Designation: C714 – 23

Standard Guide for Thermal Diffusivity of Carbon and Graphite by Thermal Pulse Method[1]

This standard is issued under the fixed designation C714; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This guide covers the determination of the thermal diffusivity of carbons and graphite at temperatures up to 500 °C. It is applicable only to small easily fabricated specimens. Thermal diffusivity values in the range from 0.04 cm^2/s to 2.0 cm^2/s are readily measurable by this guide; however, for the reason outlined in Section 7, for materials outside this range this guide may not be applicable.

1.2 *Units*—The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C781 Practice for Testing Graphite Materials for Gas-Cooled Nuclear Reactor Components

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D7775 Guide for Measurements on Small Graphite Specimens

E1461 Test Method for Thermal Diffusivity by the Flash Method

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this guide, refer to Terminology D4175.

3.1.2 *thermal conductivity, n*—the rate at which heat passes through a material, expressed as the amount of heat that flows per unit time through a unit area with a temperature gradient of one degree per unit distance.

3.1.3 *thermal diffusivity, n*—a measure of the ability of a material to conduct thermal energy relative to its ability to store thermal energy; it is equal to the thermal conductivity divided by density and specific heat capacity at constant pressure.

4. Summary of Guide

4.1 A high-intensity short-duration thermal pulse from a flash lamp is absorbed on the front surface of a specimen; and the rear surface temperature change as a function of time is recorded. The pulse raises the average temperature of the specimen only a few degrees above its initial value. The ambient temperature of the specimen is controlled by a furnace or cryostat. Thermal diffusivity is calculated from the specimen thickness and the time required for the temperature of the back surface to rise to one half of its maximum value (**1**).[3]

4.2 The critical factors in this guide are:

4.2.1 $\tau/t_{½}$ must be 0.02 or less. τ is the pulse time as defined in Fig. 1 and $t_{½}$ is the time for the rear surface temperature to rise to one half of its maximum value (see Fig. 2).

4.2.2 Heat losses from the specimen via radiation, convection, or conduction to the specimen holder must be small. Whether or not this condition is violated can be determined experimentally from the data output, an example of which is shown in Fig. 2. If $\Delta T(10\ t_{½})/\Delta T(t_{½}) > 1.98$, the heat losses are assumed to be zero.

4.2.3 The measurement must be such that ΔT_{max}, $\Delta T(10t_{½})$, and $t_{½}$ can be determined to ±2 %.

4.2.4 The other conditions are less critical, and the experimenter is left to their discretion.

[1] This guide is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.F0 on Manufactured Carbon and Graphite Products.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The boldface numbers in parentheses refer to the list of references at the end of this guide.

