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Standard Specification for Impervious Steatite Ceramics for Electrical and Electronic Applications¹

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1. Scope

1.1 This specification covers the requirements for impervious steatite ceramics having low electrical loss characteristics for use in electronic and electrical applications.

1.2 Impervious steatite ceramics described in this specification shall be designated as Type I, Type II, Type III, and Type IV.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 ASTM Standards:

C 20 Test Methods for Apparent Porosity, Water Absorption, Apparent Specific Gravity, and Bulk Density of Burned Refractory Brick and Shapes by Boiling Water²

D 116 Test Methods for Testing Vitrified Ceramic Materials for Electrical Applications³

D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation³

D 2520 Test Methods for Complex Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials at Microwave Frequencies and Temperatures to 1650°C⁴

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials⁵

3. Description of Term Specific to This Standard

3.1 *impervious steatite ceramics*—steatite ceramics showing no perceptible dye penetration when tested in accordance with Method C of Test Methods D 116.

4. Electrical Requirements

4.1 Impervious steatite ceramics shall conform to the electrical requirements specified in Table 1.

5. Dimensional Requirements

5.1 The general dimensional tolerances listed below are to be considered standard for most unground steatite ceramics, particularly those of simple geometry and good symmetry. Tolerances differing from these should be specified on the part drawing. Grinding and other finishing operations permit closer dimensional tolerances.

5.1.1 *Unglazed Surfaces*— $\pm 1\%$, but not less than ± 0.005 in. (0.127 mm).

5.1.2 *Glazed Surfaces*— $\pm 2\%$ but not less than ± 0.012 in. (0.305 mm).

5.1.3 *Angular Dimensions*— $\pm 2^\circ$.

5.1.4 *Parallelism* will be considered satisfactory if the thickness measured at any point is within the dimensional tolerance.

5.1.5 *Ellipticity* for deviation from a true circle, will be considered satisfactory with a value of 1.02 when the wall thickness is 12 %, or more, of the outside diameter. A maximum value of 1.03 will be permitted for a wall thickness of 10 % of the outside diameter (see Annex A1).

5.1.6 *Concentricity*, shall be expressed as a deviation of centers of a cylinder. Normally a total dial indicator reading of 1 % of the outside diameter or 0.010 in. (0.254 mm), whichever is larger, will be permitted where all diameters are either all ground or all unground (see Annex A1).

5.1.7 *Camber*, shall be expressed as the ratio between arc and the maximum length of the part. A maximum camber of 0.006 in./in. (0.152 mm) of length is permitted unless otherwise specified (see Annex A1).

6. Visual Requirements

6.1 Parts shall be uniform in color and texture. Visible defects, such as pits, chips, cracks, and blisters, shall not be permitted to the extent that the life and usefulness of the ceramic is impaired. Normal quality will allow defects up to 0.031 in. (0.8 mm) unless otherwise specified.

7. Handling

7.1 All parts shall be handled, inspected, and packaged in such a manner as to avoid contamination and to prevent contact

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² *Annual Book of ASTM Standards*, Vol 15.01.

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

⁴ *Annual Book of ASTM Standards*, Vol 10.02.

⁵ *Annual Book of ASTM Standards*, Vol 03.01.

TABLE 1 Electrical Requirements

	Type I	Type II	Type III	Type IV	ASTM Test Method
Dielectric strength ¼ in. (6.35 mm) thick, min, V/mil kV/mm	220 8.7	230 9.1	230 9.1	230 9.1	D 116
Volume resistivity, min, Ω·cm:					
at 25°C	10 ¹⁴	10 ¹⁴	10 ¹⁴	10 ¹⁴	D 116
at 100°C	1 × 10 ¹²	1 × 10 ¹³	5 × 10 ¹³	5 × 10 ¹³	
at 300°C	1 × 10 ⁷	1 × 10 ¹⁰	5 × 10 ¹⁰	5 × 10 ¹⁰	
at 500°C	1 × 10 ⁵	5 × 10 ⁷	1 × 10 ⁸	1 × 10 ⁹	
at 700°C	1 × 10 ⁴	1 × 10 ⁶	1 × 10 ⁶	1 × 10 ⁷	
at 900°C	1 × 10 ³	1 × 10 ⁵	1 × 10 ⁵	1 × 10 ⁶	
Relative permittivity at 25°C, max:					
at 1 MHz	6.0	6.0	6.2	6.5	D 150
at 4 GHz	5.8	5.8	6.0	6.3	D 2520
at 8.5 to 10 GHz	5.7	5.7	5.9	6.2	D 2520
Loss index at 25°C, max:					
at 1 MHz	0.035	0.016	0.008	0.004	D 150
at 4 GHz	0.038	0.018	0.015	0.007	D 2520
at 8.5 to 10 GHz	0.040	0.025	0.020	0.008	D 2520

with contaminants, particularly metals.

9. Keywords

9.1 camber; ceramic; concentricity; electrical insulation; electronic insulation; ellipticity; impervious steatite ceramics; steatite

8. Physical Requirements

8.1 Impervious steatite ceramics shall conform to the physical requirements specified in Table 2.

TABLE 2 Physical Requirements

	Type I	Type II	Type III	Type IV	ASTM Test Method
Specific gravity, min	2.5	2.6	2.7	2.7	C 20
Flexural strength (modulus of rupture), min, avg:					
psi	18 000	18 000	20 000	20 000	D 116
MPa	125	125	140	140	D 116
Dye penetration	none	none	none	none	D 116
Thermal expansion, 25 to 700°C, cm/cm·°C × 10 ⁻⁶	7 to 10	7 to 10	7 to 10	7 to 10	D 116
Hardness, Rockwell 45 N	45	45	50	50	E 18
Impact strength, min, in.-lbf	4.0	4.5	5.0	5.5	D 116

ANNEX

(Mandatory Information)

A1. DIMENSIONAL CHARACTERISTICS

A1.1 *Ellipticity*, shall be determined by dividing the maximum diameter by the minimum diameter measured in the same planes, perpendicular to the axis.

A1.2 *Concentricity*, expressed as a displacement of centers, describes the relationship of one diameter to another, both of which are on a common axis. This may be a comparison of an inside diameter to an outside diameter on a cylinder, or a part having numerous outside diameters of different dimensions. A part, such as those described above, must be mounted on centers or tapered arbors and revolved on the axis. After this is accomplished, a dial indicator and stand are mounted above the part and at right angles to the axis. Each diameter is then measured for the total variation around the circumference and

is expressed as concentricity or TIR (Total Indicator Reading). Care should be taken to not include any ellipticity or camber in these measurements.

A1.3 *Camber*, appears in a length of material which may have a variety of cross sections, for example, rectangular, circular, square, and so forth. This characteristic can be measured by mounting the parts between centers and locating a dial indicator similar to the method described for concentricity measurements. The arc height is the difference between the maximum distance measured from the zero point at the centers, minus one half the diameter or cross-sectional thickness of the part. Again, care should be exercised so that ellipticity is not included in this measurement.