Designation: B934 – 21

Standard Test Method for Effective Case Depth of Ferrous Powder Metallurgy (PM) Parts Using Microindentation Hardness Measurements[1]

This standard is issued under the fixed designation B934; 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 a procedure for determination of the effective case depth of powder metallurgy (PM) parts.

1.2 A microindentation hardness traverse procedure is described to determine effective case depth. This test method may be used to determine the effective case depth for all types of hardened cases.

1.3 The procedure for determining the microindentation hardness of powder metallurgy materials, as described in Test Method B933, shall be followed.

1.4 *Units*—With the exception of the unit for density, for which the grams per cubic centimeter unit is the long-standing industry practice, the values in SI units are to be regarded as 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]

B243 Terminology of Powder Metallurgy

B933 Test Method for Microindentation Hardness of Powder Metallurgy (PM) Materials

E384 Test Method for Microindentation Hardness of Materials

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *MPIF Standard:*[3]

Standard 70 Guide to Sample Preparation of Ferrous Powder Metallurgy (PM) Materials for Cross-Sectional Metallographic Evaluation

3. Terminology

3.1 Definitions of powder metallurgy (PM) terms can be found in Terminology B243. Additional descriptive information is available under "General Information on PM" on the ASTM B09 web page.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *case, n*—that portion of a part, extending inward from the surface that has a microindentation hardness, after hardening, equal to or greater than a specified hardness.

3.2.2 *effective case depth, n*—perpendicular distance from the surface of the hardened case to the furthest point where a microindentation hardness value equivalent to 50 HRC is maintained, unless otherwise specified.

4. Summary of Test Method

4.1 The powder metallurgy part is sectioned and the surface prepared for examination. Microindentation hardness measurements are taken at various depths below the part surface. The distance where the microindentation hardness falls below the equivalent of 50 HRC is defined as the effective case depth, unless otherwise specified.

5. Significance and Use

5.1 The engineering function of many PM parts may require an exterior portion of the part to have a specified case depth and microindentation hardness. Measurement of effective case depth is used to determine the depth to which the microindentation hardness of the exterior portion of a part has been increased over that of the interior of the part.

[1] This test method is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.05 on Structural Parts.

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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 Metal Powder Industries Federation (MPIF), 105 College Rd. East, Princeton, NJ 08540, http://www.mpif.org.

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

6. Apparatus

6.1 *Knoop or Vickers Hardness Indenters,* using 100 gf (0.9807 N) loads are recommended following Test Method E384. The type of hardness indenter and load used shall be agreed upon between customer and producer.

6.2 *Calibrated Optical Instrument, Micrometer Stage,* or other suitable means to measure the distance from the surface of the part to the center of the impression with a precision of 0.025 mm.

7. Test Specimen

7.1 Cut a test specimen from the PM part, perpendicular to the hardened surface at a specified location, being careful to avoid any cutting or grinding procedure that would affect the original microindentation hardness.

7.2 Mounting of the test specimen is recommended for convenience in surface preparation, edge retention, and microindentation hardness measurement. Edge retention is important for proper depth measurement of the case.

7.3 Guidelines for grinding and polishing specimens are provided in MPIF Standard Guide 70. The area to be traversed should be polished so the microindentation hardness impressions are unaffected, that is, the lighter the indenter load, the finer the finish necessary. Care should be taken to ensure that the true area fraction of porosity is revealed throughout the entire cross-section of the specimen. It is essential in surface preparation to remove all smeared metal and to identify pores clearly so that they may be avoided during testing.

7.4 The specimen should be lightly etched prior to microindentation hardness testing. Careful etching is necessary as heavy etching obscures features and interferes with the measurement of the diagonals of the indentation.

7.5 For heat treated steels, swabbing with or immersion in 2 % nital for 4 to 7 s gives an appropriate structure.

8. Procedure

8.1 Measure microindentation hardness at a series of known intervals from the surface of the test specimen toward the interior. Take a minimum of three acceptable microindentation hardness measurements at each depth. Space the indentations so that adjacent tests do not interfere with each other. The minimum spacing between tests is illustrated in Fig. 1. Use a calibrated optical instrument, micrometer stage, or other suitable means to measure the distance from the surface of the part to the center of the impression.

8.2 Microindentation impressions should not be placed in soft regions such as copper or the center of nickel-rich regions. Randomly encountered upper bainite or fine pearlite in the martensite should not be excluded as a measurement location.

8.3 Plot microindentation hardness versus distance from the part surface (see Fig. 2). The effective case depth shall be the distance at which the microindentation hardness falls below the equivalent of 50 HRC unless a different value is specified (see Note 1). Plot definition will dictate the required number of readings, particularly in the critical region of effective case depth. The procedure described in Appendix X1 of Test Method B933 shall be used for conversion to HRC.

NOTE 1—No compositional change occurs in induction hardened materials. The hardness of martensite is affected by the carbon content of the steel. Some lower-carbon steels will not reach the equivalent of 50 HRC when fully hardened. All concerned parties should agree upon the specified effective case depth hardness if other than 50 HRC.

NOTE 2—For routine quality control testing, where the effective case depth is reasonably well known, a somewhat simplified method of estimating effective case depth may be used. This method makes the assumption that the curve that represents microindentation hardness versus depth below the surface of the part may be regarded as a straight line in the region of the effective case-hardened depth. Microindentation hardness may be measured at two depths from the surface selected, such that, on the basis of past experience, one will be less than the estimated effective case-hardened depth and one will be greater. The two depths selected should lie at about equal distances from the estimated effective

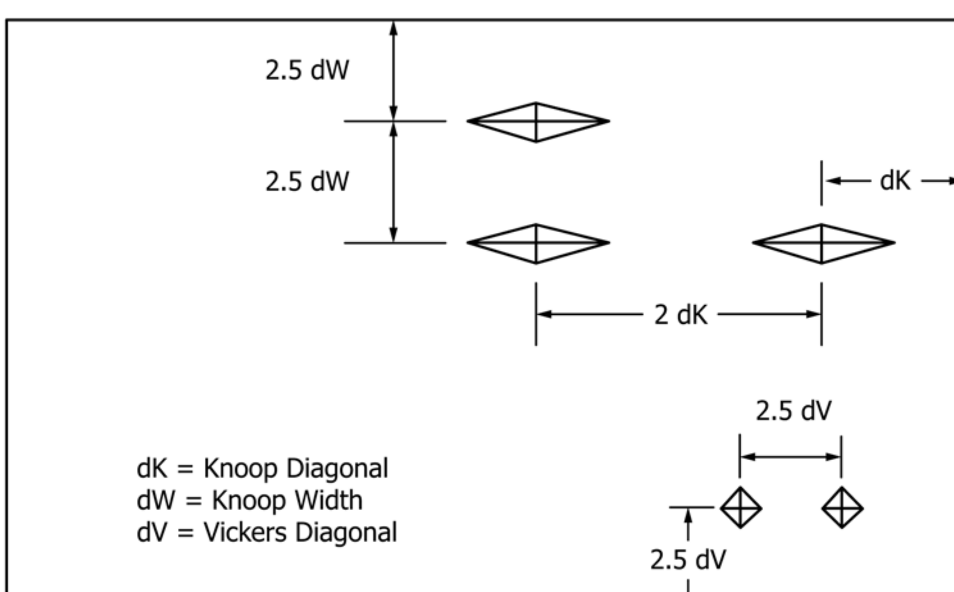

FIG. 1 Minimum Spacing between Indentations