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# AEROSPACE MATERIAL SPECIFICATION

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## Plastic Sheet and Strip, Polyimide

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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NOTICE

This document has been taken directly from U.S. Military Specification MIL-P-46112B, Notice 1 and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-P-46112B, Notice 1. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this SAE technical document.

1. SCOPE:

1.1 SCOPE:

This specification covers polyimide sheet and strip with or without heat sealable FEP-fluorocarbon coatings.

1.2 Classification:

The polyimide sheet and strip shall be of the following types and grades, as specified (see 6.2).

Type I - General purpose
Type II - Heat sealable

Grade A - One side coated
Grade B - Two sides coated

2. APPLICABLE DOCUMENTS:

The following publications, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.1 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

| | |
|---|---|
| L-P-389 | Plastic Molding Material, FEP-Fluorocarbon, Molding and Extrusion |
| PPP-B-585 | Boxes, Wood, Wirebound |
| PPP-B-601 | Boxes, Wood, Cleated Plywood |
| PPP-B-636 | Box, Shipping, Fiberboard |
| MIL-P-116 | Preservation, Packaging, Methods of |
| MIL-L-10547 | Liners, Case, and Sheet, Overwrap, Water Vaporproof or Waterproof, Flexible |
| MIL-STD-105 | Sampling Procedures and Tables for Inspection by Attributes |
| MIL-STD-129 | Marking for Shipment and Storage |

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

| | |
|---|---|
| ASTM D 149 | Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies |
| ASTM D 150 | A-C Loss Characteristics and Dielectric Constant (Permittivity) of Solid Electrical Insulating Materials |
| ASTM D 257 | Electrical Resistance of Insulating Materials |

2.2 (Continued):

ASTM D 374 Thickness of Solid Electrical Insulation
ASTM D 570 Water Absorption of Plastics
ASTM D 618 Conditioning of Plastics and Electrical Insulating Materials for Testing
ASTM D 882 Tensile Properties of Thin Plastic Sheeting
ASTM D 883 Nomenclature Relating to Plastics

2.3 National Motor Freight Traffic Association, Inc., Agent:

Available from the American Trucking Associations Inc., Traffic Department, 1616 P Street, N.W., Washington, DC 20036.

National Motor Freight Classification

2.4 Uniform Classification Committee, Agent:

Available from the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.

Uniform Freight Classification

3. REQUIREMENTS:

3.1 Materials:

The material shall be a flexible, unsupported sheet or strip made from polyimide polymer. Type II sheet or strip shall contain a heat sealable coating of FEP-fluorocarbon resin on one or both sides. The FEP-fluorocarbon shall conform to type I material of L-P-389. Reclaimed polyimide is permitted when it meets all requirements specified herein and the molecular weight is essentially the same as that of the unused polymer for the type and grade of material specified.

3.2 Property values:

When tested as specified in 4.4, the sheet or strip shall conform to the property values shown in tables I and II, as applicable.

TABLE I. Property values for type I sheet and strip

| | Test paragraph | Average property value, Nominal thickness, mm 1/ (inch) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | .075 (.0003) | .013 (.0005) | .025 (.001) | .05 (.002) | .075 (.003) | .13 (.005) | | |
| Tensile strength, MPa (psi), machine direction and transverse direction, min. | 4.4.3 | 69 (10,000) | 97 (14,000) | 138 (20,000) | 138 (20,000) | 138 (20,000) | 138 (20,000) | | |
| Elongation, percent, machine and transverse direction, min. | 4.4.3 | 10 | 20 | 35 | 40 | 45 | 45 | | |
| Elongation, percent, After 2 hours at 400°C (752°F), machine direction and transverse direction, min. | 4.4.5 | - | - | 10 | 10 | 10 | 10 | | |
| Shrinkage, percent at 400°C (752°F), machine direction and transverse direction, max. | 4.4.4 | 4.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | | |
| Moisture absorption, percent, max. | 4.4.6 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | |
| Dielectric strength, volts/mil, 60 hertz, min. | 4.4.7 | 3,000 | 3,000 | 4,500 | 3,800 | 3,600 | 2,500 | | |
| Volume resistivity, ohm-cm, at 200°C (392°F), min. | 4.4.8 | $10^{12}$ | $10^{12}$ | $10^{12}$ | $10^{12}$ | $10^{12}$ | $10^{12}$ | | |
| Dielectric constant at 1 kilohertz, max. | 4.4.9 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | |
| Dissipation factor at 1 kilohertz, max. | 4.4.9 | .007 | .005 | .004 | .004 | .004 | .004 | | |

