

TraceCERT®

Inorganic CRMs



*Certified Standard Solutions
for AAS, ICP and IC produced
under ISO/IEC 17025 and ISO
Guide 34*

TraceCERT® Traceable Certified Reference Materials

TraceCERT inorganic CRMs are high accuracy standards for instrument calibration and process validation in spectroscopy and ion chromatography.

Following lengthy cooperations with different metrological institutes, Sigma-Aldrich has built a new laboratory for Certified Reference Material (CRM) production and

certification in Buchs, Switzerland. In 2007 the new lab received the highest achievable quality assurance level for CRM producers: double accreditation, as a testing lab following ISO/IEC 17025 and also as a CRM producer following ISO Guide 34. This combination is also called the "Gold Standard" accreditation for CRM producers and therefore we devoted the cover-page to our outstanding expertise.

For all TraceCERT standards we guarantee:

- Highest accuracy and reliability of certified concentrations
- Traceability to at least two independent references (i.e. NIST, BAM or SI unit kg)
- Production in accordance with ISO/IEC 17025 and ISO Guide 34
- Comprehensive certification according to ISO Guide 31
- Competitive price

What makes TraceCERT stand above the others?



SRMS 001
ISO Guide 34

Elemental and ion standards are available from various suppliers. Why should I buy TraceCERT certified standards? Indeed many different standards are available covering a wide range in quality, service and price. As the world's number one in supplying research chemicals and standards, Sigma-Aldrich introduced TraceCERT reference materials to underpin its **leading position** in terms of **quality** and customer convenience.



STS 490
ISO 17025

What makes TraceCERT standards higher in quality? Highest quality depends on many different technical and personal skills. These CRMs are produced and certified in accordance to metrological guidelines: **highest accuracy**, low uncertainties and in-depth documentation are what make TraceCERT products so reliable. These solutions are traceable to at least two independent references; NIST traceability is guaranteed whenever possible. In addition, we have extensive packaging knowledge and we guarantee all certified values until the bottle is in customer's hands.



16368-02
ISO 9001

*What is the value of Sigma-Aldrich's double accreditation to the customer? **Reliability!*** Every analytical laboratory will demonstrate the correctness of its measurement results. The use of accurate and well-documented standards is, therefore, the first step to achieving correct measurement

results. Our double accreditation according to ISO/IEC 17025 and ISO Guide 34 is an explicit affirmation of our competence to produce, certify and supply certified reference materials. Our **customers can count on this competence** and refer to it. We know: Buying analytical standards is a matter of trust.

What about the price? These highest quality CRMs are competitively priced, compared to the products of other CRM manufacturers. When you check our website at www.sigma-aldrich.com/tracecert you will see that highest quality is not necessarily the most expensive.

**Produced in double accredited
laboratory fulfilling
ISO/IEC 17025 and
ISO Guide 34**

Manufacturing Under Double-Accreditation

The most accurate approach for the production of standards is high-precision weighing. Under ISO Guide 34 there is a particular focus on the quality of the starting materials and the entire manufacturing process including the choice of an optimal packaging.



Only **materials of highest purity** are used for the production of TraceCERT standards. The starting materials are **characterized by two different approaches**: the direct measurement of the purity by the most accurate method (e.g. titrimetry or high-precision ICP-OES). These measurements are compared to an internationally accepted reference material (i.e. NIST, BAM). In addition the purity of

the starting materials is assigned by the „100% minus impurities“ approach. Both approaches must lead to the same value within the range of their uncertainties. All starting materials are pretreated by surface etching or drying before they go to the high precision weighing room.

Gravimetric preparation using pure materials is a practical and the most accurate realization of concentration units. **High-precision weighing** is a key step of the production, leading to direct traceability to the SI unit kilogram. The use of ultramicro balances with readability down to 100 ng in combination with a specially designed weighing room leads to maximum accuracy.

