IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Reference Material for $\delta^{13}C$ and $\delta^{2}H$

REFERENCE SHEET

NBS22

NIST name: RM 8539

Mineral Oil

Reference value of $\delta^{13}C_{VPDB}$ and $\delta^{2}H_{VSMOW\text{-}SLAP}$ of NBS22 expressed in per mille (‰) on the VPDB and VSMOW-SLAP scale and their associated combined standard uncertainty (k=1).

Stable isotope ratio	Reference value	Combined standard uncertainty with k=1
$\delta^{13}C_{VPDB}$ (‰)	-30.03[(a)]	0.04[(a)]
$\delta^{2}H_{VSMOW\text{-}SLAP}$ (‰)	-117.2[(b)]	0.6[(b)]

[(a)] Values are calculated from the data sets, each being obtained by 4 different laboratories [1]. The uncertainty is expressed as combined uncertainty using a coverage factor k = 1.

[(b)] Recommended values are calculated from the data sets, each being obtained by 8 different laboratories [2]. The uncertainty is expressed as combined uncertainty using a coverage factor k = 1.

Origin and preparation of the material

NBS22 (mineral oil) was prepared by S. Silverman at the University of California, San Diego, USA and comes from Chevron Oil Company, La Habra, California [3].

Homogeneity of the material

Data from the inter-laboratory comparisons [1, 2, 4] suggest that there is no evidence of carbon or hydrogen isotopic heterogeneity.

Characterization study

The characterisation for $\delta^{13}C$ value started in 1983 [5, 6] and continued in 1987 [7] and in 2003 [4]. The current characterisation was performed in 2004 by a group of 4 experienced laboratories together with assessment and re-calibration of most of the other organic carbon stable isotope reference materials available at IAEA and published in 2006 [1]. The value has been confirmed in 2016 [2] and at IAEA in 2022.

The characterisation for $\delta^{2}H$ value started in 1983 [6] and continued in 1987 [7] and in 2010 [8]. The current characterisation has been performed in 2016 [2] by a group of 8 experienced laboratories together with assessment and re-calibration of other 21 organic reference materials. Data have been normalised against organic and water reference materials, sealed in silver tubes to guarantee the principle of identical treatment.

Assignment of values

The $\delta^{13}C$ and the $\delta^{2}H$ values has been determined using the Bayesian method and the uncertainty combines type A and B uncertainties.

The details concerning the reported results may be found in references [1, 2].

The $\delta^{13}C$ value is the value accepted by the Commission on Isotopic Abundances and Atomic Weights of the International Union of Pure and Applied Chemistry (IUPAC) in 2014 [9]. The $\delta^{2}H$ value derives from the characterisation study published in 2016 [2] and agreed with NIST and USGS, as of the date of this report. The combined uncertainty in USGS report refers to NBS22 sealed in a silver tube and it has been increased by 0.1 ‰ to account for hydrogen blank.

Statement on metrological traceability and uncertainty of assigned values

The assigned value for $\delta^{13}C$ and associated uncertainty are traceable to the VPDB $\delta^{13}C$ scale normalised by assigning consensus vales of –46.6‰ to LSVEC and +1.95‰ to NBS 19 (VPDB-scale as recommended in 2006 introduced scale normalization [1]).

The $\delta^{2}H$ value and associated uncertainty are traceable to the VSMOW-SLAP $\delta^{2}H$ scale, where SLAP2 has a consensus value of –427.5‰, respectively and VSMOW2 has a value of 0‰ [2].

Absolute isotopic abundances

No absolute isotope abundance ratio determination was performed on this material.

Intended use

NBS22 is a secondary reference material. Its intended use is as calibrant when $\delta^{13}C$ and $\delta^{2}H$ are determined in organic materials using IRMS (Isotope Ratio Mass Spectrometry) coupled with an EA (Elemental Analyser) and Pyrolizer, for obtaining traceability of the data to the VPDB $\delta^{13}C$ scale and VSMOW-SLAP $\delta^{2}H$ scale, respectively.

Instructions for use, handling and storage

NBS22 is issued in units of 1 ml.

It is recommended that it is stored in a dry and cool place protected from light in the tightly closed container in which it was supplied to the user.

Upon opening and taking a portion for the analysis, the container must be rapidly and tightly closed.

The recommended minimum sample size to be used is 0.1 mg [2, 4, 8].

Limit of distribution

Only one unit per year per laboratory may be ordered. This strategy should ensure that material is available for international use for as long as possible.

Issue and expiry date

The issue date of NBS22 was 9/1/1983. The current characterization for $\delta^{13}C$ has been published in 2006 [1], whereas the characterisation for $\delta^{2}H$ has been published in 2016 [2]. The issue date of this reference sheet is provided in the footer of this document.

The assigned $\delta^{13}C$ value was confirmed in 2016 [2] and in 2022. Based on this, the expiry date is 18/09/2032, provided the original packages are handled and stored in accordance with the instructions given in this reference sheet (see “Instructions for use, handling and storage”).

IAEA is monitoring the long-term stability of the material and customers will be informed in case of any observed change.

A revision of the realization scheme of the $\delta^{13}C$ scale is under evaluation. If approved, the assigned $\delta^{13}C$ value will be reassessed and the reference sheet will be revised accordingly.

Legal disclaimer

The IAEA makes no warranties, expressed or implied, with respect to the data contained in this reference sheet and shall not be liable for any damage that may result from the use of such data.

Compliance with ISO Guide 31:2015

The content of this IAEA Reference Sheet is in compliance with ISO Guide 31:2015, Reference materials – Contents of certificates, labels and accompanying documentation [10].

Citation of this reference sheet

It is suggested to cite this reference sheet according to the following example, as appropriate to the citation format used: INTERNATIONAL ATOMIC ENERGY AGENCY, Reference

Sheet for NBS22, IAEA, Vienna, 5 pp. (The latest version published applies, see “Note” below).

Note

Reference values as stated in this reference sheet may be updated if more information becomes available. Users of this material should ensure that the reference sheet in their possession is current. The current version can be found in the IAEA’s Reference Materials online catalogue:

https://nucleus.iaea.org/sites/ReferenceMaterials/Pages/Stable-Isotopes.aspx

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Revision information

NBS 22, IAEA-CH-3, IAEA-CH-6, IAEA-CH-7, USGS24 reference sheet issue date: 3 August 2007. Rev 1: split into individual reference sheets per material, here for NBS 22, 2022-09-19. The assigned value and uncertainty for δ^2H have been updated according to [2].

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The project officer is responsible for the content of this reference sheet.
The Chair of the RM Certification Committee approves this reference sheet and authorizes its release on behalf of the Committee.