



Designation: F 1501 – 95

Standard Test Method for Tension Testing of Calcium Phosphate Coatings¹

This standard is issued under the fixed designation F 1501; 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 covers tension testing of continuous calcium phosphate coatings adhering to dense metal substrates at ambient temperatures. It assesses the degree of adhesion of coatings to substrates, or the internal cohesion of a coating in tension, normal to the surface plane.

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

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:

C 633 Test Method for Adhesion or Cohesive Strength of Flame-Sprayed Coatings²

E 4 Practices for Force Verification of Testing Machines³

E 6 Terminology Relating to Methods of Mechanical Testing³

E 8 Test Methods for Tension Testing of Metallic Materials³

3. Terminology

3.1 **Definitions**—The definitions of terms relating to tension testing appearing in Terminology E 6 shall be considered as applying to the terms used in this test method.

4. Summary of Test Method

4.1 The tensile test method consists of subjecting a specimen assembly composed of one coated and one uncoated component to a tensile load. The components to be tested must be bonded together by use of a polymeric adhesive. The adhesive may be in film form or bulk form, but it must have a minimum bulk tensile strength of 34.5 MPa (5000 psi).

4.2 The tensile load must be applied normal to the plane of

the coating utilizing a tension machine, which is capable of determining the maximum strength of the coating or coating attachment to the substrate interface.

5. Significance and Use

5.1 This tensile test method is recommended for tension testing of calcium phosphate/substrate combinations and can provide information on the adhesive or cohesive strength of coatings under a uniaxial tensile stress.

5.2 This test method may be useful for comparative evaluation of adhesive or cohesive strengths of a variety of types of calcium phosphate coatings. Information developed using this test method may be useful for certain quality control and design purposes.

5.3 This test method should not be considered to provide an intrinsic value for utilization directly in making calculations such as determining the ability of a coating to withstand specified environmental stresses.

5.4 Processing variables such as substrate preparation prior to coating, surface texture, coating technique variables, or post-coating heat treatment variables may introduce a significant effect on the results of the tension test. The specimen being evaluated must be representative of the actual end-use coating.

6. Apparatus

6.1 **Testing Machines**—Machines used for testing shall conform to the requirements of Practices E 4. The loads used in determining tensile strength and yield strength shall be within the loading range of the testing machine as defined in Practices E 4.

6.2 Gripping Devices:

6.2.1 **General**—Various types of grips may be used to transmit the load applied to the specimens by the testing machine. To ensure axial tensile stress, it is important that the specimen axis coincide with the centerline of the heads of the testing machine and that the coating test plane be perpendicular to the axial load. Any departure from this requirement (that is, any eccentric loading) will introduce bending stresses that are not included in the usual stress calculation (force/cross-sectional area).

6.2.2 **Yoke and Dowel Pin Grips**—A schematic diagram of a typical gripping device for specimens with holes drilled for pin

¹ This test method is under the jurisdiction of ASTM Committee F-4 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.13 on Ceramic Materials.

Current edition approved Aug. 15, 1995. Published October 1995. Originally published as F 1501 – 94. Last previous edition F 1501 – 94.

² Annual Book of ASTM Standards, Vol 02.05.

³ Annual Book of ASTM Standards, Vol 03.01.

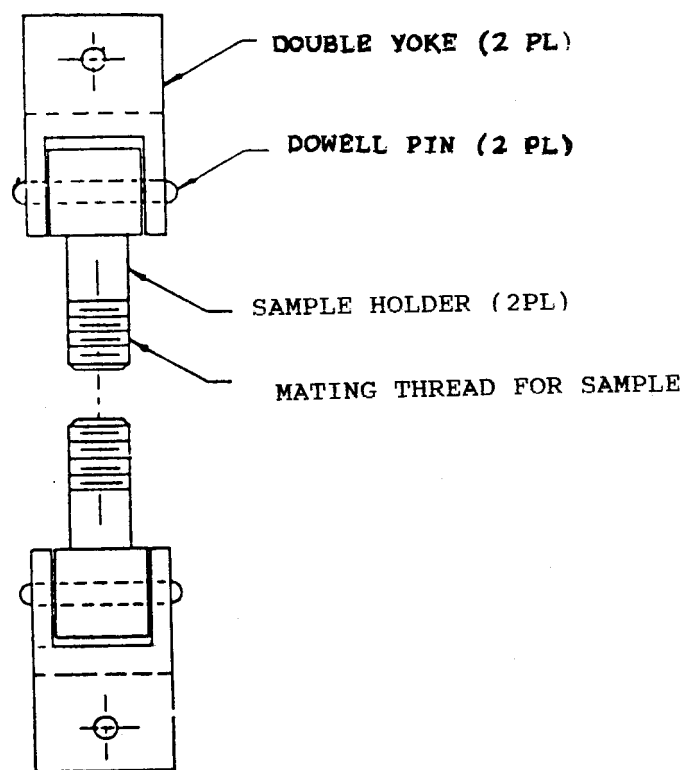


FIG. 1 Yoke and Dowel Pin Grips for Tensile Testing

loading is illustrated in Fig. 1. There should be two perpendicular pins in order to minimize off-axis loading.

