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Certificate of Analysis – Certified Reference Material

Strontium Standard for ICP

TraceCERT® Traceable Certified Reference Materials

Product no.:	75267
Lot no.:	BCCF7877
Description of CRM:	Strontium carbonate (high-purity quality) in 2% HNO_3 (prepared with HNO_3 suitable for trace analysis and high-purity water, 18.2 MΩ·cm, 0.22 µm filtered).
Expiry date:	MAR 2025 (unopened bottle in aluminized bag)
Storage:	Store at 15°C-25°C
Density (certified) at 20°C:	1011.0 kg m^{-3} ± 0.5 kg m^{-3}

Constituent	Certified values at 20°C and expanded uncertainties, U = $k \cdot u$ (k = 2) [1][2]	
Strontium	**983 mg kg^{-1} ± 8 mg kg^{-1}**	**993 mg L^{-1} ± 8 mg L^{-1}**

Metrological traceability:	Directly traceable to NIST SRM 3153a. [3]
Measurement method:	Inductively coupled plasma optical emission spectrometry ICP-OES
Intended use:	Calibration of ICP, AAS, spectrophotometry or any other analytical technique.
Instructions for handling and correct use:	The bottle's temperature must be 20°C. Shake well before every use. If storage of a partially used bottle is necessary (at the user`s risk), the cap should be tightly sealed and the bottle should be stored at reduced temperature (e.g. refrigerator) to minimize transpiration rate.
Health and safety information:	Please refer to the Safety Data Sheet for detailed information about the nature of any hazard and appropriate precautions to be taken.
Packaging:	100 mL HDPE bottle sealed with an aluminized bag
Accreditation:	Sigma-Aldrich Production GmbH is accredited by the Swiss accreditation authority SAS as registered reference material producer SRMS 0001 in accordance with ISO 17034 and registered testing laboratory STS 0490 according to ISO/IEC 17025.[4][5]
Certificate issue date:	05 MAY 2021

ISO 17034
SRMS 0001

ISO/IEC 17025
STS 0490

ISO 9001
005356 QM08

S. Matt – CRM Operations

Dr. P. Zell – Approving Officer

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Certification process details:

The certified value of the content (mg/kg) is determined using high-performance inductively coupled plasma optical emission spectrometry (HP-ICP-OES). To obtain performance comparable to isotope dilution and classical methods (titration and gravimetric analysis) the HP-ICP-OES measurement is performed using an internal standard and a drift correction procedure. [6]

The mean value is based on 20 measurements (two samples and 10 measurements per sample). All measurements are traced gravimetrically to an internationally accepted reference material e.g. from NIST (USA) or BAM (Germany).

Homogeneity assessment:

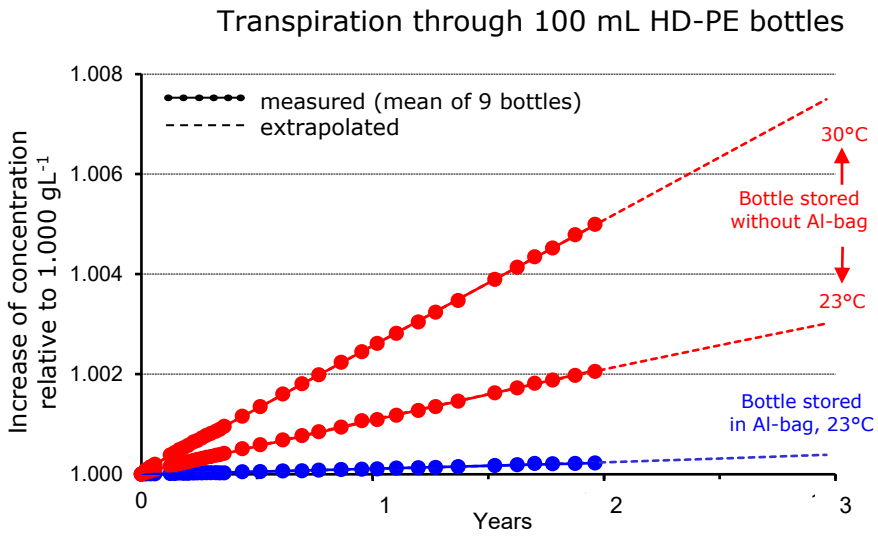
Due to the production process, a homogeneous solution derives. Nevertheless a small homogeneity contribution is included into the calculation of content uncertainty of this CRM.

Stability assessment:

The storage behavior of standard solutions is of greatest importance with regard to the certified value. Therefore the two most important effects were investigated by in-depth studies in a cooperation with EMPA, St. Gallen:

1. The leachate from HDPE (high-density polyethylene) bottles was analyzed by HR-ICP-MS after leaching the bottles with 2% nitric acid. Maximum contamination levels were found in the ng L^{-1} level for 12 elements.

