ASTM INTERNATIONAL

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Standard Test Method for
Measurement of Corrosion Sites in Nickel Plus Chromium or Copper Plus Nickel Plus Chromium Electroplated Surfaces with Double-Beam Interference Microscope[1]

This standard is issued under the fixed designation B651; 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 provides a means for measuring the average dimensions and number of corrosion sites in an electroplated decorative nickel plus chromium or copper plus nickel plus chromium coating on steel after the coating has been subjected to corrosion tests. This test method is useful for comparing the relative corrosion resistances of different electroplating systems and for comparing the relative corrosivities of different corrosive environments. The numbers and sizes of corrosion sites are related to deterioration of appearance. Penetration of the electroplated coatings leads to appearance of basis metal corrosion products.

1.2 The values stated in SI units are to be regarded as the 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 Documents

2.1 *ASTM Standards:*[2]

B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section

3. Summary of Test Method

3.1 The depths and diameter of corrosion pits or the widths of corrosion crevices, and the number of pits per square millimetre or crevices per linear millimetre on a specimen surface, are determined using optical aids (magnifier, microscope, and interference microscope). The values are compared to dimensions and numbers of corrosion sites obtained from other specimens.

4. Significance and Use

4.1 Different electroplating systems can be corroded under the same conditions for the same length of time. Differences in the average values of the radius or half-width or of penetration into an underlying metal layer are significant measures of the relative corrosion resistance of the systems. Thus, if the pit radii are substantially higher on samples with a given electroplating system, when compared to other systems, a tendency for earlier failure of the former by formation of visible pits is indicated. If penetration into the semi-bright nickel layer is substantially higher, a tendency for earlier failure by corrosion of basis metal is evident.
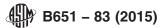
5. Apparatus

5.1 *Double-Beam Interference Microscope* (lateral magnification about 100×), capable of producing, with white light, a visible group of interference fringes, and equipped with a calibrated fine focus and a graduated bifilar (movable cross hair) eyepiece.

5.2 *Magnifier or Microscope* (10× to 20×), with light source.

5.3 *Rule,* graduated in millimetres, and a *scriber* for producing visible lines on the specimen surface.

5.4 *Microscope,* with a magnification capability of 500×, equipped with a bifilar eyepiece, for making measurements on opaque surfaces.

5.5 Equipment for mounting and polishing of specimens for microscopical cross-sectional measurements.

6. Specimen Preparation

6.1 Clean the corroded specimen surface with an agent or agents that remove soil and corrosion products, but do not significantly change the surface of the corrosion sites. Scouring powder may be used to remove insoluble corrosion products, organic solvent to remove road tar, water accompanied by gentle abrasion with a cloth to remove lightly adherent soil, etc.

6.2 Mask with paint or tape that portion of the specimen surface on which no measurements of pits or cracks will be made. Alternatively, a gasketed cell pressed onto the surface may be used. The opening in the gasket will define the area to be stripped.

NOTE 1—If pitted, the area selected for measurement should contain at least 100 pits or be as large as 50 by 50 mm. If the area contains cracks, the location for measurement should contain at least 100 cracks, or be at least 50 mm long.

6.3 Strip the chromium anodically at 6 to 8 V in a solution containing about 50 g/L of sodium carbonate (Na_2CO_3).

6.4 Remove masking material, if desired.

NOTE 2—If tape was employed for masking, its removal is recommended. When the specimen rests on tape, it will allow the specimen to settle slowly. This gradual movement interferes with measurements of penetration with the interference microscope.

7. Procedure for Determination of Average Number of Pits or Cracks

7.1 Using the 10× to 20× magnifier, count the number of pits in a known area or the number of cracks intersecting a line of known length. Where uncertainty exists as to whether localized blemishes are corrosion sites when the magnifier is employed, use the 100× microscope for verification. Extreme accuracy is not necessary; values within ±10 % of the true value are adequate.

7.1.1 For surfaces where the number of pits is more than about 1000/cm², count the pits bounded by lines seen in the eyepiece reticle of the 100× microscope enclosing a known area of specimen surface (probably about 0.5 mm²).

7.1.2 For surfaces where the number of pits is less than about 1000/cm², lightly scribe lines 10 mm or less apart to form a rectilinear grid on the surface. Count the number of pits within a scribed area, by using the magnifier, or the 100× microscope, whichever has the necessary resolution to assure pit identification. Determine the area that contains about 100 pits, or, if the area exceeds 25 cm², count the number of pits in a 25 cm² area.

7.1.3 For surfaces with more than about five cracks per millimetre, count the number of cracks on the surface image that cross a 100× microscope reticle line of known length.

7.1.4 For a surface with fewer than about five cracks per millimetre, lightly scribe a straight line up to 50 mm long on the specimen surface. Using a magnifier or, if necessary, a 100× microscope, count the number of cracks in a known length of line, or all the cracks in 50 mm length, whichever comes first.

NOTE 3—If the cracks tend to be oriented, scribe the line approximately perpendicular to the predominant crack direction.

7.2 Calculate the number of pits as pits per square millimetre, or the number of cracks as cracks per millimetre. Enter result in Table 1 under "pit density" or "crack density."

8. Determination of Mean Dimensions of Pits or Cracks

8.1 Observe one pit or crack with the interference microscope.

TABLE 1 Measurements of Corrosion Pits and Cracks in Nickel Plus Chromium or Copper Plus Nickel Plus Chromium Plated Surfaces

SAMPLE NO. _____	EXPOSURE MEDIUM _____		EXPOSURE TIME _____
Pit or crack density (7.2)	___ pits ∕ mm² ___ cracks ∕ mm²		
Pit or crack dimensions (8.1.1)	pit diameter ___ μm crack width ___ μm		
Thicknesses of deposits (8.2)	copper		____ μm
	semibright nickel		____ μm
	bright nickel		____ μm
	other nickel layer		____ μm
	chromium		____ μm
Penetration of Crack or Pit into the Semibright Nickel or Copper Layers			
Total Penetration (*P*) (8.1.2)	Penetration into Semibright Nickel (8.3)		Penetration into Copper (8.4)
A	____ μm	___ μm	___ μm
B	____ μm		
A-B	____ μm	mean penetration into semibright	mean penetration into copper
		___ μm	___ μm