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Standard Specification for Autocatalytic Nickel Boron Coatings for Engineering Use[1]

This standard is issued under the fixed designation B607; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 Nickel boron coatings are produced by autocatalytic (electroless) deposition from aqueous solutions. These solutions contain either an alkylamineborane or sodium borohydride as a reducing agent, a source of nickel ions, a buffer, complexant, and control chemicals.

1.2 This specification describes the requirements for coatings of autocatalytic nickel boron deposited from aqueous solutions onto substrates for engineering use. The specification classifies these coatings into two types:

1.2.1 *Type 1 coatings* have a boron content of 0.1 to less than 3.5 mass percent with the balance nickel.

1.2.2 *Type 2 coatings* have a boron content of 3.5 to 6 mass percent and a minimum of 90 mass percent nickel.

1.3 The coatings are hard and uniform in thickness, even on irregular shaped parts, and used in a wide range of applications.

1.4 Process solutions formulated with an alkylamineborane usually produce coatings that contain 0.1 to 3.5 % boron. Thin coatings of this type provide bondability and solderability on electronic components such as lead frames, electrical contacts, and headers. To maintain solderability, these coatings are generally not heat treated.

1.5 Process solutions formulated with sodium borohydride are strongly alkaline and are frequently used to plate steel and titanium parts to impart surface hardness and wear resistance properties. Deposits produced from these processes can contain 3 to 5 % boron and thallium or other metals which are used to stabilize the plating solution and modify the coating properties.

1.6 The physical and mechanical properties of these deposits such as density, hardness, stress, and melting point will vary with the boron content. The variation of boron content also affects the quantity and structure of nickel boride precipitated during heat treatment. In the as-plated condition the deposit consists of a predominantly amorphous mixture of nickel and boron with a hardness of about 700 HKN. When the deposit is heated above 300°C the nickel crystallizes, forming nickel clusters of Ni (111) and boron precipitates as nickel boride, Ni_3B (211) and (311), increasing the hardness to greater than 1000 HK_{100} for Type 2 coatings.

1.7 The nickel boron coatings are microporous and offer limited corrosion protection. Their columnar structure, however, is beneficial in reducing wear because it provides a means of trapping lubricants within the surface of the coated part.

1.8 This document describes only autocatalytic nickel boron coatings that have been produced without use of external electric sources.

1.9 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.10 The following hazards caveat pertains only to the Test Methods section of this specification: *This standard does not purport to address the safety problems 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.*

NOTE 1—The following AMS standards are not requirements. They are referenced for information only: AMS 2399 and AMS 2433.

2. Referenced Documents

2.1 *ASTM Standards*:[2]

B374 Terminology Relating to Electroplating

[1] This specification is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.03 on Engineering Coatings.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section
B567 Test Method for Measurement of Coating Thickness by the Beta Backscatter Method
B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry
B571 Practice for Qualitative Adhesion Testing of Metallic Coatings
B578 Test Method for Microhardness of Electroplated Coatings
B602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings
B656 Guide for Autocatalytic (Electroless) Nickel-Phosphorus Deposition on Metals for Engineering Use (Discontinued 2000) (Withdrawn 2000)[3]
B667 Practice for Construction and Use of a Probe for Measuring Electrical Contact Resistance
B678 Test Method for Solderability of Metallic-Coated Products
B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings
B762 Test Method of Variables Sampling of Metallic and Inorganic Coatings
D2670 Test Method for Measuring Wear Properties of Fluid Lubricants (Falex Pin and Vee Block Method)
D2714 Test Method for Calibration and Operation of the Falex Block-on-Ring Friction and Wear Testing Machine
D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
E39 Methods for Chemical Analysis of Nickel (Withdrawn 1995)[3]
F519 Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments

2.2 *Aerospace Materials Specifications:*
AMS 2399 Electroless Nickel-Boron Plating[4]
AMS 2433 Electroless Nickel-Thallium-Boron Plating[4]

2.3 *U.S. Government Standards:*
MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes[5]
MIL-STD-13165 Shot Peening of Metal Parts[5]

3. Terminology

3.1 *Definitions:* Many terms used in this specificationare defined in Terminology B374.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cold shut*—a void on the surface which has been closed by machining and then partially opened through cleaning.

3.2.2 *hot halide stress-corrosion cracking*—a type of mechanical failure produced by halogenated solvents that have been absorbed onto titanium and then in the presence of heat cause microcracking, and the loss of mechanical strength.

3.2.3 *lap cracks*—a surface imperfection caused by cold working of steels producing a void which can be duplicated in the deposit.

3.2.4 *significant surface*—those substrate surfaces which the coating must protect and that are essential to the appearance.

4. Classification

4.1 The classification by type of these coatings establishes the amount of boron in the alloy.

4.1.1 *Type 1*—Coatings shall contain 0.1 to less than 3.5 mass percent boron with the balance nickel.

4.1.2 *Type 2*—Coatings shall contain 3.5 to 6 mass percent boron and a minimum of 90 mass percent nickel.

4.2 The classification by class of these coatings establishes the post treatment to be performed on the part(s). The post treatment steps are designed to reduce the potential for hydrogen embrittlement, increase the adhesion of the coating to the substrate, improve the fatigue properties of the part(s), and increase the wear resistance and hardness of the coating:

4.2.1 *Class 1*—Parts are supplied as plated with no post heat treatment.

4.2.2 *Class 2*—Parts are heat treated after plating to increase hardness. The coating is heat treated at 365 to 385°C for 90 min (see 7.2.4).

4.2.3 *Class 3*—Parts are heat treated after plating at 180 to 200°C for 2 to 23 h to improve coating adhesion on steel and for hydrogen embrittlement relief of steels (see 7.2.4).

4.2.4 *Class 4*—Parts are heat treated after plating at 120 to 130°C for a minimum of 1 h to improve adhesion on heat-treatable (age-hardened) aluminum alloys and carburized steels (see 7.2.4).

4.2.5 *Class 5*—Parts are heat treated after plating at 365 to 375°C for a minimum of 4 h to improve adhesion on titanium and titanium alloys (see 7.2.4).

4.3 The classification by grade establishes the minimum thickness of the coating:

4.3.1 *Grade A*—Parts are plated to a minimum coating thickness of 0.5 µm.

4.3.2 *Grade B*—Parts are plated to a minimum coating thickness of 12 µm.

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.
[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.