



Standard Test Method for Thermal Conductivity of Solids by Means of the Guarded- Comparative-Longitudinal Heat Flow Technique¹

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1. Scope

1.1 This test method describes a steady state technique for the determination of the thermal conductivity, λ , of homogeneous-opaque solids (see Notes 1 and 2). This test method is for materials with effective conductivities in the approximate range $0.2 < \lambda < 200 \text{ W/m}\cdot\text{K}$ over the approximate temperature range between 90 and 1300 K. It can be used outside these ranges with decreased accuracy.

NOTE 1—For purposes of this technique, a system is homogeneous if the apparent thermal conductivity of the specimen, λ_A , does not vary with changes of thickness or cross-sectional area by more than $\pm 5\%$. For composites or heterogeneous systems consisting of slabs or plates bonded together, the specimen should be more than 20 units wide and 20 units thick, respectively, where a unit is the thickness of the thickest slab or plate, so that diameter or length changes of one-half unit will affect the apparent λ_A by less than $\pm 5\%$. For systems that are non-opaque or partially transparent in the infrared, the combined error due to inhomogeneity and photon transmission should be less than $\pm 5\%$. Measurements on highly transparent solids must be accompanied with infrared absorption coefficient information or the results must be reported as apparent thermal conductivity, λ_A .

NOTE 2—This test method may also be used to evaluate the thermal conductance/resistance of materials in contact.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus²
- C 408 Test Method for Thermal Conductivity of Whiteware Ceramics³
- C 1045 Practice for Calculating Thermal Transmission

¹ This test method is under the jurisdiction of ASTM Committee E-37 on Thermal Measurements and is the direct responsibility of Subcommittee E37.05 on Thermophysical Properties.

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² Annual Book of ASTM Standards, Vol 04.06.

³ Annual Book of ASTM Standards, Vol 15.02.

Properties Under Steady-State Conditions²

- D 4351 Test Method for Measuring the Thermal Conductivity of Plastics by the Evaporation-Calorimetric Method⁴
- E 220 Test Method for Calibration of Thermocouples by Comparison Techniques⁵
- E 230 Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples⁵
- F 433 Practice for Evaluating Thermal Conductivity of Gasket Materials⁶

3. Terminology

3.1 Descriptions of Terms and Symbols Specific to This Standard:

3.1.1 Terms:

3.1.1.1 *thermal conductivity*, λ —the time rate of heat flow, under steady conditions, through unit area, per unit temperature gradient in the direction perpendicular to the area;

3.1.1.2 *apparent thermal conductivity*—when other modes of heat transfer through a material are present in addition to conduction, the results of the measurements performed according to this test method will represent the apparent or effective thermal conductivity for the material tested.

3.1.2 Symbols:

$\lambda_M(T)$	= thermal conductivity of meter bars (reference materials) as a function of temperature, (W/m·K),
λ_M^1	= thermal conductivity of top meter bar (W/m·K),
λ_M^2	= thermal conductivity of bottom meter bar (W/m·K),
$\lambda_S(T)$	= thermal conductivity of specimen corrected for heat exchange where necessary, (W/m·K),
$\lambda'_S(T)$	= thermal conductivity of specimen calculated by ignoring heat exchange correction, (W/m·K),
$\lambda_I(T)$	= thermal conductivity of insulation as a function of temperature, (W/m·K),

⁴ Discontinued 1992; Vol 08.03.

⁵ Annual Book of ASTM Standards, Vol 14.03.

⁶ Annual Book of ASTM Standards, Vol 09.02.