Designation: B1021 – 21

Standard Test Method for Peel Resistance of Metal Sheets Joined by High Strength Bonds[1]

This standard is issued under the fixed designation B1021; 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 test method covers the determination of the relative peel resistance of cohesive or adhesive bonds between two adherends when tested under specified preparation and testing conditions.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are English units provided for information purposes only.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B209/B209M Specification for Aluminum and Aluminum-Alloy Sheet and Plate

D907 Terminology of Adhesives

D1876 Test Method for Peel Resistance of Adhesives (T-Peel Test)

E4 Practices for Force Calibration and Verification of Testing Machines

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of the terms used in this test method not explicitly found here, see D907 – 15.

3.1.2 *adherend, n*—a body bonded to another body.

3.1.3 *adhesive bond, n*—a bond between two adherends formed by an intermediate substance capable of holding materials together by surface attachment.

3.1.4 *cohesive bond, n*—a bond between two adherends formed by solid state diffusion where the atoms of two solid, metallic surfaces intersperse themselves.

3.1.5 *energy release rate, n*—the force per unit width of bond line times the increment in crosshead displacement divided by the increase in debond length of the two adherends.

3.1.6 *hot isostatic pressing (HIP), n*—a method of diffusion bonding two sheets of metal such as aluminum or titanium.

3.1.7 *peel strength, n*—the average force per unit width of bond line required to progressively separate a flexible member from a rigid member or another flexible member.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *ductile, adj*—indicates that the adherends are ductile or flexible enough to permit bending them through an angle up to 120° without cracking or breaking. The subject peel test method uses sample lever-arms to provide backing support to limit the bend radius when peel testing high strength bonds between metal sheets.

3.2.2 *parasitic tab bending force, n*—the force required to bend the peel specimen tabs of two unbonded adherends.

3.2.2.1 *Discussion*—The parasitic force must be measured so that it can be subtracted from the peel test force to measure the net peel force of debonding.

4. Summary of Test Method

4.1 This test method consists of testing two adherends that are bonded together. The unbonded tabs of the adherends are clamped to opposing lever-arms (sample arms) that rotate downward to peel the bond line. The test fixture and the sample arms are shown in Fig. 1.

5. Significance and Use

5.1 Use this test method for acceptance and process control testing. This test method may be used as an alternative to Test Method D1876 when the bond strength is sufficiently high that

[1] This test method is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.05 on Testing.

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[2] 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.

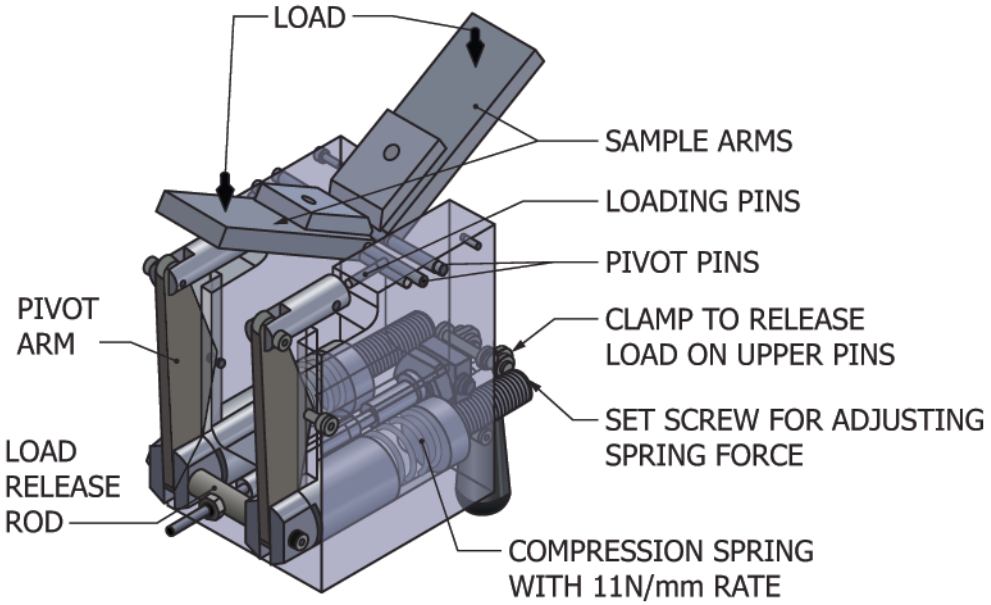

FIG. 1 Lever-Arm Peel Test Fixture

failure of the pulling tabs may occur before peeling initiates. This test method extends the bond strength measurement range by limiting the bend radius of the sample to concentrate the peeling action at the bond line. The test fixture also uses a smaller specimen size than Test Method D1876.

