This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases only the current version of the standard as published by ASTM is to be considered the official document.

Designation: ~~D8289 – 19~~ D8289 – 20

An American National Standard

Standard Test Method for Tensile Strength Estimate by Disc Compression of Manufactured Graphite[1]

This standard is issued under the fixed designation D8289; 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~~ Scope*

1.1 This test method covers testing apparatus, specimen preparation, and testing procedures for determining the splitting tensile strength of graphite by diametral line compression of a disk. This small specimen geometry (Test Method D7779) is specifically intended for irradiation capsule use. Users are cautioned to use Test Method C749 if possible for measuring tensile strength properties of graphite.

1.2 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.

1.3 All dimension and force measurements and stress calculations shall conform to the guidelines for significant digits and rounding established in Practice D6026.

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

1.5 *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.*

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D8289-20

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C749 Test Method for Tensile Stress-Strain of Carbon and Graphite
D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
D6026 Practice for Using Significant Digits in Geotechnical Data
D7542 Test Method for Air Oxidation of Carbon and Graphite in the Kinetic Regime
D7775 Guide for Measurements on Small Graphite Specimens
D7779 Test Method for Determination of Fracture Toughness of Graphite at Ambient Temperature
E4 Practices for Force Verification of Testing Machines
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 Refer to Terminology D4175 for specific definitions.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *splitting tensile strength, n*—the tensile strength of a material estimated from a splitting compressive configuration such as that described here.

4. Significance and Use

4.1 By definition, the tensile strength of manufactured graphite is obtained by the direct uniaxial tensile test (Test Method C749). The C749 tensile test specimen is relatively large and is frequently incompatible with available irradiation capsule volumes,

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.F0 on Manufactured Carbon and Graphite Products.

Current edition approved ~~Nov. 1, 2019~~May 1, 2020. Published ~~November 2019~~June 2020. Originally approved in 2019. Last previous edition approved in 2019 as D8289 – 19. DOI: ~~10.1520/D8289-19.~~10.1520/D8289-20.

[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.

***A Summary of Changes section appears at the end of this standard**

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States

or oxidation apparatus (Test Method D7542). The splitting tensile test provides an alternate means of testing tensile properties on specimens that have severe geometric constraints and otherwise cannot meet the prescribed testing geometries of Test Method C749. By loading a disc-shaped specimen, on edge, under a compressive load, the resulting tensile stresses transverse to the loading axis provide an indication of the tensile strength properties of graphite. To obtain consistent and meaningful values of a splitting tensile strength, it is vital that the fracture initiate in the center of the disk and not along an edge. This standard test helps to ensure that the disk specimens break diametrally along the loading diameter due to tensile stresses that are perpendicular to the loading axis and that the fracture initiates at the center of the disk.

4.2 The stress determined using the diametral compression test is the maximum tensile stress at the center of the disk when loaded under the prescribed conditions and the fracture initiates at the center of the disk. It should be understood that this tensile stress value is obtained with the specimen in a complex biaxial stress condition. When the test is performed carefully and consistently these tensile stress values are comparable to each other, but the performers of this test should validate the values obtained. Any bias when comparing values with this standard to the uniaxial tensile stress values obtained using Test Method C749 should be identified and reported. Validation shall be performed on the same material and may not be applicable to other states of the same material (for example, oxidized, irradiated). Guidance on small specimen testing can be found in Guide D7775.

5. Apparatus

5.1 *Loading Device,* to apply and measure an axial compressive load on the specimen (Fig. 1) of sufficient capacity and to apply the load at a rate conforming to the requirements in 8.3. The load cell/device shall be calibrated at suitable time intervals in accordance with Practices E4 and shall comply with the requirements prescribed therein.

5.2 *Bearing Surfaces*—The testing machine shall be equipped with two curved tool steel bearing blocks (Fig. 2).

5.2.1 *Curved Bearing Blocks*—Must be used to reduce the contact stresses between the bearing blocks and the specimen. The radius of curvature of the supplementary bearing blocks shall be designed such that their arc of contact with the specimen shall be 30° and such that the width of contact (*F* in Fig. 2) is less than *R*, where *R* is the radius of the specimen (Fig. 2).

