



Designation: C1908 – 21

Standard Test Method for Pummel Adhesion Testing of Two-ply Laminated Architectural Glass¹

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1. Scope

1.1 This test method determines the relative strength of the adhesive bond between interlayer and glass, inks, coatings, frit or other materials adhered to the glass surface to which interlayers may bond (hereinafter, glass substrate).

1.2 This test method outlines a test method to be used on laminated architectural glass with two layers of glass substrate bonded by an interlayer. Glass substrate can be undecorated, decorated, uncoated, coated, annealed or strengthened, flat or patterned. One or more of the surfaces of glass may have a surface with ink, coatings, frit, patterns, a low-e type coating etc.

1.3 This test method is a qualitative test which covers manual and semi-automatic mechanical pummel testing and visual rating of tested specimens.

1.4 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.5 *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.*

1.6 *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

C162 Terminology of Glass and Glass Products

¹ This test method is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.08 on Flat Glass.

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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.

C1172 Specification for Laminated Architectural Flat Glass

3. Terminology

3.1 Definitions:

3.1.1 Refer to terminology in Specifications C162 and C1172.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *ball peen hammer*, *n*—(also known as a machinist's hammer), a type of hammer having two heads, one hemispherical (peen) and the other flat.

3.2.2 *cardboard backer panel*, *n*—used in rating the pummel, a very thick (3 mm (0.125 in.) or greater) cellulose fiber paper material, usually pale brown in color (typically used for making boxes), sized to fit completely under the specimen to be rated.

3.2.3 *glass substrate*, *n*—laminate comprised of glass and interlayer which may include inks, coatings, frit, or other materials adhered to the glass surface to which interlayers may bond.

3.2.4 *laminate(s)*, *n*—two pieces of glass bonded together by an interlayer

3.2.5 *pummel*, *v*—the act of systematically striking the laminated glass sample with a defined hard object such as a ball peen hammer.

3.2.6 *pummel box*, *n*—an enclosed area in which glass specimens are pummeled, having a primary function of containing glass particles and dust coming from pummeling laminates; a secondary function of providing a frame on which to mount lighting to aid in the visual evaluation; this may be an enclosed room; acoustic damping material may be used on the walls of the box or room.

3.2.7 *pummel rating*, *n*—visually assessed amount of glass versus interlayer characterized as high, medium, low or zero and abbreviated PU.

3.2.8 *short wave UV lamp*, *n*—lamp capable of emitting short wave UV light in the range of 254 nm.

3.2.9 *split shot*, *n*—small spherical piece of lead or tin, size number 5, which is cut part way through; typically used to weight a fishing line.

3.2.10 *strike plate, n*—a hard metal flat surface with a 45° angle which allows the pulverized glass to slide away from the specimen.

3.2.11 *two-ply, n*—two glass layers, which are the outer layers of the laminated glass (for example, glass | interlayer(s) | glass).

4. Summary of Test Method

4.1 This test method involves rapid systematic and progressive striking of a laminate in an effort to pummel the glass substrate to expose the interlayer. Energy is necessary to separate the two different materials at their interface. The percentage of remaining particulates of the glass substrate which are adhered to the interlayer is then visually assessed to determine a ratio of exposed interlayer. The less interlayer visible after pummeling, the higher the adhesion of the interlayer to the surface it was in contact with.

5. Significance and Use

5.1 Pummel adhesion of laminated glass is a method used to measure the relative adhesive bond strength between the interlayer and glass substrate interface. The interlayer to substrate adhesion has a great effect on the impact resistance of laminates as well as long term stability. This test method is intended to provide three levels of grading. This test method is not intended to provide more precision. The laminate bond strength, in most applications, must be controlled to avoid potential problems of delamination at low adhesion and impact failures or undesirable post breakage characteristics at high adhesion.

6. Apparatus

6.1 Safety Equipment (Minimum):

6.1.1 Face Shield.

6.1.2 Dust Mask.

6.1.3 *Cut Resistant Clothing*, clothing such as jacket or similar.

6.1.4 Heavy Cut Resistant Glove.

6.1.5 *Hearing Protection*, in accordance with occupational exposure limits.

6.2 Tools:

6.2.1 *Freezer or Cold Cabinet*, capable of maintaining $-18 \pm 2^\circ\text{C}$ ($0 \pm 4^\circ\text{F}$).

6.3 *Ball Peen Hammer*, nominally 0.45 ± 0.05 kg (16 $\pm$ 1.8 oz), with wood or fiberglass handle. Overall length of hammer is 330 ± 13 mm (13 ± 0.5 in.) with the head length of 105 ± 6 mm (4 ± 0.25 in.). The flat head strike face 26 ± 2 mm (1 ± 0.8 in.)

6.3.1 Split Shot, size number 5.

6.3.2 Strike Plate.

6.3.3 Cardboard Backer Panels.

6.3.4 *Short Wave UV Light*, capable of emitting in the range of 254 nm.

6.4 As an alternative, an automated hammering device with a flat metal head with the same strike face dimensions to that of a ballpeen hammer as stated in 6.3 may be used.

7. Hazards

7.1 Glass dust, glass particulate, and hammer strikes.

8. Sampling, Test Specimens, and Test Units

8.1 Specimens cut to a minimum 76 mm (3 in.) wide and between 150 and 300 mm (6 and 12 in.) long to make it easier to hold during the test.

8.2 A minimum of two laminate specimens per sample set.

9. Calibration and Standardization

9.1 Hammer shall be weighed, and properly dimensioned with no damage to the head.

9.2 *Impact Consistency of Semi-automatic Pummeler*—Split shot thickness shall be measured then attached to the face of the hammer head with tape. A single impact of the strike plate with the hammer, having a single split shot attached shall be executed with the face of the hammer head parallel to the surface of the strike plate. The split shot is removed from the hammer head and the thickness re-measured after impact (Fig. 1(a)). A minimum of three impacts are needed with a new split shot for each impact. The change in the thickness of the split shot from original to post strike is measured. An average of the three hits is taken. A minimum change of 3 mm (0.125 in.) for each impact is required to ensure sufficient force is being applied with a standard deviation between the three split shots of 0.10 mm (0.004 in.) being acceptable.

NOTE 1—Split shot attached to the flat face of the ball peen hammer is also used to provide the person carrying out the test a sense of how hard to strike the laminated glass (Fig. 1(b)).

10. Conditioning

10.1 Specimens shall be conditioned at the prescribed temperature for the interlayer being tested for a time long enough to reach temperature equilibrium throughout the thickness of the laminate.

10.1.1 To determine the conditioning temperature for the type of interlayer in the laminated glass, consult the interlayer manufacturer.

10.1.1.1 Laminated glass of the same configuration of the specimens being tested may be prepared with an embedded thermocouple in the interlayer and measured to determine exact time and temperature.

10.1.1.2 Thermal conductivity calculations may be used to determine time to equilibrium.

10.2 Air movement in the conditioning cabinet shall be present and assist in temperature uniformity within the chamber. No cold spots should occur due to fans or coolant vents.

10.2.1 Allow sufficient space between specimens for air to circulate freely.

10.3 Frozen Pummel:

10.3.1 Specimens shall be placed in a cold air cabinet at $-18 \pm 2^\circ\text{C}$ ($0 \pm 4^\circ\text{F}$) for the minimum time required to reach a temperature equilibrium throughout the thickness of the laminate.

NOTE 2—Depending on the type of cold cabinet and space between the laminates for air circulation, this typically takes between 4 and 6 h for