1/ mm = millimetre

TABLE II. Property values for type II sheet and strip

| Grade | Total nominal thickness, mm (inch)[1] | Dielectric strength Volts/mil, minimum | Minimum heat seal strength, grams per 2.5mm (1 inch width) | |
|---|---|---|---|---|
| | | | Coated side sealed to uncoated side | Coated side sealed to coated side |
| A | .025 (.001) | 3000 | 450 | 450 |
| A | .038 (.0015) | 3500 | 450 | 800 |
| A | .05 (.002) | 3000 | 450 | 800 |
| A | .06 (.0025) | 2500 | 450 | 800 |
| A | .075 (.003) | 2500 | 450 | 800 |
| A | .1 (.004)[2] | 2000 | 450 | 800 |
| A | .1 (.004)[3] | 2700 | 450 | 800 |
| A | 1.5 (.006) | 2100 | 450 | 800 |
| B | .038 (.0015) | 3000 | — | 800 |
| B | .05 (.002) | 3000 | — | 800 |
| B | .075 (.003) | 2500 | — | 800 |
| B | .13 (.005) | 2200 | — | 800 |

[1] See table IX for nominal thickness of polyimide and FEP-fluorocarbon layers; mm = millimetre.

[2] FEP - Fluorocarbon coating is .05mm (.002) inches nominal thickness.

[3] FEP - Fluorocarbon coating is .025mm (.001) inch nominal thickness.

3.3 Form:

The sheet and strip shall be furnished in rolls.

3.4 Dimensions and tolerances:

The range of lengths, number of splices, width and roll diameters, thickness, and tolerances shall be as specified herein. Sheet material shall be over 76 mm (3 inches) in width, and strip material shall be 76 mm (3 inches) or less in width (see table VII for available widths.)

3.4.1 Roll length: Standard roll length of sheet and strip shall be as shown in tables III and IV.

3.4.2 Roll splices: The tolerance on splices in standard rolls shall be as shown in tables V and VI.

TABLE III. Roll length of type I sheet and strip1/

| Roll diameter mm (inches) | | Nominal roll length, meters (feet) Nominal thickness, mm (inch) | | | | | |
|---|---|---|---|---|---|---|---|
| I.D. | O.D. | .075 (.0003) | .013 (.0005) | .025 (.001) | .05 (.002) | .075 (.003) | .13 (.005) |
| 76 (3) | 124 (4-7/8) | 910 (3000) | - | - | - | - | - |
| 76 (3) | 152 (6) | - | 910 (3000) | 460 (1500) | 230 (750) | 150 (500) | - |
| 76 (3) | 241 (9-1/2) | - | - | 1500 (5100) | 760 (2550) | 510 (1700) | 300 (1000) |
| 152 (6) | 241 (9-1/2) | 3000 (10000) | 1800 (6000) | 910 (3000) | 460 (1500) | 300 (1000) | 180 (600) |

1/ The roll length tolerances from the nominal lengths shown in tables III and IV shall be ± 10%.

TABLE IV. Roll length of type II sheet and strip1/

| Roll diameter mm (inches) | | Nominal roll length available, meters (feet) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Grade A Nominal thickness mm (inches) | | | | | | | | Grade B Nominal thickness mm (inches) | | | |
| I.D. | O.D. | .025 (.001) | .038 (.0015) | .050 (.002) | .063 (.0025) | .075 (.003) | .10 (.004) | .15 (.006) | .038 (.0015) | .05 (.002) | .075 (.003) | .125 (.005) |
| 76 (3) | 152 (6) | 450 (1500) | 300 (1000) | 230 (750) | 190 (625) | 150 (500) | 110 (375) | 78 (260) | 320 (1060) | 230 (750) | 150 (500) | 90 (300) |
| 76 (3) | 241 (9-1/2) | - | 1020 (3400) | 750 (2500) | 640 (2125) | 510 (1700) | 380 (1250) | 260 (850) | - | 750 (2500) | 510 (1700) | 300 (1000) |
| 152 (6) | 241 (9-1/2) | 910 (3000) | 620 (2060) | 460 (1540) | 380 (1250) | 310 (1040) | 230 (770) | 160 (520) | 640 (2120) | 462 (1540) | 310 (1040) | 180 (600) |

1/ The roll length tolerances from the nominal lengths shown in tables III and IV shall be ± 10%.

