



Certificate of Analysis

Certified Reference Material

LUIS-1

Isotopic Certified Reference Material of Natural Lutetium

LUIS-1 is an isotopic Certified Reference Material (CRM) of natural lutetium. A unit of LUIS-1 contains approximately 1 mL aliquot of lutetium solution at 1000 mg kg⁻¹ in 2 % HNO₃. This material is intended for the calibration of instruments and evaluation of analysis methods for the determination of isotope ratios of lutetium.

Certified values for isotope amount ratio, atomic weight and isotopic composition of lutetium have been established for this isotopic reference material. These are listed in the Table below. Certified values are based on results from data generated at the National Research Council Canada (NRC). The expanded uncertainty (U_{CRM}) in the certified values is equal to $U = k u_c$ where u_c is the combined standard uncertainty calculated according to the JCGM Guide [1,2] and k is the coverage factor. A coverage factor of two (2) was applied. It is intended that U_{CRM} accounts for every aspect that reasonably contributes to the uncertainty of the measurement.

Table 1: Certified quantity values and expanded uncertainties for LUIS-1

Quantity	Value	Expanded uncertainty
Isotope ratio, $n(^{175}\text{Lu})/n(^{176}\text{Lu})$	37.660	0.032
Isotope ratio, $n(^{176}\text{Lu})/n(^{175}\text{Lu})$	0.026 553	0.000 022
Isotopic abundance, $n(^{175}\text{Lu})/n(\text{Lu})$	0.974 134	0.000 022
Isotopic abundance, $n(^{176}\text{Lu})/n(\text{Lu})$	0.025 866	0.000 022
Atomic weight, $A_r(\text{Lu})$	174.966 693	0.000 026

The analytical methods used/developed for the measurement of isotopic composition and the atomic weight of lutetium are documented in the peer-reviewed literature [3].

Certified values

Certified values are considered to be those for which the NRC has the highest confidence in accuracy, and that all known and suspected sources of bias have been taken into account and are reflected in the stated expanded uncertainties. Certified values are the best estimate of the true value and uncertainty (Table 1).

Isotopic composition of lutetium was determined by multicollector ICP-MS at the NRC. The calibration approach chosen here is based on a complete understanding of the measurement process as described elsewhere [3]. According to this strategy, the mass-bias corrected isotope ratios of lutetium are obtained from the log-linear drifts in the measured lutetium and rhenium

isotope ratios. This model avoids the unnecessary assumption regarding the equality of Lu and Re instrumental isotopic fractionation, and is able to correct both mass-dependent and mass-independent biases [4].

Intended use

This certified reference material is intended for the calibration of instruments and evaluation of analysis methods for the determination of isotope ratios of lutetium.

Storage

It is recommended that the material be stored at room temperature and the vials opened immediately prior to use.

Preparation of material

The reference material was prepared from a commercial lutetium standard solution of 10 000 mg kg⁻¹ in 5 % HNO₃. The material was diluted 10-fold in 2 % HNO₃, bottled and flame sealed in cleaned amber glass ampoules containing approximately 1 mL aliquots at 1000 mg kg⁻¹ mass fraction of lutetium.

Stability

Potential instabilities due to long-term storage and transport were considered, and such effects deemed to be negligible on the isotopic composition. The material is deemed stable with respect to the certified values for ten years.

Homogeneity

The material is deemed to be homogeneous with respect to the isotopic composition of lutetium.

Uncertainty

Included in the combined uncertainty estimate are uncertainties in the batch characterization, uncertainties related to the regression model, and uncertainties due to primary calibration standard, NIST SRM 989. The primary calibration standard constitutes 14 % of the combined uncertainty of the $A_r(\text{Lu})$ and $n(^{176}\text{Lu})/n(^{175}\text{Lu})$ values.

Metrological traceability

Results presented in this certificate are traceable to the SI through NIST SRM 989 rhenium isotopic standard [5, 6]. As such, LUIS-1 serves as a suitable reference material for laboratory quality assurance programs, as outlined in ISO/IEC 17025.

Quality Management System (ISO 17034, ISO/IEC 17025)

This material was produced in compliance with the NRC Metrology Quality Management System, which conforms to the requirements of ISO 17034 and ISO/IEC 17025. The Metrology Quality Management System supporting NRC Calibration and Measurement Capabilities, as listed in the *Bureau international des poids et mesures* (BIPM) Key Comparison Database (kcdb.bipm.org/), has been reviewed and approved under the authority of the Inter-American Metrology System (SIM) and found to be in compliance with the expectations of the *Comité*

international des poids et mesures (CIPM) Mutual Recognition Arrangement. The SIM approval is available upon request.

Updates

Users should ensure that the certificate they have is current. Our website at www.nrc.gc.ca/crm will contain any new information.

References

1. Evaluation of measurement data: Guide to the expression of uncertainty in measurement, JCGM 100:2008.
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3. J. He, J. Meija, X. Hou, C. Zheng, Z. Mester, L. Yang (2020) Determination of the isotopic composition of Lutetium using MC-ICPMS. *Anal. Bioanal. Chem.* doi: 10.1007/s00216-019-02271-6.
4. L. Yang, S. Tong, L. Zhou, Z. Hu, Z. Mester, J. Meija (2018) A critical review on isotopic fractionation correction methods for accurate isotope amount ratio measurements by MC-ICP-MS. *J. Anal. At. Spectrom.* 33: 1849-1861.
5. J.W. Gramlich, T.J. Murphy, E.L. Garner, W.R. Shields (1973) Absolute Isotopic Abundance Ratio and Atomic Weight of a Reference Sample of Rhenium. *J. Res. Natl. Bur. Stand., Sect. A 77A*: 691–698.
6. NIST SRM 989: Assay-Isotopic Standard for Rhenium, 19 Feb 1974.

Cited by

A list of scientific publications citing LUIS-1 can be found at doi.org/10.4224/crm.2020.luis-1.

Authorship

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Acknowledgments

We thank Dr. Robert D. Vocke, Jr. from the National Institute of Standards and Technology (Gaithersburg MD, USA) for the courtesy of NIST SRM 989 isotopic standard of rhenium. The contribution of Ovi Mihai (NRC) is acknowledged.

Citation

Yang L, He J, Grinberg P, Mester Z, and Meija J. LUIS-1: Isotopic Certified Reference Material of Natural Lutetium. Ottawa: National Research Council Canada; 2020.

Available from: doi.org/10.4224/crm.2020.luis-1.

LUIS-1

Date of issue: March 2020

Date of expiry: March 2030

Approved by:



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This Certificate is only valid if the corresponding material was obtained directly from the NRC or an Authorized Reseller.

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