SLOVENSKI STANDARD
SIST EN ISO 21968:2005

01-oktober-2005

Nemagnetne kovinske prevleke na kovinskih in nekovinskih osnovnih materialih ï Merjenje debeline nanosa prevleke ï Metoda vrtinļ nih tokov (ISO 21968:2005)

Non-magnetic metallic coatings on metallic and non-metallic basis materials - Measurement of coating thickness - Phase-sensitive eddy-current method (ISO 21968:2005)

Nichtmagnetische metallische Überzüge auf metallischen und nichtmetallischen Grundwerkstoffen - Messung der Schichtdicke - Phasensensitives Wirbelstromverfahren (ISO 21968:2005)

Revetements métalliques non magnétiques sur des matériaux de base métalliques et non métalliques - Mesurage de l'épaisseur de revetement - Méthode par courants de Foucault sensible aux variations de phase (ISO 21968:2005)

Ta slovenski standard je istoveten z: **EN ISO 21968:2005**

ICS:

25.220.40 Kovinske prevleke Metallic coatings

SIST EN ISO 21968:2005 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 21968

July 2005

ICS 25.220.40

English Version

Non-magnetic metallic coatings on metallic and non-metallic basis materials - Measurement of coating thickness - Phase-sensitive eddy-current method (ISO 21968:2005)

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This European Standard was approved by CEN on 22 June 2005.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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COMITÉ EUROPÉEN DE NORMALISATION
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Ref. No. EN ISO 21968:2005: E

Foreword

This document (EN ISO 21968:2005) has been prepared by Technical Committee ISO/TC 107 "Metallic and other inorganic coatings" in collaboration with Technical Committee CEN/TC 262 "Metallic and other inorganic coatings", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2006, and conflicting national standards shall be withdrawn at the latest by January 2006.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Endorsement notice

The text of ISO 21968:2005 has been approved by CEN as EN ISO 21968:2005 without any modifications.

INTERNATIONAL STANDARD

ISO 21968

First edition
2005-07-15

Non-magnetic metallic coatings on metallic and non-metallic basis materials — Measurement of coating thickness — Phase-sensitive eddy-current method

Revêtements métalliques non magnétiques sur des matériaux de base métalliques et non métalliques — Mesurage de l'épaisseur de revêtement — Méthode par courants de Foucault sensible aux variations de phase

Reference number
ISO 21968:2005(E)

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Published in Switzerland

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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 21968 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 2, *Test methods*.

Non-magnetic metallic coatings on metallic and non-metallic basis materials — Measurement of coating thickness — Phase-sensitive eddy-current method

1 Scope

This International Standard describes a method of using phase-sensitive eddy-current instruments for non-destructive measurements of the thickness of non-magnetic metallic coatings on metallic and non-metallic basis materials, such as:

a) zinc, cadmium, copper, tin or chromium on steel;

b) copper or silver on composite materials.

The phase-sensitive method can be applied without thickness errors to smaller surface areas and to stronger surface curvatures than the amplitude-sensitive eddy-current method described in ISO 2360[1], and is less affected by the magnetic properties of the basis material. However, the phase-sensitive method is more affected by the electrical properties of the coating materials.

When measuring metallic coatings on metallic basis materials, the product of conductivity and permeability (σ, μ) of one of the materials should be at least a factor of 1,5 times the product of conductivity and permeability for the other material. Non-ferromagnetic materials have a relative permeability of 1.

2 Principle

An eddy-current probe (or integrated probe/instrument) is placed on (or near) the surface of the coating(s) to be measured, and the thickness is read from the instrument's readout.

For each instrument, there is a maximum measurable thickness of the coating.

Since this thickness range depends on both the applied frequency of the probe system and the electrical properties of the coating, the maximum thickness should be determined experimentally, unless otherwise specified by the manufacturer.

An explanation of eddy-current generation and the calculation of the maximum measurable coating thickness, d_{max}, is given in Annex A.

However, in the absence of any other information, the maximum measurable coating thickness, d_{max}, can be estimated using Equation (1):

$$d_{max} = 0{,}8\delta_0 \quad (1)$$

where δ_0 is the standard penetration depth of the coating material [see Equation (A.1)].

3 Equipment

3.1 **Probe**, containing an eddy-current generator, and a **detector** linked to a system capable of measuring and displaying changes in amplitude and phase, normally as a direct readout of coating thickness.

