Designation: B946 – 11 (Reapproved 2016)

Standard Test Method for Surface Finish of Powder Metallurgy (PM) Products[1]

This standard is issued under the fixed designation B946; 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 measuring the surface finish of powder metallurgy (PM) products at all stages of manufacturing from green compact to fully hardened finished component.

1.2 This test method provides the definition and schematic of some common surface finish parameters (R_a, R_p, and R_{zISO})

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

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

2.2 *MPIF Standard:*[2]

MPIF Standard 58 Method for Determination of Surface Finish of Powder Metallurgy Products

3. Significance and Use

3.1 The surface finish of a component may be critical for certain applications, affecting properties such as wear resistance, fatigue strength, and coefficient of friction.

3.2 Surface finish may also be critical for component assembly or system performance. Dimensional fit and mating surface interaction may require certain surface finish requirements to meet performance specifications.

4. Interferences

4.1 Because many conventional PM materials contain open porosity at the surface, special consideration should be taken when measuring surface finish.

4.2 The use of a conical point stylus may result in inaccurate or inconsistent surface finish results because the sharper point of the stylus may drop into open porosity on the surface of the component.

4.3 A chisel point stylus may be used for better accuracy and consistency.

4.4 Because the direction of pressing may cause directionality in surface finish values, the direction of measurement should be specified and reported.

5. Apparatus

5.1 *Surface Finish Measuring Instrument.*

5.2 *Stylus*—Chisel point, 0.050 in. (1.27 mm) length and 0.0004 in. ± 30 % (0.010 mm ± 30 %) tip radius as shown in Fig. 1. To limit the possibility of the stylus dropping into open surface porosity, a chisel point stylus is recommended. If a cone stylus is used, filtering software shall also be used to remove the influence of open surface porosity.

6. Sampling, Test Specimens, and Test Units

6.1 The test surface shall be clean and free of any oil, dirt, debris, or foreign material.

6.2 Sufficient surface area shall be available to permit multiple traverses by the measuring instrument.

6.3 The test surface shall be flat over a sufficient length (in accordance with instrument instructions) to allow proper movement of the stylus.

7. Procedure

7.1 The PM parts manufacturer and purchaser shall agree on the desired location and direction for surface finish measurement.

7.2 Place the surface finish instrument in a position suitable for measuring the test sample.

7.3 Zero and verify the instrument over the surface finish range expected for the test sample.

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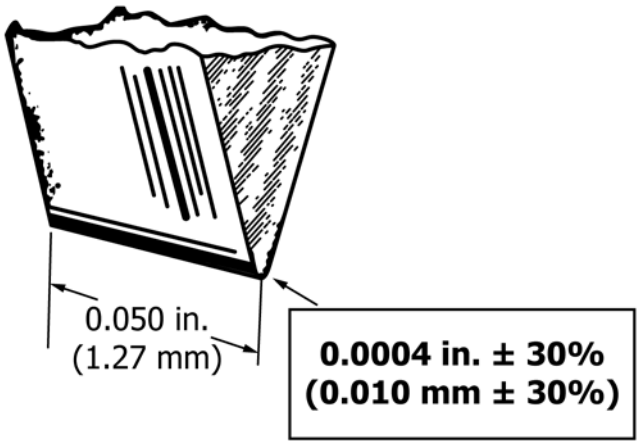
[2] Available from Metal Powder Industries Federation (MPIF), 105 College Rd. East, Princeton, NJ 08540, http://www.mpif.org.



Note 1–The stylus is chisel shaped and has a standard radius on the edge and is 0.050 in. (1.27 mm) wide so that it will not drop into the porosity of the P/M surface and give a false reading by measuring the cavities.

FIG. 1 Chisel Stylus for Surface Finish Measurement

7.4 Place the test sample under the stylus and then lower the stylus to the measuring position in accordance with the instrument instructions.

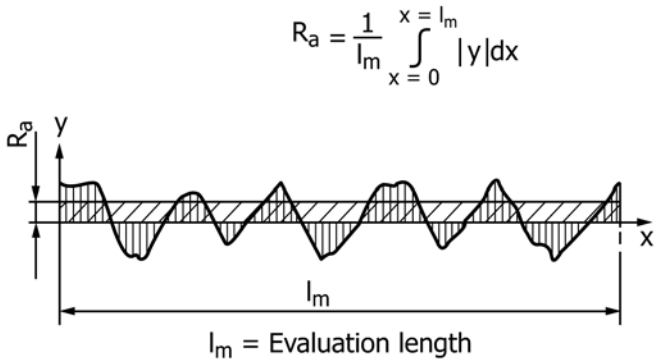
7.5 Measure the surface finish of the test surface. A minimum of three traverses at different locations is recommended.

