Designation: D 748 – 00 (Reapproved 2005)

An American National Standard

Standard Specification for Natural Block Mica and Mica Films Suitable for Use in Fixed Mica-Dielectric Capacitors[1]

This standard is issued under the fixed designation D 748; 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 specification covers natural block mica[2] and mica films (cut and uncut) suitable for use in the manufacture of fixed mica-dielectric capacitors, based on electrical, visual, and physical properties as determined by tests specified herein.

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

2. Referenced Documents

2.1 *ASTM Standards:* [3]

D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D 351 Classification for Natural Muscovite Block Mica and Thins Based on Visual Quality

D 1082 Test Method for Dissipation Factor and Permittivity (Dielectric Constant) of Mica

3. Terminology

3.1 For definitions pertaining to this specification see Classification D 351.

4. Significance and Use

4.1 The properties included in this specification are those required to identify the types of natural block mica and mica films (cut and uncut) suitable for use in the manufacture of fixed mica-dielectric capacitors. There may be other requirements necessary to identify particular characteristics. These will be added to the specification as their inclusion becomes generally desirable, and the necessary test data and methods become available. Natural block mica and mica films that do not conform to the requirements of this specification for capacitor use may well be capable of meeting the requirements for other critical electrical insulation purposes.

4.2 The system of classifying electrical quality of natural block and mica films (cut and uncut) covered by this specification is based on a combination of electrical and physical properties, and visual qualities specified herein, which the mica must possess. This system differs radically from past practices and previous concepts of mica quality for capacitor use. The electrical classification system does not discriminate against the presence of spots and stains in even first quality electrically selected mica, provided the mica conforms to specific and physical requirements. Appreciable amounts of air inclusions and waviness also are permitted in all electrical quality classes, provided the mica meets specific electrical and physical requirements. Mica meeting these requirements is acceptable without regard to color or origin. However, mica meeting these electrical and physical requirements but having lower visual quality than that meeting the requirements for the visual quality classification is not considered generally as desirable.

4.3 In capacitor fabrication, one or more pieces of cut film or block mica having lower than required electrical and physical properties may prevent meeting the end requirements of the capacitor. It is therefore required that each piece of block (cut) or film (cut or uncut), or both, be tested for the electrical requirements and inspected for the visual requirements listed in this specification.

5. Forms

5.1 This specification covers the following three forms of natural mica, suitable for use in the manufacture of mica-dielectric capacitors:

5.1.1 *Form 1*—Full-knife trimmed natural block mica 0.007 to 0.035 in. (0.18 to 0.89 mm) in thickness.

NOTE 1—A certain percentage of block mica thinner than 0.007 in. may be accepted under this specification, upon agreement between the purchaser and the manufacturer.

5.1.2 *Form 2*—Half-knife trimmed natural block mica 0.007 to 0.035 in. in thickness.

[1] This specification is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.19 on Dielectric Sheet and Roll Products.

Current edition approved Sept. 10, 2000. Published November 2000. Originally approved in 1943. Last previous edition approved in 1994 as D 748 – 71 (1994)$^{\epsilon 1}$.

[2] Coutlee, K. G., "Electrical Quality Classification of Raw Mica by a Rapid, Direct-Reading Test Method," *Proceedings*, *ASTM*, Vol 46, 1946, p. 1486.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

5.1.3 *Form 3*—Films (cut or uncut) split or manufactured from natural block mica in any range from 0.0008 up to and including 0.006 in. (0.020 to 0.15 mm).

6. Grades (Sizes)

6.1 For grades see Classification D 351.

7. Classes

7.1 This specification covers the following four classes and subdivisions of natural block mica or mica films. The class of mica desired shall be specified by the purchaser. Block mica or mica films shall conform to all of the requirements of its respective class, unless otherwise specified by the purchaser.

7.1.1 *Class C-1 Special*—Class C-1 special mica films, in addition to having the highest *Q* obtainable for mica in the megacycle range also have the highest *Q* generally obtainable for mica in the audio frequency range (1000 min at 1 kHz). Such mica therefore is particularly suitable for capacitors which must meet highest *Q* requirements at both high and low frequencies.

