific micropore volume (cm^3/g)	—	—	—
Median pore width (nm)	—	—	—

CRM-No.	**BAM-P106**	**ERM®-FD107 (BAM-P107)**	**BAM-P108**	**BAM-P109**
Description	Nanoporous TiO_2 Granular material	Faujasite type zeolite Pellets	Nanoporous carbon	Nanoporous carbon
Adsorptive	Nitrogen	Nitrogen	Nitrogen	Nitrogen
Year of issue	2012	2000	2007	2010
BET Specific surface area (m^2/g)	96,6 ± 1,7	—	550 ± 5	1396 ± 24
Specific pore volume (cm^3/g) *p/p₀*=0,99	0,2341 ± 0,0024	—	—	—
Mean pore radius (nm)	9,69 ± 0,16	—	—	—
Most frequent pore radius (nm)	8,2 ± 1,0 [1)] 11,5 ± 0,9 [2)]	—	—	—
Specific micropore volume (cm^3/g)	—	0,217 ± 0,002	—	—
Median pore width (nm)	—	0,86 ± 0,02	—	—

[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 ERM®-FD107, BAM-P105, BAM-P106, BAM-P108, and BAM-P109 is it the expanded uncertainty with a coverage factor of *k*=2.

The reference materials are intended for for checking the performance of instruments used for the determination of BET specific surface area, specific pore volume, and the pore radius (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.

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	Porous glass	Porous glass	Alumina
	Beads	Beads	Beads	Beads
Year of issue	2000	2000	2000	2002
Pore volume (in mm^3/g) at 50 MPa	—	—	—	69,4 ± 8,0
Pore volume (in mm^3/g) at 100 MPa	545,0 ± 12,2	425,0 ± 47,1	919,7 ± 16,8	625,4 ± 13,6
Pore volume (in mm^3/g) at 195 MPa	546,7 ± 12,7	621,9 ± 12,9	922,5 ± 17,5	637,1 ± 14,4
Pore volume (in mm^3/g) at 200 MPa	546,8 ± 12,7	621,9 ± 12,9	922,6 ± 17,5	—
Pore volume (in mm^3/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 $V'_p = V_p(p_{Hg}) - V_p(0,1\ MPa)$
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 U 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 U** [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 U** [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 U** [2)]	**Unit**
$\boldsymbol{y}_1$ [3)]	110,9	8,5	mm^3g^{-1}
$\boldsymbol{y}_2$ [4)]	0,8682	0,0408	MPa
$\boldsymbol{y}_3$ [5)]	0,2965	0,0305	MPa
$\boldsymbol{p}_{50}$	0,8441	0,0416	MPa
$\boldsymbol{d}_{50}$	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.

