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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Flexural Strength (Modulus of Rupture) of Electronic-Grade Ceramics[1]

This standard is issued under the fixed designation F 417; 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 procedures for determining the flexural strength (modulus of rupture) of electronic-grade ceramics, including procedures for specimen preparation.

1.2 This test method is applicable to specimens prepared from ceramic blanks at least 0.080 by 0.080 by 1⅛ in. (2.0 by 2.0 by 28.6 mm).

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

1.4 *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:*

C 623 Test Method for Young's Modulus, Shear Modulus, and Poisson's Ratio for Glass and Glass-Ceramics by Resonance[2]

D 116 Methods of Testing Vitrified Ceramic Materials for Electrical Applications[3]

E 4 Practices for Load Verification of Testing Machines[4]

F 109 Terminology Relating to Surface Imperfections on Ceramics[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *flexural strength, S* [psi(MPa)]—the maximum stress in a mode of flexure that a specimen develops at rupture; normally, the calculated maximum longitudinal tensile stress at mid-point of the specimen test span surface.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *modulus of rupture, MOR* [psi(MPa)]—*for purposes of this method*, synonymous with flexural strength.

3.3 Definitions relating to surface imperfections may be found in Definitions F 109.

4. Summary of Test Method

4.1 The test specimen, a small bar of square cross section, rests on two cylindrical supports in a compression test machine. It is bent by the application of force, at mid-span, to the opposite face of the bar from that resting on the two supports. The bending force is applied by a third cylinder (identical to the other two) at a prescribed constant rate until the specimen breaks. The breaking load, the dimensions of the specimen, and the test span are used to compute flexural strength.

5. Significance and Use

5.1 Ceramic materials are considered to be brittle or perfectly elastic. Fracture normally occurs at the surface under a tensile stress caused by flexure. The stress is termed the modulus of rupture. The modulus of rupture is influenced by variables associated with the procedure used for its measurement, including the rate of application of stress, test environment, and area of the specimen subject to stress, all of which are specified in this method.

5.2 The modulus of rupture affords a convenient basis for comparing the mechanical properties of ceramic materials. It indicates quality and consistency of quality.

5.3 This test method is intended for use by manufacturers and users of brittle ceramics for electronic applications. It provides for the testing of small specimens (commonly designated "microbars") which may be cut from actual ceramic parts. The test may be used for the purpose of specification acceptance by agreement between manufacturer and user, or for manufacturing control, research, and development.

5.4 The techniques described have been routinely used for similar purposes on larger specimens throughout the ceramics industry for many years.

6. Apparatus

6.1 *Testing Machine* capable of providing a uniform stress rate of 200 ± 30 ksi/min (19.5 to 26.4 MPa/s, or 120 to 162 kgf/mm^2·min) as verified in accordance with Practices E 4. The machine shall contain a load- or force-measuring cell with a resolution of 0.2 % of full scale or better on a scale appropriate to the material under test; normally, full scale need not exceed 25 lbf (110 N, or 11 kgf) for typical ceramic materials. The

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[2] *Annual Book of ASTM Standards*, Vol 15.02.

[3] *Annual Book of ASTM Standards*, Vol 10.01.

[4] *Annual Book of ASTM Standards*, Vol 03.01.