5.2.2 *Spherical Seating*—One of the compressive machine platens (Fig. 1) upon which the bearing blocks are situated should be spherically seated in order to facilitate correct load train alignment.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

5.3 *Fixture Design*—The test fixture shall be similar to that shown in Fig. 2.

5.4 *Fixture Dimensions*—Dimensions are given in Table 1 for fixture sizing appropriate for the specimen dimensions in Table 2. These dimensions maintain the critical 30° of specimen contact arc. An illustration of the loading fixture is given in Fig. 3.

6. Sampling

6.1 The specimens shall be selected from the billet(s) to obtain a representative strength for the grade and orientation of the graphite under consideration.

ASTM D8289-20
https://standards.iteh.ai/catalog/standards/sist/0ee5ba98-79ad-44b6-9abd-9982c7f78264/astm-d8289-20

7. Test Specimens

7.1 The ~~diameter of the specimen shall be at least two times greater than the graphite fracture process zone largest dimension. The process zone size is calculated from the fracture toughness, K~~minimum specimen diameter is 6 mm. Specimen ~~$_{Ic}$, measured according to Test Method D7779. Acceptable specimen geometries that are bounded by~~ geometries used in the intra-laboratory study are given in Table 2. Note the thickness values represent the maximum allowed thickness for the corresponding diameter.

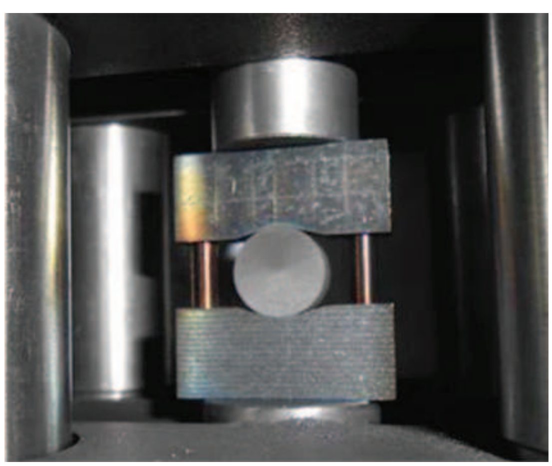

FIG. 1 Proposed Testing Setup for Splitting Tensile Strength

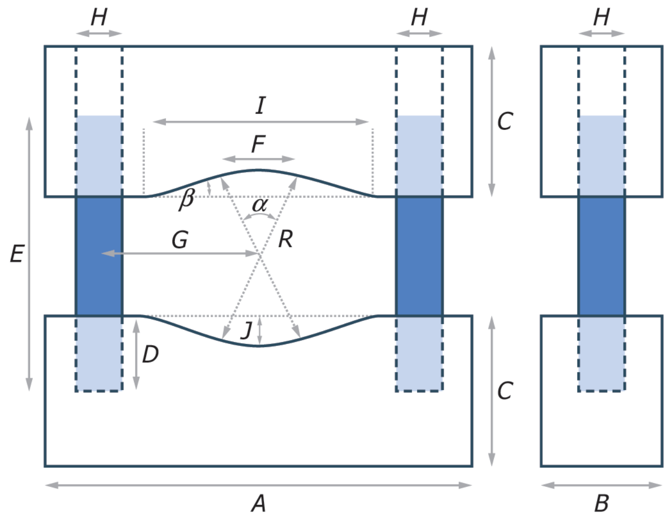

FIG. 2 Loading Fixture Diagram

TABLE 1 Fixture Dimensions That Maintain a 30° Contact Angle Suitable for the Specimen Geometries in Table 2

Designation	Fixture Dimensions, mm			
Specimen Diameter	6	8	10	12.7
R	3	4	5	6.35
A	30	30	30	30
B	10	10	10	10
C	12	12	12	12
D	5	5	5	5
E	17	17	17	17
F	1.55	2.07	2.59	3.29
G	10	10	10	10
H	5	5	5	5
I	11.99	12.25	12.51	12.87
J	1.5	1.5	1.5	1.5
α	30°	30°	30°	30°
β	15°	15°	15°	15°

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D8289-20
https://standards.iteh.ai/catalog/standards/sist/0ee5be88-70ad-44b6-8ebd-9982c7f78264/astm-d8289-20

TABLE 2 Acceptable Specimen Geometries

Specimen Dimensions	
Diameter, mm	Thickness, mm
6	3
8	4
10	5
12.7	6.35

7.2 *Number of Specimens*—At least six specimens shall be tested to obtain a meaningful average value. If the reproducibility of the test results is good (coefficient of variation less than 5 %), a smaller number of specimens may be acceptable.

