



# Standard Practices for Production and Preparation of Powder Metallurgy (P/M) Test Specimens<sup>1</sup>

This standard is issued under the fixed designation B 925; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 These standard practices cover the specifications for those uniaxially compacted test specimens that are used in ASTM standards, the procedures for producing and preparing these test specimens, and reference the applicable standards.

1.2 Basic tool design and engineering information regarding the tooling that is required to compact the test specimens and machining blanks are contained in the annexes.

1.3 This standard is intended to be a comprehensive one-source document that can be referenced by ASTM test methods that utilize P/M test specimens and in ASTM P/M material specifications that contain the engineering data obtained from these test specimens.

1.4 These practices are not applicable to metal powder test specimens that are produced by other processes such as cold isostatic pressing (CIP), hot isostatic pressing (HIP), powder forging (P/F) or metal injection molding (MIM). They do not pertain to cemented carbide materials.

1.5 Detailed information on P/M presses, compacting tooling and sintering furnaces, their design, manufacture and use are not within the scope of these practices.

1.6 Test specimen and die cavity dimensions shown in inch-pound units are to be regarded as standard and are applicable to the referenced ASTM test methods and material specifications. Values in SI units are shown in parentheses and result from conversion in accordance with IEEE/ASTM Standard SI-10. They may be approximate and are only for information.

1.7 *This standard may involve hazardous materials, operations, and equipment. 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 34/A 34M Practice for Sampling and Procurement Testing of Magnetic Materials<sup>2</sup>
- A 341/A 341M Test Method for Direct-Current Magnetic Properties of Materials Using D-C Permeameters and the Ballistic Test Methods<sup>2</sup>
- A 596/A 596M Test Method for Direct-Current Magnetic Properties of Materials Using the Ballistic Method and Ring Specimens<sup>2</sup>
- A 773/A 773M Test Method for dc Magnetic Properties of Materials Using Ring and Permeameter Procedures with Electronic Hysteresigraphs<sup>2</sup>
- A 811 Specification for Soft Magnetic Iron Parts Fabricated by Powder Metallurgy (P/M) Techniques<sup>2</sup>
- A 839/A 839M Specification for Iron Phosphorus Powder Metallurgy (P/M) Parts for Soft Magnetic Applications<sup>2</sup>
- A 904 Specification for 50 Nickel-50 Iron Powder Metallurgy (P/M) Soft Magnetic Alloys<sup>2</sup>
- A 927/A 927M Test Method for Alternating-Current Magnetic Properties of Toroidal Core Specimens Using the Voltmeter-Ammeter-Wattmeter Method<sup>2</sup>
- B 215 Practices for Sampling Finished Lots of Metal Powder<sup>3</sup>
- B 243 Terminology of Powder Metallurgy<sup>3</sup>
- B 312 Test Method for Green Strength for Compacted Metal Powder Specimens<sup>3</sup>
- B 328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Metal Structural Parts and Oil-Impregnated Bearings<sup>3</sup>
- B 331 Test Method for Compressibility of Metal Powders in Uniaxial Compaction<sup>3</sup>
- B 438/B 438M Specification for Sintered Bronze Bearings (Oil-Impregnated)<sup>3</sup>
- B 439 Specification for Iron-Base Sintered Bearings (Oil-Impregnated)<sup>3</sup>
- B 528 Test Method for Transverse Rupture Strength of Metal Powder Specimens<sup>3</sup>
- B 595 Specification for Sintered Aluminum Structural Parts<sup>3</sup>
- B 610 Test Method for Measuring Dimensional Changes of

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.02 on Base Metal Powders.

Current edition approved April 10, 2003. Published June 2003.

<sup>2</sup> Annual Book of ASTM Standards, Vol 03.04.

<sup>3</sup> Annual Book of ASTM Standards, Vol 02.05.

Metal Powder Specimens<sup>3</sup>

- B 612 Specification for Iron Bronze Sintered Bearings (Oil-Impregnated)<sup>3</sup>
- B 715 Specification for Sintered Copper Structural Parts for Electrical Conductivity Applications<sup>3</sup>
- B 782 Specification for Iron Graphite Sintered Bearings (Oil-Impregnated)<sup>3</sup>
- B 783 Specification for Materials for Ferrous Powder Metallurgy (P/M) Structural Parts<sup>3</sup>
- B 817 Specification for Powder Metallurgy (P/M) Titanium Alloy Structural Components<sup>3</sup>
- B 823 Specification for Materials for Nonferrous Powder Metallurgy (P/M) Structural Parts<sup>3</sup>
- B 853 Specification for Powder Metallurgy (P/M) Boron Stainless Steel Structural Components<sup>3</sup>
- E 8 Test Methods for Tension Testing of Metallic Materials<sup>4</sup>
- E 9 Test Methods of Compression Testing of Metallic Materials at Room Temperature<sup>4</sup>
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials<sup>4</sup>
- E 23 Test Methods for Notched Bar Impact Testing of Metallic Materials<sup>4</sup>
- E 228 Test Method for Linear Thermal Expansion of Solid Materials with a Vitreous Silica Dilatometer<sup>2</sup>
- E 1876 Test Method for Dynamic Young's Modulus, Shear Modulus and Poisson's Ratio by Impulse Excitation of Vibration<sup>4</sup>

