



# National Institute of Standards & Technology

## Certificate of Analysis

### Standard Reference Material<sup>®</sup> 2235

#### Bismuth for Thermal Analysis

This Standard Reference Material (SRM) is intended for use in calibrating differential scanning calorimeters, differential thermal analyzers, and similar instruments. A unit of SRM 2235 consists of 1.5 g of high purity bismuth in the form of shot with diameters of about 1 mm.

**Certified Values:** The certified value for the enthalpy of fusion and the fusion temperature were measured in an adiabatic calorimeter. Complete details of the measurement method are given in reference 1.

Enthalpy of Fusion (J/g)	Fusion Temperature (K)
53.146 ± 0.082	544.556 ± 0.005

The certified values were obtained from a set of 24 measurements made with an adiabatic calorimeter in the temperature range of 514 K to 576 K. The methods used for determination of the certified values are given in reference 2. The temperature was determined with platinum resistance thermometry; the thermometer was calibrated at NIST on the International Temperature Scale of 1990. The enthalpy of fusion is traceable to NIST calibrations of volt, time, and resistance. The uncertainties assigned to the certified values of the enthalpy of fusion and the temperature of fusion were calculated as described in reference 2. The uncertainties correspond to an expansion factor of 2 (95 % confidence) [3].

**Expiration of Certification:** The certification of **SRM 2235** is valid, within the measurement uncertainty specified, until **01 August 2025**, provided the SRM is handled and stored in accordance with the instructions given in this certificate (see "Instructions for Handling, Storage, and Use"). The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

**Maintenance of SRM Certification:** NIST will monitor this SRM over the period of its certification. If substantive changes occur which affect the certification before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet or register) will facilitate notification.

Overall direction and coordination of the technical measurements leading to certification were performed by D.G. Archer formerly of the NIST Applied Chemicals and Materials Division.

Support aspects involved with the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

James Fekete, Chief  
Applied Chemicals and Materials Division

Gaithersburg, MD 20899  
Certificate Issue Date: 07 August 2015  
*Certificate Revision History on Last Page*

Robert L. Watters, Jr., Director  
Office of Reference Materials

## INSTRUCTIONS FOR HANDLING, STORAGE, AND USE

**Use:** There are different calibration methods for differential scanning calorimetry and differential thermal analysis. This material can be used with those protocols to calibrate the temperature and enthalpy flux scales of a differential scanning calorimeter.

**Storage and Handling:** The sample was packaged in 10 mL glass bottles and the glass bottles were sealed in aluminized bags, both under argon in a glove-box. Bismuth oxidizes in air; therefore, the sample should be stored under an inert gas (e.g. argon or nitrogen) or in a vacuum desiccator. Bismuth used for a set of measurements for calibration should be discarded after several determinations or if the enthalpy or temperature values begin to drift with subsequent determinations.

## REFERENCES

- [1] Archer, D.G.; Rudtsch, S.; *Enthalpy of Fusion of Indium: A Certified Reference Material for Differential Scanning Calorimetry*; J. Chem. Eng. Data, Vol. 48, pp. 1157–1163 (2003).
- [2] Archer, D.G.; *Enthalpy of Fusion of Bismuth: A Certified Reference Material for Differential Scanning Calorimetry*; J. Chem. Eng. Data, Vol. 49, pp. 1364–1367 (2004).
- [3] JCGM 100:2008; *Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement*; (GUM 1995 with Minor Corrections), Joint Committee for Guides in Metrology (JCGM) (2008); available at [http://www.bipm.org/utls/common/documents/jcgm/JCGM\\_100\\_2008\\_E.pdf](http://www.bipm.org/utls/common/documents/jcgm/JCGM_100_2008_E.pdf) (accessed Aug 2015); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297, U.S. Government Printing Office: Washington, DC (1994); available at <http://www.nist.gov/pml/pubs/index.cfm> (accessed Aug 2015).

**Certificate Revision History:** 07 August 2015 (Change of expiration date; editorial changes); 09 March 2012 (Extension of certification expiration date; editorial revisions); 12 October 2004 (Original certificate date).

*Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 948-3730; e-mail [srminfo@nist.gov](mailto:srminfo@nist.gov); or via the Internet at <http://www.nist.gov/srm>*