7.1.2 *Class C-1*—Class C-1 block mica or mica films have the highest *Q* value obtainable for mica (2500 min at 1 MHz in capacitors) and is suitable for use in all sizes and types of silver and foil electrode, molded and clamped unit capacitors, including the most critical types, for use in high stability tuned circuits, as well as high current radio frequency capacitors used in radio transmitter circuits.

NOTE 2—Based[4] on commerical experience Class C-1 block mica or mica films are satisfactory for the manufacture of all of these types of mica capacitors. However, it has been found that "medium to heavy" air-stained mica may produce a slightly lower yield of highest stability and high current radio frequency types of capacitors as well as a somewhat lower yield of satisfactory silver electrode mica laminations. Likewise, "medium to heavy" wavy mica may also adversely influence the application of silver electrodes. In addition, there is some possibility that excessive waviness may cause cracked laminations in molded capacitors due to the high molding pressures employed and it may be less suitable from a stacking standpoint. Similarly, some reduction in unit volume capacitance of foil electrode capacitors may result from excessive amounts of either air inclusions or waviness.

7.1.3 *Class C-2*—Class C-2 block mica and mica films have a high order of *Q* value (1500 min at 1 MHz in capacitors) and are suitable for use in all sizes and types of silver and foil electrode molded and clamped unit capacitors similar to those specified for Class C-1 mica. However, a certain percentage of capacitors made with Class C-2 block mica and films may show a somewhat higher temperature rise in transmitter types than capacitors made with Class C-1 block mica or mica films.

7.1.4 *Class C-3*—Class C-3 block mica and mica films have the lowest *Q* value (200 min at 1 MHz in capacitors) of the three classes covered by this specification. Such *Q* value, however, is sufficiently high to permit this mica to be classed as a low-loss insulating material. This mica is particularly suitable for use in foil electrode molded and clamped type capacitors (Note 3) used in less critical circuits for blocking and coupling purposes where high *Q* value, high stability, and low temperature coefficient are not required.

NOTE 3—Experience has shown that silver electrode molded capacitors made with Class C-3 mica which contained slightly conducting spots and stains but contained" very slight" air inclusions and "nearly flat" waves, had temperature coefficient and capacitance stability characteristics just as good as that obtained with capacitors made with the best Class C-1 mica.

8. Electrical and Physical Properties, and Visual Qualities

8.1 Natural block mica and mica films shall conform to the requirements as to electrical and physical properties and visual qualities as prescribed in Table 1. Visual qualities not covered in this specification are permitted provided mica meets the electrical and physical requirements.

9. Test Methods

9.1 The properties enumerated in this specification shall be determined in accordance with the following:

9.2 *Grading According to Size*—Classification D 351.

9.3 *Electrical Conductivity*—See Annex A1.

NOTE 4—For the purpose of this specification, electrical conductivity in spotted and stained areas of block mica is revealed when visible sparking or glowing takes place inside or on the surface of the mica in the vicinity of the test probe and not by actual puncture of the mica by the high-potential current. If actual puncture of the test specimen does take place this indicates the presence of mechanical faults, such as pinholes, tears, or cracks which extend completely through the mica. While this test method had been found suitable for controlling conductivity in spots and stains and dielectric weakness due to mechanical faults in block mica, an even greater factor of safety will be realized if this flash test is applied directly to capacitor films. In this instance the purpose of the test is to detect dielectric weakness due to any cause.

9.4 *Q Value or Dissipation Factor*— Test Method D 1082 at 1 MHz, or by the rapid, direct-reading method described in Appendix X1.

NOTE 5—In cases of dispute arising from borderline cases of *Q* value or dissipation factor and dielectric strength, the test specimens shall be baked for a minimum period of 2 h at a temperature of 121 °C (250 °F), and tested immediately upon cooling to room temperature.

9.5 *Dielectric Strength*—Test Method D 149, using the short-time test with ¼-in. (6.4-mm) diameter electrodes in oil.

9.6 *Weight Loss on Heating*—Preheat the test specimens in an oven at 121 °C (250 °F) for a minimum time of 2 h and then weigh. Then heat the specimens in the oven at 600 °C (1110 °F) for 5 min and reweigh. Calculate the percentage loss in weight after heating based on the weight of the specimen at the end of the 2-h preheating period.