6. Apparatus

6.1 *Testing Machine,* that conforms to the requirements of Practices E4.

6.2 Data acquisition equipment must be able to record simultaneous values of applied force and displacement from the testing machine. Autographic recording is acceptable. Force measurements must be recorded with an error not exceeding ±1 % of reading. Displacement measurements must be recorded with an error not exceeding 0.13 mm (0.005 in.).

6.3 *Peel Fixture*—The peel fixture, shown schematically in Fig. 1, is mounted in the testing machine so that displacement can be applied to the pivoting sample arms. The applied displacement must cause the sample arms to rotate equally. Threaded clamp blocks press the specimen tabs against the abrasive coated sample arms, with the bonded region extending below and between the sample arms. The dimensions of the sample arms are shown in Fig. 2.

6.4 Attach the peel test fixture shown in Fig. 1 to the base of the testing machine and attach the two-point load beam in Fig. 3 to the upper ram to apply equal compressive load to the two sample arms. The two-point load beam has a span of 127 mm (5 in.) and rounded loading points with 3.18 mm (0.125 in.) radius.

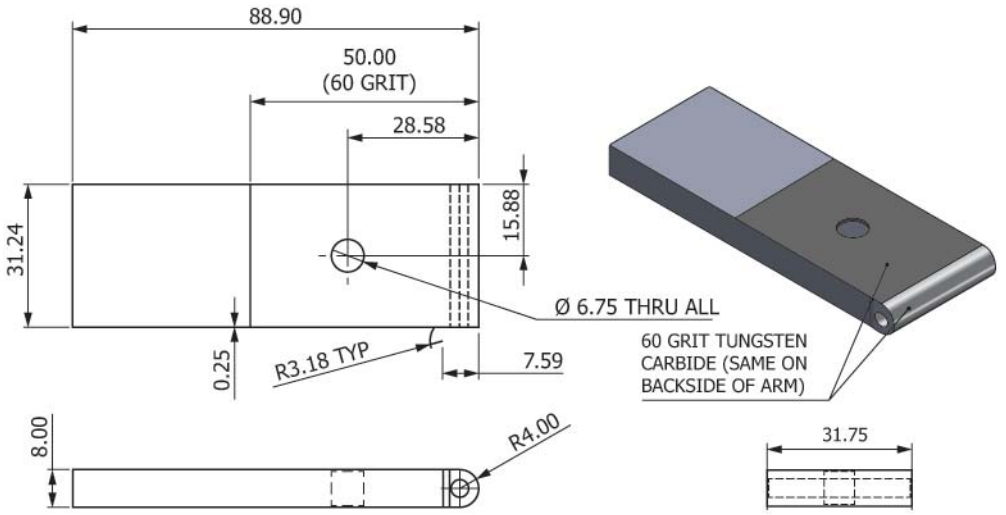

FIG. 2 Dimensions of Peel Test Sample Arms (dimensions in mm)

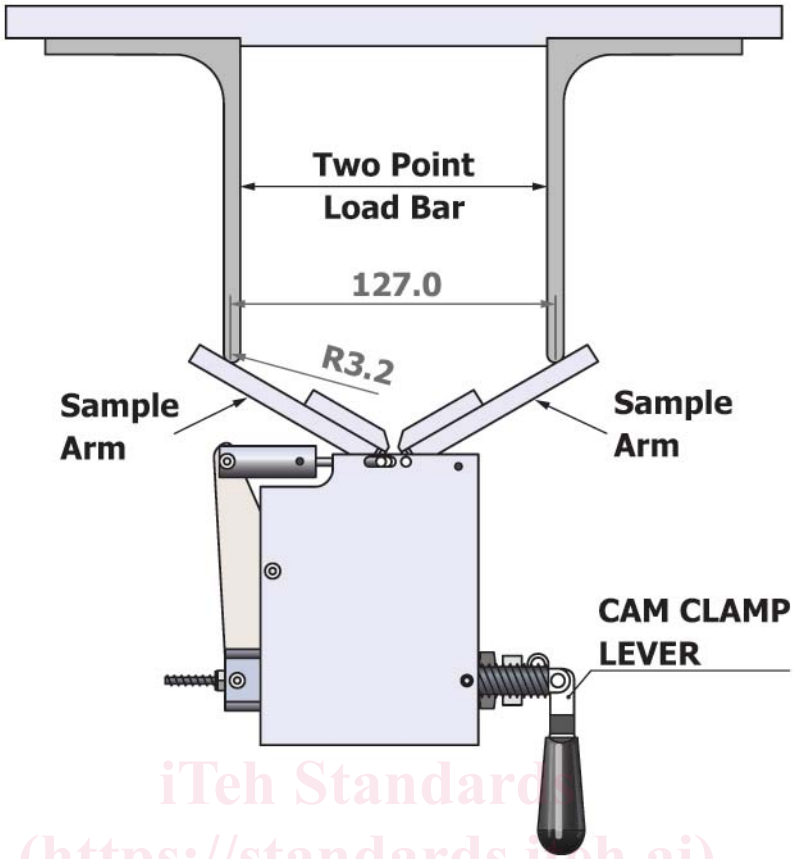

FIG. 3 Two-Point Load Bar Applies Equal Displacement to the Peel Test Sample Arms (dimensions in mm)

