National Institute of Standards & Technology

Certificate

Standard Reference Material® 1453

Thermal Conductivity – Expanded Polystyrene Board

This Standard Reference Material (SRM) is intended primarily for use in the measurement of the thermal conductivity or thermal resistance of insulation materials. SRM 1453 is a high-density expanded polystyrene board certified for thermal conductivity (λ). The SRM can be used in conjunction with ASTM C177 [1], ASTM C518 [2], or ASTM C1199 [3]. A unit of SRM 1453 consists of a molded, rectangular panel of expanded polystyrene board. The nominal dimensions of the board are 930 mm × 660 mm × 13.4 mm, and the bulk density of the material ranges from 37 $kg \cdot m^{-3}$ to 46 $kg \cdot m^{-3}$.

Certified Thermal Conductivity (λ) Values: The certified λ ($W \cdot m^{-1} \cdot K^{-1}$) values and their associated relative expanded uncertainties ($k = 2$) for this unit are

$$\lambda = 0.001\ 11 - 0.000\ 042\ 4 \times \rho + 0.000\ 115 \times T \pm 1.5\ \%$$

where ρ is the bulk density ($kg \cdot m^{-3}$) valid from 37 $kg \cdot m^{-3}$ to 46 $kg \cdot m^{-3}$ and T is the mean specimen temperature (K) valid from 281 K to 313 K. The determination of the certified equation is discussed in reference 4.

Measurement Uncertainty: The uncertainties in the certified values apply only to this lot of polystyrene board and can be expressed as an expanded uncertainty $U = ku_c$ with the coverage factor of $k = 2$. The determination of U and its interpretation are discussed in reference 4. The uncertainties in the certified values of thermal conductivity are consistent with the GUM 1995 with minor corrections [5].

Expiration of Certification: The certification of SRM 1453 is valid indefinitely, within the measurement uncertainty specified, provided the SRM is handled and stored in accordance with instructions given in this certificate (see "Instructions for Handling, Storage, and Use"). 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 of the NIST Energy and Environment Division.

Statistical analysis was provided by A.L. Pintar of the NIST Statistical Engineering Division.

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

A. Hunter Fanney, Chief
Energy and Environment Division

Gaithersburg, MD 20899
Certificate Issue Date: 26 February 2013
Certificate Revision History on Last Page

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

INSTRUCTIONS FOR HANDLING, STORAGE, AND USE

Stacking: Certified values are not valid for stacked units. Thermal conductivity measurements should be made with single units only.

Slicing: If the thickness of the material is reduced, the certified values are invalid for the sliced section.

Cutting: The material may be cut into smaller sections. The density of the material should be verified to ensure it is within the range of bulk density (37 $kg \cdot m^{-3}$ to 46 $kg \cdot m^{-3}$).

Upper Temperature Limit: The upper temperature limit is limited to the softening point of the polystyrene polymer which is 347 K (74 °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 has not been established.

Drying: It is recommended that a desiccator is used when drying the material. Drying the SRM in an oven can remove other volatiles and potentially affect the chemical or physical properties of the material. If drying the material in an oven, the upper temperature limit shall not be exceeded. The bulk density of the material should be verified to remain within the range of bulk density (37 $kg \cdot m^{-3}$ to 46 $kg \cdot m^{-3}$) after oven drying.

Use: The SRM unit should not be compressed more than 304 kPa. 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 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], C1199 [3], or other similar international standard.

SOURCE, PREPARATION, AND ANALYSIS[(1)]

Source: SRM 1453 is a commercial insulation product supplied by Polyfoam, Incorporated.

Sample Selection: Test specimens were selected from the larger population using stratified random sampling. The strata were defined by partitioning the total range of bulk densities (37 $kg \cdot m^{-3}$ to 46 $kg \cdot m^{-3}$) equally into three levels. Five pairs (10 specimens) were sampled at random from each stratum giving a total of 15 pairs (30 specimens).

Measurement Technique: Thermal conductivity measurements were made on the NIST 1016 mm line-heat-source guarded-hot-plate apparatus [4] in accordance with ASTM Test Method C177 [1]. Following a randomized full factorial design, the thermal conductivity ($W \cdot m^{-1} \cdot K^{-1}$) was determined for three levels of bulk density ranging from 37 $kg \cdot m^{-3}$ to 46 $kg \cdot m^{-3}$ and five levels of mean temperature (281 K, 289 K, 297 K, 305 K, and 313 K).

Supplemental Information: For unit conversions to non-SI units, the user should consult NIST Special Publication 811 [6].

[(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 (2012).

[2] ASTM C518-10, *Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*; Annual Book of ASTM Standards, Vol. 04.06, West Conshohocken, PA (2012).

[3] ASTM C1199-09, *Standard Test Method for Measuring the Steady-State Thermal Transmittance of Fenestration Systems Using Hot Box Methods*; Annual Book of ASTM Standards, Vol. 04.06, West Conshohocken, PA (2012).

[4] Zarr, R.R.; Pintar, A.L.; *SRM 1453, Expanded Polystyrene Board, for Thermal Conductivity from 281 K to 313 K*; NIST Special Publication 260-175; U.S. Government Printing Office: Washington, DC (2012); available at http://dx.doi.org/10.6028/NIST.SP.260-175 (accessed Feb 2013).

[5] 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/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Feb 2013); 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 Feb 2013).

[6] 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/sp811/index.cfm (accessed Feb 2013).

Certificate Revision History: 26 February 2013 (Thermal conductivity and expanded uncertainty corrected; editorial changes); 30 December 1996 (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) 948-3730; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.