Standards Topics

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Porosity & Porosity Test Specifications—Part 2

Initially (1909), porosity tests were simple color "spot" tests. A reagent capable of forming a colored reaction product with the underplate or basis metal was used to coat the surface, react, and reveal any pores. These simple formulas did not warrant a standalone specification and, therefore, were included in one of the paragraphs of the coating standard. There was no examination of the physical aspects of porosity testing, nor was the aggressiveness of the reagent solution considered.

Critical examinations of porosity tests began to emerge in the late 1920s, and the advent of electronics plating in the 1950s caused rapid growth in these studies. An outstanding treatment of the subject can be found in *Properties of Electrodeposits, Their Measurement and Significance*, edited by Sard, Leidheiser and Ogburn, and published in 1975 by the Electrochemical Society. Chapter eight of the proceedings of the Symposium, written by Dr. Michael Clarke, remains the classic work on porosity and porosity testing.

Currently, ASTM has published five porosity test standards—B 735, B 741, B 798, B 799 and B 809. The first four concern gold coatings or gold and palladium coatings, and were developed in ASTM Committee B 04—Electrical Contacts in Collaboration with Committee B 08; the fifth method concerns coatings of gold, nickel, tin, tin-lead, and palladium (or their alloys), and was developed in Committee B 08.

Porosity Test Standards

Method B 735

The first porosity test standard prepared by ASTM was B 735 in 1984. The current edition, approved in 1992, is titled Porosity in Gold Coatings on Metal Substrates by Nitric Acid Vapor. The method is suitable for electroplatings containing 95 percent or more of gold on substrates of copper, nickel, and their alloys. The test is too severe for gold coatings less than 0.6 μm (25 μin.) in thickness. It can also be used for platinum coatings, but not for less nobel metals such as palladium.

The chemistry of the test does not resemble that found in natural or service environments, and is therefore not recommended for prediction of the electrical performance of contacts, unless correlation is first established with service experience.

Method B 741

The second porosity test, B 741, Porosity in Gold Coatings on Metal Substrates by Paper Electrography, is suitable for electroplatings containing 95 percent or more of gold on substrates of copper, nickel, and their

alloys. The test can be used on flat surfaces or gently curved surfaces.

This method is designed to show whether the porosity level is less or greater than some value that, by experience, is considered by the user to be acceptable for the intended application. It uses chemically impregnated, moistened paper, pressed against the specimen surface at controlled pressure. Current is then passed from the specimen, which is anodic, to an inert cathode, at a fixed voltage for a specified time. Base metal ions at pore sites migrate to the paper, where a reaction occurs. Depending on the reagents used, this gives either colored or colorless products, which can be made visible by developing the paper in appropriate chemical vapors or solutions.

Method B 798

In 1988, ASTM developed two additional methods—B 798, Porosity in Gold or Palladium Coatings on Metal Substrates by Gel-Bulk Electrography, and B 799, Porosity in Gold Palladium Coatings by Sulfurous Acid/Sulfur-Dioxide Vapor.

Method B 798 is also designed to show whether the porosity level is less or greater than some value that, by experience, is considered by the user to be acceptable for the intended application. The test method is an electrographic technique, where the specimen is made the anode, in a cell containing a solid or semi-solid electrolyte of gelatin, conducting salts, and an indicator. Application of current to this cell results in migration of base metal ions through continuous pores. Reaction of cations with an indicator gives rise to colored reaction products at pore sites, which may be counted through the clear gel. The test is suitable for coatings containing 75 percent or more of gold on substrates of silver, nickel, copper and its alloys. It is also suitable for coatings of 95 percent or more of palladium on nickel, copper and its alloys.

Method B 799

Method B 799, like the others, is designed to show whether the porosity level is less or greater than some value that, by experience, is considered by the user to be acceptable for the intended application. The test employs concentrated sulfurous acid, which emits sulfur-dioxide gas. Exposure periods may vary, depending on the degree of porosity to be revealed. Reaction of the gas with a corrodible base metal at pore sites produces reaction products that appear as discrete spots on the gold or palladium surface. The method is suitable for coatings containing 95 percent or more of gold or palladium, on substrates of copper, nickel, and their alloys.

Method B 809

In 1990, ASTM developed B 809, Porosity in Metallic Coatings by Humid Sulfur Vapor ("flowers-of-sulfur," or powdered sulfur). This test method is suitable for determining porosity in coatings consisting of single or combined layers of any coating that does not significantly tarnish in a reduced sulfur atmosphere (*e.g.*, gold, nickel, tin, tin-lead, and palladium, or their alloys), where the pores penetrate down to a silver, copper or copper-alloy substrate.

The test specimens are suspended over "flowers-of-sulfur" in a vented container at a controlled, elevated, relative humidity and temperature. Elemental sulfur vapor, which always exists in equilibrium with sulfur powder in a closed system, attacks any exposed silver, copper or copper alloy, such as at the bottom of pores. Brown or black tarnish spots indicate porosity.

Future columns will continue the discussion of porosity tests. **P&SF**