Layer and surface reference materials

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

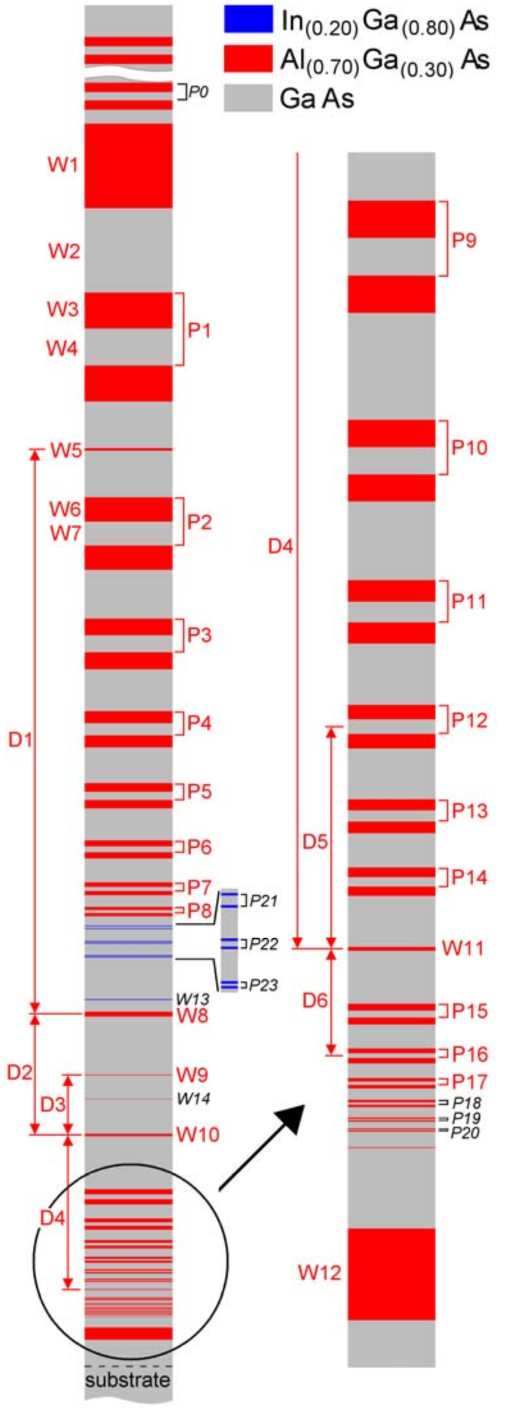
BAM-L200

BAM-L200 is a certified reference material for determination and control of lateral resolution in surface analysis 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 and performance test programme for the determination of the properties of an energy dispersive X-ray spectrometer (EDS)

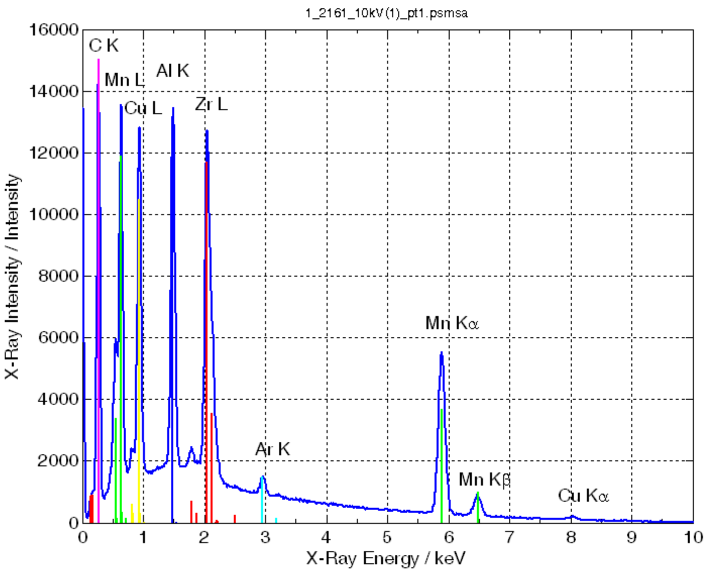
Energy dispersive X-ray spectrometers (EDS) are generally sophisticated devices with a high degree of operating reliability. Malfunctions only occur rarely, although they cannot be excluded. The causes may include poor contacts between the electronic components (particularly with older devices) or an unsealed detector window. It is therefore recommended that the EDS performance be checked on a regular basis. Such an inspection is even prescribed for a testing laboratory, accredited in compliance with DIN/EN/ISO 17075 “General requirements on the competence of testing and calibration laboratories”.

The checking of the EDS performance usually consists of a recalibration of the energy scale (more precisely the channel width of the multichannel analyser) via the position of the Kα line of Cu or Mn and the quantification of a suitable reference sample. This procedure has the following disadvantages:

- Line broadenings, which result from malfunctions of the electronics, are not considered.
- The result of the performance test depends on the choice of reference sample, whose X-ray spectrum is possibly insensitive to malfunctions.
- Detector icing is only perceptible if soft X-ray lines (below 1 keV) are also used for quantification of the reference sample.
- Quantification software updates on the part of the manufacturer may “simulate” a change in spectrometer properties.

BAM offers the EDS-TM002 test material, whose spectrum is sensitive to EDS malfunctions. All the measurements required for the performance test of an EDS on a scanning electron microscope in compliance with 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” can be undertaken with this single sample. It consists of a ca. 6 µm thick layer, containing the elements C, Al, Mn, Cu and Zr, on a silicon substrate.

In principle, the evaluation of the measurements is possible with the software offered by the spectrometer manufacturer. The evaluation is, however, easier and quicker to perform using the “EDX spectrometer test” software offered for the EDS-TM002. The software assumes that the detector possesses a thin-film window. It is not applicable for detectors with a beryllium window.



10 kV X-ray spectrum of the EDS-TM002 and CD with the evaluation software EDX Spectrometer Test (version 3.4, Release 28.01.2013).

