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IPC-TM-650 TEST METHODS MANUAL

Number 2.4.9	
Subject Peel Strength, Flexible Dielectric Materials	
Date 04/14	Revision E
Originating Task Group Flexible Circuits Test Methods Subcommittee (D-15)	

1 Scope This test method defines the procedure for determining the bond strength of metal foils that are 18 microns thick or greater clad flexible dielectric material as nominally defined being measured with a 90° peel.

2 Applicable Documents None

3 Test Specimens If a statistically sound evaluation by a given supplier can prove that die cut and etched specimens differ, the preparation giving the lower measurement can be the only preparation tested. In case of conflict, the die cut sample will be used as the referee method. The sample preparation will be the same for as received, after solder and after aging.

3.1 Type A – Etched Specimen

3.1.1 The test specimen **shall** consist of an etched conductor pattern in accordance with Figure 1. *Note:* Conductors are 3.2 mm wide by 228.6 mm long [0.125 in wide by 9 in long].

3.1.2 A minimum of four specimens, two from the machine direction (MD) and two from the transverse direction (TD), **shall** be prepared for each of the procedure Methods A, C, E. If a statistically sound evaluation by a given supplier can prove that MD and TD measurements differ, the direction giving the lower measurement can be the only direction tested. If the two directions are the same, only the MD direction needs to be tested. In the event a test specimen tears during testing, another test specimen will be prepared to replace it.

3.1.3 For double clad laminate, a separate sample unit **shall** be prepared and tested for each side.

3.2 Type B – Die Cut Specimen

3.2.1 The test specimen **shall** consist of a strip of clad flexible material 12.7 mm wide by 228.6 mm long [1/2 in wide by 9 in long].

3.2.2 A minimum of four specimens, two from the machine direction and two from the transverse direction, **shall** be prepared for each of the procedure Methods B, D, F. If a statistically sound evaluation by a given supplier can prove that MD and TD measurements differ, the direction giving the lower measurement can be the only direction tested. If the two directions are the same, only the MD direction needs to be tested.

3.2.3 For double clad laminate, a separate sample unit **shall** be prepared and tested for each side. The metal foil on the non-test side may remain to provide stability to prevent tenting of the specimen from the German Wheel (free wheel rotary drum). Both samples must be the same with respect to being with or without the non-test side metal foil.

4 Test Equipment

4.1 Testing Machine Power driven testing machine, crosshead autographic type, or an equivalent constant speed drive machine.

4.2 Sample Cutter Thwing Albert sample cutter, Model No. JDC-50, or equivalent.

4.3 Test Fixture Free wheeling rotary drum (Figure 2), sliding plate (Figure 3), or equivalent. The referee fixture will be a 152.4 mm [6.0 in] diameter free wheeling rotary drum.

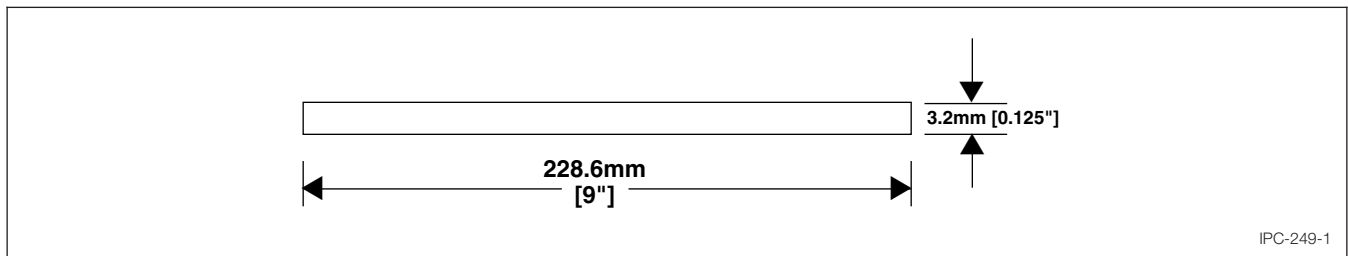


Figure 1 Type A Peel Strength Test Pattern

IPC-TM-650		
Number 2.4.9	Subject Peel Strength, Flexible Dielectric Materials	Date 04/14
Revision E		