7. Adhesive Bonding Materials

7.1 Adhesive Bonding Agent—A polymeric adhesive bonding agent in film form, or filled viscous adhesive cement, when used, shall be identified and shall meet the following requirements:

7.1.1 The bonding agent shall be capable of bonding the coating on the test specimen components with a tensile strength that is at least 34.5 MPa (5000 psi) or as great as the minimum required adhesion or cohesion strength of the coating.

7.1.2 In instances where porosity extends to the coating/substrate interface, the bonding agent shall be sufficiently viscous and application to the coating sufficiently careful to ensure that it will not penetrate through the coating to the substrate. The FM 1000 adhesive film⁴ with a thickness of 0.25 mm (0.01 in.) has proven satisfactory for this test.

7.1.3 If a material other than FM 1000⁴ is used, or the condition of the FM 1000 is unknown, it must be tested to establish its equivalence for fresh FM 1000.⁴ Testing should be performed without the presence of the calcium phosphate coating to establish the performance of the adhesive.

8. Test Specimens

8.1 General:

8.1.1 In order to ensure precision and accuracy in test results, it is important that care be exercised in the preparation

of specimens, both in machining and in the case of multipart specimens, in the assembly. Specimen components must be properly aligned in order that generated stresses be purely axial, that is, normal to the coated surface.

8.1.2 Tensile Specimens—Three general types of test specimens are illustrated in Fig. 2 and Fig. 3. A complete, assembled test assembly consists of two solid pieces; one with a coated surface and the other with an uncoated surface. The uncoated surface may be roughened to aid in the bonding of the adhesive.

8.1.3 The cross-sectional area of the substrate upon which the coating is applied shall be nominal 5.07 cm² (0.78 in.²). When specimens of another cross-sectional area are used, the data must be demonstrated to be equivalent to a 5.07-cm² standard cross-sectional area and the specimen size should be reported.

8.1.4 Coating thickness, density and substrate material, substrate preparation, subsequent thermal treatment, and other pertinent processing parameters shall be representative of the coating application.

8.2 Specimen Coating Preparation:

8.2.1 Calcium phosphate coatings may be applied by any one of a number of techniques. The coating should be applied in the same manner as the actual device. The coating should consist of a layer that is mechanically or chemically attached and covers the surface.

8.2.2 All thermal treatments normally performed on the devices should be performed on the test specimens.

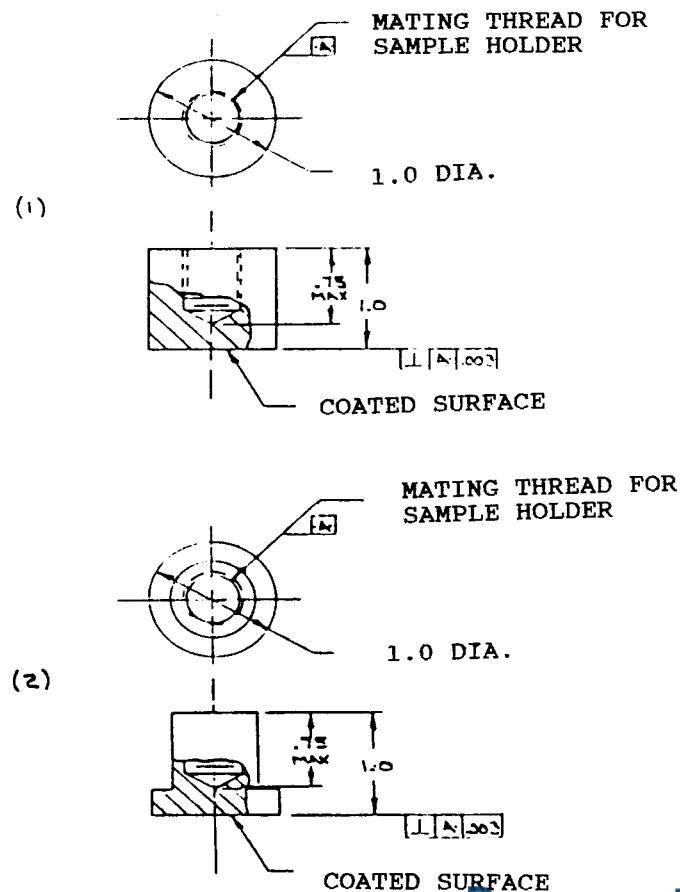


FIG. 2 Threaded Tensile Specimens

⁴ Available from American Cyanamid, Engineering Materials Division, Wayne, NJ.