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 *U* [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 U 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 (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/ cm^3	3,205

3) Wavelength: 633 nm

CRM for particle size distribution of nano silver by Small Angle X-ray Scattering (SAXS)

BAM-N001

Description: aqueous suspension with a nano silver concentration of 100 µg/ml.

Recommended use: BAM-N001 is intended to be used as a control sample of particle size determination methods, like SAXS and TSEM, as well as for toxicological tests.

Year of issue: 2013

Certified values:

Size Parameter*	volume weighted		number weighted	
	Diameter** nm	**Uncertainty *U***** nm	**Diameter**** nm	**Uncertainty *U***** nm
d_{10}	12,0	1,9	6,9	2,7
d_{50}	18,5	2,5	12,6	2,1
d_{90}	34,6	4,8	19,4	2,2

* Particle diameter corresponding to the cumulative undersize distribution

** The certified values are traceable to the SI under the assumptions of the model used for interpretation of the SAXS data (details see certification report).

*** The stated uncertainty is an expanded combined uncertainty consisting of contributions from method repeatability, measurement setup geometry, method bias, possible but undetected inhomogeneity and instability, and the model used, in particular binning, expanded by a factor of *k* = 2 corresponding to a confidence level of approximately 95 %.

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®-AE101 (BAM-I001)**	**ERM®-AE102* (BAM-I002)**	**ERM®-AE103 (BAM-I003)**	**ERM®-AE104* (BAM-I004)**
Isotope amount ratio $n(^{10}B)/n(^{11}B)$	0,28197 (40)	0,42485 (60)	0,9895 (14)	0,45966 (62)
Amount fraction $n(^{10}B)/n(B)$	21,995 (24)	29,817 (30)	49,737 (34)	0,31491 (29)
$n(^{11}B)/n(B)$	78,005 (24)	70,183 (30)	50,263 (34)	0,68509 (29)
Mass fraction $m(^{10}B)/m(B)$	20,411 (22)	27,871 (28)	47,368 (34)	0,29481 (28)
$m(^{11}B)/m(B)$	79,589 (22)	72,129 (28)	52,632 (34)	0,70519 (28)
Molar mass $M(B)$ in $g \cdot mol^{-1}$	10,79015 (24)	10,71222 (30)	10,51374 (34)	10,69554 (29)
	Informative value			
Mass fraction in solution $w(B)$ in $mg \cdot kg^{-1}$	1000 (20)	999 (20)	1000 (20)	999 (20)

* Replaced by ERM®-AE102a and -AE104a

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 parenthesis and apply to the last one or two digits of the value.

Due to a limited stock of ERM®-AE102 and -AE104, the materials ERM®-AE102a and -AE104a have been recently certified to avoid shortage of these materials.

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	0,29995 (27)	0,31488 (28)	0,19832 (22)	0,96006 (6)
^{11}B	0,70005 (27)	0,68512 (28)	0,80168 (22)	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.

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: $\delta^{11}B = ((R_{sample}/R_{reference})-1)\cdot 10^3$. 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 indispensible 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®-AE121**	**ERM®-AE122**
$\delta^{11}B_{NIST\ 951}$ in ‰	-20,2 (0,6)	19,9 (0,6)	39,7 (0,6)
	Informative value		
Isotope abundance ratio $R(^{10}B/^{11}B)$	0,25236 (33)	0,24233 (32)	0,23782 (31)
Isotope abundance ratio $R(^{11}B/^{10}B)$	3,963 (6)	4,127 (6)	4,205 (6)
Isotope abundance			
^{10}B	0,20150 (21)	0,19506 (21)	0,19213 (20)
^{11}B	0,79850 (21)	0,80494 (21)	0,80787 (20)
Molar mass M(B) in g·mol^{-1}	10,80853 (21)	10,81495 (21)	10,81787 (20)
Mass fraction in solution w(B) in mg·kg^{-1}	100,0 (2,0)	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.