***A Summary of Changes section appears at the end of this standard**

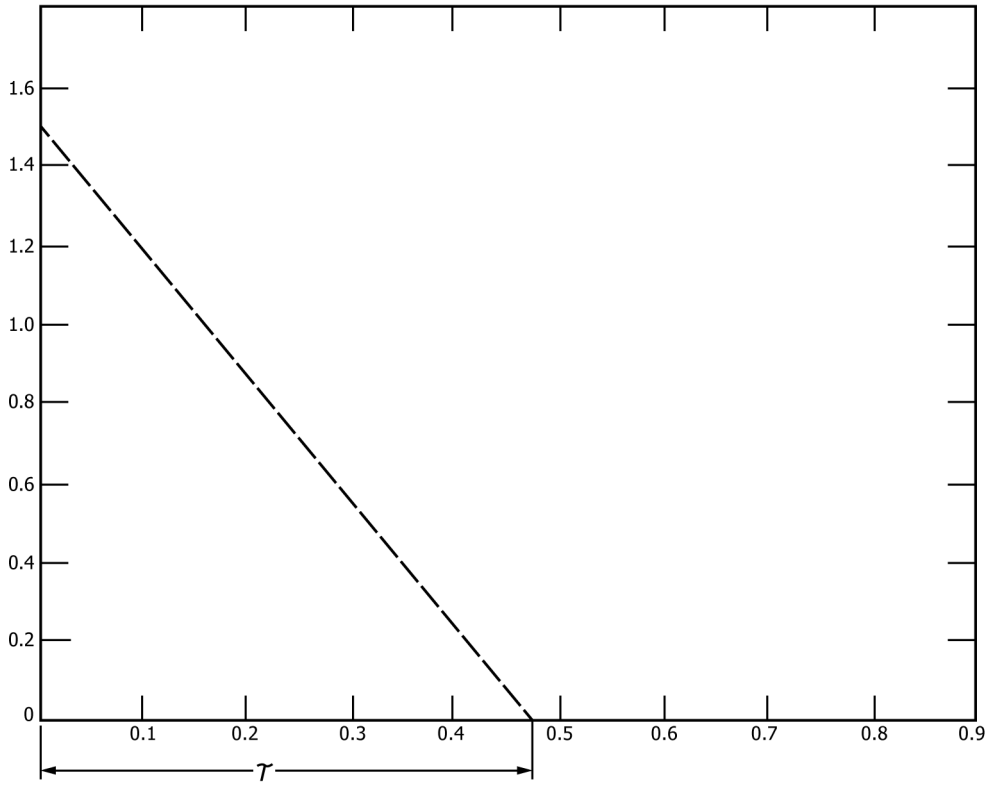

FIG. 1 Flash Source Response

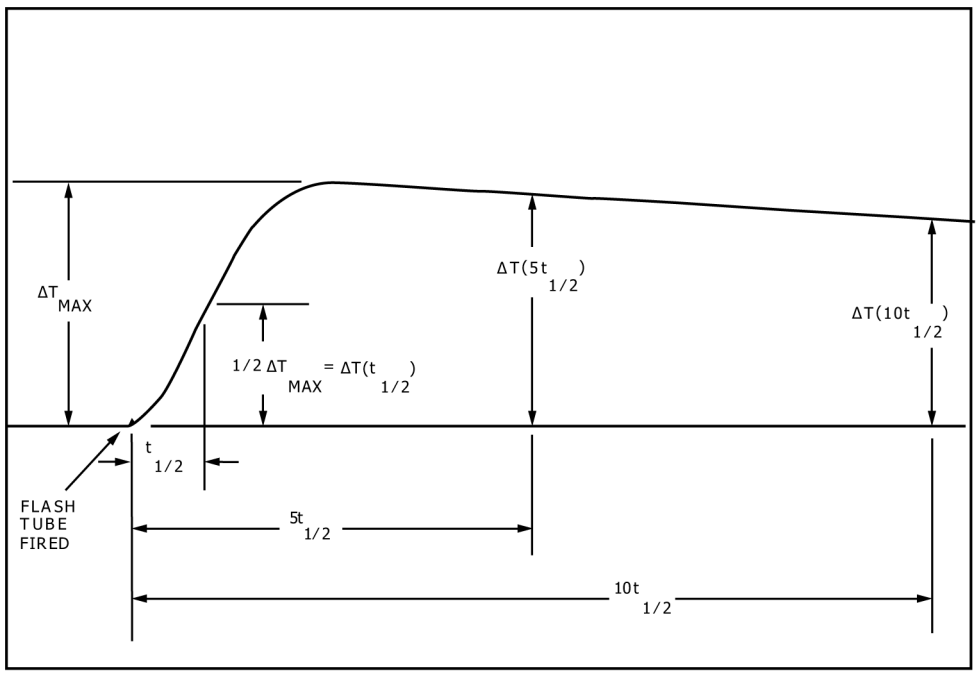

FIG. 2 Example of a Data Output Showing Parameters Used to Calculate Thermal Diffusivity

5. Significance and Use

5.1 Thermal diffusivity is an important property required for such purposes as design applications under transient heat flow conditions, determination of safe operating temperature, process control, and quality assurance.

5.2 The flash method is used to measure values of thermal diffusivity (α) of a wide range of solid materials. It is particularly advantageous because of the simple specimen geometry, small specimen size requirements, rapidity of measurement, and ease of handling materials having a wide