The weighted starting materials are dissolved in **ultrapure acids or bases** and then **precisely diluted** with ultrapure water to the final concentration. Also this operation is performed gravimetrically to achieve highest precision. **Homogenization** of the solution is achieved by overhead tumbling of the container for several hours. In the final bottling step, contamination is prevented by working under **clean room conditions** and by using PTFE-tubing and an inert peristaltic pump. After bottling, every batch is then compared to a second (whenever possible independent) reference material. Only when calculation and measurements are matching within their uncertainties (usually within 0.2 - 0.5 %) the batch is released for certification.




Certification and Comprehensive Documentation

For each TraceCERT product, a detailed and comprehensive certificate is supplied, either delivered with the product (for the ICP standards) or downloadable from the Internet using product number and lot number (for the AAS and IC standards). **Example certificates** for every product can be downloaded from the Internet (www.sigmaldrich.com/tracecert).

The certificates are in accordance with ISO Guide 31 and contain **lot specific information** such as exact content, expiration date, traceability statements, values of up to 70 impurities (for ICP standards) and a proper uncertainty calculation. Uncertainty budgets are obtained by summing up all the contributing influence parameters ("bottom-up" approach) and are illustrated by a cause-effect diagram.

The certificates consist of up to four pages. See on the right the first page of certificate of the platinum ICP standard solution.



TraceCERT[®]
Traceable Certified Reference Materials

Produced in double accredited
laboratory facilities
ISO/IEC 17025 and
ISO Guide 34

This certificate is designed in accordance with ISO Guide 31¹⁾.

Object of certification: Platinum standard for ICP

Fluka product no.: 19078 (Lot 1371987, Filling Code 42208193)

Composition: Platinum metal (high purity quality) in 5% HCl (prepared from HCl TraceSELECT[®], HNO₃ TraceSELECT[®] and water TraceSELECT[®] Ultra, 18.2 MΩ·cm, 0.22 μm filtered)

Density at 20°C: $\rho = 1024.9 \text{ kg m}^{-3}$ $\omega(\rho) = 0.5 \text{ kg m}^{-3}$

Intended use: Calibration of ICP-spectrometry, AAS, spectrophotometry or any other analytical technique

Storing and handling: This reference material shall be stored in the original closed bag between 5°C and 30°C. After opening the bottle should be stored at reduced temperature to minimize transpiration rate. Before every use of the material the bottle must be shaken well and its temperature has to be 20°C. We highly recommend using this reference material no longer than 15 months after the aluminum bag was opened.

Expiry date: **8. May 2012** (unopened bottle in aluminized bag)

Bottle opening date: [redacted]

Certified value traceable to SI unit kg and uncertainty according to ISO Guide 35 ²⁾ and Eurachem/CITAC Guide ³⁾		
Constituent	Certified value at 20°C ⁴⁾	Expanded uncertainty (U = k · u _c ; k = 2)
Platinum	1001 mg L⁻¹	2 mg L⁻¹
	977 mg kg⁻¹	2 mg kg⁻¹

1. CONCEPT OF CERTIFICATION AND TRACEABILITY STATEMENT

To guarantee top reliability of the values for this TraceCERT[®] certified reference material three independent procedures were followed. The values have to agree in the range of their uncertainties, but the impurity corrected value from the gravimetric preparation has been chosen as certified value⁵⁾.

1. Gravimetric preparation using pure materials is a practical realization of concentration units, through conversion of masses and mole fraction to mass fraction⁶⁾. If the purity of the materials is demonstrated and if contamination and loss of material is strictly prevented this approach allows highest accuracy and small uncertainties. The certified value of TraceCERT[®] reference materials is based on this approach and directly traceable to the SI unit kilogram.
- Therefore comprehensively characterized materials of highest purity are used (see paragraph 2). All balances are certified by DKD and calibrated with OIML Class E2 (up to 12 kg) and F2 (up to 84 kg) weights. The bulk solution was homogenized by overhead tumbling in a PVDF container for at least 6 hours. A peristaltic pump with perfluorinated polymer tubing was used for bottling. Detailed information about the long-term stability of the bottled solution is given in paragraph 5 of this certificate.
2. The starting material is measured against a certified reference material (i.e. NIST, BAM or EMPA) followed by gravimetric preparation using balances calibrated with SI-traceable weights. Consequently the value calculated by this unbroken chain of comparisons is traceable to the reference to which the starting material is compared.
3. Whenever applicable the bottled TraceCERT[®] calibration solution is compared to a second reference (e.g. from NIST, BAM or EMPA) which is independent from the first reference.