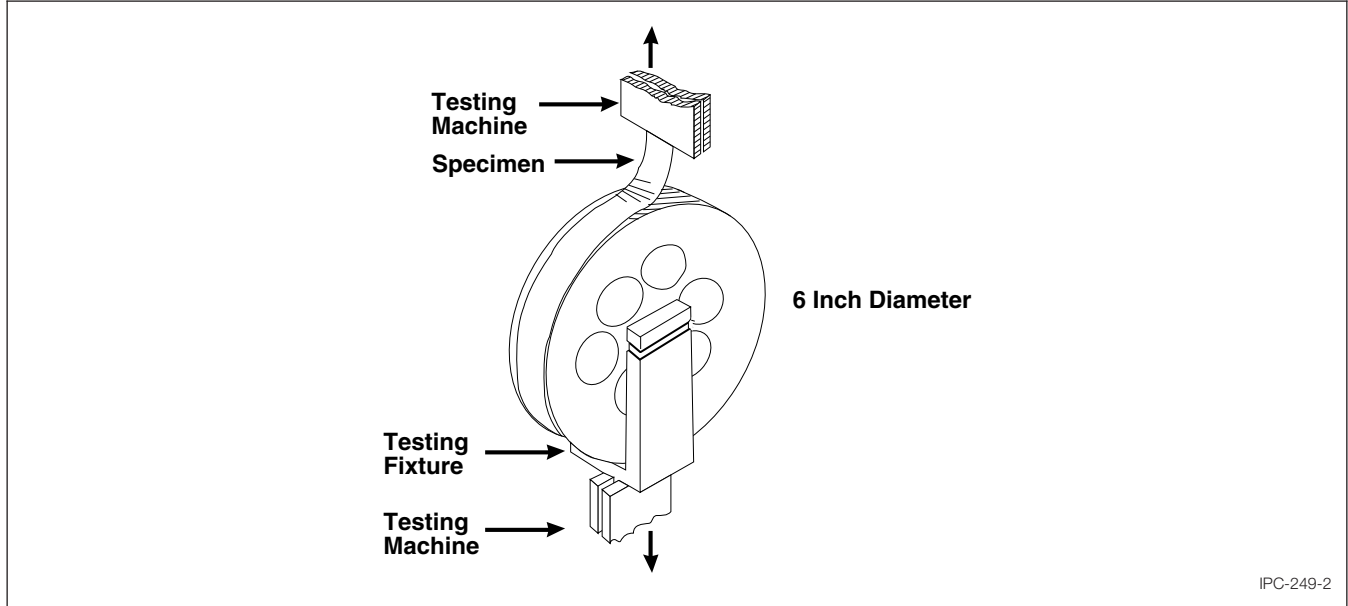


Figure 2 Free Wheeling Rotary Drum Test Fixture

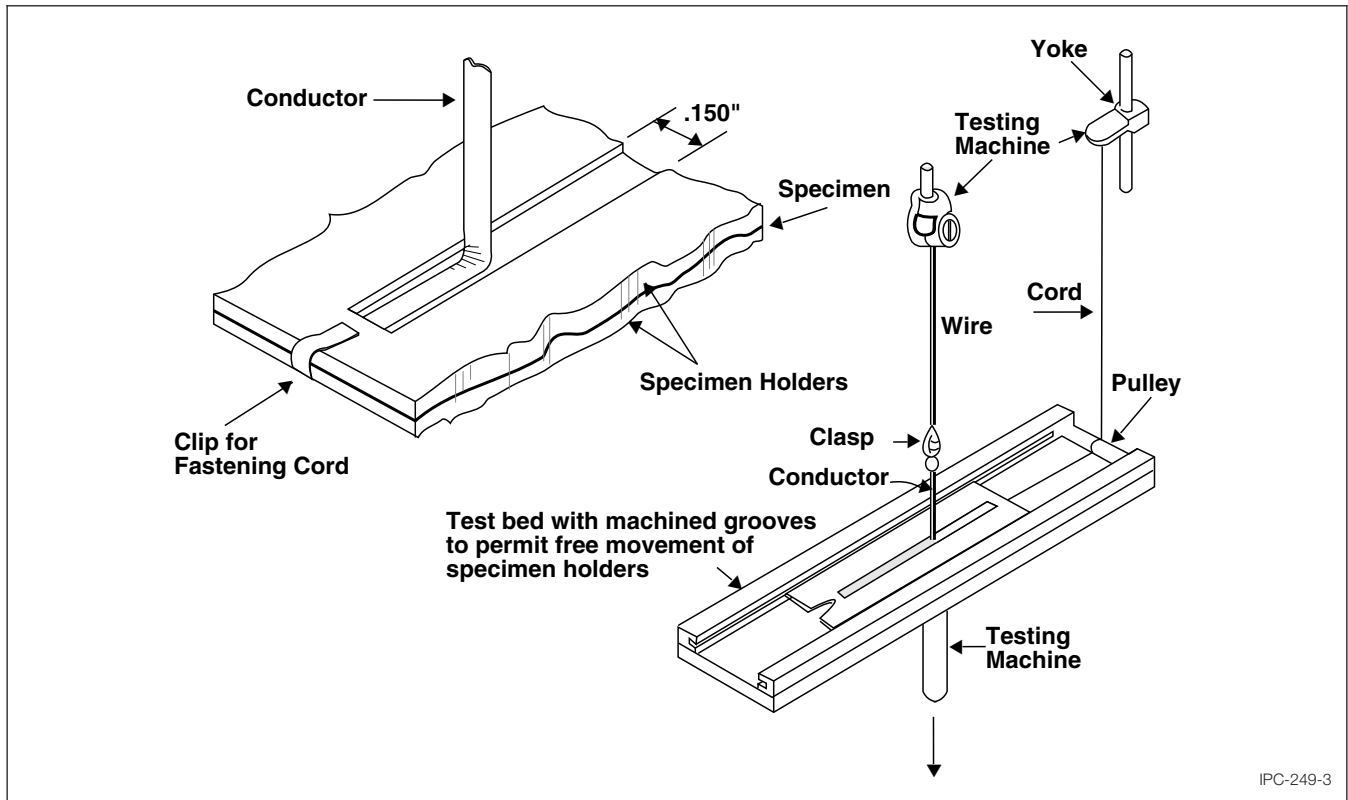


Figure 3 Sliding Plate Test Fixture

IPC-TM-650		
Number 2.4.9	Subject Peel Strength, Flexible Dielectric Materials	Date 04/14
Revision E		

4.4 Solder Pot An electrically-heated, thermostatically controlled solder pot of adequate dimensions to accommodate the specimen and contain no less than 2.25 Kg [5 pounds] of SN60 solder.

4.5 Automatic Temperature Cycling Chamber (See 5.5.3.)

5 Procedure

5.1 Method A – As Received – Etched Specimen

5.1.1 Prepare Type A etched conductor test specimens in accordance with Figure 1 using standard commercial practices per 3.1.2.

5.1.2 Condition specimens for 24 hours at 23 °C ± 2 °C [73.4 °F ± 3.6 °F] and 50% ± 5% relative humidity. Stabilization time may be reduced if statistically sound evidence has been generated on the specific product line to support the shorter stabilization times.

5.1.3 Attach the specimen to the test fixture with double-sided tape, cement, and/or mechanical clamps. The referee attachment technique will be double sided adhesive tape.