9.7 *Thickness* [*Uniformity* (*Films*)]—Judge splitting quality by the uniformity of thickness of films split from mica by viewing between crossed polaroids.

9.8 *Visual Qualities*—See Classification D 351.

9.8.1 *Air Inclusions*—Reflected daylight or equivalent.

9.8.2 *Waves, Buckles, Ridges, etc.*—Reflected daylight or its equivalent where distortion of parallel and vertical lines of reflected image, such as a window frame, can be judged.

9.8.3 *Cracks, Tears, Pinholes, and Stones*—Determine the presence of such mechanical defects as cracks, tears, pinholes,

[4] Coutlee, K. G., "Judging Mica Quality Electrically," *Transactions*, Am. Inst. Electrical Engrs., Vol 64, 1945.

TABLE 1 Electrical, Physical, and Visual Quality Requirements of Natural Block Mica and Mica Films for Use in Capacitors

		Class C-1	Class C-2	Class C-3
Electrical Properties:				
Conducting paths[A]		none	none	none
Q value or dissipation factor at 1 MHz		E-1[B]	E-2[B]	E-3[B]
Dielectric strength, min	average	1000	1000	1000
V/mil at 60 Hz	single	850	850	850
Dielectric constant		[C]	[C]	[C]
Physical Properties:				
Weight loss on heating (5 min at 600 °C), max %		0.2	0.2	0.2
Thickness uniformity (mica films)[D]		best	best	intermediate
Temperature coefficient of capacitance and retrace			[E]	[E]
Visual Qualities:[F]				
Air inclusions[G]	*A*	very slight[H]	very slight[H]	very slight[H]
	B	slight[I]	slight[F]	slight[I]
	C	medium[J]	medium[J]	medium[J]
Waves[K]	*A*	nearly	nearly	nearly
	B	flatslight	flatslight	flatslight
	C	medium	medium	medium
	D	heavy	heavy	heavy
Cracks		none	none	none
Tears		none	none	none
Pin holes		none	none	none
Stones		none	none	none
Buckles		none	none	none
Ridges		none	none	none

[A] This applies to the conductivity of visible spots and stains only and excludes air stains or air inclusions.

[B] The *Q* values or dissipation factor $Q = \left(\frac{1}{\textit{dissipation factor}}\right)$ of block mica or mica films suitable for use in capacitors shall fall within specified electrical quality groups, based on end-use requirements, designated E-1 Special, E-1, E-2, or E-3. These quality groups shall conform to the *Q* or dissipation factor values prescribed in Table 2 or the corresponding scale readings of the vacuum-tube voltmeter when tested by the rapid, direct-reading method described in Appendix X1.

[C] As the dielectric constant of natural block mica suitable for use in capacitors is fairly uniform, no value is specified.

[D] Until definite values can be specified, the permissible amounts of such defects shall be agreed upon between the purchaser and the manufacturer.

[E] It has been found that the temperature coefficient of capacitance and retrace of capacitors made with Classes C-1, C-2, and C-3 mica are more dependent on such factors as electrical and mechanical design and manufacturing technique than on any differences in the mica itself.

[F] See Classification D 351.

[G] The amount of air inclusions shall not exceed the specified limits for each subclass. The permissible amount of air inclusions shall be stated by suffixing the letter A, B, C, or D as the case may be, to the required electrical quality class.

[H] Few and tiny in one fourth of usable area (must not contain air chains, etc.).

[I] In one half of usable area (must not contain air chains, etc.).

[J] In two thirds of usable areas.

[K] The waviness shall not exceed the specified limits for each subclass. The permissible amount of waves shall be stated by suffixing the letter A, B, C or D, as the case may be, to the letter denoting the amount of permissible air inclusions. For example, Class C-1 B A block mica or mica films denotes:

C-1	B	A
Best electrical quality	slight air inclusion in one half usuable area	nearly flat waves

and stones by the spark coil test as prescribed in Annex A1, or by visual inspection as judged by transmitted daylight or its equivalent.