2.2 IEEE/ASTM Standard:

SI-10 Standard for Use of the International System of Units (SI): The Modern Metric System<sup>2</sup>

2.3 MPIF Standard:

Standard 56 Method for Determination of Rotating Beam Fatigue Endurance Limit in Powder Metallurgy Materials<sup>5</sup>

3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy terms can be found in Terminology B 243. Additional descriptive information is available in the Related Materials section of Vol 02.05 of the *Annual Book of ASTM Standards*.

4. Summary of Practice

4.1 These practices describe the production, by pressing and sintering metal powders, and the preparation, by machining sintered blanks, of test specimens used to measure properties of metal powders and sintered materials.

5. Significance and Use

5.1 Test specimens are used to determine the engineering properties of P/M materials, for example, tensile strength, ductility, impact energy, etc.; property data that are essential to the successful use of P/M material standards. Processing P/M test specimens under production conditions is the most efficient method by which to obtain reliable P/M material property data since in most cases it is impractical or impossible to cut test bars from sintered parts.

5.2 The performance characteristics of metal powders, for example, compressibility, green strength and dimensional changes associated with processing are evaluated using P/M test specimens under controlled conditions. The data obtained are important to both metal powder producers and P/M parts manufacturers.

5.3 P/M test specimens play a significant role in industrial quality assurance programs. They are used to compare properties of a new lot of metal powder with an established lot in an acceptance test and are used in the part manufacturing process to establish and adjust production variables.

5.4 In those instances where it is required to present equivalent property data for a production lot of P/M parts, standard test specimens compacted from the production powder mix to the same green density can be processed with the production P/M parts and then tested to obtain this information.

5.5 Material property testing performed for industrial or academic research and development projects uses standard P/M test specimens so the test results obtained can be compared with previous work or published data.

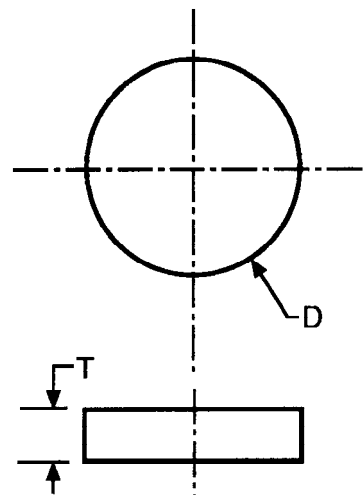
5.6 Powder metallurgy test specimens may have multiple uses. The dimensions and tolerances given in this standard are nominal in many cases. The user is cautioned to make certain that the dimensions of the test specimen are in agreement with the requirements of the specific test method to be used.

6. Powder Metallurgy Test Specimens

POWDER COMPRESSIBILITY TESTING

6.1 *Cylindrical Powder Compressibility Test Specimen:*

6.1.1 *Description and Use*—This solid cylindrical test specimen, see Fig. 1, is produced by compacting a test portion of powder mix in laboratory powder metallurgy tooling similar to that shown in Fig. A1.1 in the Annex. An alternative test specimen for measuring powder compressibility is the transverse rupture test specimen. These test specimens are not



	Dimensions	
	in.	mm
D—Diameter	1.00	25.4
T—Compact thickness	0.280 ± 0.010	7.11 ± 0.25

FIG. 1 P/M Cylindrical Powder Compressibility Test Specimen

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>5</sup> Available from MPIF, 105 College Road East, Princeton, NJ 08540.

sintered. The compressibility of the metal powder mix or a compressibility curve showing the green density as a function of compacting pressure is determined according to the procedures in Test Method B 331.

6.1.2 *Applicable ASTM Standards:*

6.1.2.1 See Test Method B 331.

**TRANSVERSE RUPTURE, DIMENSIONAL CHANGE AND GREEN STRENGTH TESTING**

6.2 *Transverse Rupture Strength Test Specimen:*

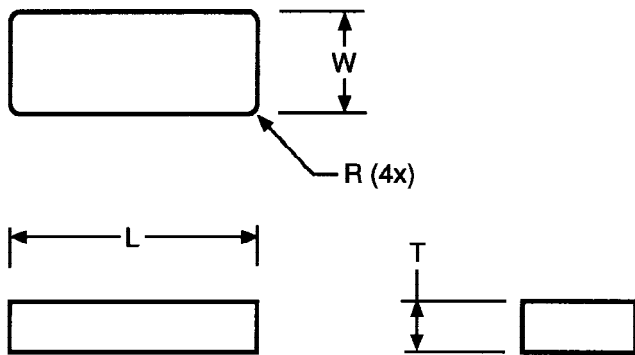
6.2.1 *Description and Use*—The pressed-to-size transverse rupture test specimen, Fig. 2, is produced by compacting metal powder in tooling similar to that shown in Fig A1.2.

