



Standard Test Method for Determination of Magnetic Saturation (Ms) of Cemented Carbides¹

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1. Scope *

1.1 This test method covers the determination of magnetic saturation (Ms) of cemented carbide powder materials and sintered products using magnetic saturation induction test instrumentation.

1.2 The values stated in SI units are to be regarded as the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

A 340 Terminology of Symbols and Definitions Relating to Magnetic Testing²

B 243 Terminology of Powder Metallurgy³

E 1316 Terminology for Nondestructive Examinations⁴

3. Terminology

3.1 Definitions:

3.1.1 For definition of terms used in this procedure refer to Terminology A 340, Terminology B 243, and Terminology E 1316.

3.1.2 *dc*—direct current.

4. Summary of Test Method

4.1 A test specimen is statically positioned in the magnetic field generated by d-c coils or a permanent magnet and sensing coils of the test apparatus. The specimen is magnetized to induction saturation by the field and translated linearly that the intrinsic magnetic moment of the specimen's binder phase

induces a d-c current to flow in the sensing coils of the test apparatus. The induced current is proportional to the amount of magnetic binder phase present in the test specimen. Measurement of the induced current permits calculation of the intrinsic magnetic saturation of the test sample.

5. Significance and Use

5.1 This test method allows the non-destructive measurement of the magnetic fraction of the binder phase in cemented carbide powder materials and sintered product, and may be used as an indirect measure of the carbon level in the material or product.

5.2 Measurement of magnetic saturation provides a comparison of the relative fraction of magnetic binder phase that is, cobalt, nickel, or iron, present in the material and can be used for acceptance of product to specification.

5.3 Measurement of magnetic saturation can be used as a measure of the quality of powder material.

6. Interferences

6.1 No direct absolute measurement of magnetic saturation can be made. The measurement is a relative comparison of standard reference materials.

6.2 Measurement of magnetic saturation is a non-destructive "bulk" measurement which is averaged over the test specimen volume. The technique cannot be used to infer anything regarding the relative distribution of the binder phase within the test sample.

6.3 Measurement of magnetic saturation is affected by test sample size and shape, especially aspect ratio, and the composition of the binder phase, that is, a mixture of ferromagnetic elements of varying intrinsic magnetic moments

6.4 Small test samples or test samples containing relatively low concentrations of the binder phase may be immeasurable in that the low concentration prohibits detection by the field sensing coils of the specific apparatus employed.

7. Apparatus

7.1 Instrumentation capable of inducing magnetic saturation and then sensing the inherent intrinsic magnetic moment of the magnetic fraction of the binder phase.

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.

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² *Annual Book of ASTM Standards*, Vol 03.04.

³ *Annual Book of ASTM Standards*, Vol 02.05.

⁴ *Annual Book of ASTM Standards*, Vol 03.03.

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

7.2 Balance having a capacity of 200 g and a sensitivity of 0.001 g.

8. Standards

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

8.2 Pure ferromagnetic materials such as cobalt (Co), iron (Fe), or Nickel (Ni), and iron oxide, that is, Fe_3O_4 , with known magnetic moments are recommended for calibration of the instrumentation.

9. Test Specimen

9.1 Test specimens may be in the form of sintered solids, unsintered powder compacts, or encapsulated powders of a size suitable to fit into the specimen holder of the apparatus. The long axis of the specimen should be perpendicular to the magnetic field of the test apparatus.

10. Procedure

10.1 For commercial instrumentation, refer to the equipment manufacturers operating manual and follow operating instructions.

10.2 Obtain the mass of each test specimen.

10.3 Position the test sample in the center of the magnetic field/sensing coils.

10.4 Saturate the test specimen.

10.5 Remove/translate the test specimen in the sensing coils.

10.6 Read and record the value of the intrinsic magnetic saturation from the test apparatus. Measurement units are Tesla-m per kilogram (emu per gram (cgs)).

10.7 Relative percent of magnetic saturation of the test sample may be calculated and reported. Consideration must be

given to the composition of the binder phase with respect to ferromagnetic components, and the presence of other metallic constituents, for example, chromium (Cr) in the powder material or sintered product, that would affect the binder phase composition or magnetic moment of the constituents.

10.8 Repeat measurements can be made to obtain an average value and range of values for test specimens of asymmetric shape. Orientation of the test sample should be changed within the test apparatus sample chamber for each repeat measurement.

11. Report

11.1 Report magnetic saturation as Tesla- m^3 per kilogram (emu per gram), or as relative percent, (that is, magnetic portion of the binder phase/total mass of binder phase in test sample).

12. Precision and Bias

12.1 *Precision*—Measurement of magnetic saturation is a relative comparison against well characterized reference materials of similar composition and mass (see 8.1). No statement about precision can be made due to the effects of test specimen size and shape, variations in the binder phase composition that are within material or product specification, and the effect of variations of the carbon content of the test samples (see 6.3).

12.2 *Bias*—Measurement of magnetic saturation is a relative comparison against well characterized reference materials of similar composition and mass (see 8.1). No statement about bias can be made due to the affects of test specimen size and shape, variations in the binder phase composition that are within material or product specification, and the affect of variations of the carbon content of the test samples (see 6.3).

13. Keywords

13.1 cemented carbide; magnetic saturation (Ms)

SUMMARY OF CHANGES

Committee B09 has identified the location of selected changes to this standard since the last issue (B 886 – 98) that may impact the use of this standard.

(1) The use of a permanent magnet to induce saturation was added.

(2) The word “or” was added in Section 5.2. It has been determined that mixtures of nickel, cobalt, and iron in sintered carbides will produces alloys of various amounts whose intrinsic magnet moment is different than the sum of the

individual binder materials.

(3) The units were changed to SI units as the standard unit in Sections 10.6 and 11.

(4) The reference to vanadium affecting the magnetic moment of the binder material was removed, because vanadium does not affect magnetic saturation determinations.

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