Designation: D2557 – 98 (Reapproved 2004)

Standard Test Method for Tensile-Shear Strength of Adhesives in the Subzero Temperature Range from –267.8 to –55°C (–450 to –67°F)[1]

This standard is issued under the fixed designation D2557; 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 comparative shear strength of adhesives for bonding metals when tested on a standard specimen and under specified conditions of preparation and testing at extreme subzero temperatures.

1.2 This test method is applicable to the temperature range from -267.8 to -55°C (-450 to -67°F).

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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.* Specific precautions are given in 8.3.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

B265 Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate

D907 Terminology of Adhesives

D1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)

D4896 Guide for Use of Adhesive-Bonded Single Lap-Joint Specimen Test Results

3. Terminology

3.1 *Definitions*—Many terms in this test method are defined in Terminology D907.

4. Significance and Use

4.1 This test method may be used as an accelerated screening test for assessing the strength properties of adhesives and adhesive joints at subzero temperatures. This test method may also be used to determine the effects of various surface preparations, substrates, or adhesive systems on the durability of the adhesive joints at subzero temperatures.

4.2 Tensile shear strengths of various adhesives, surface preparations, and substrates may be compared by using this test method for uniform sets of conditions. To assess the overall tensile shear strength of a given adhesive, surface preparation, and substrate should be tested under a range of stress and temperatures. For a specific end use, the needed strength properties using only one set of test conditions may be obtained.

4.3 The misuse of strength values obtained from this test method as design-allowable stress values for structural joints could lead to product failure, property damage, and human injury.

4.3.1 The apparent shear strength of an adhesive obtained from a given small single-lap specimen may differ from that obtained from a joint made with different adherends or by a different bonding process. The normal variation of temperature and moisture in the service environment causes the adherends and the adhesive to swell or shrink. The adherends and adhesive are likely to have different thermal and moisture coefficients of expansion. Even in small specimens, short-term environment changes can induce internal stresses of chemical changes in the adhesive that permanently affect the apparent strength and other properties of the adhesive.

4.3.2 The problem of predicting joint behavior in a changing environment is even more difficult if a different type of adherend is used in a larger structural joint than was used in the small specimen.

4.3.3 The apparent shear strength measured with a single-lap specimen is not suitable for determining design-allowable stresses for designing structural joints that differ in any manner

[1] This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.80 on Metal Bonding Adhesives.

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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.

from the joints tested without thorough analysis and understanding of the joint and adhesive behaviors.

4.3.4 Single-lap tests may be used for comparing and selecting adhesives or bonding processes for susceptibility to fatigue and environmental changes, but such comparisons must be made with great caution since different adhesives may respond differently in different joints. See Guide D4896 for further discussion of the concepts relative to interpretation of adhesive-bonded single-lap-joints.

5. Apparatus

5.1 The testing machine shall conform to the requirements of Test Method D1002 except that pin-type grips as shown in Fig. 1 shall be used to hold the test specimen.

5.2 The cooling equipment shall consist of a cold box or a cryostat filled with a gaseous or liquid refrigerant in which the standard specimen is immersed prior to and during the test. A typical cryostat is shown in Fig. 2.

6. Test Specimens

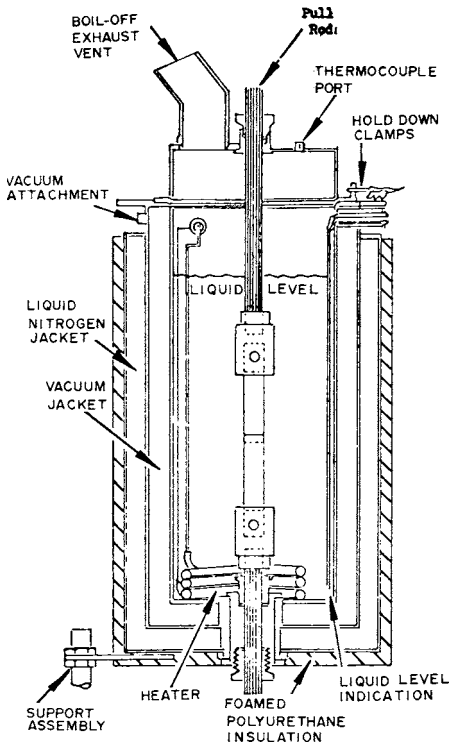
6.1 Test specimens shall be cut from panels shown in Fig. 3(A). These test specimens shall conform to the form and dimensions shown in Fig. 3(B). The specimens are in every respect similar to the tension lap shear specimens described in Test Method D1002 Fig. 1, except that doublers and pin grips shall be used.

6.2 The selection of materials shall be based on the test temperature range. The following metals (Note 1) are recommended for use although other aluminum, titanium, and stainless steel alloys may be used.

NOTE 1—Other alloys can be used as adherends, but caution should be used in choice since many alloys become brittle at extreme subzero temperatures.

Metal[A]	ASTM Designation
Steel, corrosion-resistant sheet, 301 FH	A167
Aluminum alloy, sheet, 2024-T3	B209
Titanium alloy, sheet, 5A1-2.5 Sn	B265

[A]The above sheets shall have a thickness of 1.270 mm (0.050 in.) except in the case of the aluminum alloy sheet which shall have a thickness of 1.630 mm (0.064 in.).



NOTE 1—Cold box configurations are commercially available which can be used from room temperature to −185°C. These utilize chilled gaseous nitrogen or gaseous carbon dioxide.

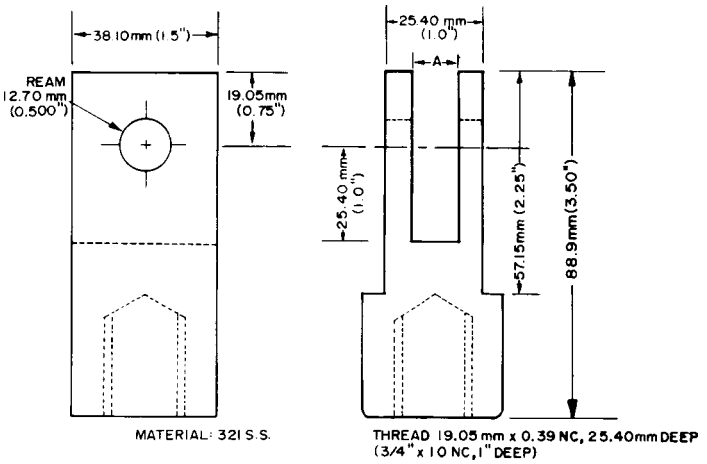
FIG. 2 Diagrammatic View of Cryostat and Accessories

7. Preparation of Test Specimens

7.1 Cut test specimens to dimensions from the test panel, as shown in Fig. 3(B). Measure the width of the specimen and the length of the overlap to the nearest 0.25 mm (0.01 in.).

7.2 Specimens are to have bonded, spot welded, or mechanically attached doublers.

7.3 Test specimens may be prepared by bonding individual strips as shown in Fig. 3(B). Machine unbonded individual strips to size. They shall be free of burrs or other irregularities.



NOTE 1—"A" dimension varies with specimen thickness.

FIG. 1 Clevis for Holding "Pin-Type" Lap Shear Coupons