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Electrodeposited coatings and related finishes — Electroless Ni-P-ceramic composite coatings

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Electroless nickel-phosphorus (Ni-P) alloy coatings are produced by the controlled chemical reduction of nickel ions onto a catalytic surface in hot, usually mildly acidic or occasionally alkaline solutions using hypophosphite ion as the reducing agent. Because the deposited nickel alloy is a catalyst for the reaction, the process is self-sustaining or autocatalytic.

Fine ceramic (nano-sized) particles dispersed in the electroless nickel plating bath can be incorporated with the deposition of a Ni-P layer, which produces a nickel-phosphorus-ceramic (Ni-P-ceramic) composite coating. There is no molecular bonding between the Ni-P matrix and the incorporated ceramic particles. The incorporation phenomenon basically results from the impact and settling of the particles on the surface of the work piece and the subsequent surrounding of these particles by the growing Ni-P matrix. The deposits produced are uniform in thickness on irregularly shaped articles as the processing solution circulates freely over their surfaces. The physicochemical properties and the structure of electroless Ni-P-ceramic composite coatings are dependent on the size, type, chemical inertness and deposition homogeneity of the ceramic particles as well as plating conditions such as pH, temperature, plating bath composition, surfactants used, quality of the substrates and their pre-treatment, activation methods and post-heat treatment.

Electroless Ni-P-ceramic composite is applied to improve hardness, as well as wear, and corrosion-resistant properties of the coating depending on the nature of the ceramics.

Electrodeposited coatings and related finishes — Electroless Ni-P-ceramic composite coatings

1 Scope

This document specifies the requirements and recommendations for electroless Ni-P-ceramic composite coatings applied from aqueous solutions onto metallic and non-metallic substrates.

This document does not apply to ternary nickel alloys and nickel-boron ceramic composite coatings.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1463, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method*

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 2081, *Metallic and other inorganic coatings — Electroplated coatings of zinc with supplementary treatments on iron or steel*

ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*

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

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 2859-2, *Sampling procedures for inspection by attributes — Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*

ISO 2859-3, *Sampling procedures for inspection by attributes — Part 3: Skip-lot sampling procedures*

ISO 2859-4, *Sampling procedures for inspection by attributes — Part 4: Procedures for assessment of declared quality levels*

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

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

ISO 4288, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture*

ISO 4516, *Metallic and other inorganic coatings — Vickers and Knoop microhardness tests*

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

ISO 4526, *Metallic coatings — Electroplated coatings of nickel for engineering purposes*

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

ISO 9220, *Metallic coatings — Measurement of coating thickness — Scanning electron microscope method*

ISO 9587, *Metallic and other inorganic coatings — Pretreatment of iron or steel to reduce the risk of hydrogen embrittlement*

ISO 9588, *Metallic and other inorganic coatings — Post-coating treatments of iron or steel to reduce the risk of hydrogen embrittlement*

ISO 10289, *Methods for corrosion testing of metallic and other inorganic coatings on metallic substrates — Rating of test specimens and manufactured articles subjected to corrosion tests*

ISO 27307, *Thermal spraying — Evaluation of adhesion/cohesion of thermal sprayed ceramic coatings by transverse scratch testing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2064, ISO 2080, ISO 4527, ISO 9587 and ISO 9588 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Designation

4.1 General

The designation shall comprise the following:

a) the term, “electroless Ni-P-ceramic composite coating”;

b) the number of this document, i.e. ISO 23363;

c) a hyphen;

d) the chemical symbol of the basis metal;

e) a solidus (/);

f) symbols for the nickel-phosphorus and ceramics as well as coatings applied prior to and after electroless coating, separated by solidi (/) for each stage in the coating sequence in the order of application. The coating designation shall include the thickness of the coatings in µm.

4.2 Examples of designations

The following are examples of designations.

a) 20 µm thick electroless nickel-phosphorus silicon carbide composite coating having a nominal phosphorus content of 8 % mass fraction, and 25 volume % of SiC in average size of 300 nm on 10800 copper-base alloy is designated as follows:

Electroless Ni-P-ceramic composite coating ISO 23363-Cu<10800>/NiP(8)20/SiC300(25)/

b) The same coating applied to G43400 steel requiring stress relief prior to coating at 210 °C for 22 h and subsequently electroplated with 0,5 µm chromium, requiring heat treatment for hydrogen embrittlement relief at 210 °C for 22 h, is designated as follows:

Electroless Ni-P-ceramic composite coating ISO 23363-Fe<G43400>[SR(210)22]//NiP(8)20/SiC 300(25)// Cr0,5[ER(210)22]

5 Requirements

5.1 Special test specimens

Special test specimens may be used to measure adhesion, thickness, porosity, corrosion resistance, hardness and other properties of Ni-P-ceramic composite coatings. When the coated articles are of a size, shape or material that is not suitable for the test, or if it is not practical to submit the coated articles to destructive tests because the parts are few in number or too expensive, special test specimens shall be required.

5.2 Surface finish

The incorporation of ceramic particles into the deposit can increase the surface roughness of the coating, especially in the case of hard and sub-micron-sized ceramic particles. If a specified final surface roughness is required, the method of measurement shall be as specified in ISO 4288.

NOTE The surface finish of electroless nickel composite coatings is not usually superior to that of the substrate before coating.

5.3 Thickness

The coating thickness shall be measured using one of the test methods given in ISO 2178, ISO 1463, ISO 3497, ISO 3543, ISO 4527 and ISO 9220 unless otherwise specified by the purchaser.

5.4 Hardness

In addition to the heat treatment, the hardness of the Ni-P-ceramic composite coatings shall be different to the electroless Ni-P coatings depending on the type, size, nature and the homogeneity of the dispersed ceramic particles into the deposit, in accordance with Annex A. When hardness is specified, it shall be measured by the method given in ISO 4516. The measured hardness of the coating shall be within ± 10 % of that specified by the purchaser.

5.5 Adhesion

Prior to the electroless nickel composite coating, an electro/electroless nickel or other metallic undercoat is recommended to improve adhesion to the substrate. Coatings shall be capable of passing one or more of the adhesion tests given in ISO 2819 and ISO 27307 or as specified by the purchaser.

5.6 Porosity

If required, a maximum degree of porosity of the electroless Ni-P-ceramic composite coating shall be specified by the purchaser together with a method of testing for porosity.

5.7 Corrosion resistance

Corrosion resistance can be affected by the nature, types and the amount (volume %) of incorporated ceramic particles into the Ni-P matrix (see Annex A). Similarly, surface conditions such as surface smoothness, hydrogen embrittlement, porosity and the interface between the ceramics and nickel matrix as well as phosphorus content in the deposit can affect the corrosion behaviour of the coating. The corrosion resistance and the corrosion test method shall be specified by the purchaser. If required,