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Packaging and Stability



The ideal container for standard solutions is totally inert; i.e. will not absorb the analyte, does not leach impurities into the solution, is impermeable to the solvent and atmosphere and is easy to handle and affordable.

For TraceCERT standards we have developed the **most suitable container** fulfilling all of these criteria: the HDPE bottles are extensively tested for leaching of impurities and the loss of weight by transpiration of the solvent was also investigated comprehensively. The results of this study are also stated in the certificate of each TraceCERT product. For maximum shelf life the bottles for ICP standards are sealed in aluminum bags to further prevent transpiration.

Only this **special packaging** makes it possible to guarantee the ambitious specification of 0.2% uncertainty over the entire shelf life.

TraceCERT Product Portfolio

The TraceCERT product line actually comprises about 150 products. Since we are continuously expanding the product range, we also recommend to consult our website at www.sigma-aldrich.com/tracecert. In addition to our broad catalog offering, we also offer custom standards.

1000 mg/L Single Element Standard Solutions for AAS and ICP

AAS standards are supplied in 250 mL HDPE bottles (with some exceptions). Expiry of these products is usually 3 years. The certificate can be downloaded from the Internet using product number and lot number.

ICP standards are supplied in 100 mL HDPE bottles and sealed in an aluminum bag. We can therefore guarantee for up to 4 years expiry for the ICP standards. The printed certificate is delivered with the product.

Element (1000 mg/L)*	Composition	Cat. No. AAS Standard	Package Size	Cat. No. ICP Standard	Package Size
Aluminum	Al(NO ₃) ₃ x 9H ₂ O + HNO ₃	39435	250 mL	61935	100 mL
Antimony	Sb metal + HNO ₃ (HF traces)	94117	250 mL	73495	100 mL
Arsenic	As ₂ O ₃ + HNO ₃ (+ NaOH for AAS)	39436	250 mL	01969	100 mL
Barium	BaCO ₃ + HNO ₃	90092	250 mL	59943	100 mL
Bismuth	Bi metal + HNO ₃	76668	250 mL	05719	100 mL
Boron	H ₃ BO ₃ + H ₂ O	40591	250 mL	01932	100 mL
Cadmium	Cd metal + HNO ₃	51994	250 mL	36379	100 mL
Calcium	CaCO ₃ + HNO ₃	69349	250 mL	19051	100 mL
Cerium	CeO ₂ + HNO ₃	53378	250 mL	16734	100 mL
Cesium	CsNO ₃ + HNO ₃	67717	250 mL	96664	100 mL
Chromium	(NH ₄) ₂ Cr ₂ O ₇ + HNO ₃	02733	250 mL	68131	100 mL
Cobalt	Co metal + HNO ₃	05202	250 mL	30329	100 mL
Copper	Cu metal + HNO ₃	38996	250 mL	68921	100 mL
Gallium	Ga metal + HNO ₃	52874	100 mL	16639	100 mL
Germanium	Ge metal + HNO ₃ (HF traces)	92685	250 mL	05419	100mL
Gold	Au metal + HCl (HNO ₃ traces)	08269	100 mL	38168	100 mL
Indium	In metal + HNO ₃	42225	100 mL	00734	100 mL
Iron	Fe metal + HNO ₃	16596	250 mL	43149	100 mL
Lead	Pb(NO ₃) ₂ + HNO ₃	16595	250 mL	41318	100 mL
Lithium	Li ₂ CO ₃ + HNO ₃	59916	250 mL	12292	100 mL
Magnesium	Mg metal + HNO ₃	42992	250 mL	30083	100 mL
Manganese	Mn metal + HNO ₃	77036	250 mL	74128	100 mL
Mercury	Hg metal + HNO ₃	16482	100 mL	28941	100 mL
Molybdenum	Mo metal + HCl (HNO ₃ traces)	67210	250 mL	68780	100 mL
Nickel	Ni metal + HNO ₃	42242	250 mL	28944	100 mL
Niobium	Nb metal + HNO ₃ (HF traces)	42887	100 mL	67913	100 mL
Palladium	Pd metal + HCl (HNO ₃ traces)	78437	100 mL	77091	100 mL
Phosphorus	H ₃ PO ₄ + H ₂ O	51474	250 mL	38338	100 mL
Platinum	Pt metal + HCl (HNO ₃ traces)	47037	100 mL	19078	100 mL
Potassium	KNO ₃ + HNO ₃	96665	250 mL	06335	100 mL
Rhodium	RhCl ₃ + HCl	11561	100 mL	04736	100 mL
Rubidium	RbNO ₃ + HNO ₃	55727	100 mL	01444	100 mL
Scandium	Sc ₂ O ₃ + HNO ₃	68418	100 mL	92279	100 mL
Selenium	Se metal + HNO ₃	89498	250 mL	50002	100 mL
Silicon	Si metal + NaOH	16259	250 mL	15747	100 mL

