



Designation: B920 – 16 (Reapproved 2022)

# Standard Practice for Porosity in Gold and Palladium Alloy Coatings on Metal Substrates by Vapors of Sodium Hypochlorite Solution<sup>1</sup>

This standard is issued under the fixed designation B920; 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 This test practice covers equipment and methods for revealing the porosity of gold and palladium coatings, particularly electrodeposits and clad metals used on electrical contacts.

1.2 This test practice is suitable for coatings containing gold or 75 % by mass of palladium on substrates of copper, nickel, and their alloys, which are commonly used in electrical contacts.

1.3 A variety of full porosity testing methods is described in the literature.<sup>2,3</sup> These porosity Test Methods are B735, B741, B798, B799, and B809. An ASTM Guide to the selection of porosity tests for electrodeposits and related metallic coatings is available as Guide B765.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use. For specific hazards, see Section 6.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.11 on Electrical Contact Test Methods.

Current edition approved Oct. 1, 2022. Published November 2022. Originally approved in 2001. Last previous edition approved in 2016 as B920 – 16. DOI: 10.1520/B0920-16R22.

<sup>2</sup> For example see: Nobel, F. J., Ostrow, B. D., and Thompson, D. W., “Porosity Testing of Gold Deposits,” *Plating*, Vol 52, 1965, p. 1001.

<sup>3</sup> Krumbien, S J., Porosity Testing of Contact Platings, Proceedings, Connectors and Interconnection Technology Symposium, Oct. 1987, p. 47.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>4</sup>

B374 Terminology Relating to Electroplating

B542 Terminology Relating to Electrical Contacts and Their Use

B735 Test Method for Porosity in Gold Coatings on Metal Substrates by Nitric Acid Vapor

B741 Test Method for Porosity In Gold Coatings On Metal Substrates By Paper Electrography (Withdrawn 2005)<sup>5</sup>

B765 Guide for Selection of Porosity and Gross Defect Tests for Electrodeposits and Related Metallic Coatings

B798 Test Method for Porosity in Gold or Palladium Coatings on Metal Substrates by Gel-Bulk Electrography

B799 Test Method for Porosity in Gold and Palladium Coatings by Sulfurous Acid/Sulfur-Dioxide Vapor

B809 Test Method for Porosity in Metallic Coatings by Humid Sulfur Vapor (“Flowers-of-Sulfur”)

## 3. Terminology

3.1 *Definitions*—Many terms used in this practice are defined in Terminology B542 and terms relating to metallic coatings are defined in Terminology B374.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *corrosion products, n*—those reaction products emanating from the pores that protrude from, or are otherwise attached to, the coating surface after a vapor test exposure.

3.2.2 *metallic coatings, n*—include platings, claddings, or other metallic layers applied to the substrate. The coatings can comprise a single metallic layer or a combination of metallic layers.

3.2.3 *porosity, n*—the presence of any discontinuity, crack, or hole in the coating that exposes a different underlying metal.

3.2.4 *underplate, n*—a metallic coating layer between the substrate and the topmost layer or layers. The thickness of an underplate is usually greater than 0.8  $\mu\text{m}$  (30  $\mu\text{in.}$ ).

<sup>4</sup> 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.

<sup>5</sup> The last approved version of this historical standard is referenced on www.astm.org.

#### 4. Summary of Practice

4.1 The test practice employs a solution of sodium hypochlorite, a material readily available as household bleach. The test is recommended primarily as a qualitative means for assessing the plating quality in electrical connectors and is desirable because it uses readily available reagents and equipment and is extremely inexpensive, simple, and fast. In the test, the coated parts to be evaluated are suspended above a solution of sodium hypochlorite in a vessel that is closed but not sealed. Paper towels extend from the solution in the bottom part of the way up the sides of vessel providing a wicking action for the solution. After exposure in this manner for 30 min to 45 min, the parts are removed from the vessel, dried with hot air and examined for the presence of corrosion products that indicate porosity.

