INTERNATIONAL STANDARD

ISO 17334

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Metallic and other inorganic coatings — Autocatalytic nickel over autocatalytic copper for electromagnetic shielding

Revêtements métalliques et autres revêtements inorganiques — Dépôts autocatalytiques de nickel sur dépôts autocatalytiques de cuivre pour protection contre les interférences électromagnétiques

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17334 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 3, *Electrodeposited coatings and related finishes*.

Introduction

The proliferation of electronic equipment has created a need for methods for shielding components from the hazards of electromagnetic radiation, hazards that can result in the malfunctioning of computers, as well as medical, navigational, detonation, telecommunication and other devices. Electromagnetic shielding requirements have been established by government regulations and directives in many parts of the world.

The capability of an enclosure, housing or cabinet to prevent electromagnetic radiation from being emitted or absorbed is related to its conductivity; hence, metal enclosures are highly effective for electromagnetic shielding purposes. The cost/weight advantages of plastics, however, have led to their widespread use in computer cabinets and other enclosures. Plastics are non-conductive and as a result, metallic coating methods have been developed to shield components from the interference caused by electromagnetic radiation.

An effective method of protecting computer housings from electromagnetic interference involves the autocatalytic deposition of a layer of copper on the plastic housing. To provide durability and corrosion protection, a thin layer of autocatalytic nickel is applied over the autocatalytic copper. Although this method was first utilized in computer housings made of plastics, it is applicable to other substrates and applications. The need for effective shielding will likely intensify and the use of autocatalytic nickel over autocatalytic copper for electromagnetic shielding purposes is expected to increase.

This International Standard is intended for use by purchasers in specifying requirements to the electroplater, supplier or processor and is to be indicated on the part drawing or purchase order.

Metallic and other inorganic coatings — Autocatalytic nickel over autocatalytic copper for electromagnetic shielding

WARNING — This International Standard calls for the use of substances and/or procedures that may be injurious to health if adequate safety measures are not taken. This International Standard does not address any health hazards, safety or environmental matters associated with its use. It is the responsibility of the user of this International Standard to establish appropriate health, safety and environmentally acceptable practices and take suitable actions for any national and international regulations. Compliance with this International Standard does not in itself confer immunity from legal obligations.

1 Scope

This International Standard specifies the requirements for autocatalytic nickel-phosphorus alloy coatings applied over autocatalytic copper coatings to provide electromagnetic interference (EMI) or electrostatic discharge (ESD) protection for parts fabricated from either plastics or metallic materials.

This International Standard does not apply to high-strength steels that are susceptible to hydrogen embrittlement.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2064, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness*

ISO 2080, *Metallic and other inorganic coatings — Surface treatment, metallic and other inorganic coatings — Vocabulary*

ISO 2177, *Metallic coatings — Measurement of coating thickness — Coulometric method by anodic dissolution*

ISO 2819, *Metallic coatings on metallic substrates — Electrodeposited and chemically deposited coatings — Review of methods available for testing adhesion*

ISO 2859 (all parts), *Sampling procedures for inspection by attributes*

ISO 3543, *Metallic and non-metallic coatings — Measurement of thickness — Beta backscatter method*

ISO 3497, *Metallic coatings — Measurement of coating thickness — X-ray spectrometric methods*

ISO 3882, *Metallic and other inorganic coatings — Review of methods of measurement of thickness*

ISO 4519, *Electrodeposited metallic coatings and related finishes — Sampling procedures for inspection by attributes*

ISO 4525, *Metallic coatings — Electroplated coatings of nickel plus chromium on plastics materials*

ISO 4527, *Metallic coatings — Autocatalytic (electroless) nickel-phosphorus alloy coatings — Specification and test methods*

ISO 16348, *Metallic and other inorganic coatings — Definitions and conventions concerning appearance*

IEC 60454-2, *Pressure-sensitive adhesive tapes for electrical purposes — Part 2: Methods of test*

IEC 61587-3, *Mechanical structures for electronic equipment — Tests for IEC 60917 and IEC 60297 — Part 3: Electromagnetic shielding performance tests for cabinets, racks and subracks*

ASTM D4935, *Standard Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials*[1)]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2064, ISO 2080, ISO 16348 and the following apply.

3.1
shielding effectiveness
ratio of power received with and without a material present for the same incident power, by the following equation:

$$\alpha = 10 \ (\lg P_1/P_2)$$

where

α is the shielding effectiveness;

P_1 is the received power without the material present;

P_2 is the received power with the material present (see ASTM D4935 or IEC 61587-3).

NOTE Shielding effectiveness is usually expressed in decibels (dB).