5.1.4 Peel the conductor at a rate (crosshead speed) of 50.8 mm/minute [2 in/minute]. The peel load **shall** fall within 15% to 85% of the range of the scale used on the testing machine. The peel load **shall** be continuously recorded, and the recorded load for the entire length of the peeled conductor **shall** be evaluated per 5.7.1. A minimum of 57.2 mm [2-1/4 in] must be peeled, the first 6.4 mm [1/4 in] to be disregarded.

5.2 Method B – As Received – Die Cut Specimen

5.2.1 Cut Type B test specimens with the Thwing Albert sample cutter per 3.2.2.

5.2.2 Condition specimens for 24 hours at 23 °C ± 2 °C [73.4 °F ± 3.6 °F] and 50% ± 5% relative humidity. Stabilization times may be reduced if statistically sound evidence has been generated on the specific product line to support the shorter stabilization times.

5.2.3 Attach the specimen to the test fixture with double-sided tape, cement, and/or mechanical clamps. The referee attachment technique will be double sided adhesive tape.

5.2.4 Peel the foil at a rate (crosshead speed) of 50.8 mm/minute [2 in/minute]. The peel load **shall** fall within 15% to 85% of the range of the scale used on the testing machine. The peel load **shall** be continuously recorded, and the recorded load for the entire length of the peeled conductor **shall** be evaluated per 5.7.1. A minimum of 57.2 mm [2-1/4 in] must be peeled, the first 6.4 mm [1/4 in] to be disregarded.

5.3 Method C – Solder Float – Etched Specimen

5.3.1 Prepare Type A etched conductor test specimen in accordance with Figure 1 using standard commercial practices per 3.2.1.

5.3.2 Dry the test specimens in an area circulating oven maintained at 135 °C ± 10 °C [275 °F ± 18 °F] for one hour.

5.3.3 Remove the specimen from the conditioning chamber, apply solder stop (e.g., petroleum jelly) to the conductor side and float each specimen, conductor side down, just beneath the surface of molten solder at 288 °C ± 6 °C [550 °F ± 10 °F] for at least five seconds. A solder float test fixture that keeps the test specimen flat and just below the solder surface **shall** be used. Agitate the specimen from side to side during immersion, then remove the specimen and tap the edge to remove excess solder. Suitable procedures **shall** be used to ensure that solder does not remain on test specimen.

5.3.4 Repeat steps 5.1.2 through 5.1.4 as performed in Method A.

5.4 Method D – Solder Float – Die Cut Specimen

5.4.1 Cut Type B test specimens with the Thwing Albert sample cutter per 3.2.1.

5.4.2 Dry the test specimens in an air circulating oven maintained at 135 °C ± 10 °C [275 °F ± 18 °F] for one hour.

5.4.3 Remove the specimen from the conditioning chamber, apply solder stop (e.g., petroleum jelly) and float each specimen, conductor side down, just beneath the surface of molten solder at 288 °C ± 6 °C [550 °F ± 10 °F] for at least five seconds. A solder float test fixture that keeps the test specimen flat and just below the solder surface **shall** be used. Agitate the specimen from side to side during immersion, then remove the specimen and tap the edge to remove excess solder. Suitable procedures **shall** be used to ensure that solder does not remain on test specimen.

IPC-TM-650		
Number 2.4.9	Subject Peel Strength, Flexible Dielectric Materials	Date 04/14
Revision E		

5.4.4 Repeat steps 5.2.2 through Method B.

5.5 Method E – After Aging Etched Specimen

5.5.1 Prepare Type A etched conductor test specimen in accordance with Figure 1 using standard commercial practices per 3.1.1.

5.5.2 Condition specimens for 24 hours at 23 °C ± 2 °C [73.4 °F ± 3.6 °F] and 50% ± 5% relative humidity. Stabilization time may be reduced if statistically sound evidence has been generated on the specific product line to support the shorter stabilization times.

