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Standard Specification for Autocatalytic Nickel over Autocatalytic Copper for Electromagnetic Interference Shielding¹

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1. Scope

This specification presents the requirements for multilayer coatings of autocatalytic nickel-phosphorus over autocatalytic copper on metallic and polymeric substrates. The coating system is intended to provide electromagnetic interference (EMI) protection properties or electrostatic discharge (ESD) protection to parts fabricated from either polymeric or metallic materials.

2. Referenced Documents

2.1 ASTM Standards:²

A919 Terminology Relating to Heat Treatment of Metals (Withdrawn 1999)³

B183 Practice for Preparation of Low-Carbon Steel for Electroplating

B242 Guide for Preparation of High-Carbon Steel for Electroplating

B252 Guide for Preparation of Zinc Alloy Die Castings for Electroplating and Conversion Coatings

B253 Guide for Preparation of Aluminum Alloys for Electroplating

B320 Practice for Preparation of Iron Castings for Electroplating

B322 Guide for Cleaning Metals Prior to Electroplating

B374 Terminology Relating to Electroplating

B504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method

B532 Specification for Appearance of Electroplated Plastic Surfaces

B533 Test Method for Peel Strength of Metal Electroplated Plastics

B553 Test Method for Thermal Cycling of Electroplated Plastics (Withdrawn 1991)³

B554 Practice for Measurement of Thickness of Metallic Coatings on Nonmetallic Substrates (Withdrawn 1987)³

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

B602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings

B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings

B727 Practice for Preparation of Plastics Materials for Electroplating

B733 Specification for Autocatalytic (Electroless) Nickel-Phosphorus Coatings on Metal

D3330/D3330M Test Method for Peel Adhesion of Pressure-Sensitive Tape

D3359 Test Methods for Measuring Adhesion by Tape Test

D4935 Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials

2.2 Military Standard:

MIL-STD-461 Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference⁴

3. Terminology

3.1 *Definitions*—Many of the terms used in this specification can be found in Terminologies A919 or B374.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *significant surfaces, n*—these surfaces are classified as primary, secondary, nonsignificant, and coating-free surfaces.

3.2.1.1 *coating-free areas, adj*—areas specified on part drawings or suitably marked samples.

3.2.1.2 *nonsignificant surfaces, adj*—all holes, recesses, and other areas where a controlled deposit cannot be obtained under normal coating conditions and that cannot be touched

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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.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave. Philadelphia, PA 19111-5094, Attn: NPODS.

with a 20-mm diameter ball shall be considered nonsignificant surfaces unless otherwise specified on part drawings or suitably marked samples.

3.2.1.3 *primary significant surface, adj*—all mating surfaces and those other surfaces specified on part drawings or suitably marked samples.

3.2.1.4 *secondary significant surfaces, adj*—all surfaces, other than primary significant surfaces, that can be touched with a 20-mm diameter ball shall be considered secondary significant surfaces unless otherwise specified on part drawings or suitably marked samples.

4. Classification

4.1 This classification system provides for the following:

4.1.1 Types of coating based on thickness and testing requirements, and

4.1.2 Grades of coating based on alloy composition.

4.2 *Coating Type:*

4.2.1 The coating type indicates the type of application and tests to be used in determining the acceptance of the coating.

4.2.2 *Coating Type Definitions:*

4.2.2.1 *Type 1*—Coatings intended to shield devices for FCC/VDE Class B service.

4.2.2.2 *Type 2*—Coatings intended to shield devices for FCC/VDE Class B service in harsh environments.

4.2.2.3 *Type 3*—Coatings intended to shield devices for MIL-STD-461 requirements.

4.2.2.4 *Type 4*—Coatings intended to shield devices for FCC/VDE Class A requirements.

4.2.3 The description of Types 1, 2, 3, and 4 is summarized in **Table 1**.

4.3 *Coating Grade:*

4.3.1 The coating grade is based upon phosphorus content.

NOTE 1—The coating grade indicates the relative contact impedance and the relative corrosion resistance of the nickel-phosphorus coating and tests to be used in determining the acceptance of the coating

4.3.2 *Coating Grade Definitions:*

4.3.3 Grade 1 coatings have a phosphorus content between 3 and 5 %.

NOTE 2—Low phosphorus coatings exhibit low electrical contact impedance. High phosphorus contents exhibit somewhat higher contact impedance, however, the coating is more corrosion resistant.

TABLE 1 Autocatalytic Nickel-Phosphorus Over Autocatalytic Copper Coating Descriptions Summary

Type	Thickness	Shielding Effectiveness (Typical) in accordance with Test Method D4935	Application
	Autocatalytic Copper	Autocatalytic Nickel-Phosphorus	
1	1 µm min	0.25 µm min	FCC/VDE Class B
2	1 µm min	1.5 µm min	Harsh Environment MIL-STD-461B
3	2.5 µm min	0.25 µm min	FCC/VDE Class A
4	Optional/Not required	1.0 µm min	50-70 dB

4.3.4 Grade 2 coatings have a phosphorus content between 6 and 11 %.

NOTE 3—The adhesion and resistance to blistering are improved on some polymeric substrates by an initial flash deposit of autocatalytic nickel.

5. Ordering Information

5.1 To avoid misunderstanding between contractual parties, purchase orders or contracts for autocatalytic nickel over autocatalytic copper coatings under this specification should include the designation, issue date, and the following information:

5.1.1 Type of substrate.

5.1.1.1 Metallic substrates should state the composition and metallurgical condition. Assemblies of dissimilar materials should be identified.

5.1.1.2 Polymeric substrates should state the polymer type and should be of a plating grade.

5.1.2 Classification of the deposit by type and grade.

5.1.3 Primary significant surfaces and coating-free surfaces must be indicated on drawings.

5.1.4 Any special requirements.

5.1.5 Test methods for coating adhesion, thickness, porosity.

5.1.6 Sampling program.

6. Surface Preparation

6.1 *Surface Contamination*—Surfaces of polymeric parts must be free of all mold release agents, dirt, oil, grease, and contamination detrimental to the final finish. Surfaces of metallic parts must be free of all scale, oxidation, and contamination detrimental to the final finish. A clean surface is essential to the adhesion and electrical conductivity requirements of the subsequent coated part.

6.2 *Cleaning, Conditioning, and Activating*—Any adequate method of cleaning, conditioning, and activating is acceptable provided the coated parts meet the inspection requirements and are free of distortion. Examples of adequate methods of cleaning can be found in **10.2**.

6.2.1 *Base Material Suitability*—The parts to be coated shall be inspected by the coater prior to any processing to determine their suitability for coating. Unsuitable parts shall be returned to the fabricator or molder.

6.3 *Mechanical Roughening*—Mechanical roughening of polymer surfaces, to promote adhesion, may only be used when specified on the part drawing.

7. In-Process Storage and Handling

7.1 Following cleaning, conditioning, and activating, all parts shall be immediately coated with copper and then nickel-phosphorus to the thickness specified in **Table 1**. The parts processing cycle shall be a continuous operation without any interruption.

7.2 *Handling*—The parts shall be suitably racked so as to prevent gas entrapment and to avoid physical handling of the primary significant surfaces.

7.3 *Drying*—Following coating, the parts may be dried with warm air currents. Drying temperature shall not exceed the