



# BUREAU OF ANALYSED SAMPLES LTD

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BRITISH CHEMICAL STANDARD CERTIFIED REFERENCE MATERIAL

## CERTIFICATE OF ANALYSIS

### BCS-CRM No. 516 STANDARD GLASS SAND

### SGT STANDARD GLASS SAND 10

Prepared under rigorous laboratory conditions and, AFTER CERTIFICATION ANALYSIS IN GREAT BRITAIN, GERMANY, GREECE, ITALY, JAPAN, TURKEY AND THE UNITED STATES OF AMERICA, issued by the Bureau of Analysed Samples Ltd and the Society of Glass Technology

#### ANALYSES

Mean of 4 values - mass content in %. All results relate to the dried (105°C) sample.

Analyst No.	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	TiO <sub>2</sub>	Fe <sub>2</sub> O <sub>3</sub>	Mn <sub>3</sub> O <sub>4</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	BaO	PbO	Cr <sub>2</sub> O <sub>3</sub>	LOI
1	98.5300	0.5240	0.1768	0.0578	0.0010	0.0255	0.0413	...	0.1305	0.0048	...	0.0088	0.2363
2	98.6874	0.5310	0.1706	0.0568	0.0009	...	...	...	0.1255	...	...	0.0082	0.2304
3	98.7903	0.5268	0.1793	...	...	0.0258	...	...	0.1323	0.0048	0.0140	...	0.2150
4	...	0.4888	0.1800	0.0583	0.0013	0.0235	0.0373	0.0205	0.1275	...	0.0135	0.0083	0.2375
5	98.8999	0.4901	0.1689	0.0596	0.0014	0.0181	0.0359	0.0192	0.1128	...	0.0123	0.0078	0.2505
6	98.9226	0.5213	0.1648	...	...	0.0208	0.0403	...	0.1228	...	...	...	...
7	98.4030	...	0.1775	...	...	...	...	...	0.1215	0.0045	...	...	0.2415
8	98.7705	0.5183	0.1708	0.0593	0.0013	0.0208	0.0390	...	0.1313	...	...	0.0084	0.2506
9	98.7975	0.4655	0.1717	0.0655	...	...	...	...	...	...	...	...	0.2653
10	...	0.5150	0.1818	0.0577	...	...	0.0445	...	...	...	...	0.0070	0.2238
11	...	0.5620	0.1725	0.0625	0.0010	0.0275	0.0408	0.0175	0.1388	0.0038	0.0123	0.0080	0.2500
12	98.8500	0.4825	0.1625	0.0555	0.0011	0.0220	0.0350	0.0200	0.1225	0.0030	0.0120	0.0087	0.2550
13	...	0.5250	0.1650	0.0618	0.0014	0.0275	0.0374	0.0210	0.1333	0.0035	0.0124	0.0072	0.2500
14	98.7275	...	0.1755	0.0569	0.0014	0.0326	0.0389	0.0190	...	0.0037	0.0121	0.0078	0.2466
15	98.6175	0.5182	0.1703	0.0629	0.0013	0.0229	0.0355	0.0196	0.1301	0.0035	0.0126	0.0090	0.2426
16	...	...	0.1654	0.0607	...	...	...	...	...	...	...	...	...
<b>M<sub>M</sub></b>	<b>98.7269</b>	<b>0.5130</b>	<b>0.1721</b>	<b>0.0596</b>	<b>0.0012</b>	<b>0.0243</b>	<b>0.0387</b>	<b>0.0195</b>	<b>0.1274</b>	<b>0.0040</b>	<b>0.0127</b>	<b>0.0081</b>	<b>0.2425</b>
<i>s<sub>M</sub></i>	0.1586	0.0252	0.0060	0.0029	0.0002	0.0041	0.0029	0.0011	0.0069	0.0007	0.0008	0.0007	0.0132
<i>s<sub>w</sub></i>	0.1462	0.0070	0.0032	0.0016	0.0003	0.0012	0.0011	0.0008	0.0026	0.0006	0.0005	0.0006	0.0143

The above figures are those which each Analyst has decided upon after careful verification.

*M<sub>M</sub>*: Mean of the intralaboratory means. *s<sub>M</sub>*: standard deviation of the intralaboratory means. *s<sub>w</sub>*: intralaboratory standard deviation.

