Designation: E289 – 04 (Reapproved 2016)

# Standard Test Method for Linear Thermal Expansion of Rigid Solids with Interferometry[1]

This standard is issued under the fixed designation E289; 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 test method covers the determination of linear thermal expansion of rigid solids using either a Michelson or Fizeau interferometer.

1.2 For this purpose, a rigid solid is defined as a material which, at test temperature and under the stresses imposed by instrumentation, has a negligible creep, insofar as significantly affecting the precision of thermal length change measurements.

1.3 It is recognized that many rigid solids require detailed preconditioning and specific thermal test schedules for correct evaluation of linear thermal expansion behavior for certain material applications. Since a general method of test cannot cover all specific requirements, details of this nature should be discussed in the particular material specifications.

1.4 This test method is applicable to the approximate temperature range −150 to 700°C. The temperature range may be extended depending on the instrumentation and calibration materials used.

1.5 The precision of measurement of this absolute method (better than ±40 nm/(m·K)) is significantly higher than that of comparative methods such as push rod dilatometry (for example, Test Methods D696 and E228) and thermomechanical analysis (for example, Test Method E831) techniques. It is applicable to materials having low and either positive or negative coefficients of expansion (below 5 µm/(m·K)) and where only very limited lengths or thickness of other higher expansion coefficient materials are available.

1.6 Computer or electronic based instrumentation, techniques and data analysis systems equivalent to this test method can be used. Users of the test method are expressly advised that all such instruments or techniques may not be equivalent. It is the responsibility of the user to determine the necessary equivalency prior to use.

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 *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:*[2]

D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer

E220 Test Method for Calibration of Thermocouples By Comparison Techniques

E228 Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer

E473 Terminology Relating to Thermal Analysis and Rheology

E831 Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

E1142 Terminology Relating to Thermophysical Properties

## 3. Terminology

3.1 *Definitions:*

3.1.1 The following terms are applicable to this document and are listed in Terminology E473 and E1142: *coefficient of linear thermal expansion*, *thermodilatometry*, and *thermomechanical analysis*.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *mean coefficient of linear thermal expansion,* $\alpha_m$—the average change in length relative to the length of the specimen accompanying a change in temperature between temperatures $T_1$ and $T_2$, expressed as follows:

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

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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.

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