Element (1000 mg/L)*	Composition	Cat. No. AAS Standard	Package Size	Cat. No. ICP Standard	Package Size
Silicon	Si metal + HNO ₃ + HF	--	--	08729	100 mL
Silver	Ag metal + HNO ₃	39361	250 mL	12818	100 mL
Sodium	NaNO ₃ + HNO ₃	05201	250 mL	00462	100 mL
Strontium	Sr(NO ₃) ₂ + HNO ₃	51287	250 mL	75267	100 mL
Sulfur	H ₂ SO ₄ + H ₂ O	18020	250 mL	18021	100 mL
Tellurium	Te metal + HNO ₃	68525	250 mL	07193	100 mL
Thallium	TlNO ₃ + HNO ₃	75159	100 mL	51873	100 mL
Tin	Sn metal + HCl	74244	250 mL	92615	100 mL
Titanium	Ti metal + HNO ₃ (HF traces)	04689	100 mL	12237	100 mL
Uranium*	UO ₂ (NO ₃) ₂ + HNO ₃	-	-	01996	100 mL
Vanadium	V ₂ O ₅ + HNO ₃	02334	250 mL	18399	100 mL
Yttrium	Y ₂ O ₃ + HNO ₃	40423	250 mL	01357	100 mL
Zinc	Zn metal + HNO ₃	18827	250 mL	18562	100 mL
Zirconium	Zr metal + HNO ₃ + HF	73574	250 mL	51244	100 mL

*concentration of the Uranium ICP standard (01996) is 10 mg/L

10,000 mg/L Single Element Standard Solutions for ICP

The most commonly used single element standards are also offered as concentrated solutions at 10,000 mg/L. The 100mL HDPE bottles are sealed in an aluminum bag and the printed certificate is delivered with the product.

Element (10,000 mg/L)	Composition	Cat. No.	Package Size
Zinc	Zn metal + HNO ₃	68961	100 mL
Silicon	Si metal + HNO ₃ + HF	04713	100 mL
Sulfur	H ₂ SO ₄ + H ₂ O	94430	100 mL
Potassium	KNO ₃ + HNO ₃	68371	100 mL
Phosphorous	H ₃ PO ₄ + H ₂ O	19916	100 mL
Nickel	Ni metal + HNO ₃	19013	100 mL
Sodium	NaNO ₃ + HNO ₃	39924	100 mL
Magnesium	Mg metal + HNO ₃	80759	100 mL
Iron	Fe metal + HNO ₃	56209	100 mL
Calcium	CaCO ₃ + HNO ₃	94458	100 mL
Copper	Cu metal + HNO ₃	94459	100 mL
Aluminum	Al(NO ₃) ₃ x 9H ₂ O + HNO ₃	41377	100 mL

Multielement Standards for ICP

We currently offer 4 Multielement Standard Solutions for ICP, also delivered in 100 mL HDPE bottles, sealed in an aluminium bag and the printed certificate is delivered with the product.