#### CERTIFIED VALUES (C<sub>v</sub>)

mass content in %

	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	TiO <sub>2</sub>	Fe <sub>2</sub> O <sub>3</sub>	Mn <sub>3</sub> O <sub>4</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	BaO	PbO	Cr <sub>2</sub> O <sub>3</sub>	LOI
<b>C<sub>v</sub></b>	<b>98.73</b>	<b>0.513</b>	<b>0.172</b>	<b>0.0596</b>	<b>0.0012</b>	<b>0.0243</b>	<b>0.0387</b>	<b>0.0195</b>	<b>0.127</b>	<b>0.0040</b>	<b>0.0127</b>	<b>0.0081</b>	<b>0.24</b>
C(95%)	0.11	0.016	0.004	0.0018	0.0002	0.0027	0.0020	0.0011	0.005	0.0006	0.0006	0.0005	0.01

The half width confidence interval C(95%) =  $\frac{t \times s_M}{\sqrt{n}}$  where "t" is the appropriate two sided Student's t value at the 95% confidence level for "n" acceptable mean values

For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 sections 6.1 and 10.5.2.

#### Additional Information (mass content in %)

Analyst No	P <sub>2</sub> O <sub>5</sub>	ZrO <sub>2</sub>
1	0.0148	0.0858
2	...	...
3	0.0205	0.0770
4	0.0070	0.0855
5	0.0139	...
6	...	0.0745
7	0.0235	...
8	...	0.0735
9	...	...
10	0.0111	0.0809
11	0.0083	0.0705
12	0.0125	0.0708
13	0.0131	0.0610
14	0.0125	0.0644
15	0.0126	0.0755
16	0.0092	...

Analyst No. 1 determined HfO<sub>2</sub>, ZnO, SrO, SnO<sub>2</sub> and CuO by XRF and found <0.01% in every case. Analyst No. 1 also determined Bi by hydride generation and ICP-OES and found 0.2μg/g.

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### NOTES ON METHODS USED

#### SILICA

Analysts Nos. 1, 2, 3, 6, 7 and 8 determined silica using X-ray Fluorescence Spectrometry (XRF). The remaining Analysts determined silica gravimetrically after dehydration with hydrochloric acid, No.9 according to the British Standard Method BS 2795:1988.

#### ALUMINA

Analysts Nos. 1, 2, 3, 4, 6, 8 and 10 determined alumina using XRF. Analysts Nos. 5, 11, 12 and 15 used Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Nos. 9 and 13 determined alumina by complexometric titration with ethylenediaminetetra-acetic acid (EDTA), No. 9 according to the method in BS 2795:1988.

#### TITANIA

Analysts Nos. 1, 2, 3, 4, 6, 7, 8 and 10 determined titania using XRF. Analysts Nos. 5, 11, 12, 13, 15 and 16 used ICP-OES, Analysts Nos. 9 and 14 determined titania photometrically with tiron, No. 9 according to the British Standard Method BS 2795:1988.

#### FERRIC OXIDE

Analysts Nos. 1, 2, 4, 8 and 10 determined ferric oxide using XRF. Analysts Nos. 5, 11, 12, 15 and 16 used ICP-OES and Nos. 9, 13 and 14 determined ferric oxide photometrically with 1, 10 phenanthroline, No. 9 according to the British Standard Method BS 2795:1988.

#### MANGANESE OXIDE

Analysts Nos. 1, 2, 8 and 10 determined manganese oxide using XRF. Analyst No. 4 used Flame Atomic Absorption Spectrometry (FAAS), whilst Analysts Nos. 5, 12, 13 and 14 used ICP-OES.

#### CALCIUM OXIDE

Analysts Nos. 1, 3, 6 and 8 determined calcium oxide using XRF. Analyst Nos. 4, 11 and 13 used FAAS whilst Analysts Nos. 5, 12, 14 and 15 used ICP-OES.

#### MAGNESIUM OXIDE

Analysts Nos. 1, 6, 8 and 10 determined magnesium oxide by XRF. Analysts Nos. 4 and 13 used FAAS whilst Nos. 5, 11, 12, 14, 15 and 16 used ICP-OES

#### SODIUM OXIDE

Analysts Nos. 4 and 15 determined sodium oxide by Flame Emission Spectrometry (FES). The remaining Analysts used FAAS.