TABLE V. Splice tolerance per standard roll of type I sheet or strip

| Roll diameter, mm (inches) | | Splices per standard roll, maximum<br>Nominal thickness, mm (inches) | | | | | |
|---|---|---|---|---|---|---|---|
| I.D. | O.D. | .0075 (.0003) | .013 (.0005) | .025 (.001) | .05 (.002) | .075 (.003) | .13 (.005) |
| 76 (3) | 124 (4-7/8) | 9 | - | - | - | - | - |
| 76 (3) | 152 (6) | - | 5 | 2 | 1 | 1 | 1 |
| 76 (3) | 241 (9-1/2) | - | - | 7 | 5 | 4 | 4 |
| 152 (6) | 241 (9-1/2) | 40 | 10 | 5 | 3 | 3 | 2 |
| | | Length between splices or from end of standard roll, meters (feet), minimum | | | | | |
| 76 (3) | 152 (6) | - | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 22 (75) |
| 76 (3) | 241 (9-1/2) | - | - | 30 (100) | 30 (100) | 30 (100) | 22 (75) |
| 152 (6) | 241 (9-1/2) | 22 (75) | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 22 (75) |
| | | Average splice-free length per standard roll, meters (feet), minimum[1/] | | | | | |
| 76 (3) | 152 (6) | - | 150 (500) | 151 (505) | 110 (380) | 75 (250) | 45 (150) |
| 76 (3) | 241 (9-1/2) | - | - | 190 (640) | 128 (425) | 100 (340) | 60 (200) |
| 152 (6) | 241 (9-1/2) | 90 (300) | 160 (550) | 150 (500) | 112 (375) | 75 (250) | 60 (200) |

1/ Divide length of standard roll (see table IV) by total number of splice-free increments (total splices + 1).

TABLE VI. Splice tolerance per standard roll of type II sheet and strip

| Roll diameter mm (inches) I.D. | Roll diameter mm (inches) O.D. | Grade A Nominal thickness mm (inches) .025 (.001) | .038 (.0015) | .05 (.002) | .063 (.0025) | .075 (.003) | .10 (.004) | .15 (.006) | Grade B Nominal thickness mm (inches) .038 (.0015) | .05 (.002) | .075 (.003) | .13 (.005) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Splices per standard roll, maximum 1/ | | | | | | | | | | | | |
| 76 (3) | 152 (6) | 5 | 3 | 2 | 2 | 2 | 1 | - | 5 | 2 | 2 | 1 |
| 76 (3) | 241 (9-1/2) | - | 8 | 7 | 5 | 5 | 5 | 4 | - | 7 | 6 | 5 |
| 152 (6) | 241 (9-1/2) | 9 | 5 | 5 | 4 | 4 | 4 | 3 | 9 | 5 | 4 | 4 |
| Length between splices or from end of standard roll, meters (feet), minimum 1/ | | | | | | | | | | | | |
| 76 (3) | 152 (6) | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 30 (100) | - | 30 (100) | 30 (100) | 30 (100) | 22 (75) |
| 76 (3) | 241 (9-1/2) | - | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 22 (75) | - | 30 (100) | 30 (100) | 22 (75) |
| 152 (6) | 241 (9-1/2) | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 30 (100) | 22 (75) | 30 (100) | 30 (100) | 30 (100) | 22 (75) |
| Average splice-free length per standard roll, meters (feet), minimum 1/ 2/ | | | | | | | | | | | | |
| 76 (3) | 152 (6) | 75 (250) | 75 (250) | 75 (250) | 60 (200) | 50 (165) | 56 (185) | - | 50 (165) | 75 (250) | 50 (165) | 45 (150) |
| 76 (3) | 241 (9-1/2) | - | 110 (375) | 93 (310) | 100 (335) | 84 (280) | 62 (205) | 51 (170) | - | 93 (310) | 74 (245) | 48 (160) |
| 152 (6) | 241 (9-1/2) | 90 (300) | 110 (375) | 75 (250) | 60 (200) | 63 (210) | 45 (150) | 38 (125) | 42 (140) | 75 (250) | 63 (210) | 36 (120) |

1/ Based on nominal roll length in meters (feet), as specified in table IV. The longer the length of roll, the greater the number of splices allowed.

2/ See table V footnote for explanation of average splice-free length.

