



Designation: B577-93 (Reapproved 2004)^{ε1} Designation: B577 - 10

Standard Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper¹

This standard is issued under the fixed designation B577; 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.

This standard has been approved for use by agencies of the Department of Defense.

~~^{ε1}Note—Editorial changes were made throughout in October 2004.~~

1. Scope*

1.1 These test methods describe procedures for determining the presence of cuprous oxide (Cu_2O) in products made from deoxidized and oxygen-free copper.

1.2 ~~Units—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.~~

1.3 ~~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.~~

1.4 The test methods appear in the following order:

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	Sections
Microscopical Examination without Thermal Treatment	9-11
Microscopical Examination after Thermal Treatment	13-15
Closed Bend Test after Thermal Treatment	17-19
Reverse Bend Test after Thermal Treatment	21-23

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2. Referenced Documents

2.1 ~~ASTM Standards:~~²

E3 [Guide for Preparation of Metallographic Specimens](#)

E883 [Guide for Reflected Light Photomicrography](#)

3. Terminology

3.1 ~~Definitions—Definitions of Terms Specific to this Standard:~~

3.1.1 ~~deoxidized copper~~—material produced substantially free of cuprous oxide, by the use of metallic or metalloidal deoxidizers, as determined by metallographic examination at 75 \times under polarized light. Oxygen may be present as residual deoxidation products.

3.1.2 ~~embrittlement~~—the reduction of the normal ductility in a metal as a result of a physical or chemical change. As it relates to these test methods, embrittlement is the loss of ductility caused by the reaction of cuprous oxide in the copper material when exposed at elevated temperatures to a reducing atmosphere.

3.1.3 ~~oxygen-free copper~~ oxygen-free copper—electrolytic copper produced substantially free of cuprous oxide without the use

¹ These test methods are under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.06 on Methods of Test.

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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.

of metallic or metalloidal deoxidizers as determined by metallographic examination at 75× under polarized light. Oxygen may be present up to a maximum of 5 ppm in Copper UNS No. C10100 and 10 ppm in Copper UNS No. C10200.

4. Summary of Test Methods

4.1 The presence of cuprous oxide is determined either by microscopical examination under polarized light or by methods that involve heating the test specimens in a hydrogen-rich atmosphere and rapidly cooling the specimens without undue exposure to air followed by a microscopical examination or a suitable bend test.

5. Significance and Use

5.1 These test methods determine whether copper products will be resistant to embrittlement when exposed to elevated temperatures in a reducing atmosphere.

5.1.1 It is assumed that all who use these test methods will be trained personnel capable of performing these procedures skillfully and safely. It is expected that work will be performed in a properly equipped facility.

6. Apparatus

6.1 *Test Method A*—Metallographic equipment of the type described in Practice E3 and Guide E883 suitably equipped with a polarized light illuminating device.

6.2 *Test Methods B, C, and D*:

6.2.1 Metallographic equipment of the type described in Practice E3 and Guide E883 provided with normal illumination.

6.2.2 A furnace of sufficient capacity, capable of maintaining the required reducing atmosphere while the specimens are being heated. A rapid cooling device using either water or a reducing atmosphere is required.

6.2.3 A machinist vise with replaceable matching pairs of jaw mandrels of various radii contours.

7. Sampling

7.1 Sampling shall be in accordance with the requirements of the specification under which the material was ordered.

8. Test Specimens

8.1 Longitudinal specimens, that is, specimens whose axes are parallel to the direction of working are preferable. However, equally reliable results can be obtained with specimens in which the axis is perpendicular to the directions of working.

8.2 Specimens shall be of dimensions suitable for the performance of the required tests. Where necessary to cut a specimen from an oversize piece of material, at least one of the original surfaces of the material shall be retained in the test specimen. Suggested dimensions for test specimens are given in the following table (for Procedures C or D):

Wrought Products	Suggested Dimensions for Test Specimens
Flats (wire, strip, sheets, bar, and plate)	thickness—that of the product but should not exceed ½ in. (13 mm) width—approx. ½ in. (13 mm) length—approx. 6 in. (152 mm)
Shapes and forgings	To the extent that the dimensions of the material permit, the dimensions of the test specimens are those suggested for the flat products specimens. (Where the product dimensions, particularly length, as in the case of forgings, do not permit taking a specimen, the total product may then become the test specimen for examination by Procedures A or B.)
Wire or rod	diameter or distance between parallel surfaces—that of the product but not to exceed ½ in. (13 mm) length—approx. 6 in. (152 mm)
Tubular products: Diameter or distance between parallel surfaces: Up to ⅝ in. (8 mm), incl.	full section of tube, approx 6 in. (152 mm) long
Over ⅝ in. (8 mm) to 1 in. (25.4 mm), incl.	a slit half section of the tube, approx 6 in. (152 mm) long
Over 1 in. (25.4 mm)	a slit section approx ½ in. (13 mm) wide and 6 in. (152 mm) long taken either transverse or parallel to the tube axis
Refinery shapes	a 0.080-in. (2.03-mm) diameter wire specimen made by forging, swaging, hot rolling, and cold drawing as may be necessary

8.3 All specimens made by cutting from larger stock shall have their corners or edges deburred to a slight radius before testing.