Designation: B797 – 15

Standard Test Method for Surface Finger-Oxide Penetration Depth and Presence of Interparticle Oxide Networks in Powder Forged (PF) Steel Parts[1]

This standard is issued under the fixed designation B797; 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 metallographic method for determining the maximum depth of surface finger-oxide penetration and the concentration of subsurface interparticle oxide networks in critical areas of powder forged steel parts.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Document

2.1 *ASTM Standards:*[2]

E3 Guide for Preparation of Metallographic Specimens

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *surface finger-oxides*—surface finger-oxides are surface oxides that follow prior particle boundaries into a powder forged part from the surface and cannot be removed by physical means such as rotary tumbling. Examples of surface finger-oxides are shown in Fig. 1.

3.1.2 *interparticle oxide networks*—interparticle oxide networks are continuous or discontinuous oxides that follow prior particle boundaries in powder forged parts. Examples of interparticle oxide networks are shown in Fig. 2.

4. Summary of Test Method

4.1 A section representing both surface and subsurface regions of a critical area is cut from the powder forged part and mounted for metallographic grinding and polishing.

4.2 For surface finger-oxide penetration, the polished and unetched sample is examined microscopically at a magnification of 400 to 500×. The maximum depth of penetration of surface finger-oxides is measured.

4.3 For interparticle oxide network concentration, the polished and unetched sample is examined microscopically at a magnification of 200 to 500× to determine the presence of interparticle oxide networks.

5. Significance and Use

5.1 The presence of surface finger-oxide penetration and interparticle oxide networks are two of the properties used to evaluate powder forged steel parts for proper processing. Maximum acceptable depths of penetration of surface finger-oxide penetration and acceptable concentrations of subsurface interparticle oxide networks depend on the component and its service environment.

5.2 Results of tests may be used to qualify parts for shipment.

6. Apparatus

6.1 Equipment for the metallographic preparation of test specimens.

6.2 A metallographic microscope permitting observation and measurement up to a magnification of 500×.

7. Sampling

7.1 A metallographic specimen shall be removed from the powder forged part to cover each designated critical area. Critical areas shall be defined by the applicable part drawing or the purchaser order. Specimens shall be taken from the powder forged part in the condition in which it is to be supplied. The

[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 B09.11 on Near Full Density Powder Metallurgy Materials.

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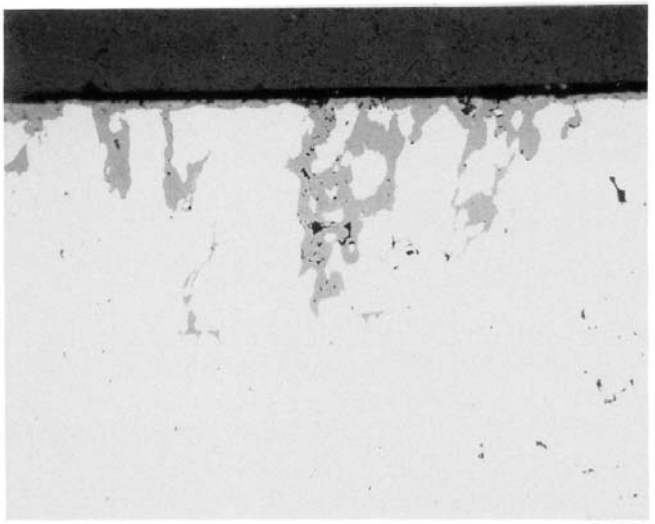
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

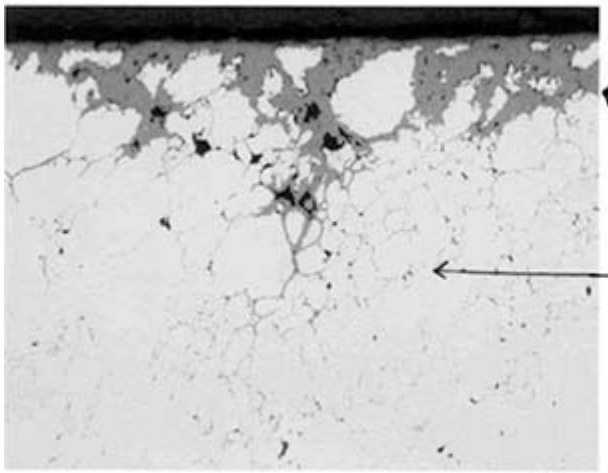
100X



400X

FIG. 1 Example of Surface Finger-Oxide Penetration Extending Inward from the Powder Forged Part Surface (Shown more clearly at high magnification.)

