



Designation: F 865 – 84 (Reapproved 1996)

Standard Test Methods for Gross Camber of Ceramic Substrates for Thick Film Applications¹

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1. Scope

1.1 These test methods cover procedures for determining the gross camber of ceramic substrates in a free (nonclamped) state and for appraising the quality of a substrate lot by relating the deviation from flatness of faces due to curvature.

1.2 These test methods are applicable to substrates of sizes ranging up to 4 in. (102 mm) in the maximum dimension.

1.3 In principle, these test methods may be applied to larger dimensioned substrates.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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

2. Referenced Documents

2.1 ASTM Standards:

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specification²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *gross camber*—the ratio of the difference in gross thickness and the average thickness to the longest dimension or diameter of the ceramic substrate specimen multiplied by 100 and expressed in percent.

3.1.2 *lot*—is defined herein as substrates that have the same processing history.

3.1.3 *warpage*—a long-order departure from flatness as opposed to sharp discontinuities. Amplitude is in excess of specified surface finish. In general, warpage will exhibit a number of inflection points that, if connected, would form a line whose path may be open or closed.

4. Summary of Test Methods

4.1 Two procedures are included in these test methods:

¹ This test method is under the jurisdiction of ASTM Committee C-21 on Ceramic Whitewares and Related Products and is the direct responsibility of Subcommittee C21.03 on Fundamental Properties.

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

Method A, for determining the gross camber of an individual substrate and Method B, for appraising the gross camber quality of a substrate lot.

4.1.1 *Method A*—The gross thickness of the substrate, t_g , the distance between two parallel planes that envelop the substrate, is measured with a special gage. The average thickness, t_a , of the substrate is determined from three measurements made along a diagonal. The gross camber is calculated as the ratio of the difference between the gross thickness and the average thickness to the largest dimension of the substrate.

4.1.2 *Method B*—The mode thickness of a sample taken from the lot is determined from measurements of the average thickness of each substrate in the sample. The maximum acceptable gross thickness is calculated from the specified gross camber, the mode thickness, and the largest dimension of the substrate. The gross camber gage is set to this value, and the substrates in the sample are tested to determine whether they will fall freely between the plates of the gage. The percent defective of the lot with respect to the specified gross camber is calculated from the fraction of the substrates in the sample which fail to fall freely between the plates of the gage.

5. Significance and Use

5.1 The warpage of commercially available substrates does not follow a simple pattern that can be easily defined. Excessive warpage can adversely affect the performance of the substrate in thick film processes such as screen printing, bonding of devices, laser trimming, and scribing. It is desirable to have a quantitative appraisal of this physical characteristic of the substrate in the manufacture of thick film or hybrid circuits. Gross camber, as measured by these methods, is a quality that has been found to relate to the performance of the substrate in thick film applications.

5.2 These test methods have been found to be useful in quality control, process control, and other such applications.

6. Apparatus

6.1 *Thickness Standards*, made of dense alumina ceramic with a surface finish of 30 $\mu\text{in.}$ (7.6×10^{-7} m) maximum. The dimensions of these standards shall be 1.00 ± 0.01 in. (25.4 ± 0.25 mm) by 1.00 ± 0.01 in. by the standard thickness in increments of 0.001 in. (0.0254 mm). The thickness shall be held to a tolerance of ± 50 $\mu\text{in.}$ ($\pm 1.27 \times 10^{-6}$ m) and a