7.3 The test specimen shall be a (button-type) right cylinder with ends machined to yield planar and parallel faces. These faces shall be perpendicular to the cylindrical surface to within 0.025 mm (0.001 in.) of diameter total indicator reading. All surfaces shall have a surface finish visually comparable to 0.8 µm (32 µin.) rms or better. Reasonable care should be exercised to ensure that all edges are sharp and without chips or other flaws.

7.4 Determine the thickness and diameter of the specimen to the nearest 0.25 % of the dimension. The thickness shall be based on the average of at least three measurements, one of which shall be at the center of the disk. The diameter shall be the average of at least two measurements taken at perpendicular locations.

7.5 The moisture conditions of the specimen at the time of test can have a significant effect upon the indicated strength of the graphite. Dry the specimens for 1 h at a minimum of 130 °C. If the tests are not immediately carried out following specimen drying, it is recommended the cleaned and dried specimens be stored in a desiccator.

8. Procedure

8.1 *Marking*—A reference mark on the specimen can aid in the desired orientation of the specimen. This reference mark can also be used during dimensional measurements. These reference marks should in no way damage the surface of the specimen. If

FIG. 3 Illustration of the Loading Fixture

the graphite grade being tested is anisotropic, take care to ensure that the grain orientation is known with respect to the mark. The reference line on each specimen shall refer to the same orientation.

8.2 *Positioning:*

8.2.1 *Loading Fixture*—Position the loading fixture in the center of the spherically seated platen to within 1.25 mm (0.05 in.).

8.2.2 *Specimen Alignment*—Ensure that the specimen is oriented to within 10° of the appropriate reference mark with the axis perpendicular to the loading direction, this being the direction of tensile loading and the orientation of record. The specimen's alignment is critical in the case of anisotropic graphite but is not important for isotropic graphite where $\sigma_{AG} = \sigma_{WG}$.

8.3 *Loading*—Apply the load continuously, at a constant rate of crosshead or platen movement, and without shock until ultimate failure. Choose the rate of movement so that average rupture time is greater than 30 s.

8.4 *Fracture Orientation*—The fracture, if visible, should occur in the vertical plane initiating from the center of the specimen as seen in Fig. 3.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D8289-20
https://standards.iteh.ai/catalog/standards/sist/...-44b6-9abd-9982c7f78264/astm-d8289-20

9. Calculation

9.1 Calculation of the estimated maximum tensile stress follows Awaji[3] and Hondros[4]:

$$\sigma_{sts} \approx \frac{P}{\pi LR}\left[1-\left(\frac{b}{R}\right)^2\right] \tag{1}$$

9.2 Using the 30° included angle as in the anvil design described in this standard results in:

$$\sigma_{sts} \approx 0.931\frac{P}{\pi LR} \tag{2}$$

where:

σ_{sts} = splitting tensile strength, MPa (psi),
P = maximum applied load indicated by the testing machine, N (or lbf),
L = thickness of the specimen, mm (or in.),
D = diameter of the specimen, mm (or in.),
b = circumference of contact length, mm (or in.), and
R = specimen radius, mm (or in.).

10. Report

10.1 The report shall include as much of the following as possible:

10.1.1 Source of the specimen, including: manufacturer's name and graphite grade number, forming method, billet number, orientation of the specimen to billet's forming axis (that is, WG or AG or no preferred grain orientation).

10.1.2 Dates of sampling and testing.

10.1.3 Specimen diameter and thickness.

10.1.4 Rate of loading or deformation rate.

[3] Awaji, H. and Sato, S., "Diametral Compressive Stress Considering the Hertzian Contact," *Journal of the Society of Materials Science, Japan*, Vol 27, 1978, pp. 336–341.

[4] Hondros, G., "The Evaluation of Poisson's Ratio and Young's Modulus of Materials of a Low Tensile Resistance by the Brazilian Test," *Australian Journal of Applied Science*, 1959.