5.5.3 Expose each test specimen to five cycles at the time-temperature sequence: 30 minutes +1/-0 minutes at 150 °C +5 °C/-0 °C [302 °F +9 °F/-0 °F]; 15 minutes +1/-0 minutes at 23 °C ± 10 °C [73.4 °F ± 18 °F]; 30 minutes +1/-0 minutes at -55 °C +0 °C /-5 °C [-67 °F -9 °F/+0 °F]; 15 minutes +1/-0 minutes at 23 °C ± 10 °C [73.4 °F ± 18 °F].

5.5.4 Repeat steps 5.1.2 through 5.1.4 as performed in Method A.

5.6 Method F – After aging – Die Cut Specimen

5.6.1 Cut Type B test specimens with the Thwing Albert sample cutter per 3.2.1.

5.6.2 Condition specimens for 24 hours at 23 °C ± 2 °C (73.4 °F ± 3.6 °F) and 50% ± 5% relative humidity. Stabilization time may be reduced if statistically sound evidence has been generated on the specific product line to support the shorter stabilization times.

5.6.3 Expose each test specimen to five cycles at the time-temperature sequence: 30 minutes +1/-0 minutes at 150 °C +5 °C/-0 °C [302 °F +9 °F/-0 °F]; 15 minutes +1/-0 minutes at 23 °C ± 10 °C [73.4 °F ± 18 °F]; 30 minutes +1/-0 minutes

at -55 °C +0 °C /-5 °C [-67 °F -9 °F/+0 °F]; 15 minutes +1/-0 minutes at 23 °C ± 10 °C [73.4 °F ± 18 °F].

5.6.4 Repeat steps 5.2.2 through 5.2.4 as performed in Method B.

5.7 Evaluation

5.7.1 Average the chart recordings for both specimens over the entire peel length if the mode of failure hasn't changed. In the case of changes in failure mode, the average specimen peel strength **shall** be determined using the area of the chart associated with the failure modes producing the lowest peel strength number (see Figures 4 and 5).

5.7.2 Measure and record the width of the etched conductor or peeled foil to the nearest 0.02 mm [0.001 in].

5.7.3 Compute the peel strength using the following formula: Peel Strength [(metric units first) pounds/in of width] = Average load per 5.7.1 conductor width per specimen.

6 Notes

6.1 The force required to bend the test conductor will affect the measured peel strength. The magnitude of this effect will increase as the conductor thickness increases.

6.2 In order to prevent tenting of the peel specimens, suitable support material may be applied to the back side of the test specimen. A referee support material will be a 0.25 mm [0.010 in] glass epoxy material. Bonding during sample preparation should occur at conditions not exceeding 65.6 °C +0 °C/-9 °C [150 °F +0 °F/-16.2 °F] 1 hour cure @ 5171.5 torr [100 pounds/square in]. In the event of a conflict, a backer will be used to prevent tenting. **Note:** The metal foil on the non-test side may remain to provide stability to prevent tenting of the specimen from the German Wheel.

Number 2.4.9	Subject Peel Strength, Flexible Dielectric Materials	Date 04/14
Revision E		