10. Precision and Bias

10.1 This test method has been in use for many years, but no information has been presented to ASTM upon which to base a statement of precision or bias. No activity has been planned to develop such information.

11. Keywords

11.1 block mica; capacitor; classes; dielectric strength; electrical conductivity; form; grades; mica; mica films; Q value; visual quality; weight loss

TABLE 2 Q and Dissipation Factor Values for Electrical Quality Group E-1 Special, E-1, E-2, and E-3

Electrical Quality Designation	Mica Form	*Q* Requirements,[A]		Rapid Meter Reading: Perpendicular Method[B]			Rapid Meter Reading: Parallel Method[C]
		1 MHz	1 kHz	0.010 in.[D] (0.007 to 0.015 in.) [0.25 mm[D] (0.18 to0.38 mm)]	0.020 in.[D] (0.015 to 0.025 in.) [0.51 mm[D] (0.38 to 0.64 mm)]	0.030 in.[D] (0.025 to 0.035 in.) [0.76 mm (0.64 to0.89 mm)]	0.0008 to 0.004 in.[E] [(0.033 to 0.10 mm)[E]]
E-1 Special	Film	2500 min[F]	1000 min[F]	...	...	...	95 to 100
E-1	Block	2500 min[G]	...	95 to 100	95 to 100	95 to 100	...
	Film	2500 min[F]	500 min[F]	...	...	...	90 to 100
E-2	Block	1500 min[G]	...	87 to 95	77 to 95	71 to 95	...
	Film	1500 min[F]	200 min[F]	...	...	...	71 to 90
E-3	Block	200 min[G]	...	50 to 87	32 to 77	24 to 71	...
	Film	200 min[F]	100 min[F]	...	...	...	24 to 71

[A] Conversion Table follows Footnote[G].
[B] *Method A,* see Appendix X1.
[C] *Method B,* see Appendix X1.
[D] Thickness of block mica specimens (use corresponding meter calibration).
[E] Thickness range of single mica film specimens.
[F] Minimum *Q* values for mica purchased as film. These values apply to minimum *Q* values of individual mica films with fired-on silver, parallel-plate, or mercury electrodes when tested at ≤50 % relative humidity at 1 MHz, and at ≤10 % relative humidity at 1 kHz.
[G] Extensive commercial tests have verified the validity of the 1 MHz *Q* values of molded type, 1000 pF stacked-foil and silvered capacitors made with films from electrically selected E-1, E-2, and E-3 block mica. These will apply when all factors which would adversely influence the *Q* values, such as entrapped moisture, dielectric loss of other insulations used in the capacitor, as well as electrode and contact resistance, are under control.

Q Value	Dissipation Factor (tan δ)
2500	0.00040
1500	0.00067
1000	0.00100
500	0.00200
200	0.00500
100	0.01000

ANNEX

(Mandatory Information)

A1. METHOD OF TEST FOR CONDUCTING PATHS IN MICA

A1.1 *General*—This Appendix contains a description of a method of testing for conducting paths in mica.

A1.2 The tests shall be made in subdued light as follows:

A1.2.1 *Spark Coil*— A spark coil of the vibrator type capable of giving a spark from ⅛ to 1 in. (9.6 to 25.4 mm) in length between needle points. (Ignition-type spark coil is satisfactory.)

A1.2.2 *Current Source*— Six volts direct current.

A1.2.3 *Electrodes*— One electrode consisting of a sharp pointed No. 8 (AWG) bare copper wire, or equivalent, about 4 in. (100 mm) in length mounted on the end of a suitable insulated handle shall be connected to the high-tension side of the spark coil with high-grade automobile ignition wire, or equivalent. The other electrode shall be a sheet of metal of suitable size connected to the grounded side of the spark coil.

A1.3 *Procedure*—With both electrodes connected to the current source, bring the electrodes together within the sparking distance at which point a continuous spark discharge should take place. Insert the mica specimen to be tested on the grounded electrode and bring the pointed electrode to within approximately ¼ in. (6 mm) of the sample surface. A slight bluish brush discharge will be noted. Then carefully explore the stained areas of the sample holding the point approximately ¼ in. above the mica surface. When a conducting area is located, sparks will jump and scatter to it in lightning-like forks.