4.2 For more quantitative characterization of porosity it is better to use one of the previously mentioned porosity test standards. This practice is oftentimes used as an early predictor of the likelihood of failure in a full mixed flowing gas (MFG) test used as an accelerated environmental test.

4.3 Exposure periods may vary, depending upon the degree of porosity to be revealed. Reaction of the gas with a corrodable base metal at pore sites produces reaction products that appear as discrete spots on the gold or palladium surface. Individual spots may be counted with the aid of a loupe or low-power stereomicroscope.

4.4 This porosity test involves corrosion reactions in which the products delineate defect sites in coatings. Since the chemistry and properties of these products may not resemble those found in natural or service environments this test is not recommended for prediction of the electrical performance of contacts unless correlation is first established with service experience.

#### 5. Significance and Use

5.1 Palladium and gold coatings are often specified for the contacts of separable electrical connectors and other devices. Electrodeposits are the form of gold that is most used on contacts, although it is also employed as inlay or clad metal and as weldments on the contact surface. The intrinsic nobility of gold and palladium alloys enables it to resist the formation of insulating oxide films that could interfere with reliable contact operation.

5.2 In order for these coatings to function as intended, porosity, cracks, and other defects in the coating that expose base-metal substrates and underplates must be minimal or absent, except in those cases where it is feasible to use the contacts in structures that shield the surface from the environment or where corrosion inhibiting surface treatments for the deposit are employed. The level of porosity in the coating that may be tolerable depends on the severity of the environment to the underplate or substrate, design factors for the contact device like the force with which it is mated, circuit parameters, and the reliability of contact operation that it is necessary to maintain. Also, when present, the location of pores on the surface is important. If the pores are few in number and are

outside of the zone of contact of the mating surfaces, their presence can often be tolerated.

5.3 Methods for determining pores on a contact surface are most suitable if they enable their precise location and numbers to be determined. Contact surfaces are often curved or irregular in shape, and testing methods should be suitable for them. In addition, the severity of porosity-determining tests may vary from procedures capable of detecting all porosity to procedures that detect only highly porous conditions.

5.4 The present test practice is capable of detecting virtually all porosity or other defects that could participate in corrosion reactions with the substrate or underplate. In addition, it can be used on contacts having complex geometry such as pin-socket contacts (although with deep recesses it is preferred that the contact structures be opened to permit reaction of the vapors with the interior significant surfaces).

5.5 The relationship of porosity levels revealed by particular tests to contact behavior must be made by the user of these tests through practical experience or by other forms of testing. Thus, absence of porosity in the coating may be a requirement for some applications, while a few pores in the contact zone may be acceptable for others. The acceptable number, sizes and locations of the pore corrosion products shall be as specified on the appropriate drawing or specification.

5.6 This test is considered destructive in that it reveals the presence of porosity by contaminating the surface with corrosion products and by undercutting the coating at pore sites or at the boundaries of the unplated areas. Any parts exposed to this test shall not be placed in service.

5.7 The test is simple and inexpensive. The cost associated with the test is very low, using standard basic equipment found in an industrial laboratory. There are minimal waste disposal issues associated with the procedure. The test is very popular because of its very quick means of assessing the likelihood of plating quality problems, prior to the performance of accelerated environmental testing on the 1 to 2 week scale at much greater expense.

#### 6. Safety Hazards

6.1 Carry out this test procedure in a clean, working fume hood. The vapor emitted is toxic, corrosive, and irritating.

6.2 Because the test is conducted in a reaction vessel using a loose-fitting cover, it is desirable to insure that the drafts often found in hoods are not so high as to adversely effect the reproducibility of the test within the reaction vessel.

6.3 Observe good laboratory practices when handling the sodium hypochlorite (household bleach) solution. In particular, wear eye protection completely enclosing the eyes, and make eye wash facilities readily available.

#### 7. Apparatus

7.1 *Test Glassware*, a vessel of sufficient size such that the sodium hypochlorite solution at least 1 cm in depth can be placed in the bottom of the vessel without interfering with the samples. The vessel (see [Figs. 1 and 2](#)) shall be made of glass