6.2.1.1 This rectangular test specimen has multiple uses in P/M. Primarily, it is designed to determine the transverse rupture strength of sintered or heat treated compacts by breaking the test specimen as a simple beam in three-point loading following Test Method B 528. But, it is also used to measure the dimensional changes of metal powder mixes due to pressing and sintering or other processing steps according to Test Method B 610, and it is used in both a 0.250 and 0.500 in. (6.35 and 12.70 mm) thick version to determine green strength using the procedure in Test Method B 312.

6.2.1.2 It is an acceptable alternative test specimen to the cylindrical compact to determine powder compressibility according to Test Method B 331. The sintered or heat treated specimen may be used to generate data for the elastic constants. Young's Modulus is determined by impulse excitation of vibration and Poisson's ratio may then be calculated. This test specimen is also a convenient compact on which to measure macroindentation hardness after various processing steps.

6.2.2 *Applicable ASTM Standards:*

6.2.2.1 See the following Test Methods: B 312, B 331, B 528, B 610, E 18, and E 1876.



Dimensions

	in.	mm
W—Width	0.50	12.7
L—Length	1.25	31.8
R—Corner radius	0.01	0.3
T—Thickness (thin)	0.250 ± 0.005	6.35 ± 0.13
T—Thickness (thick)	0.500 ± 0.005	12.70 ± 0.13

NOTE—Thickness shall be parallel within 0.005 in. (0.13 mm).

FIG. 2 P/M Transverse Rupture Strength Test Specimen

6.2.2.2 See the following P/M Material Specifications: A 811, A 839/A 839M, A 904, B 783, and B 823.

**RADIAL CRUSHING TESTING**

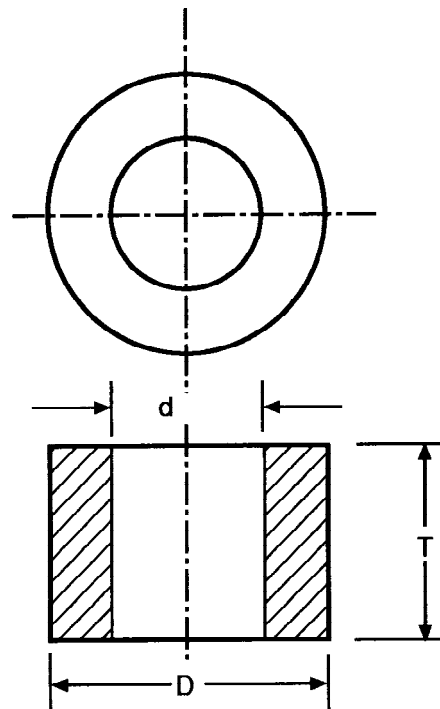
6.3 *Radial Crushing Strength Test Specimen:*

6.3.1 *Description and Use*—The radial crushing strength test specimen shown in Fig. 3 is compacted to size in tooling (Fig. A2.3) suitable for the production of a thin-walled hollow cylinder within the range of the dimensions listed. The testing procedure involves the application of a compressive force perpendicular to the central axis of the test cylinder and calculating the radial crushing strength from the breaking load and test specimen dimensions. Radial crushing strength is the material property that is used to quantify the mechanical strength of sintered metal bearings, (oil impregnated).

6.3.1.1 This test specimen is widely used in a quality control test to determine the sintered material strength of powder mixes that are to be used for the production of any metal powder product because it is a quick, easy test and gives reliable and reproducible results. Laboratories testing powder mixes intended for the manufacture of porous bearings have recognized that breaking an unsintered test specimen by diametrical loading will give a green strength value that is relevant in production.

6.3.2 *Applicable ASTM Standards:*

6.3.2.1 See the following P/M Bearing Specifications: B 438/B 438M, B 439, B 612, and B 782.



Dimensions

	in.	mm
D—Outside diameter	0.80 to 2.00	20 to 51
d—Inside diameter	0.50 to 1.00	13 to 25
T—Thickness	0.25 to 1.00	6 to 25

NOTE—Wall thickness (D-d) shall be less than D/3.

FIG. 3 P/M Radial Crushing Strength Test Specimen