Designation: D3929 – 03 (Reapproved 2015)

Standard Test Method for Evaluating Stress Cracking of Plastics by Adhesives Using the Bent-Beam Method[1]

This standard is issued under the fixed designation D3929; 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 describes a procedure for determining the compatibility of adhesives with plastics based on whether the adhesive causes cracking of stressed samples.

1.2 Specimen configurations and test fixture designs are given.

1.3 This test method is suitable for products in the form of sheet or strip. It can also be used on injection molded tensile specimens or flexural bars.

1.4 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D638 Test Method for Tensile Properties of Plastics

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D907 Terminology of Adhesives

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cracking, n*—a continuous localized failure of the plastic, leading to loss of structural integrity.

3.2.2 *crazing, n*—apparent fine cracks at or under the surface of a plastic.

3.2.2.1 *Discussion*—This is a form of localized yielding of the plastic due to the combined action of stress and an attacking medium. Initial crazing may be detectable only by inspection under magnification.

3.2.3 *failure, n*—an arbitrary point defined by the initial detection of cracks or crazes.

4. Summary of Test Method

4.1 This test method involves the qualitative determination of the compatibility of adhesives with plastics by observing the effect of adhesives applied in the liquid state on stressed plastic specimens. Bars of plastic are bent in a three-point loading fixture to cause a predetermined initial tensile stress on the surface of the bar. The liquid adhesive is then applied to the area of maximum stress which is checked periodically for crazing or cracking.

4.1.1 Due to the stress relaxation behavior of certain plastics, initial stress only can be determined and the stress level may decrease significantly during the course of the test.

5. Significance and Use

5.1 This test method is designed for obtaining a qualitative estimate of the compatibility of plastics and adhesives. Due to the many process variables associated with the fabrication of plastic parts, it is not possible to use this test as a substitute for compatibility tests on actual parts.

5.2 The detection of cracks or crazes may be determined with or without optical aid. Make comparisons only among tests employing crack detection methods of equivalent sensitivity.

6. Apparatus

6.1 *Test Fixtures*—Bent beam test fixtures (see Fig. 1)[3] are designed to place the specimen in three-point bending. The

[1] This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.40 on Adhesives for Plastics.

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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.

[3] Detailed drawings are shown in Figs. 3–5. Also necessary to complete the test fixture are the following parts: 2 pieces at 6 by 38 mm (¼ by 1½-in.) dowel pins and 2 pieces of M4–0.7 (8–32 unc) by 32 mm (1¼-in.) socket head cap screws.

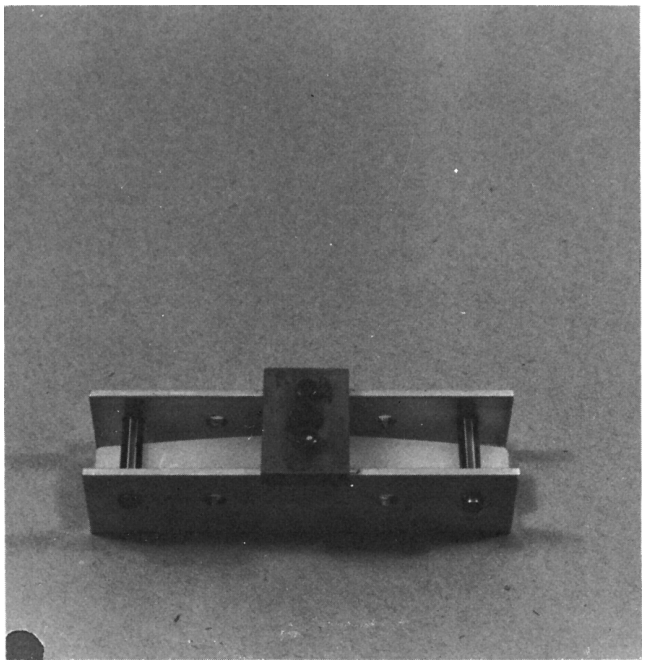

FIG. 1 Test Fixture with Plastic Bar in Place

amount of deflection is adjustable as well as the loading span. Other fixtures may be used as long as specimen deflection is known.

6.2 The amount of deflection on the specimen is measured by use of a dial gage indicator or a vernier caliper having a depth indicator (see Fig. 2). Use a measuring device capable of reading to 0.025 mm (0.001 in.).

7. Test Specimen

7.1 The preferred specimen is a flexural bar designed in accordance with Test Methods D790.

Depth	6.4 mm (¼ in.)
Width	13 mm (½ in.)
Length	130 mm (5 in.)
Loading Span	100 mm (4 in.)
L/d	16/1

Tensile bars, such as Type I in Test Method D638, can also be used. Specimens of rectangular section may also be cut from sheets or molded plastic articles.

7.2 Mold specimens in a low-stress condition or anneal so that molded-in stresses will not have a significant effect.

7.3 Carefully cut or machine specimens in accordance with the plastic manufacturers' recommended procedures to avoid introducing stresses at machined surfaces.

8. Procedure

8.1 Place the plastic test specimen in the test fixture at the required loading (see Fig. 6).

8.2 Apply adhesive to be tested to the center point on the length of the loaded specimen. Cover a specimen length of approximately 25 mm (1 in.). In general, apply the adhesive only once, as would be the case in an actual end-use application.

8.2.1 If the adhesive contains a solvent, allow it to evaporate at a normal rate.

8.2.2 If the adhesive is a curing type, cure in a normal fashion.

8.2.3 If the adhesive is a hot melt, apply at the normal application temperature and then allow to cool. This is a less severe condition than would occur if the adhesive were continually applied, but is more consistent with situations that occur in actual adhesive use.

8.3 *Control Specimens*—Concurrently run one control specimen with the test specimens in the same location. Excessive molded-in stresses or airborne solvent vapors may cause stress cracking even without application of adhesive.

9. Stress Calculations

9.1 The equation given below is valid only for specimens of rectangular cross section at stresses below the elastic limit of the material. The deflection is based on initial stress only. The level of stress will normally decrease with time as the plastic undergoes relaxation. Deflection is calculated based on the desired stress level as follows:

$$D = SL^2/6\,d\,E \tag{1}$$

where:

D = deflection, m (in.),
S = stress, Pa (psi),
L = loading span, m (in.),
d = specimen depth, m (in.), and
E = modulus of the plastic, Pa (psi).

NOTE 1—This equation holds for rectangular specimens only.

9.2 If it is desired to run tests on the basis of constant strain, the following formula can be used:

$$D = \frac{rL^2}{6\,d} \tag{2}$$

where r = strain, m/m (in./in.).

9.3 Tensile stress and strain values represent the maximum level at the surface of the specimen in the area to which adhesive is applied. This is mid-span in the three-point loading arrangement.

10. Choice of Test Conditions

10.1 Suggested stress levels for testing are 7, 14, and 21 MPa (1000, 2000, and 3000 psi). For initial screening, 21 MPa (3000 psi) is recommended since incompatible adhesives will cause rapid crazing or cracking. Lower stress levels may be used for discerning finer differences in materials.

10.2 Testing can also be based on constant strain if this is more meaningful for particular end-use applications.

10.3 The test duration is 5 days for adhesives that harden or cure. For adhesives that remain in the liquid state on the specimens (for example, anaerobic adhesives), the test should be extended to 10 days.

10.4 Maintain environmental conditioning at 23 ± 2°C (73 ± 3.5°F), 50 ± 5 % RH. Specify other conditions as agreed to by user and manufacturer.