



Standard Test Method for Coulometric Reduction of Surface Films on Metallic Test Samples¹

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1. Scope

1.1 This test method covers procedures and equipment for determining the relative buildup of corrosion and tarnish films (including oxides) on metal surfaces by the constant-current coulometric technique, also known as the cathodic reduction method.

1.2 This test method is designed primarily to determine the relative quantities of tarnish films on control coupons that result from gaseous environmental tests, particularly when the latter are used for testing components or systems containing electrical contacts.

1.3 This test method may also be used to evaluate test samples that have been exposed to indoor industrial locations or other specific application environments. (See 4.6 for limitations.)

1.4 This test method has been demonstrated to be applicable particularly to copper and silver test samples (see (1)).² Other metals require further study to prove their applicability within the scope of this test method.

1.5 The values stated in SI units are the preferred units. The values provided in parentheses are for information only.

1.6 *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 become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- B 809 Test Method for Porosity in Metallic Coatings by Humid Sulfur Vapor (“Flowers-of-Sulfur”)³
- B 810 Test Method for Calibration of Atmospheric Corro-

sion Test Chambers by Change in Mass of Copper Coupons⁴

B 827 Practice for Conducting Mixed Flowing Gas (MFG) Environmental Tests⁵

D 1193 Specification for Reagent Water⁶

3. Summary of Test Method

3.1 In constant-current coulometry, a fixed reduction-current density is applied to the sample in an electrolytically conductive solution, and the resulting variations in potential—measured against a standard reference electrode in the same solution—are followed as a function of time. Typically, with well-behaved surface films, the voltage-time plot should show a number of horizontal portions, or steps, each corresponding to a specific reduction potential or voltage (Fig. 1). The final potential step, which is always present with all substances, corresponds to the reduction of hydrogen ions in the solution (to form hydrogen gas), and represents a limit beyond which no higher potential reduction process can occur.

NOTE 1—As shown in Figs. 1 and 2, a differential circuit is recommended to help in resolving the individual voltage steps by pinpointing the corresponding inflection points on the main reduction curve (see 6.2.3).

3.2 From the elapsed times at the various steps, conclusions can often be drawn regarding the corrosion processes that have taken place to produce the surface films. Also, calculations can be made from the time at each voltage step in order to calculate the number of coulombs of electrical charge required to complete the reduction process at that particular voltage. Furthermore, since the reduction of any particular chemical compound takes place at a characteristic reduction potential or voltage range, this voltage can be used to indicate the presence of a compound or compounds whose characteristic reduction potential has already been established under the conditions of the test. Under ideal conditions it may also be possible to determine the number of reducible compounds present in the tarnish film.

3.3 For the purpose of this test method, tarnish films shall be defined as the corrosion products of the reactions of oxygen or

¹ This test method 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.

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² The boldface numbers in parentheses refer to the list of references at the end of this standard.

³ *Annual Book of ASTM Standards*, Vol 02.05.

⁴ *Annual Book of ASTM Standards*, Vol 02.04.

⁵ *Annual Book of ASTM Standards*, Vol 03.04.

⁶ *Annual Book of ASTM Standards*, Vol 11.01.