8. Report

8.1 Report the surface finish to the nearest whole number in microinches (micrometres). Unless otherwise indicated, the surface finish shall be R_a (average surface roughness) (see Fig. 2). Depending on the type of instrument being used, other surface finish measures may also be reported.

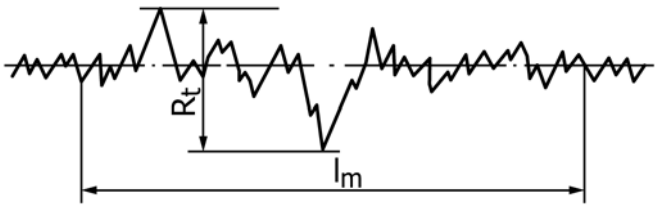
NOTE 1—R_t is the maximum peak-to-valley height over the tested length (absolute value between the highest and lowest peaks) as shown in Fig. 3. R_z is the ten-point height or the absolute value of the five highest peaks and five lowest valleys over the evaluation length as shown in Fig. 4. R_z is also known as the ISO ten-point height parameter.

8.2 If it has been specified, report the direction of measurement with respect to the pressing direction.



Note 2–The arithmetic average value of filtered roughness profile determined from deviations about the centerline within the evaluation length l_m.

FIG. 2 R_a Arithmetic Mean Roughness Value



Note 3–The maximum peak-to-valley height of the filtered profile over the evaluation length l_m, irrespective of the sampling lengths l_e.

FIG. 3 R_t Maximum Peak-to-Valley Height

9. Precision and Bias

The Precision for this standard was developed by the Metal Powder Industries Federation (MPIF) and is used herein with their permission.

9.1 *Precision*—The precision of this test has been determined from an interlaboratory study performed in 2007 in which 11 Metal Powder Industries Federation laboratories participated.

9.1.1 The repeatability (r) and reproducibility (R) measurements listed in Table 1 were determined according to Practice E691.

9.1.2 FLC2-4808 sinter-hardened transverse rupture test specimens with a sintered density of 6.94 g/cm3 and an apparent hardness of 45 HRC were used in the study. Each laboratory received a single TRS sample from this batch.

9.1.3 On the basis of test error alone, the difference in absolute value of two test results obtained in the same laboratory will be expected to exceed (r) only 5% of the time. If such a difference is found to be larger than (r), there is reason to question one or both results. Similarly, the difference in two test results obtained in different laboratories will be expected to exceed (R) only 5% of the time. If the difference is found to be larger than (R), there is reason to question one or both measurements.

9.1.4 The analysis is based on three measurements per surface using a length of travel that varied from 0.098 inch (2.49 mm) to 0.5 inch (12.7 mm). Some laboratories used the recommended chisel stylus, others used the conventional full radius stylus point and one laboratory provided data using both types of stylus.

TABLE 1 Precision of Surface Finish Measurements on Sinter-Hardened FLC2-4808 TRS Specimens

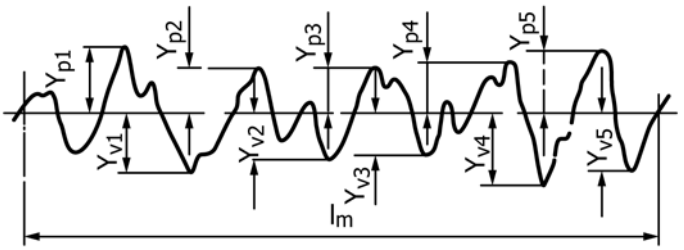
Surface Tested	Type of Stylus	Surface Finish	r	R
		microinch (micrometres)		
Punch Face	Chisel	66 (1.65)	8 (0.20)	19 (0.48)
Die Face	Chisel	26 (0.65)	29 (0.73)	40 (1.00)
Punch Face	Spherical	70 (1.75)	38 (0.95)	56 (1.40)
Die Face	Spherical	36 (0.90)	14 (0.35)	52 (1.30)

9.2 *Bias*—No information can be presented on the bias of the procedure in Test Method B946 for measuring surface finish because no material having an accepted reference value is available.

10. Keywords

10.1 PM; powder metallurgy; powder metallurgy parts; stylus; surface finish; surface roughness

$$R_{ZISO} = \frac{1}{5} \cdot \left(\sum_{i=1}^{5} |Y_{pi}| + \sum_{i=1}^{5} |Y_{vi}| \right)$$



Note 4–The average height difference between the five highest peaks and five lowest valleys contained within a chosen evaluation length.

FIG. 4 R_{zISO} Ten-Point Height