2. To avoid significant loss of mass through transpiration the bottle is delivered in aluminum coated bags. After the bottle has been removed from the bag, transpiration will occur at an accelerated rate (see figure). We highly recommend not opening the bag until the solution is needed. Once the bottle is opened the solution should be stored at reduced temperature (4°C) to reduce transpiration.



Density Measurement:

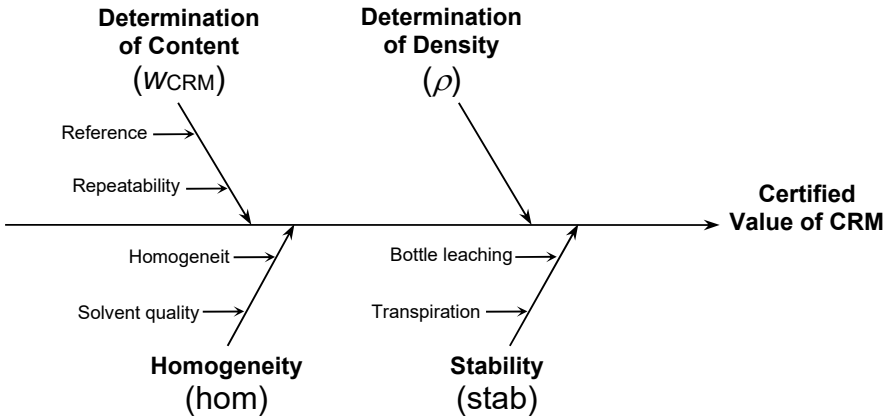
The density measurement is carried out under the scope of the ISO/IEC 17025 accreditation according to ISO 15212-1 [7] and using the digital density meter DMA 4500M from Anton Paar with an oscillating U-tube installed. The measurement uncertainty is calculated according to Eurachem/CITAC Guide and reported as combined expanded uncertainty at the 95% confidence level, using a coverage factor of $k = 2$.

Uncertainty evaluation:

The uncertainty contributions are illustrated by the following cause-effect diagram:

Typical relative contributions are:

$u(w_{CRM})$	0.1 – 0.3 %
u_{hom}	< 0.03 %
u_{stab}	< 0.09 %
$u(\rho)$	< 0.05 %



The combined standard uncertainty is calculated by combination of the standard uncertainties of the input estimates according to Eurachem/CITAC Guide "Quantifying Uncertainty in Analytical Measurement" and ISO 17034.[2][4]

Expanded uncertainty is then calculated to a confidence level of 95%, typically by multiplying with a confidence level factor of k=2.

Trace Impurities:

Up to 75 trace impurities were analyzed by ICP-OES, ICP-MS and AAS. Some of the impurities are determined in the starting material and calculated for the solution (e.g. for rare earth elements contamination during the preparation is rendered impossible). Other elements are determined both in the starting material as well as in the bottled solution.

All values listed below are given in mg kg^{-1} (ppm), <X = below detection limit, m = matrix, n.a. = not analyzed

Li	Be											B	C	N	O	F	Ne
<0.010	<0.005											<0.10	n.a.	n.a.	n.a.	n.a.	n.a.
Na	Mg											Al	Si	P	S	Cl	Ar
<0.050	<0.005											<0.010	<0.050	<0.050	<0.050	n.a.	n.a.
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
<0.050	0.024	<0.002	<0.005	<0.010	<0.010	<0.005	0.023	<0.005	0.013	<0.005	<0.005	<0.001	<0.050	<0.001	<0.002	n.a.	n.a.
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
<0.001	m	0.006	<0.010	<0.001	<0.010	n.a.	<0.001	0.034	<0.001	<0.010	<0.005	<0.001	<0.025	<0.001	<0.001	n.a.	n.a.
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.025	<0.025	<0.050	n.a.	n.a.	n.a.
Fr	Ra	Ac															
n.a.	n.a.	n.a.															

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
<0.001	<0.001	<0.001	n.a.	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Th	Pa	U
<0.001	n.a.	<0.001

References:

[1] ISO Guide 35:2017, "Reference materials - Guidance for characterization and assessment of homogeneity and stability"
[2] Eurachem/CITAC Guide, 3rd Ed. (2012), "Quantifying uncertainty in analytical measurement"
[3] Eurachem/CITAC Guide, 2nd Ed. (2019), "Metrological Traceability in chemical measurement"
[4] ISO 17034:2016, "General requirements for the competence of reference material producers"
[5] ISO/IEC 17025:2017, "General requirements for the competence of testing and calibration laboratories"
[6] Marc L. Salit et al., Anal. Chem. 2001, 73, 4821-4829, "Single-Element Solution Comparisons with a High-Performance Inductively Coupled Plasma Optical Emission Spectrometric Method"
[7] DIN EN ISO 15212-1:1998, Oscillation-type density meters - Part 1: Laboratory instruments

Certificate of analysis revision history:

Certificate version	Certificate issue date	Reason for version
01	05 MAY 2021	Initial version

Disclaimer:

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