NOTE 1 The probe and measuring system/display may be integrated into a single instrument.

NOTE 2 Factors affecting measurement accuracy are discussed in Clause 5.

4 Sampling

Sampling depends on the specific application and coating to be tested; the area, location and number of test specimens shall be agreed between interested parties and shall be included in the test report (see Clause 9).

5 Factors affecting measurement accuracy

5.1 Coating thickness

A measurement uncertainty is inherent in the method. For thin coatings, this measurement uncertainty (in absolute terms) is constant, independent of the coating thickness. The absolute value of the uncertainty depends on the applied frequency of the probe system, and also on the conductivity and permeability of the used sample materials. With increasing thickness within the measurement range of the probe system, this uncertainty becomes a function of the thickness and is approximately a constant fraction of that thickness.

The mean of several measurements should be used as the thickness value to reduce the uncertainty, especially in the lower part of the measurement range of the used probe system.

5.2 Electrical properties of the basis materials

Both conductivity and permeability have some effect on the measurement, but these effects are small when compared to those with the amplitude method described in ISO 2360[1].

5.3 Electrical properties of the coating materials

Coating thickness measurements are affected by the electrical conductivity of the coating material, which in turn can be dependent upon composition, the coating process (additives, contaminants, etc.) and any post-coating treatments, such as heating or mechanical working.

5.4 Basis-metal thickness

For each instrument, there is a critical minimum basis-metal thickness above which measurements will not be affected by an increase in thickness.

This thickness depends on both the applied frequency of the probe system and the electrical and magnetic properties of the basis material. Its value should be determined experimentally, unless otherwise specified by the manufacturer.

An explanation of eddy-current generation and the calculation of the minimum basis-material thickness, d_{min}, is given in Annex A.

However, in the absence of any other information, the required minimum thickness of basis material, d_{min}, can be calculated from Equation (2):

$$d_{min} = 2{,}5\delta_0 \tag{2}$$

where δ_0 is the standard penetration depth of the metallic basis material [see Equation (A.1)].

5.5 Edge effects

Eddy-current instruments can be sensitive to abrupt changes in surface contour of the test specimen. Therefore, measurements made too near to an edge or corner may not be valid, unless the instrument has been specifically calibrated for such measurements (see 6.2.4 and Annex B).

NOTE The phase-sensitive eddy-current instruments can be substantially less affected by edge effects when compared with the amplitude method of ISO 2360.

5.6 Surface curvature

Measurements are affected by the curvature of the test specimen. This influence of curvature varies considerably with the make and type of instrument and probe, but always becomes more pronounced as the radius of curvature decreases. Measurements made on curved test specimens may not, therefore, be valid unless the instrument is specifically calibrated for the surface curvature in question, or a special probe, which compensates for surface influence, is used.

The effect of surface curvature can be reduced by the use of so-called microprobes, in which the radial area of probe influence has been reduced.

NOTE The phase-sensitive eddy-current measurement can be substantially less affected by the surface curvature of the test specimen when compared with the amplitude-sensitive eddy-current method given in ISO 2360.

5.7 Surface roughness

Measurements are influenced by the surface topography of the basis material and of the coating. Rough surfaces can cause both systematic and random errors. Random errors can be reduced by making multiple measurements, with each measurement being made at a different location, and then calculating the average value of this series of measurements.

If the basis material is rough, the zero of the instrument shall be checked at several locations on a typical sample of the uncoated, rough, basis material. If no typical uncoated basis material is available, the coating of the test specimen shall be stripped, at least over part of its area, with a chemical solution which does not attack the basis material.

NOTE The phase-sensitive eddy-current measurement can be substantially less affected by basis-material roughness and coating roughness when compared with the amplitude-sensitive eddy-current method given in ISO 2360.

5.8 Lift-off effect

If the probe is not placed directly down onto the coating, the gap between probe and coating (lift-off) will affect the measurement of the metal coating thickness. The use of an appropriate electronic circuit design, and/or mathematical algorithm in the instrument, allows lift-off compensation to be applied for gaps of up to 1 mm.

Lift-off compensation shall be verified in accordance with the manufacturer's instructions, by the use of electrically non-conductive shims of known thickness which are inserted between the probe and the coating.

Lift-off can be produced intentionally, as when measuring a metallic coating through paint, or when it is necessary to make a contactless measurement, or unintentionally due to the presence of foreign particles between the probe and coating.

The probe tip shall be frequently checked for cleanliness.