4 Essential information to be supplied by the purchaser

When ordering articles to be coated in accordance with this International Standard, the following information shall be provided in writing by the purchaser to the processor or supplier providing the coating services as part of the contract or purchase order, or on engineering drawings:

a) the number of this International Standard and the designation, including the deposit type and grade (see Clause 5);

b) the specification and metallurgical condition of metallic substrate and surface condition of polymeric substrate; identifications of assemblies of dissimilar substrates; polymeric substrates shall be of a plating grade;

c) the appearance required (see 6.2); alternatively, samples showing the required finish or range of finish to be supplied;

1) This ASTM standard has been withdrawn. However, copies are still publicly available for purchase on the ASTM website.

d) the significant surfaces, non-significant surfaces, and surfaces that shall be free of any coating, as indicated on the engineering drawings or by the provision of suitably marked samples (see Clause 6);

e) the requirements for thickness test, and minimum thickness, the adhesion test and the specific test methods for thickness to be used (see 6.5, 6.6 and 6.10);

f) the minimum requirements for electrical continuity, the thermal cycle resistance, the specific test method for shielding effectiveness to be used and the minimum requirement for shielding effectiveness (see 6.7, 6.8 and 6.9);

g) the sampling methods, acceptance levels or any other inspection requirements (see Clause 7);

h) any special requirements, e.g. mechanical roughening of polymeric surfaces to promote adhesion or requirements of any test coupons or test specimens, a porosity test, and the use of any special test specimens or coupons.

5 Designation

5.1 General

The designation is a means of specifying the coatings appropriate for various conditions of service (see Bibliography) and is comprised of the following:

a) the term “Autocatalytic coating”;

b) the number of this International Standard (ISO 17334) followed by a hyphen;

c) the symbol of the substrate or the chemical symbol of the basis metal (or for the principal metal if an alloy) followed by a solidus (/) as follows:

   PL for a plateable plastic substrate;

   Fe for iron or steel;

   Zn for zinc alloys;

   Al for aluminium or aluminium alloys;

   Mg for magnesium and magnesium alloys;

d) the chemical symbol for autocatalytic copper (Cu);

e) a number indicating the minimum local thickness, in micrometres, of the autocatalytic copper coating;

f) the chemical symbol for a nickel-phosphorus alloy coating (NiP) followed by a number in parenthesis giving the percent mass fraction of phosphorus in the coating;

g) a number indicating the minimum local thickness, in micrometres, of the autocatalytic nickel coating.

See 5.4 for examples of designations.

5.2 Coating type

The coating type designates the minimum local thickness of the autocatalytic copper and autocatalytic nickel coating, the shielding effectiveness of the composite coating and its shielding capability in accordance with Table 1.

Table 1 — Type, thickness and shielding capability of autocatalytic nickel-phosphorus alloy coatings over autocatalytic copper coatings

Type	Minimum local coating thickness µm		Shielding effectiveness dB	Shielding capability
	Autocatalytic copper	Autocatalytic nickel		
1	1,0 to 2,5	0,25 to 1,5	> 80	Very high, for severe environment
2	⩽ 1,0	1,0	50 to 80	Moderate

5.3 Coating grades

The coating grade designates the phosphorus content of the autocatalytic nickel-phosphorus alloy coating as follows:

a) Grade 1 — Autocatalytic nickel-phosphorus alloy coating having a phosphorus content of 1,0 % ± 0,5 % mass fraction;

b) Grade 2 — Autocatalytic nickel-phosphorus alloy coating having a phosphorus content of 4 % ± 1 % mass fraction;

c) Grade 3 — Autocatalytic nickel-phosphorus alloy coating having a phosphorus content of 8,5 % ± 2 % mass fraction.

NOTE 1 The coating grade provides qualitative information about the contact impedance and the relative corrosion resistance of nickel-phosphorus alloy coatings. For example, low phosphorous coatings (Grade 1) have low electrical contact impedance. High-phosphorous coatings (Grade 3) exhibit higher contact impedance, but greater resistance to corrosion than low-phosphorus coatings.

NOTE 2 Autocatalytic copper coatings are commonly deposited from highly alkaline solutions (above pH 12) employing formaldehyde as the reducing agent. The solutions contain copper salts, complexing and/or chelating agents and proprietary additives to control the stability of the solution, the rate of deposition and the appearance of the deposit. Autocatalytic copper coatings are prepared by chemical reduction with formaldehyde containing over 99 % copper by mass.

5.4 Examples of designations

A type 1 coating in which the nominal phosphorus content of the autocatalytic nickel layer is 8 % ± 1 % by mass fraction (Grade 3) on a plastic substrate would have the following designation:

Autocatalytic coating ISO 17334 - PL/Cu1/NiP(8)0,25

A type 1 coating in which the nominal phosphorus content of the autocatalytic nickel layer is 4 % (Grade 2) by mass fraction deposited on aluminium would have the following designation:

Autocatalytic coating ISO 17334 - Al/NiP(4)1,0

For ordering purposes, the detailed product specification shall not only comprise the designation, but shall also include clear written statements of other requirements essential for the serviceability of the particular product (see Clause 4).

6 Requirements

6.1 Substrate

Appropriate preparation of plastics and metal surfaces is essential to meet the requirements for adhesion and electrical conductivity specified in this International Standard. Prior to surface preparation, parts to be coated shall be inspected to determine their suitability for coating; unsuitable parts shall be rejected. Accepted methods of cleaning, conditioning and activating shall be used (see References [4] and [5] in the Bibliography).

