Designation: F 519 – 97$^{\epsilon 2}$

Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments[1]

This standard is issued under the fixed designation F 519; 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—Fig. A3.2 was editorially changed to Fig. A4.2 in December 1997.
ϵ[2] NOTE—Note 3 was deleted in Fig. A2.1 and Footnote 11 has been added to Note A3.1 in July 2000.

1. Scope

1.1 This test method covers mechanical tests for the evaluation and control of the potential for hydrogen embrittlement that may arise from various sources of hydrogen in plating processes, or from subsequent service environments that include fluids, cleaning treatments, maintenance chemicals or gaseous environments that may contact the surface of steels.

1.2 This test method is intended for process control of hydrogen produced by different plating processes and exposure to different chemicals encountered in a service environment and not to measure the relative susceptibility of different steels.

1.3 This test method assumes that air melted AISI 4340 steel per MIL-S-5000 at 51 to 53 HRC is the worst case; that is, all other heat-treated, high-hardness steels are less susceptible to hydrogen embrittlement. The sensitivity to hydrogen embrittlement shall be demonstrated for each heat of AISI 4340 steel used in the manufacture of test specimens.

1.4 Test procedures and acceptance requirements are specified for seven specimens of different sizes, geometries, and loading configurations. For plating processes, notched specimens must exceed 200 h at a sustained load of 75 % of the fracture stress or exceed a threshold of 75 % of the fracture stress for a quantitative, accelerated (≤24 h) incrementally increasing or rising step load (RSL) test. For service environments, equivalent loading conditions and pass/fail requirements for each specimen are specified.

1.5 This test method is divided into two main parts. The first part gives general information concerning requirements for hydrogen embrittlement testing. The second part is composed of annexes that give specific requirements for the seven specimens covered by this test method.

1.5.1 Annex A1 details notched tensile specimens under constant load; Annex A2 details notched round bars tensile, bend, and C-ring specimens using a self-loading fixture; Annex A3 details a notched four point bend specimen that combines sustained load and slow strain rate testing for hydrogen embrittlement by using incremental loads and hold times under displacement control to measure a threshold stress in an accelerated manner. The test is described as an accelerated (≤24 h) incrementally increasing or rising step load test method that measures the threshold for hydrogen stress cracking that is used to quantify the amount of residual hydrogen in the specimen. Annex A4 details a smooth O-ring under displacement control; Annex A5 details testing in a service environment.

1.6 Specific requirements for the two types of specimen and the seven specific loading and geometrical configurations are as listed:

1.6.1 Type 1—Notched Specimens
1.6.2 Type 1a: Round Bar Tension—Constant Load
1.6.3 Type 1a.1—Standard Size Annex A1
1.6.4 Type 1a.2—Oversized Annex A1
1.6.5 Type 1b: Round Bar Tension—Self Loading Fixture-Annex A2
1.6.6 Type 1c: Round Bar Bend—Self Loading Fixture-Annex A2
1.6.7 Type 1d: C-ring Bend—Self Loading Fixture-Annex A2
1.6.8 Type 1e: Square Bar Bend—Displacement Annex A3
1.6.9 Type 2—Smooth Specimens
1.6.10 Type 2a: O-ring—Displacement Control Annex A4

1.7 The values stated are in American Standard units.

1.8 *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:*

B 851 Specification for Automated Controlled Shot Peening of Metallic Articles Prior to Nickel, Autocatalytic Nickel, or Chromium Plating, or Final Finish[2]

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

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[2] *Annual Book of ASTM Standards,* Vol 02.05.

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