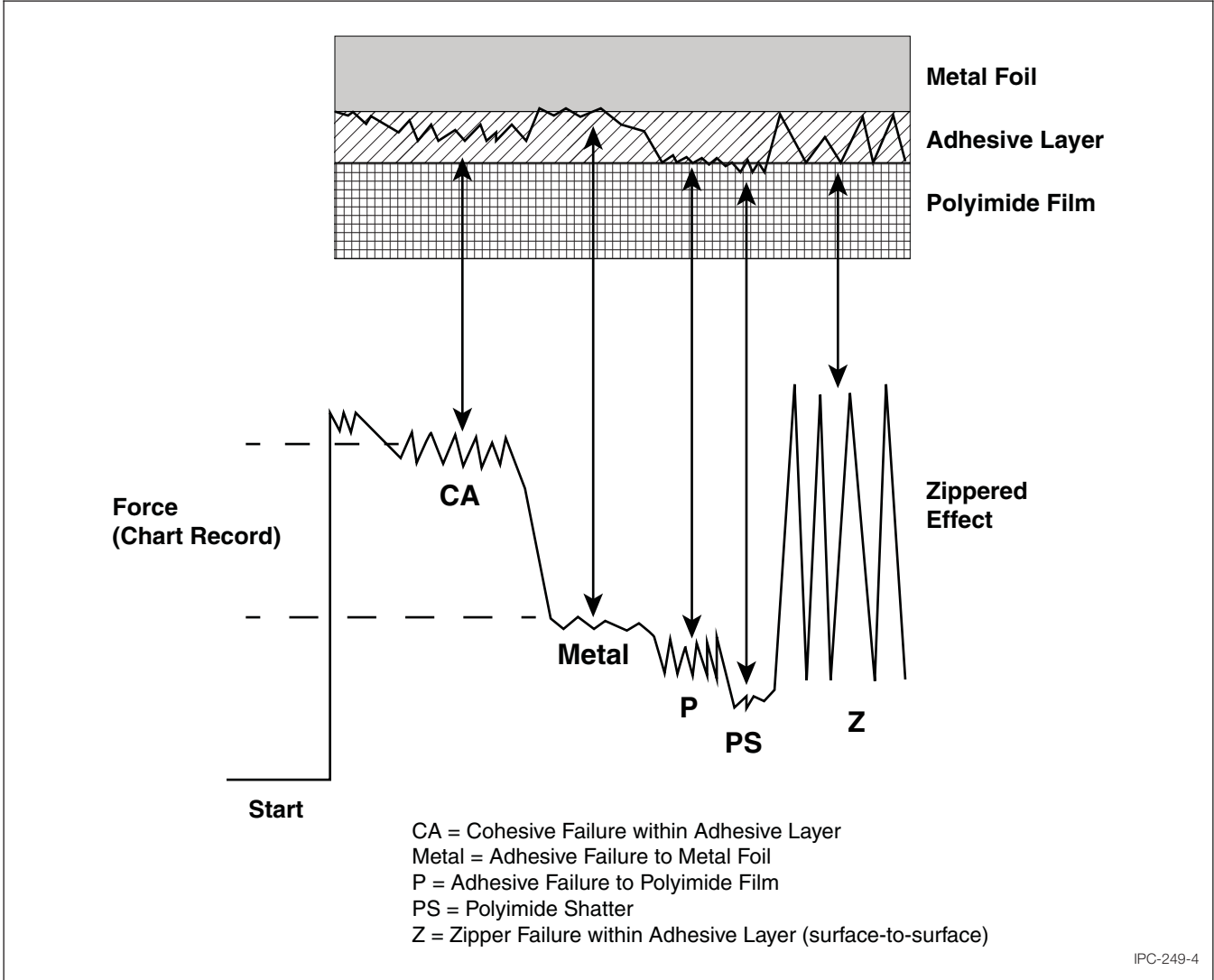


Figure 4 Typical Failure Modes with Adhesive

NOTE: Zipper failure (also termed Slipstick failure): A peel failure that propagates faster than the crosshead speed and oscillates from the interface between the adhesive layer and the metal foil through the cohesive layer of the adhesive itself to the adhesive interface with the dielectric film and into the dielectric film where it fails cohesively and reverses this failure. It also exhibits itself by peel strengths that vary widely from a gradual build to a maximum peel value to a nearly instantaneous drop to no peel value at all in a cyclic manner.

