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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Linear Thermal Expansion of Porcelain Enamel and Glaze Frits and Ceramic Whiteware Materials by Interferometric Method¹

This standard is issued under the fixed designation C 539; 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 interferometric determination of linear thermal expansion of premelted frits (porcelain enamel and glaze) and fired ceramic whiteware materials at temperatures lower than 1000°C (1830°F).

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 289 Test Method for Linear Thermal Expansion of Rigid Solids with Interferometry²

3. Significance and Use

3.1 This test method defines the thermal expansion of porcelain enamel and glaze frits by the interferometric method. This determination is critical in avoiding crazing (cracking) of these glass coatings due to mismatching of the thermal expansion between the coating and substrate materials.

4. Apparatus

4.1 Sample Preparation Equipment:³

4.1.1 *Glazed Porcelain Crucible*, No. 0.

4.1.2 *Fireclay Crucible*, 102 mm (4 in.) in diameter.

4.1.3 *Rotating Abrasive Grinding Wheel* (a silicon carbide type is satisfactory).

4.2 *Micrometer Calipers*, having a sensitivity such that the

index can be read to 0.002 mm (0.0001 in.).

4.3 *Measuring Apparatus*, consisting of fused silica interferometer plates, viewing apparatus, an electric furnace and control, potentiometer, pyrometer, and a suitable monochromatic light source of known wavelength.

4.3.1 *Furnace*—The furnace shall be a vertical electric tube furnace controlled by rheostat or other means so the heating rate of the furnace can be readily duplicated from room temperature to 1000°C (1830°F). The heating rate shall not exceed 3°C (5.5°F)/min.

4.3.2 *Temperature Measuring Instrument*—A calibrated platinum versus platinum-rhodium thermocouple (or a Chromel versus Alumel thermocouple if it is frequently calibrated) in conjunction with a potentiometer shall be used. The potentiometer shall be capable of being read to 2°C (4°F) and shall have automatic compensation for the temperature of the reference junction, or the reference junction shall be held at 0°C (32°F) by means of an ice bath.

5. Test Specimens

5.1 For frit samples, three test specimens shall be prepared as follows:

5.1.1 Fill a No. 0 glazed porcelain crucible with frit, place the filled crucible inside a 102-mm (4-in.) diameter fireclay crucible partly filled with silica, and work the small crucible down into the silica until approximately 75 % of the small crucible is below the level of the silica.

5.1.2 Place the crucible assembly into a furnace at a temperature high enough to just melt the mass. Hold for 15 min after the frit has reached the furnace temperature.

5.1.3 Remove the crucible, rapidly transfer it to another furnace that is at the frit firing temperature, and cool in the furnace at a rate not to exceed 60°C (110°F)/h.

5.1.4 Break the small crucible open and break up the vitreous mass. Select six fragments from the interior of the mass (to avoid side portions diluted by the ceramic crucible) having minimum conical dimensions of 3 mm ($\frac{1}{8}$ in.) at the base and 6 mm ($\frac{1}{4}$ in.) high.

5.2 For fired samples, break and select six samples having minimum conical dimensions of 3 mm ($\frac{1}{8}$ in.) at the base and 6 mm ($\frac{1}{4}$ in.) in height. For all samples, grind the base of the flat cones and cement the flat cone base to the flat end of a glass

¹ This test method is under the jurisdiction of ASTM Committee B-8 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.12 on Materials for Porcelain Enamel and Ceramic-Metal Systems.

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² *Annual Book of ASTM Standards*, Vol 14.02.

³ An example of suitable test equipment and an interferometric method may be found in the paper by Merritt, G. E., "The Interference Method of Measuring Thermal Expansion," *Journal of Research*, National Institute of Standards and Technology, Vol 10, No. 1, January 1933, p. 59 (RP 515).

A description of a permissible automatic fringe recording device may be found in the paper by Saunders, J. B., "An Apparatus for Photographing Interference Phenomenon," *Journal of Research*, National Institute for Standards and Technology, Vol 35, No. 3, September 1945, p. 157 (RP 1668).