7. Sampling, Test Specimens, and Test Units

7.1 Peel test specimens (see Fig. 4) consist of two adherends properly prepared and bonded together in accordance with the bonding process specifications. An area of at least 90 mm (3.5 in.) by 25.4 mm (1.0 in.) of the flexible member should be masked with graphite foil release film, or an equivalent mold release compound, to prevent bonding of the metal sheets in the unbonded area of Fig. 4. This will enable the flexible tabs to be separated and bent as shown in the test specimen pictured at the right of Fig. 4 and described in 8.3.

7.2 *Aluminum Sheet for Bonded Specimens*—Unless otherwise specified, use aluminum alloy sheet that conforms to the specification for aluminum-alloy sheet and plate (Specification B209/B209M) Alloy 6061-T6. Note that the high temperature HIP bonding process will partially anneal the Alloy 6061-T6 plates to a lower strength condition.

7.3 Machine specimens from the bonded plate (Fig. 4) and remove graphite foil from between peeling tabs. Machine or saw along the sides of the plate to expose both sides of the unbonded pocket. Take small passes when machining to ensure that the aluminum does not deform or tear during cutting. Permanently mark each specimen with a unique identifier so each specimen can be traced back to the manufacturing run, processing parameters, etc. Cut or shear the plate at mid-length to give two specimens with the unbonded tabs exposed on each specimen. Scrape the graphite foil or mold release compound from between the specimen tabs using a scraper, razor blade or similar means. Lightly sand with 120 grit sandpaper to further clean the surfaces. Measure and record the width and thickness of the specimen tabs and the thickness of the bonded section adjacent to the bond line to the nearest 0.01 mm. The peel test results will be reported as force per unit width of the specimen.

7.4 Mark the bond line location on the two edges of the specimen. Mark a point on the tabs 29.3 mm from the bond line and centered in the width of the specimen. This point marks the center of a hole through both tabs to fix the specimen tabs to the sample arms. With the sample arm dimensions in Fig. 3, the 29.3 mm distance locates the bond line at the tangent point between the two sample arms when they are inclined 30° above horizontal. Using a drill or hole-punch, make a 6.4 mm diameter hole through the two unbonded tabs at the marked location. An alignment fixture like that shown in Fig. 5 can also be used to align the bond line with the cross hairs, then clamp and drill the hole. The tab clamping bolts go through these holes. Line the specimen hole up with the hole in a spare sample arm on the benchtop. With the hole aligned with the sample arm hole and the specimen held flat against the sample arm, bend the bonded end of the specimen downward to create an approximate 30° bend in one tab. Turn the specimen over and bend the other tab to the same angle. Remove the graphite layer from between the tabs using the cleaning steps in 7.3. Do not disturb the angle of the specimen tabs.

