Electrodeposited nickel coatings on magnetic and non-magnetic substrates — Measurement of coating thickness — Magnetic method

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2361 was developed by Technical Committee ISO/TC 107, Metallic and other non-organic coatings, and was circulated to the member bodies in November 1980.

It has been approved by the member bodies of the following countries:

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No member body expressed disapproval of the document.

This second edition cancels and replaces the first edition (i.e. ISO 2361-1972).
Electrodeposited nickel coatings on magnetic and non-magnetic substrates — Measurement of coating thickness — Magnetic method

1 Scope and field of application

This International Standard specifies the method of using coating thickness instruments of the magnetic type for non-destructive measurements of the thickness of electrodeposited nickel coatings on magnetic or non-magnetic substrates.

The method may not be applicable to autocatalytic (electroless) nickel coatings depending on their chemical composition.

For the purposes of this International Standard, two types of nickel coating are distinguished:

a) nickel coatings on magnetic substrates (type A coatings);

b) nickel coatings on non-magnetic substrates (type B coatings).

It should not be assumed that all instruments are applicable to both types of coating.

The effective measuring ranges of instruments using the principle of magnetic attraction are up to 50 µm for type A coatings, and up to 25 µm for type B coatings.

For instruments using the principle of reluctance, the effective ranges are much greater and measurements up to 1 mm, or more, can be made on both types of coating.

2 References


ISO 2064, Metallic and other non-organic coatings — Definitions and conventions concerning the measurement of thickness.

ISO 2177, Metallic coatings — Measurement of coating thickness — Coulometric method by anodic dissolution.1)

3 Principle

Coating thickness instruments of the magnetic type measure either the magnetic attraction between a permanent magnet and the coating/substrate combination, or the reluctance of a magnetic flux path passing through the coating and the substrate.

4 Factors affecting the measuring accuracy2)

The following factors may affect the accuracy of measurements of coating thickness.

4.1 Coating thickness

The precision of a measurement changes with coating thickness depending on the instrument design. For thin coatings, the precision is constant, independent of the thickness. For thick coatings, the precision is an approximately constant fraction of the thickness.

4.2 Magnetic properties of the basis metal

(type A coatings only)

Thickness measurements by the magnetic method are affected by variations in the magnetic properties of the basis metal. For practical purposes, magnetic variations in low carbon steels can be considered to be insignificant.

4.3 Basis metal thickness

(type A coatings only)

For each instrument, there is a critical thickness of basis metal above which measurements will not be affected by an increase in thickness. Since it depends on the instrument probe and the nature of the basis metal, its value should be determined experimentally, unless it is specified by the manufacturer.

1) At present at the stage of draft. (Revision of ISO 2177 1972.)

2) For the purpose of this International Standard, the measuring uncertainty is defined as that obtained with an instrument correctly calibrated and used.
ISO 2361-1982 (E)

4.4 Edge effects

The method is sensitive to abrupt changes in surface contour of the test specimen. Therefore, measurements made too near an edge or inside corner will not be valid unless the instrument is specifically calibrated for such measurements. The effect may extend up to about 20 mm from the discontinuity, depending on the instrument.

4.5 Curvature

Measurements are affected by the curvature of the test specimen. The influence of curvature varies considerably with the make and type of instrument, but always becomes more pronounced as the radius of curvature decreases.

Instruments with two-pole probes may also produce different readings if the poles are aligned in planes parallel or perpendicular to the axis of a cylindrical surface. A similar effect can occur with a single-pole probe if the tip is unevenly worn.

Measurements made on curved test specimens may not, therefore, be valid unless the instrument is specifically calibrated for such measurements.

4.6 Surface roughness

If the range of a series of measurements, made within the same reference area (see ISO 2064) on a rough surface, substantially exceeds the inherent repeatability of the instrument, the number of measurements required should be increased to at least five.

4.7 Direction of mechanical working of the basis metal (type A coatings only)

Measurements made by an instrument having a two-pole probe or an unevenly worn single-pole probe may be influenced by the direction in which the magnetic basis metal has been subjected to mechanical working (such as rolling), the reading changing with the orientation of the probe on the surface.

4.8 Residual magnetism (type A coatings only)

Residual magnetism in the basis metal affects measurements made by instruments which employ a stationary magnetic field. Its influence on measurements made by reluctance instruments employing an alternating magnetic field is much smaller (see 6.7).

4.9 Magnetic fields

Strong magnetic fields, such as those produced by various types of electrical equipment, can seriously interfere with the operation of instruments which employ a stationary magnetic field (see 6.7).

4.10 Foreign particles

The probes of the instruments have to make physical contact with the test surface because these instrument are sensitive to foreign material that prevents intimate contact between the probe and the surface of the coating. The probe tip should be checked for cleanliness.

4.11 Magnetic properties of the coating

Measurements are affected by variations in the magnetic properties of the coating. These properties depend on the conditions under which the deposit is made, the type and composition of the coating, and its stress conditions. Heat treatment at 400 °C for 30 min will equalize the magnetic permeability of dull (sulphur-free or nearly sulphur-free) nickel coatings of the same composition. Bright nickel deposits may or may not have the same magnetic properties after heat treatment; heat treatment may also damage the article. The magnetic properties of multiple layer nickel coatings will also depend on the relative thickness of each of the layers.

4.12 Nickel coatings on the back of the substrate (type B coatings only)

Nickel coatings on the back of the substrate can affect the measurements depending on the thickness of the substrate.

4.13 Probe pressure

The poles of the test probe have to be applied at a constant but sufficiently high pressure, such that no deformation of the coating occurs.

4.14 Probe orientation

The readings of instruments using the magnetic attraction principle may be affected by the orientation of the magnet in relation to the field of gravity of the earth. Thus, the operation of an instrument probe in a horizontal or upside-down position may require a different calibration, or may be impossible.

5 Calibration of instruments

5.1 General

Before use, each instrument shall be calibrated in accordance with the manufacturer's instructions, using suitable calibration standards.

During use, the calibration of the instrument shall be checked after a warm-up period and at regular intervals of at least once a day. Appropriate attention shall be given to the factors listed in clause 4 and to the procedures specified in clause 6.

5.2 Calibration standards

5.2.1 Calibration standards shall be coated standards obtained by electroplating nickel adherently onto a substrate.

The surface roughness and magnetic properties of the substrate and the coating of the standards shall be similar to
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