#### POTASSIUM OXIDE

All Analysts except for Nos. 5, 11, 12, 13 and 15 determined potassium oxide using XRF. Analysts Nos. 5, 11, 12 and 13 determined the constituent using FAAS, whilst Analyst No. 15 used FES.

#### BARIUM OXIDE

Analysts Nos. 1, 3 and 7 determined barium oxide using XRF. All of the other Analysts determined barium oxide using ICP-OES.

#### LEAD OXIDE

Analyst No. 3 determined lead oxide using XRF. Analysts Nos. 4 and 13 used FAAS and the remainder used ICP-OES.

#### CHROMIUM OXIDE

Analysts Nos. 1, 2, 8 and 10 determined chromium oxide using XRF. Analysts Nos. 4 and 13 used FAAS, whilst Nos. 5, 11, 12, and 15 used ICP-OES and Analyst No. 14 determined chromium oxide photometrically with diphenylcarbazide. Analyst No 16 also determined chromium oxide by ICP and reported a mean value of 0.0076% from duplicate determinations.

#### LOSS ON IGNITION

All Analysts determined the loss on ignition gravimetrically by heating at  $1000^{\circ} \pm 25^{\circ}$  C to constant weight.

#### PHOSPHORUS PENTOXIDE

*Analysts Nos. 1, 3 and 10 determined phosphorus pentoxide using XRF. Analysts Nos. 4 and 14 determined the constituent photometrically as phosphovanadomolybdate without extraction whilst the remaining Analysts used ICP-OES.*

#### ZIRCONIUM OXIDE

*Analysts Nos. 1, 3, 4, 6, 8 and 10 determined zirconium oxide by XRF, whilst Analysts Nos. 11, 12, 13, 14 and 15 used ICP-OES.*

## CO-OPERATING ANALYSTS

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## **DESCRIPTION OF SAMPLE**

Bottles of 100g of finely divided material for chemical analysis passing a nominal 250 micron aperture.

## **INTENDED USE & STABILITY**

This sample is intended for the verification of analytical methods, such as those used by the participating laboratories, for the calibration of analytical instruments, for establishing values for secondary reference materials and for training purposes.

It will remain stable provided that the bottle remains sealed and is stored in a dry atmosphere. When the bottle has been opened the lid should be secured immediately after use.

In order to ensure that a fully representative sample is taken users should take a minimum sub-sample size of 1.0g. Users of this material should be aware that the use of a smaller sub-sample size will invalidate the certified values and the associated 95% confidence limits. Provided that the material is stored in a suitable environment there will be no contribution to the uncertainty from the long term stability of this CRM.

## **TRACEABILITY**

The traceability of this CRM has been established in accordance with principles of ISO Guides 30 – 35 and the International Vocabulary of Basic and General Terms in Metrology.

The characterisation of this material has been achieved by inter-laboratory study, each laboratory using the method of their choice, details of which are given above. Most methods used were either international or national standard methods or methods which are technically equivalent. All laboratories used either stoichiometric analytical techniques or methods which were calibrated predominantly against pure metals or stoichiometric compounds.

Nine of the participating laboratories were accredited to ISO/IEC 17025 at the time of the analysis, although not necessarily for all of the constituents determined and not necessarily for the analysis of sand. It has been established statistically that, with the exception of PbO, there is no difference between the results of the accredited and the non-accredited laboratories. In the case of PbO only two non-accredited laboratories provided results, both were higher than the other laboratories. These results have been retained as there are no technical grounds for their elimination.

Bureau of Analysed Samples Ltd is the Reference Material Producer as defined in ISO Guide 34:2000 section 3.1 and is fully responsible for assigning the certified values and their uncertainties in accordance with ISO Guides 34:2000 and 35:2006. The Society of Glass Technology has acted as a collaborator, as defined in ISO Guide 34:2000 section 3.1 and provided substantial advice during the certification of this material.

Bureau of Analysed Samples Ltd is a UKAS Accredited Reference Material Producer No 4004.

Further information and advice on this or other Certified Reference Materials or Reference Materials produced by Bureau of Analysed Samples Ltd and the Society of Glass Technology may be obtained from the addresses below.

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