3.4.3 Roll width and diameter: The maximum variation in roll width and diameter shall be as shown in table VII.

TABLE VII. Roll diameter and width tolerances

| Roll diameter mm (inches) | | O.D. Tolerance mm (inches) | Nominal thickness, mm (inches) | Width range[1] mm (inches) | |
|---|---|---|---|---|---|
| I.D. | O.D. | | | Minimum | Maximim |
| | | | | Type I material | |
| 76 (3) | 124(4-7/8) | ± 6.4 (± 1/4) | .0075 (.0003) | 25 (1) | 100 (4) |
| 32 (1-1/8) | 89 (3-1/2) | ± 6.4 (± 1/4) | .0075 (.0003) | 25 (1) | 100 (4) |
| 76 (3) | 152 (6) | ± 6.4 (± 1/4) | .013 (.0005) | 4.8 (3/16) | 1220 (48) |
| 76 (3) | 152 (6) | ± 6.4 (± 1/4) | .025 thru .13 (.001 thru .005) | 4.8 (3/16) | 1530 (60) |
| 76 (3) | 241 (9-1/2) | ± 6.4 (± 1/4) | .025 thru .075 (.001 thru .003) | 27 (1-1/16) | 1530 (60) |
| 76 (3) | 241 (9-1/2 | ± 6.4 (± 1/4) | .013 (.005) | 13 (1/2) | 1530 (60) |
| 152 (6) | 280 (11) | ± 6.4 (± 1/4) | .025 thru .13 (.001 thru .005) | 27 (1-1/16) | 1530 (60) |
| 152 (6) | 241 (9-1/2) | ± 6.4 (± 1/4) | .0075 (.0003) | 25 (1) | 1220 (48) |
| 152 (6) | 241 (9-1/2) | ± 6.4 (± 1/4) | .013 (.0005) | 27 (1-1/16) | 1220 (48) |
| 152 (6) | 241 (9-1/2) | ± 6.4 (± 1/4) | .025 thru .13 (.001 thru .005) | 27 (1-1/16) | 1530 (60) |
| | | | | Type II material | |
| 76 (3) | 152 (6) | ± 6.4 (± 1/4) | All | 4.8 (3/16) | 152 (6) |
| 76 (3) | 241 (9-1/2) | ± 6.4 (± 1/4) | All[2] | 13 (1/2) | 460 (18)[3] |
| 152 (6) | 241 (9-1/2) | ± 6.4 (± 1/4) | All | 27 (1-1/16) | 152 (6) |
| 152 (6) | 280 (11) | ± 6.4 (± 1/4) | All[2] | 27 (1-1/16) | 460 (18)[3] |

[1] Width tolerance on all put-ups is as follows:

25mm (1 inch or less). . . . . tolerance ± .4mm (± 1/64 inch)
27 to 100mm (1-1/16 to 4 inch) . . . . . tolerance ± .8mm (± 1/32 inch)
102mm and over (4-1/16 inch and over). . . . . tolerance ± 1.6mm (± 1/16 inch)

[2] .025mm (.001 inch) thick type I, grade A and .038mm (.0015) inch thick type II, grade B, not available in this put-up.

[3] Wider widths to 910mm (36 inches) are available as non-standard items.

3.4.4 Thickness of sheet and strip: Tables VIII and IX specify allowable nominal thickness and tolerances.

TABLE VIII. Thickness and tolerances for type I sheet and strip

| Thickness tolerance, mm (inches) | Nominal thickness, mm (inches) | | | | | |
|---|---|---|---|---|---|---|
| | .0075 (.0003) | .013 (.0005) | .025 (.001) | .05 (.002) | .075 (.003) | .13 (.005) |
| Maximum | .009 (.00036) | .016 (.00065) | .03 (.0012) | .058 (.0023) | .085 (.0033) | .14 (.0055) |
| Minimum | .006 (.00024) | .0088 (.00035) | .02 (.0008) | .0425 (.0017) | .068 (.0027) | .11 (.0045) |

