



Designation: D 3664 – 00

An American National Standard

Standard Specification for Biaxially Oriented Polymeric Resin Film for Capacitors in Electrical Equipment¹

This standard is issued under the fixed designation D 3664; 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 thin biaxially oriented polymeric resin film for use in capacitors for electrical equipment. The material is biaxially oriented to improve the tensile properties in the machine (MD) and transverse (TD) directions.

1.2 The following safety hazards caveat pertains only to the test methods section of this specification. *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.* For specific warning statements see 9.3 and Table 1 footnote B.

1.3 The values stated in SI units are the standard. The values in parentheses are for information only.

NOTE 1—This standard resembles IEC 60674-3-2, Specification for plastic films for electrical use, in title only. The content is significantly different.

2. Referenced Documents

2.1 ASTM Standards:

- D 149 Test Methods for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies²
- D 150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials²
- D 202 Test Methods for Sampling and Testing Untreated Paper Used for Electrical Insulation²
- D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials²
- D 374 Test Methods for Thickness of Solid Electrical Insulation²

- D 543 Test Method for Resistance of Plastics to Chemical Reagents³
- D 570 Test Method for Water Absorption of Plastics³
- D 756 Practice for Determination of Weight and Shape Changes of Plastics Under Accelerated Service Conditions³
- D 774 Test Method for Bursting Strength of Paper⁴
- D 882 Test Methods for Tensile Properties of Thin Plastic Sheetings³
- D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheetings³
- D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheetings or Film at Elevated Temperature³
- D 1434 Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheetings⁴
- D 1435 Practice for Outdoor Weathering of Plastics³
- D 1505 Test Method for Density of Plastics by the Density-Gradient Technique³
- D 2176 Test Method for Folding Endurance of Paper by the M.I.T. Tester⁴
- D 2305 Test Methods for Polymeric Films Used for Electrical Insulation²
- D 2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)⁵
- D 3417 Test Method for Heats of Fusion and Crystallization of Polymers by Thermal Analysis⁵
- D 3420 Test Method for Dynamic Ball Burst (Pendulum) Impact Resistance of Plastic Film⁵
- D 3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials⁶
- D 3755 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials Under Direct-Voltage Stress⁶

¹ This specification is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.07 on Flexible and Rigid Insulating Materials.

Current edition approved Sept. 10, 2000. Published November 2000. Originally published as D 3664-78. Last previous edition D 3664-95.

² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 08.01.

⁴ Annual Book of ASTM Standards, Vol 15.09.

⁵ Annual Book of ASTM Standards, Vol 08.02.

⁶ Annual Book of ASTM Standards, Vol 10.02.

D 3985 Test Method for Oxygen Gas Transmission Rate Through Plastic Film and Sheeting Using a Coulometric Sensor⁴

D 6054 Practice for Conditioning Electrical Insulating Materials for Testing⁶

E 96 Test Methods for Water Vapor Transmission of Materials⁷

E 252 Test Method for Thickness of Thin Foil and Film by Weighing⁸

2.2 IEC Standards:

IEC 60674-3-2 Specification for plastic films for electrical purposes—Part 3: Specifications for individual materials—Sheet 2: Requirements for balanced biaxially oriented polyethylene phthalate (PET) films used for electrical insulation⁹

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *shiner*, n —as related to dielectric films, a protrusion of material beyond the plane of either edge of the roll.

3.1.2 *space factor*, n —as related to dielectric films, a measure of surface roughness of film expressed by the following equation:

$$\text{Space factor} = 100 [T_b - T_g] [T_g]^{-1} \quad (1)$$

where:

T_b = bulking thickness determined using Test Methods D 374, and

T_g = gravimetric thickness determined using Test Method E 252.

Space factor is expressed as %.

TABLE 1 Physical, Mechanical, and Electrical Requirements for Biaxially Oriented Polyethylene Terephthalate Capacitor Film (25.4 μm or less in thickness)^A

Tensile Properties				
Tensile strength modulus, and elongation, MD and TD:				
Nominal Thickness, μm	Tensile Strength, min, MPA MD and TD	Break Elongation, % min		Tensile Modulus min, MPa MD and TD
		MD	TD	
1.5	110	40	20	2410
1.8	110	40	20	2410
2.0	110	...	30	2410
2.5	117	...	35	2410
3.0	131	...	35	2410
3.5	131	...	35	2716
4.0	131	45	...	2716
5.0	138	...	40	3103
6.0	138	...	40	3103
8.0	145	...	45	3103
10.0	145	...	50	3103
12.0	145	...	60	3103
19.0	145	...	60	2759
23.0	145	...	65	2759

Insulation resistance and conducting paths:

TABLE 1 Continued

Nominal Thickness, μm	Insulation Resistance, min $\text{M}\Omega$ at 125°C	Conducting Paths, max No. per m^2
1.5	1000	...
1.8	1000	...
2.0	1000	...
2.5	850	...
3.0	850	...
3.5	850	128
4.0	825	107
5.0	825	86
6.0	800	64
8.0	600	53
10.0	600	43
12.0	600	22
19.0	500	11
23.0	400	11

Permittivity, 23°C, 50 % RH:

60 Hz 1 kHz 3.2 ± 0.1 3.2 ± 0.1

Dissipation factor, max 23°C:

60 Hz 1 kHz
2.0 to 4.0 μm thick 0.006 0.008
5.0 to 25.0 μm thick 0.004 0.006

Thickness, μm :

Nominal Thickness, μm	Average Thickness per Single-Slit Roll			
	Based on Roll Weight		Ten-Sheet Stack	
	min	max	min	max
1.5	1.48	1.62	...	...
1.8	1.61	1.89	...	...
2.0	1.79	2.11	1.50	3.00
2.5	2.30	2.70	2.03	3.56
3.0	2.71	3.19	2.54	4.06
3.5	3.10	3.69	3.05	4.57
4.0	3.72	4.28	3.81	5.33
5.0	4.65	5.25	4.57	6.10
6.0	5.64	6.36	5.59	7.11
8.0	7.52	8.48	7.62	9.14

Nominal Thickness, μm	Average Thickness per Single-Slit Roll, μm			
	Based on Roll Weight		Ten-Sheet Stack	
	min	max	min	max
10.0	9.40	10.60	9.40	11.43
12.0	11.28	12.72	11.43	13.46
19.0	18.05	19.95	17.78	20.32
23.0	21.85	24.15	21.84	24.89

Width tolerance, variation from nominal, mm:

less than 76 mm ± 0.2
76 to 152 mm ± 0.4
over 152 to 456 mm ± 0.8
over 456 mm ± 1.6

Density, 23/23°C, g/cm^3 ^B

Melting point, min, °C 1.385 to 1.410

Shrinkage, max, MD and TD at 150 $\pm$ 1°C, %

3.0 MD, 2.0 TD

Dielectric breakdown voltage, dc:

Critical test voltage, V	Number of capacitors that must survive the critical test voltage per 20 capacitors ^C														
	Thickness, μm														
	1.5	1.8	2.0	2.5	3.0	3.5	4.0	5.0	6.0	8.0	10.0	12.0	19.0	23.0	
100			18												
200				17		18	18								
300					17			18							
400						17									
500							17		19						
600								17		19	19				
800												19			
1000									18				19		
1200										18					
1600											18				
1800												18			

⁷ Annual Book of ASTM Standards, Vol 04.06.

⁸ Annual Book of ASTM Standards, Vol 02.02.

⁹ Available from American National Standards Institute, 11 W. 42nd Street, New York, NY 10036.