IPC-TM-650		
Number 2.4.9	Subject Peel Strength, Flexible Dielectric Materials	Date 04/14
Revision E		

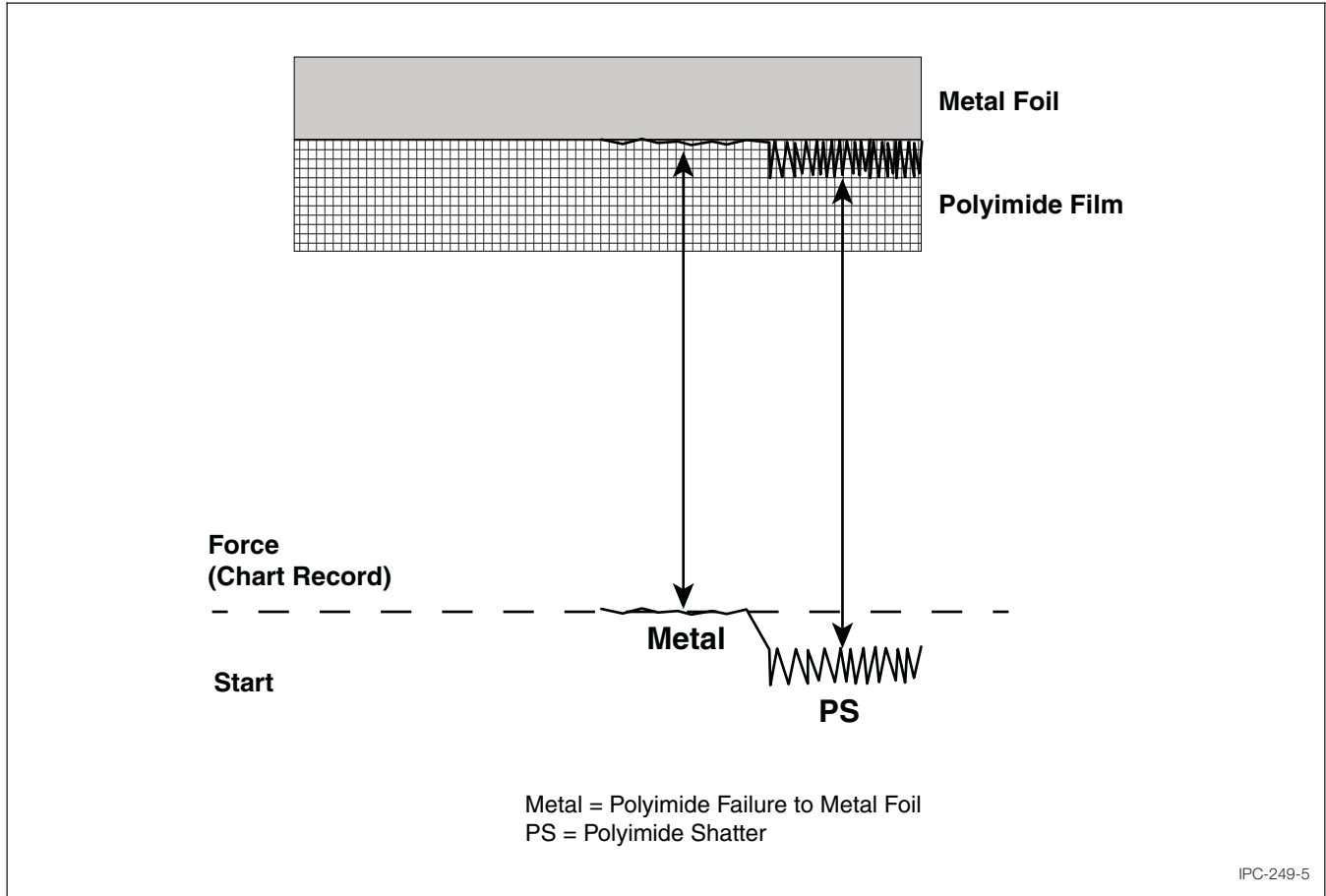


Figure 5 Failure Modes with Adhesiveless