



Standard Test Method for Linear Thermal Expansion of Porcelain Enamel and Glaze Frits and Fired Ceramic Whiteware Products by the Dilatometer Method¹

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1. Scope

1.1 This test method covers the determination of the linear thermal expansion of premelted frit (porcelain enamel and glaze) and ceramic whiteware products by the thermal dilatometer method. This test method is applicable to apparatus meeting the reproducibility and accuracy requirements of this test method, which are to produce percent linear expansion accuracy of $\pm 3\%$ or better and coefficient of linear expansion accuracy of $\pm 5\%$ or better.

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:

- E 220 Method for Calibration of Thermocouples by Comparison Techniques²
- E 228 Test Method for Linear Thermal Expansion of Solid Materials with a Vitreous Silica Dilatometer³
- E 230 Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples²
- E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method³

3. Terminology

3.1 Definitions:

3.1.1 *mean coefficient of linear thermal expansion*—from temperature T_1 to temperature T_2 ($T_1 < T_2$):

$$\alpha, \text{ mm/mm}\cdot^\circ\text{C or in./in.}\cdot^\circ\text{C} = \frac{0.01 P}{T_2 - T_1}$$

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² *Annual Book of ASTM Standards*, Vol 14.03.

³ *Annual Book of ASTM Standards*, Vol 14.02.

where:

α = mean coefficient of linear thermal expansion from temperature T_1 to T_2 , and

P = percent linear thermal expansion as defined in 3.1.2.

3.1.2 *percent linear thermal expansion*—from temperature T_1 to temperature T_2 ($T_1 < T_2$):

$$P = \frac{L_2 - L_1}{L_0} \times 100 + A$$

$$= \frac{\Delta L}{L_0} \times 100 + A$$

where:

P = percent linear thermal expansion from temperature T_1 to T_2 ,

L_0 = sample length at T_0 (T_0 between 20 and 30°C),

L_1 = sample length at T_1 ,

L_2 = sample length at T_2 , and

A = instrument correction.

4. Significance and Use

4.1 Measurement of thermal expansion is useful for predicting stress within joined materials or single materials under conditions of changing or nonuniform temperature. It can also serve as an indicator of phase composition or changes in structure.

5. Apparatus

5.1 Thermal Dilatometer:

5.1.1 *General Description*—A thermal dilatometer is an apparatus that provides means for varying the temperature of a test specimen in a controlled manner, measuring the specimen length, and measuring the temperature of the specimen for each reading of specimen length. There are several different types as follows:

5.1.1.1 *Manual*—A manual dilatometer is one in which any or all of the above are done by manual means and the corrected percent linear thermal expansion curve is plotted by hand.

5.1.1.2 *Recording*—A recording dilatometer is an apparatus by which the above are recorded by instrumental means but the