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An American National Standard

Standard Test Method for Electronic Measurement for Hydrogen Embrittlement From Cadmium-Electroplating Processes[1]

This standard is issued under the fixed designation F 326; 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.

ϵ^1 NOTE—Editorial corrections were made throughout the standard and in Fig. 3 in May 2001.

1. Scope

1.1 This test method covers an electronic hydrogen detection instrument procedure for measurement of plating permeability to hydrogen. This method measures a variable related to hydrogen absorbed by steel during plating and to the hydrogen permeability of the plate during post plate baking. A specific application of this method is controlling cadmium-plating processes in which the plate porosity relative to hydrogen is critical, such as cadmium on high-strength steel.

1.2 *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.* For specific hazard statement, see Section 8.

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

2. Referenced Documents

2.1 *ASTM Standards:*

D 1193 Specification for Reagent Water[2]

F 519 Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *hydrogen pressure peak*—the maximum hydrogen pressure value (see I_H) obtained when the probe is heated following calibration, plating, or fluid testing.

3.2 *Symbols:*

3.2.1 HP = calibration hydrogen pressure peak.

3.2.2 HP_p = plating hydrogen pressure peak.

3.2.3 I_E = probe cathode emission current.

3.2.4 I_H = probe hydrogen pressure.

3.2.5 I_γ = integral of I_H curve from probe on to HP.

3.2.6 *lambda* = time in seconds for hydrogen pressure peak to drop to half its value.

3.2.7 λ = lambda obtained from a calibration run.

3.2.8 λ_p = lambda obtained from a plating run.

3.2.9 λ_{pc} = normalized test lambda, obtained as follows:

$$\lambda_{pc} = \lambda_p\,(40/\lambda) \tag{1}$$

3.2.10 $\bar{\lambda}_{pc}$ = arithmetic average of normalized lambdas for a set of tests.

3.2.11 *range* = difference between maximum λ_{pc} and minimum λ_{pc} for a given set of tests.

3.2.12 *run* = calibration or plating of a probe.

3.2.13 *test* = single evaluation of a plating solution for hydrogen embrittlement determination; run using a previously calibrated probe.

3.2.14 *set of tests*—all consecutive tests on a plating solution for a given operator-instrument-day evaluation.

3.2.15 *window*—test surface of a probe described in Fig. 1(A).

4. Summary of Test Method

4.1 This method uses a metal-shelled vacuum probe as an ion gage to evaluate electrodeposited cadmium characteristics relative to hydrogen permeation. After calibration, a section of the probe shell is electroplated at the lowest current density encountered in the cadmium electroplating process. During the subsequent baking of the probe at a closely controlled temperature, the probe ion current, proportional to hydrogen pressure, is recorded as a function of time. From these data and the calibration data of the probe, a number related to the porosity of the electroplated metal relative to hydrogen is obtained.

4.2 During the initial part of the bakeout, hydrogen continues to diffuse through the metal shell of the probe and the ion current increases. Within a short time, however, a maximum current is observed and then falls off as hydrogen is driven out of the system.

4.3 Observations of the ion current-time curve indicate that the slope of the curve has an empirical relationship with failure

[1] This test method is under the jurisdiction of ASTM Committee F07 on Aerospace and Aircraft and is the direct responsibility of Subcommitteee F07.04 on Hydrogen Embrittlement.

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 15.03.

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