Cat. No.	Description and composition	Package Size
90243	Multielement standard solution I for ICP (in 10 % HNO ₃) Ag, Ba, Ca, Cd, Co, Cu, Fe, Mg, Mn, Sr, Zn: 10 mg/L each Al, B, Cr, Li, Mo, Na, Ni, Ti: 50 mg/L each Bi, K, Pb: 100 mg/L each	100 mL
49596	Multielement standard solution III for ICP (in 5 % HNO ₃) K: 200 mg/L Mg: 400 mg/L Na: 1000 mg/L Ca: 2000 mg/L	100 mL
51844	Multielement standard solution IV for ICP (in 10 % HNO ₃) Be, Cd, Co, Mn: 10 mg/L each Cr, Cu, Ni: 20 mg/L each Al, As, Ba, Pb, V: 40 mg/L each B, Fe, Se, Ti, Zn: 100 mg/L each	100 mL
54704	Multielement standard solution V for ICP (in 10 % HNO ₃) Ag, Al, Ba, Be, Bi, Cd, Co, Cr, Cs, Cu, Ga, In, Li, Mg, Mn, Mo, Ni, Pb, Rb, Sr, Ti, V, Zn: 10 mg/L each Ca, Fe, Ca, Na: 100 mg/L each	100 mL

1000 mg/L Single Ion Standards for IC

For ion chromatography (IC) we currently offer 10 anion and 15 cation standard solutions at 1000 mg/L. The products are supplied in 100mL HDPE bottles. As a unique feature for these IC standards we list the most common

trace impurities that are relevant for the IC separation (13 elements for cation standards and 7 inorganic anions for anion standards). The certificates are available on the web using product and lot number.

Anion (1000 mg/L)	Composition	Cat. No.	Package Size
Bromide	NaBr + H ₂ O	43147	100 mL
Chloride	NaCl + H ₂ O	39883	100 mL
Chromate	K ₂ CrO ₄ + H ₂ O	40121	100 mL
Cyanide	K ₂ Zn(CN) ₄ + H ₂ O	90157	100 mL
Fluoride	NaF + H ₂ O	77365	100 mL
Iodide	KI + H ₂ O	41271	100 mL
Nitrate	NaNO ₃ + H ₂ O	74246	100 mL
Nitrite	NaNO ₂ + H ₂ O (NaOH stabilized)	67276	100 mL
Phosphate	Na ₂ HPO ₄ + H ₂ O	38364	100 mL
Sulfate	Na ₂ SO ₄ + H ₂ O	90071	100 mL

Cation (1000 mg/L)	Composition	Cat. No.	Package Size
Ammonium	NH ₄ Cl + H ₂ O	59755	100 mL
Barium	BaCO ₃ + HNO ₃	87142	100 mL
Cadmium	Cd metal + HNO ₃	69679	100 mL
Calcium	CaCO ₃ + HNO ₃	39865	100 mL
Cobalt	Co metal + HNO ₃	49594	100 mL
Copper	Cu metal + HNO ₃	40786	100 mL
Lead	Pb(NO ₃) ₂ + HNO ₃	51777	100 mL
Lithium	Li ₂ CO ₃ + HNO ₃	59878	100 mL
Magnesium	Mg metal + HNO ₃	89441	100 mL
Manganese	Mn metal + HNO ₃	51439	100 mL
Nickel	Ni metal + HNO ₃	42637	100 mL
Potassium	KNO ₃ + H ₂ O	53337	100 mL
Sodium	NaNO ₃ + H ₂ O	43492	100 mL
Strontium	Sr(NO ₃) ₂ + HNO ₃	42151	100 mL
Zinc	Zn metal + HNO ₃	67902	100 mL

Custom Standard Solutions

If you cannot find the standard you need in our portfolio, you can request a quotation for customized standard solutions for AAS, ICP or IC using our new online custom standards platform at www.sigma-aldrich.com/csp

Using the interactive periodic table, it takes only a few mouse clicks to define the matrix, analytes, concentrations and pack size and to send us your enquiry online.



Sensitive trace analysis applications require extremely pure sample preparation reagents. Sigma-Aldrich offers a comprehensive range of reagents to satisfy all purity requirements.

Visit our website to view our products or obtain a copy of our Inorganic Trace Analysis brochure (code LBJ)

sigma-aldrich.com/traceselect

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*Accelerating Customers'
Success through Leadership
in Life Science, High
Technology and Service*