TABLE IX. Thickness and tolerances for type II sheet or strip

| Grade | Total nominal thickness mm (inches) | First FEP layer | Polyimide layer mm (inches) | Second FEP layer mm (inches) | Thickness tolerance, mm (inches) | |
|---|---|---|---|---|---|---|
| | | | | | minimum | maximum |
| A | .025 (.001) | None | .013 (.0005) | .013 (.0005) | .019 (.00075) | .031 (.00125) |
| A | .038 (.0015) | None | .025 (.001) | .013 (.0005) | .031 (.00125) | .044 (.00175) |
| A | .050 (.002) | None | .025 (.001) | .025 (.001) | .042 (.0017) | .058 (.0023) |
| A | .062 (.0025) | None | .05 (.002) | .013 (.0005) | .060 (.00238) | .066 (.00263) |
| A | .075 (.003) | None | .05 (.002) | .025 (.001) | .065 (.0026) | .085 (.0034) |
| A | .10 (.004) | None | .05 (.002) | .050 (.002) | .09 (.0036) | .11 (.0044) |
| A | .10 (.004) | None | .075 (.003) | .025 (.001) | .09 (.0036) | .11 (.0044) |
| A | .15 (.006) | None | .13 (.005) | .025 (.001) | .14 (.0054) | .16 (.0066) |
| B | .038 (.0015) | .013 (.0005) | .013 (.0005) | .013 (.0005) | .030 (.00120) | .045 (.00180) |
| B | .050 (.002) | .013 (.0005) | .025 (.001) | .013 (.0005) | .042 (.0017) | .058 (.0023) |
| B | .075 (.003) | .013 (.0005) | .05 (.002) | .013 (.0005) | .065 (.0026) | .085 (.0034) |
| B | .13 (.005) | .025 (.001) | .075 (.003) | .025 (.001) | .11 (.0045) | .14 (.0055) |



3.5 Color:

The color of the sheet or strip shall vary from pale yellow to dark amber.

3.6 Workmanship:

The sheet and strip shall be uniform in color and appearance as determined by visual examination. The sheet and strip shall be clean and free from contamination, wrinkles, holes, scratches and other defects that may affect appearance or which may affect serviceability. (These defects may be defined in accordance with ASTM D 883, as applicable.) The heat sealable coating of FEP-fluorocarbon for type II material shall be uniform in appearance.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Sampling for inspection and acceptance:

Sampling for inspection and acceptance shall be performed in accordance with the provisions set forth in MIL-STD-105, except where otherwise indicated. For purposes of sampling, an inspection lot for examination and tests shall consist of all material of the same type, grade, and nominal thickness submitted for delivery at one time.

4.2.1 Inspection of materials and components: In accordance with 4.1, the contractor is responsible for insuring that materials and components used were manufactured, tested, and inspected in accordance with the requirements of this specification and to the extent specified of referenced subsidiary specifications and standards. In the event of conflict, this specification shall govern. For type II material, a supplier's certificate of compliance with 3.1 shall be furnished. The certificate shall certify, also, that the polyimide polymer in type II sheet or strip complies with the property values specified for the type I materials.

4.2.2 Inspection of sheets and strips:

4.2.2.1 Examination of sheets and strips: Examination of sheets and strips shall be made in accordance with the classification of defects, inspection levels and acceptable quality levels (AQL's) set forth below. The lot size, for purpose of determining the sample size in accordance with MIL-STD-105, shall be expressed in units of rolls of plastic sheets or strips for examination in 4.2.2.1.1, 4.2.2.1.2, and in units of shipping containers for examination in 4.2.2.1.3.

4.2.2.1.1 Examination of sheets and strips for defects in form, appearance and workmanship: The sample unit for the examination specified in table X shall be one plastic sheet or strip, as applicable.

TABLE X. Examination of sheets and strips for defects in form, appearance and workmanship

| Examine | Defect |
|---|---|
| Appearance and workmanship | Not uniform coating for type II material<br>Not in rolls<br>Not uniform texture, or color<br>Not clean<br>Not free of contamination, wrinkles, holes, scratches and other defects (see 3.6). |

4.2.2.1.2 Examination of sheets for defects in dimensions: The sample unit for the examination specified in table XI shall be one plastic sheet.

TABLE XI. Examination of sheets for defects in dimensions

| Examine | Defect |
|---|---|
| Length | Not as specified, not within ± 10 percent tolerances. |
| Width | Not as specified, not within tolerances. |
| Roll diameters | Not as specified, not within tolerances. |
| Splices | Maximum number not as specified. |

4.2.2.1.3 Examination of packaging: An examination in accordance with table XII shall be made to determine that preservation, packing, and marking comply with section 5 requirements. The sample unit for this examination shall be one shipping container fully packed, selected just prior to the closing operation. Shipping containers fully prepared for delivery shall be examined for closure defects.