National Institute of Standards & Technology

Certificate

Standard Reference Material® 1450d

Thermal Conductivity - Fibrous Glass Board

Serial Number: SAMPLE

This Standard Reference Material (SRM) is intended primarily for use in the measurement of the thermal conductivity or thermal resistance of insulation materials. SRM 1450d is a high-density fibrous glass board certified for bulk density (ρ) and thermal conductivity (λ). The SRM can be used in conjunction with ASTM C177 [1] or ASTM C518 [2]. A unit of SRM 1450d consists of a square panel of fibrous glass and phenolic binder molded into a semi-rigid board. The nominal dimensions of a unit are 611 mm × 611 mm × 26 mm, and the bulk density of the material lot ranges from 114 kg • m^{-3} to 124 kg • m^{-3}.

Certified Values and Uncertainties: The certified values of ρ (kg • m^{-3}) and λ (W • m^{-1} • K^{-1}), and their associated relative expanded uncertainties ($k = 2$) for this unit are

$$\rho = \text{SAMPLE} \pm 1.2\ \%\ (k = 2)$$

$$\lambda = (1.10489 \times 10^{-4}) \times T \pm 1.0\ \%\ (k = 2)$$

where T is the mean specimen temperature (K) valid from 280 K to 340 K.

Expiration of Certification: The certification of **SRM 1450d** is valid indefinitely, within the uncertainty specified, provided the SRM is handled and stored in accordance with instructions given in this certificate (see "Instructions for Handling, Storage, and Use"). Accordingly, periodic recalibration or recertification of this SRM is not required. 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 technical changes occur that affect the certification, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

The overall direction and coordination of the technical measurements leading to the certification of this SRM were performed by R.R. Zarr, A.C. Harris, and J.F. Roller of the NIST Energy and Environment Division.

Statistical analysis was provided by S.D. Leigh of the NIST Statistical Engineering Division.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Measurement Services Division.

A. Hunter Fanney, Chief
Energy and Environment Division

Gaithersburg, MD 20899
Certificate Issue Date: 20 January 2012
Certificate Revision History on Last Page

Robert L. Watters, Jr., Chief
Measurement Services Division

INSTRUCTIONS FOR HANDLING, STORAGE, AND USE

Stacking: Certified values of thermal conductivity are valid for a single unit, and are invalid for stacked units.

Slicing: Certified values of thermal conductivity are invalid for a unit where the thickness of the material has been modified by slicing.

Cutting: It is possible to cut the SRM unit into smaller pieces. It is imperative to verify that bulk density of each piece is within the certified range of bulk density (114 kg • m^{-3} to 124 kg • m^{-3}).

Upper Temperature Limit: The decomposition point of the binder is approximately 473 K (200 °C). As a precaution, this SRM should not be heated above 380 K (107 °C). It should be noted that oven drying, as opposed to desiccant drying, can remove other volatiles and potentially affect chemical or physical properties of the material.

Lower Temperature Limit: A lower temperature limit for SRM 1450d has not been established.

Use: The SRM unit should not be compressed more than 10 % of original thickness. The unit should be stored in the original packaging for identification purposes in a clean dry environment at temperatures between 15 °C and 30 °C. Prior to the thermal conductivity measurement, the SRM should be maintained in laboratory conditions of 20 °C to 25 °C and from 40 % relative humidity (RH) to 65 % RH until the mass of the unit is stable (i.e., two successive measurements within 24 h differ by less than 1 %). Thermal conductivity measurements should be conducted in accordance with the appropriate ASTM Test Method C177 [1], C518 [2], or other similar international standard.

SOURCE, PREPARATION, AND ANALYSIS [(1)]

Source: SRM 1450d is a commercial insulation product supplied by Quiet Core, Incorporated.

Sample Selection: Test specimens for characterizing the steady-state thermal transmission properties of SRM 1450d were selected based on a randomized full factorial experimental design that required 30 test specimens (15 pairs) covering three nominal levels of density. The breakdown consisted of five pairs having a relatively low bulk density, five pairs near the mean bulk density, and five pairs having a relatively high bulk density.

Measurement Technique: Thermal conductivity measurements were made on the NIST 1016 mm line-heat-source guarded-hot-plate apparatus [3] in accordance with ASTM Test Method C177 [1]. Following a randomized full factorial design, the thermal conductivity (W • m^{-1} • K^{-1}) was determined for three levels of bulk density ranging from 114 kg • m^{-3} to 124 kg • m^{-3} and five levels of mean temperature (280 K, 295 K, 310 K, 325 K, and 340 K). A temperature difference of 25 K was maintained across the thickness of the test specimens. A model, linear in mean temperature (in kelvin), was fit from the experimental data by least squares regression.

$$\lambda = \left(1.10489 \times 10^{-4}\right) \times T$$

The last digit of the coefficient is provided to reduce rounding errors. The residual standard deviation of the fit was 0.00012 W • m^{-1} • K^{-1}.

Measurement Uncertainty: Measurement uncertainties for SRM 1450d are discussed in reference 3. The uncertainties in the certified values of thermal conductivity were calculated according to the ISO Guide [4]. These uncertainties apply only to this lot of fibrous glass board and can be expressed as an expanded uncertainty $U = ku_c$ with U determined from a combined standard uncertainty u_c and a coverage factor of $k = 2$. The determination of u_c and the interpretation of the expanded uncertainties are discussed in reference 4. The expanded uncertainties of the certified thermal conductivity values are not expected to exceed 1 %. This estimate is based on the budget for the measurement uncertainties.

Supplemental Information: For unit conversions to non-SI units, the user should consult NIST Special Publication 811 [5].

[(1)] Certain commercial equipment, instruments or materials are identified in this certificate to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

REFERENCES

[1] ASTM C177-10, *Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus*; Annual Book of ASTM Standards, Vol. 04.06, West Conshohocken, PA (2010).

[2] ASTM C518-10, *Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*; Annual Book of ASTM Standards, Vol. 04.06, West Conshohocken, PA (2010).

[3] Zarr, R.R.; Harris, A.C.; Roller, J.F.; Leigh, S.D.; *SRM 1450d, Fibrous-Glass Board, for Thermal Conductivity from 280 K to 340 K*; NIST Special Publication 260-173; U.S. Government Printing Office: Washington, DC; available at http://www.nist.gov/srm/publications.cfm (accessed Jan 2012).

[4] JCGM 100:2008; *Guide to the Expression of Uncertainty in Measurement*; (ISO GUM 1995 with Minor Corrections), Joint Committee for Guides in Metrology (JCGM) (2008); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Jan 2012); 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 Jan 2012).

[5] Thompson, A.; Taylor, B.N.; *Guide for the Use of the International System of Units (SI)*; NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (2008); available at http://www.nist.gov/pml/pubs/index.cfm (accessed Jan 2012).

Certificate Revision History: **20 January 2012** (Bulk density expanded uncertainty corrected; Editorial changes); **11 July 2011** (Original certificate date).

Users of this SRM should ensure that the Certificate in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.