Designation: B294 – 17

Standard Test Method for Hardness Testing of Cemented Carbides[1]

This standard is issued under the fixed designation B294; 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 hardness testing of cemented carbides by use of a Rockwell hardness tester performing tests in the Rockwell HRA scale (regular scale, diamond indenter, 10 kgf (98.07 N) preliminary test force, and 60 kgf (588.4 N) total test force in the range of Rockwell 80 HRA and above. Also covered are the procedures for the testing and selection of diamond indenters, the management and traceability of the four levels of standardized test blocks, and the making and calibration of Primary, Secondary, and Working standardized test blocks.

1.2 The Rockwell hardness tester is a convenient and reliable means of measuring the hardness of cemented carbides. A hardness value is obtained easily, but it is subject to considerable error unless certain precautions are observed.

1.3 The latest version of Test Methods E18 shall be followed except where otherwise indicated in this test method.

1.4 The values stated in SI units are to be regarded as standard except that force and length values associated with the Rockwell hardness testers will comply with E18 with force values specified as N (kgf) and indenter length values specified as mm.

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]

E18 Test Methods for Rockwell Hardness of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *ISO Standards:*[3]

ISO/IEC 17011 Conformity Assessment—General Requirements for Accreditation Bodies Accrediting Conformity Assessment Bodies

ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

3. Significance and Use

3.1 Rockwell hardness testing is one of the more important methods used to evaluate cemented carbides. For compositional groups of cemented carbides, hardness is an indication of wear resistance and toughness. Lower hardness grades usually indicate less wear resistance but greater toughness. For a specific grade of cemented carbide, hardness is an indication of the metallurgical quality of the material. In no case is Rockwell hardness testing the only test method to be considered in evaluating cemented carbides.

4. Principles of Test Apparatus

4.1 *Tester*—All hardness tests shall be performed using a Rockwell hardness tester that meets the requirements defined in the latest version of Test Method E18 except where otherwise indicated in this test method. Testers shall comply with the requirements of Annex A3 of this test method.

4.2 *Scale*—All tests shall be performed using the carbide Rockwell HRA scale (a carbide diamond indenter, 10 kgf (98.07 N) preliminary force, and 60 kgf (588.4 N) total test force.

4.3 *Effect of Vibration*—The Rockwell hardness tester should be located in a vibration-free area in order to avoid

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

erroneous results. If this is not possible, the tester shall be mounted so as to minimize vibrations, since vibrations tend to cause erratic readings.

4.4 *Indenter*—The indenters used shall conform to the requirements defined in Annex A2 of this test method.

4.5 *Anvils*—Select an anvil suitable for the specimen to be tested. The test piece should be supported rigidly, with the test surface perpendicular to the line of travel of the indenter. For the best accuracy, flat test pieces should be tested on a flat spot anvil of approximately 6-mm diameter. The surface of the anvil that contacts the sample should have a Rockwell hardness of at least 58 HRC, and shall be polished smooth and be free of pits and heavy scratches that could affect the test results. The mounting surface of the anvil support and the mating surface of the anvil should be clean. Dust, dirt, grease, or scale should not be allowed to accumulate on any part of the apparatus, as this will affect the results. Seat the anvil securely.

4.6 *Test Blocks*—Standardized test blocks used to verify the performance of the tester shall comply with the requirements in Annex A1 of this test method.

5. Test Specimens

5.1 *Size of Specimens*—A minimum thickness of 1.6 mm is recommended. With thinner specimens, breakage may occur, resulting in damage to the anvil, the indenter, or both. Specimens that have enough overhang to cause imbalance shall be supported properly. The 6-mm anvil will support flat test specimens up to approximately 113 g and will also support the standard test blocks recommended previously.

5.2 *Preparation of Test Specimens:*

5.2.1 The finish of the test surface is of major importance. The surface to be tested should be prepared to obtain a roughness of Ra ≤0.2 µm. A coarser finish will provide a wider range of readings. Preparation shall be conducted in such a way that alteration of the surface due to heat or cold-working is minimized. A 220-grit medium hardness resinoid bond diamond wheel, downfed 0.01 mm per pass with abundant flow of coolant, should provide the desired surface. The thickness of the layer removed from an as-sintered surface to be tested shall be not less than 0.2 mm.

5.2.2 The test and anvil surfaces of the test specimen shall be parallel within 0.01 mm/mm in general practice, but within 0.001 mm/mm when critical comparisons are being made. The surface in contact with the anvil shall be free of any irregularity (for example, a previous hardness indentation). Taper that results in the test surface not being normal to the axis of the indenter, or irregularity that causes instability during the test, will result in error.

5.2.3 When determining the hardness of a test specimen with a curved surface, the radius of curvature shall not be less than 15 mm. If less, then a flat surface at least 3 mm wide shall be prepared on which to conduct the test, and there shall be an opposite flat surface such that the specimen conforms to the requirements of 5.2 and 5.3. If the test surface is curved or the opposite surface must be supported in a V-anvil, the repeatability and reproducibility limits of 8.2 and 8.3 may not apply.

5.3 *Preparation of Mounted Carbides*—Remove mounted carbides from the steel body by heating or some other convenient method. All braze metal or other bond material shall be removed from both the test surface and the opposite face. The specimen should then be prepared as described in 5.1 and 5.2.

6. Procedure

6.1 Rockwell hardness tests should be carried out at an ambient temperature within the limits of 10 to 35°C. Users of the Rockwell hardness test are cautioned that the temperature of the test material and the temperature of the hardness tester may affect test results. Consequently, users should ensure that the test temperature does not adversely affect the hardness measurement.

6.2 Procedures that are not described in this test method shall conform to those of Test Method E18.

6.3 Disregard the first two readings after an indenter or anvil has been newly mounted.

6.4 *Test Cycle Time*

6.4.1 The application time for the additional test force (major load) shall be 2 to 6 s.

6.4.2 The total test force (major load) shall be maintained for 2 to 4 s.

NOTE 1—On manual machines, the abrupt actuation of the total test force (major load) application trip lever may affect the hardness value obtained. In addition the abrupt actuation of the total test force (major load) removal lever may significantly affect the hardness value obtained.

6.5 The Rockwell HRA hardness value is read after the total test force (major load) has been removed and while the preliminary test force (minor load) is still applied.

6.6 Hardness should be read or estimated to at least the nearest 0.1 HRA. Calculations should be carried to two decimal places.

6.7 The distance between the centers of any two adjacent indentations, and the distance between the center of any indentation and the edge of a test specimen, shall be at least 1.5 mm.

6.8 Make two trial determinations of the hardness of the test specimen. This action also reassures that the indenter is seated properly. Disregard the results and perform the following steps.

6.8.1 Select a standardized test block that complies with Annex A1 having a value closest to the trial hardness of the test specimen. Determine the Rockwell HRA hardness at three points on the block.

6.8.2 If the arithmetic mean of the three determinations differs from the certified hardness value of the standardized test block by more than ±0.5 HRA, check the diamond indenter and the testing equipment, and eliminate the cause of the error. Repeat the determinations.

6.8.3 If the arithmetic mean of the three determinations differs from the certified hardness value of the standardized test block by ±0.5 HRA or less, record the difference, giving due regard to the algebraic sign. This difference will be used to correct the arithmetic mean of the hardness of the test specimens.