



Designation: B887 – 24

Standard Test Method for Determination of Coercivity (Hcs) of Cemented Carbides¹

This standard is issued under the fixed designation B887; 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 determination of magnetization coercivity (Hcs) of cemented carbide materials and products using coercive force instrumentation. It is patterned after ISO 3326.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *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.*

1.4 *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

[A340 Terminology of Symbols and Definitions Relating to Magnetic Testing](#)

[B243 Terminology of Powder Metallurgy](#)

[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](#)

2.2 ISO Standard:³

[ISO 3326 Hardmetals - Determination of \(the Magnetization\) Coercivity](#)

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 B09.06 on Cemented Carbides.

Current edition approved Feb. 1, 2024. Published February 2024. Originally approved in 1998. Last previous edition approved in 2019 as B887 – 12 (2019). DOI: 10.1520/B0887-24.

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>.

3. Terminology

3.1 Definitions:

3.1.1 For definition of terms used in this procedure refer to Terminology [A340](#) and Terminology [B243](#).

3.1.2 *dc*—direct current.

4. Summary of Test Method

4.1 A test sample is positioned in the dc magnetic field of the test apparatus and magnetized to technical saturation. The magnetic field polarity is then reversed and the test sample is demagnetized by increasing the energy of the reversed magnetic field until the test sample reaches zero magnetism. The coercive force (Hc) is the magnetizing force required to return the saturated magnetic induction to zero.

5. Significance and Use

5.1 Measurement of coercivity provides a relative comparison of carbide grain size, binder content, and possibly carbon deficiency for a given graded carbide material or product, and may be employed as a non-destructive measurement indicating deviation from a specified norm.

5.2 This test method allows the non-destructive estimate of average carbide grain size in sintered cemented carbide hardmetals. It is appropriate for a wide range of compositions and tungsten carbide (WC) WC grain sizes, and can be used for acceptance of material or product to specification.

6. Interferences

6.1 Hcs measurement is a non-destructive “bulk” measurement that is averaged over the specimen volume. Bi-modal grain size distributions will give approximately the same Hc value as would be obtained from a normal grain size distribution about the same mean value.

6.2 Large test specimens must be sized to fit within the magnetic field coil spacing available for the apparatus employed.

6.3 Small test specimens may be immeasurable if their size prohibits detection by the magnetic field coils for the apparatus employed.

6.4 Specimen shape, that is, symmetry and aspect ratio, influence Hc measurement values and repeatability of results. Test specimens should be positioned with their long axis in the

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

direction of the magnetic field. Asymmetrically shaped test specimens should be tested in several positions, the measurement values recorded, and the average value reported.

6.5 Compositional variation of the binder in hardmetal due to cooling rate can affect Hc. For instance, formation of Co₃W precipitate in the binder phase during aging of hardmetal after fast cooling can significantly change Hc of the material.

6.6 Difference in contiguity of hard particles in hardmetal can affect Hc. For instance, two materials with different WC/WC contiguity but similar WC grain size will have different interphase areas and different Hc values.

6.7 Deformation and residual stresses affect Hc. Deformed hardmetal shows a significant increase in Hc due to deformation of its binder phase. Tumbling which is a standard method used for imparting residual stress into hardmetal, increases Hc.

7. Apparatus

7.1 Instrumentation capable of the dc magnetization of appropriately sized test samples to technical saturation and accurate measurement of the energy required to restore the magnetic induction to zero.

8. Standards

8.1 No certified cemented carbide standards, powder materials or sintered product, are available for Hc measurement. Most common practice is the development of (internal) reference materials representative of the test samples being evaluated.

8.2 Soft magnetic material (50 percent Ni – 50 percent Fe alloy) with low Hc and hard ferromagnetic material with high Hc are recommended for calibrating the instrument.

9. Procedure

9.1 For commercial instrumentation, refer to the equipment operators manual and follow the manufacturer's operating instructions.

9.2 Position the test sample in the center of the magnetic field. The test sample should be positioned with its long axis in the direction of the magnetic field (see 6.4).

9.3 Magnetize the test sample to technical saturation.

9.4 Reverse the magnetic field polarity and demagnetize the test sample to zero.

9.5 Record the Hc measurement, that is, energy required to demagnetize the test sample.

9.6 Replicate measurement of the same test sample shall be made, reversing the polarity of the saturation and demagnetizing magnet fields, where possible.

9.7 For asymmetric sample shapes, repeat measurements shall be made by repositioning the specimen in the dc magnetic field of the instrumentation with consideration being given to the shape, that is, symmetry of the test sample, and to its aspect ratio, that is, length versus width.

10. Report

10.1 Report the following information:

10.1.1 Test sample identification,

10.1.2 Average Hcs coercivity (amp per metre (A/m) or oersteds), and

10.1.3 Range of measured Hc values, especially for replicate measurements of asymmetric sample shapes.

11. Precision and Bias

11.1 The precision of this test method is based on an interlaboratory study of ASTM B887- Standard Test Method for Determination of Coercivity (Hcs) of Cemented Carbides, conducted in 2010. Three laboratories participated in this study, recording the coercivity on three specimens each, of ten different materials. This procedure was performed three times on each material in order to determine the precision of the test method. Every "test result" represents an individual observation. Except for the limited number of participating laboratories, Practice E691 was followed for the design and analysis of the data.⁴

11.1.1 *Repeatability limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "r" value for that material; "r" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

11.1.1.1 Repeatability limits are listed in Table 1 below.

11.1.2 *Reproducibility limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "R" value for that material; "R" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

11.1.2.1 Reproducibility limits are listed in Table 1 below.

11.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

11.1.4 Any judgment in accordance with statement 11.1.1 and 11.1.2 would normally have an approximate 95 % probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses.

⁴ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:B09-1018.

TABLE 1 Coercivity (Oe)

MATERIAL	Average ^A	sr	sR	r	R
10	56.0	0.0	0.0	0.0	0.0
5	78.0	0.0	0.0	0.0	0.0
2	128.6	0.5	0.5	1.3	1.5
7	154.2	0.5	0.5	1.3	1.3
4	221.3	0.5	0.5	1.3	1.4
6	238.3	0.6	0.6	1.6	1.6
3	297.0	0.7	0.7	2.1	2.1
1	322.6	28.4	28.4	79.4	79.4
8	442.0	15.9	15.9	44.7	44.7
9	563.1	1.0	2.2	2.8	6.1

^A The average of laboratories' calculated averages.