Surfaces of metallic parts shall be free of scale, oxidation, and any contamination detrimental to the final finish. Defects in the surface of the polymeric parts may adversely affect the final finish. Surfaces of these parts shall be free from contamination, e.g. mould release agents, oil or grease, that is detrimental to the final finish. Mechanical roughening of polymeric surfaces, to promote adhesion, shall not be used unless specified by the purchaser [see 4 h)].

Following surface preparation, all parts shall be immediately coated with autocatalytic copper and autocatalytic nickel-phosphorus to the designated thickness (see Table 1) without interruption in processing. The parts shall be placed on racks to prevent gas entrapment and to avoid physical handling of significant surfaces.

Commercial processes exist that meet the requirements of this International Standard, and that may be applied to plating grades of the following polymers: polycarbonate; modified polyphenylene oxide; acetal; polysulfone; acrylonitrile-butadiene-styrene; poly(phenylene ether); polystyrene; nylon; polyester and styrene-malic-anhydride.

6.2 Appearance

The autocatalytic nickel-phosphorus coating applied on top of the autocatalytic copper coating shall be smooth, semi-bright unless otherwise specified [see 4 c)], adherent, and free from defects that are detrimental to the corrosion resistance, electrical conductivity or effectiveness of electromagnetic shielding of the coating. See ISO 16348 for definitions and conventions concerning appearance.

Approved samples of artefacts shall be used for comparison purposes to control the final appearance of the production items [4 c)].

The parts shall be inspected visually and those exhibiting blisters shall be rejected.

Blisters, voids or cracks on uncoated mating surface areas visible to the unaided eye are not permitted. On uncoated non-mating surfaces, maximum size of void or of any defect visible to the unaided eye exposing the substrate shall be less than 100 mm^2 and maximum void or defect area per 10 000 mm^2 of surface area/mm^2 shall be less than 200. Voids, cracks, skips or other unplated area exposing copper shall be rejected.

6.3 Storage

Following coating, the parts are dried with warm air. Drying temperature shall not exceed the heat distortion temperature of the substrate. Wetting agents may be used to enhance water shedding provided they do not interfere with subsequent adhesion of organic coatings.

Following drying, all parts shall be stored in a clean dry area, protected from corrosive fumes and humidity prior to packaging and shipping.

6.4 Coating composition

The phosphorus content of the autocatalytic nickel-phosphorus alloy coating shall be that given in the designation and shall be within the range defined by the coating grade (see 5.3). Use methods for determining the phosphorus content of autocatalytic nickel-phosphorus alloy coatings described in ISO 4527. The autocatalytic copper coating shall contain a minimum of 99 % by mass copper.

6.5 Local coating thickness

The local coating thickness shall be that specified in the designation (see Clause 5 and Table 1) and shall be measured on all significant surfaces of the finished part. The combined thickness of autocatalytic copper plus nickel may be used provided representative parts also meet the electrical conductivity requirements specified in 6.7.

The thickness of deposits on non-significant surfaces shall be that which results from control of deposition on significant surfaces provided complete coverage occurs, unless otherwise specified on the part drawing.

The thickness shall be measured by one of the methods given in Annex A.

6.6 Adhesion

6.6.1 General

The purchaser shall specify one or more of the qualitative methods of measuring adhesion described in ISO 2819 or select the method described below.

The coatings shall not peel or separate from the substrate when subjected to the test for adhesion.

6.6.2 Adhesive tape

Using a straight edge and a hardened steel scriber that has been ground to a sharp point, scribe a grid of 2 mm by 2 mm squares over the test area. Apply sufficient pressure to cut through the coating to the substrate in a single stroke. Apply the adhesive side of a non-transferable adhesive tape, having an adhesion value of 2,9 N/cm to 3,1 N/cm, to the coating being tested taking care to exclude air bubbles. After an interval of 10 s, remove the tape (see IEC 60454-2) rapidly by pulling perpendicular to the surface of the specimen. Examine the sample and the tape for signs of removal of the coating. No part of the coating shall be removed by the adhesive tape. This test will only detect gross defects of adhesion.

6.7 Electrical continuity and integrity

The DC resistance of the coating system of parts or coupons between all points on the significant surface shall not exceed 0,1 Ω unless otherwise specified by the purchaser [see 4 h)].

6.8 Thermal cycling

The thermal cycling test assesses adhesion and monitors the effectiveness of processes for preparing plastics for electroplating. Carry out the test in accordance with ISO 4525. Special test specimens or coupons subjected to the thermal cycling test are to be stabilized at room temperature for at least 30 min and examined at a 10× magnification; any evidence of cracks, delamination or any other defect shall constitute failure. A second set of test specimens following the thermal cycle test is to be subjected to cross-hatch adhesion described in ISO 2819 and visually examined for removal of coating.

6.9 Shielding effectiveness

Parts or coupons shall be subjected to 20 cycles of the cyclic temperature-humidity test in accordance with the test method in ASTM D4935. These tested parts or coupons shall meet the shielding effectiveness requirements of Table 1 when shielding effectiveness performance is tested in accordance with IEC 61587-3.