100X



200X

FIG. 2 Example of Interparticle Oxide Networks Within a Powder Forged Part (Shown more clearly at high magnification.)

polished surface of the specimens shall be parallel to the forging direction, that is, parallel to the direction of travel of the forging punch.

8. Procedure

8.1 *Preparation of Specimens*—In mounting the specimen for grinding and polishing, protection from rounding the edge of the part is essential. In polishing the specimen it is important that a clean polish be obtained and that edge detail of the part not be destroyed. Specimens shall be examined in the as-polished condition, free of the effects of any prior etching (if used). It is recommended that the procedures described in Methods E3 be followed. Automated grinding and polishing procedures are recommended.

8.2 *Measurement of Surface Finger-Oxide Penetration Depth*—Scan the perimeter of the metallographic specimen, initially at a magnification of 100×, and carefully examine each designated critical area at a higher magnification, for example, 400 to 500×. Measure the maximum depth of penetration of surface finger-oxides from the finished part surface in micrometres for each designated critical area.

8.3 *Measurement of Interparticle Oxide Network Concentration*—Scan the perimeter of the metallographic specimen at a magnification of 100×. Carefully examine each designated critical area at a higher magnification, for example, 200 to 500×. Record the presence of any interparticle oxide networks in the designated critical areas.

9. Report

9.1 The test report shall include the following information:

9.1.1 Identification of the part and location of the test specimen,

9.1.2 The maximum depth of penetration of surface finger-oxides from the finished part surface in micrometres for each designated critical area, and

9.1.3 The presence or lack of interparticle oxide networks in each designated critical area. If interparticle oxide networks are present, if possible, prepare a photomicrograph for record purposes and report the magnification used.

10. Precision and Bias

10.1 The precision of this test method is based on an intralaboratory study of ASTM B797, Standard Test Method for Surface Finger Oxide Penetration Depth and Presence of Interparticle Oxide Networks in Powder Forged (PF) Steel Parts, conducted in 2014. A single laboratory participated in this study, testing a powder forged connecting rod. Every "test result" represents an individual determination. The laboratory reported 20 replicate test results. Except for the use of only one laboratory, Practice E691 was followed for the design and analysis of the data; the details are given in ASTM Research Report No. B09-1023.[3]

10.1.1 *Repeatability (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

TABLE 1 Finger-Oxide Penetration Depth (µm)

	Average	Repeatability Standard Deviation	Repeatability Limit
	$\bar{x}$	S_r	r
PF Connecting Rod	53.3	0.98	2.7

10.1.1.1 Repeatability can be interpreted as maximum difference between two results, obtained under repeatability conditions, which is accepted as plausible due to random causes under normal and correct operation of the test method.

10.1.1.2 Repeatability limits are listed in Table 1 below.

10.1.2 *Reproducibility (R)*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

10.1.2.1 Reproducibility can be interpreted as maximum difference between two results, obtained under reproducibility conditions, which is accepted as plausible due to random causes under normal and correct operation of the test method.

10.1.2.2 Reproducibility limits cannot be calculated from a single laboratory's results. The reproducibility of this test method is being determined and will be available on or before December 2020.

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

10.1.4 Any judgment in accordance with statement 10.1.1 would normally have an approximate 95% probability of being correct. The precision statistics obtained in this ILS must not, however, be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of laboratories reporting replicate results essentially guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95% probability limit would imply. Consider the repeatability limit as a general guide, and the associated probability of 95% as only a rough indicator of what can be expected.

10.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

10.3 The precision statement was determined through statistical examination of 20 results, from a single laboratory, on a powder forged connecting rod.

10.4 The test method for interparticle oxide network concentration is a "go-no go" test designed to give a qualitative estimate. This method will be subject to sample preparation care and to interpretation.

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:B09-1023. Contact ASTM Customer Service at service@astm.org.

11. Measurement Uncertainty

11.1 The precision of Test Method B797 shall be considered by those performing the test when reporting surface finger-oxide penetration depth results.

12. Keywords

12.1 interparticle oxide networks; powder-forged (PF) steel parts; surface finger-oxides

SUMMARY OF CHANGES

Committee B09 has identified the location of selected changes to this standard since the last issue (B797–93(2007)) that may impact the use of this standard.

(1) Added a statement on units as subsection 1.2.
(2) Changed the magnification in subsections 4.2 and 8.2 from 400× to "from 400 to 500×."
(3) Changed the magnification in subsection 4.3 and 8.3 from "200 to 400×" to "from 200 to 500×."
(4) Changed the magnification in subsection 6.2 to 500×.
(5) Added, "…and report the magnification used" to subsection 9.1.3.
(6) Added a precision statement in Section 10.