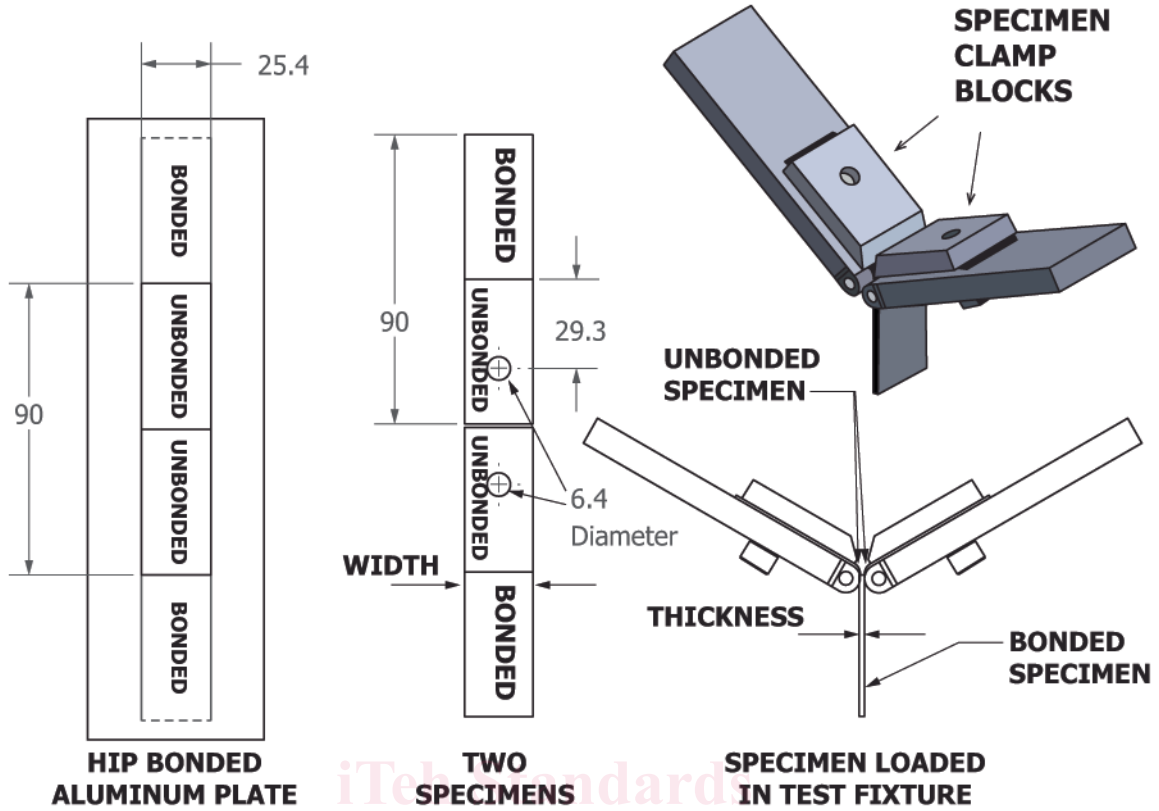

FIG. 4 Test Panel and Test Specimen (dimensions in mm)

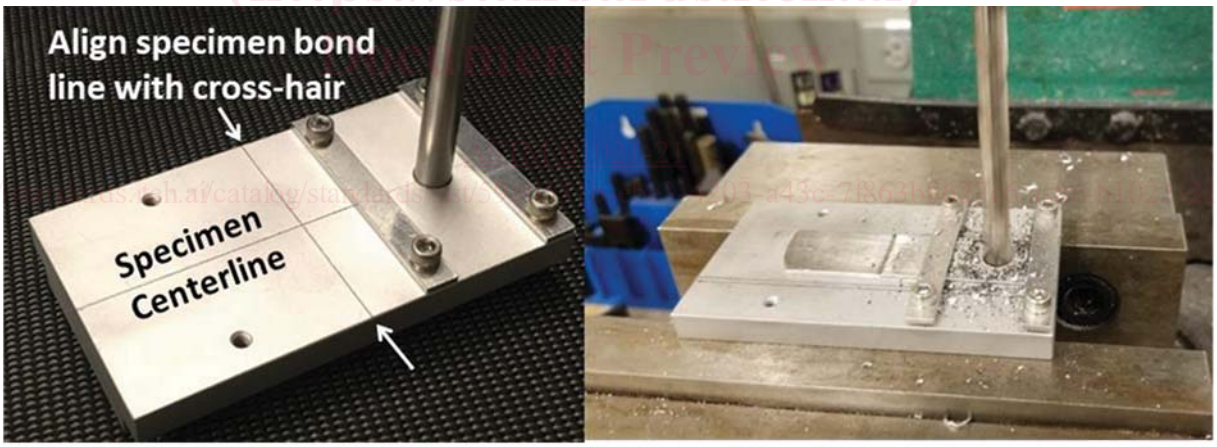

FIG. 5 Specimen Hole Alignment Fixture

8. Procedure

8.1 Load the peel test specimen. Depress the cam clamp lever shown in Fig. 3 to relieve the pinching force between the sample arms. Insert the specimen between the sample arms, supporting the sample arms to match the specimen angle. Place the threaded clamp blocks over the specimen tabs, insert the allen head cap screws from the under-side of the sample arms and tighten the screws ensuring:

8.1.1 The sample arms are at equal and opposite angles.

8.1.2 The bonded specimen end is vertical between the sample arms.

8.1.3 No force is placed on the sample arms.

8.2 Rotate the sample arms until they are approximately 30° above horizontal. A fixture can be used to provide a positive stop for the sample arms at 30° above horizontal (Fig. 6). Engage the cam clamp lever in Fig. 3 to apply the pinching force between the two sample arms.

8.3 Move the crosshead down to bring the two-point load bar in contact with the sample arms (Fig. 3). Set the crosshead displacement rate to a value of 30 mm/minute. Set the testing machine to stop the crosshead when the sample arm angle is 30° below horizontal. Start the data acquisition system to record the force versus applied displacement. Start the crosshead and run the test until the sample arms are 30° below