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CRMs under development

Iron and steel products

ECRM 077-3	**unalloyed steel, chips**
Certified properties:	Element contents of trace elements
Fields of application:	Wet chemical analysis; Calibration of C/S and N-analysers
Completion date:	2014
ECRM 083-2	**unalloyed steel, chips and discs**
Certified properties:	Element contents of main and trace elements
Fields of application:	Wet chemical analysis; Calibration and recalibration of spark emission spectrometers and X-ray fluorescence spectrometers
Completion date:	2014
ECRM 194-2	**alloyed steel, chips and discs**
Certified properties:	Element contents of main and trace elements
Fields of application:	Wet chemical analysis; Calibration and recalibration of spark emission spectrometers and X-ray fluorescence spectrometers
Completion date:	2014
ECRM 284-3	**highly alloyed steel, chips and discs**
Certified properties:	Element contents of main and trace elements
Fields of application:	Wet chemical analysis; Calibration and recalibration of spark emission spectrometers and X-ray fluorescence spectrometers
Completion date:	2014
ECRM 784-1	**MoO_3, powder**
Certified properties:	Element contents of main and trace elements
Fields of application:	Wet chemical analysis; Calibration and recalibration of spark emission spectrometers and X-ray fluorescence spectrometers
Completion date:	2014

Non ferrous metals

ERM®-EB393a	**CuZn21Si3P, discs**
Certified properties:	Element contents of alloying elements and traces
Fields of application:	Calibration and recalibration of spark emission spectrometers and X-ray fluorescence spectrometers
Completion date:	2014
ERM®-EB314a	**AlSi11Cu2Fe, discs**
Certified properties:	Element contents of alloying elements and traces
Fields of application:	Calibration and recalibration of spark emission spectrometers and X-ray fluorescence spectrometers
Completion date:	2014

ERM®-EB366a **SF-copper, discs**

Certified properties: Element contents of alloying elements and traces

Fields of application: Calibration and recalibration of spark emission spectrometers and X-ray fluorescence spectrometers

Completion date: 2014

Food

Ergot alkaloids in rye flour

Certified properties: Mass fraction of ergot alkaloids

Fields of application: Method development, validation and internal laboratory quality control of analytical procedures for the quantitative determination of ergot alkaloids in flour

Completion date: 2015

Zearalenone in edible oil

Certified property: Mass fraction of zearalenone

Fields of application: Method development, validation and internal laboratory quality control of analytical procedures for the quantitative determination of zearalenone in edible oils

Completion date: 2015

A Brief History of BAM

1870 The Prussian Ministry of Commerce, Trade and Public Works announces the establishment of a Mechanical and Technical Research Institute. Its task is to perform experiments of general scientific and public interest and to test the strength of components.

1904 The Royal Materials Testing Office is established in Berlin-Dahlem following the merger of the Royal Mechanical Testing Institute with the Royal Testing Station for Building Materials (founded in 1875) and the Royal Chemical Technical Testing Office (founded in 1877).

1919 Renamed the Public Materials Testing Office (MPA), the institute is responsible to the Prussian Ministry of Science, Fine Arts and Public Education; from 1936 on the Public X-ray Investigation Office is included.

1920 The State Chemical Technical Institute (CTR) is established under the State Ministry of the Interior from the Military Testing Office, established in 1889 as the Central Research Office for Explosives.

1945 MPA and CTR are united and operate under the jurisdiction of Berlin City Council.

1954 The Federal Republic of Germany takes over responsibility for MPA/CTA as Federal Institute for Mechanical and Chemical Testing (BAM), renamed the Federal Institute for Materials Testing in 1956. In addition BAM takes over responsibility for public materials testing for the state of Berlin.

1969 Under the Statute on Explosive Substances BAM is granted the status of senior federal authority; an amendment to the law in 1986 adds the word “research“ to BAM’s title.

1975 Under the Statute on the Transport of Hazardous Goods BAM is given greater responsibility in the field of public technical safety.

1990 German reunification and a recommendation from the German Scientific Council strengthen BAM’s function as a federal chemical technical institute. Its personnel is increased by staff gained from the defunct Office for Standardisation, Measurements and Product Testing (ASMW) and Academy of Sciences in the former GDR. Responsibility for public testing for Berlin is gradually ended.

1995 Following an external evaluation and extensive reorganisation, under a decree from the Federal Ministry of Economics BAM is given a new statute, revised management structures and methods and a future-oriented profile as an essential element of the scientific and technical infrastructure of the Federal Republic of Germany.

2006 After further external appraisal (by the German Scientific Council among others) BAM‘s profile was further developed as a departmental research establishment of the German Federal Republic for safety in technology and chemistry.