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SWEDISH STANDARDS INSTITUTE

Termisk sprutning – Mätning av elektrisk konduktivitet för termiska sprutade icke-järnmetallbeläggningar med virvelströmsmetoden (Eddy current)

Thermal spraying – Measurement of the electrical conductivity of thermal sprayed non-iron metal coatings by means of eddy current method

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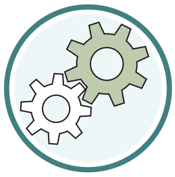

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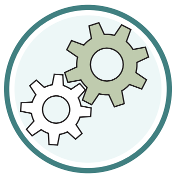

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Europastandarden EN 16813:2016 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 16813:2016.

The European Standard EN 16813:2016 has the status of a Swedish Standard. This document contains the official English version of EN 16813:2016.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00. Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.

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Denna standard är framtagen av kommittén för Termisk sprutning, SIS/TK 134/AG 448.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16813

November 2016

ICS 25.220.20

English Version

Thermal spraying - Measurement of the electrical conductivity of thermal sprayed non-iron metal coatings by means of eddy current method

Projection thermique - Mesurage de la conductivité électrique des revêtements métalliques non ferreux obtenus par projection thermique, à l'aide de la méthode par courants de Foucault

Thermisches Spritzen - Messung der elektrischen Leitfähigkeit thermisch gespritzter Nichteisenmetall-Schichten mittels Wirbelstromverfahren

This European Standard was approved by CEN on 24 September 2016.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 16813:2016) has been prepared by Technical Committee CEN/TC 240 “Thermal spraying and thermally sprayed coatings”, the secretariat of which is held by DIN.

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 May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

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Introduction

In many applications, the electrical conductivity is a relevant technical parameter. For testing of imperfections in components or technological material properties the eddy current method can be very well applied. It can be detected or determined, for example:

— defects in welds;

— imperfections or change in the structure of a component, for example, due to aging processes in structures made out of aluminium;

— change in structure caused by temperature effects;

— thickness;

— physical material properties such as the electrical conductivity.

Due to an interaction between high frequency magnetic fields, emitted from a measuring probe, and the eddy currents induced in the object to be measured the electrical conductivity can be determined, e.g. according to ASTM E 1004 or can be used for fast and contact less measurements of a coating thickness according to EN ISO 21968.

Due to the manufacturing process thermal sprayed coatings contain a layer orientated structure. Dependent on the material used, it can also contain oxides and/or inclusions as well as porosity created due to splat boundary effects during spraying.

Besides the structure with its grain boundaries, dislocations, internal stresses and impurities, e.g. oxide skins, the specific gravity of a material plays an important role for the level of the electrical conductivity. In order to produce the highest possible level of electrical conductivity in the coating, the influencing factors for the thermal spraying process should be minimized.

1 Scope

This European standard specifies the procedure of the measurement of the electrical conductivity of non-Ferro-magnetic thermal sprayed coatings. By this measurement the absolute value of the electrical conductivity in the coating sprayed on component can be determined as well as also deviations from the agreed rated value can be used to control a running production. With that, a remarkable contribution can be applied to process and quality assurance measures of a manufacture process.

2 Normative references

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

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
electrical conductivity
σ
physical value, which shows the ability of a material – in this case of a thermal sprayed coating – to conduct the current

Note 1 to entry: It is defined to be the constant of proportionality between the current density and the electrical field intensity within the general Formula (1) of the ohmic law. σ is measured in S/m.

$$J = \sigma \times E \tag{1}$$

where

J is the current density;

σ is the electrical conductivity;

E is the field intensity.

3.2
electrical resistance
R
value, which defines the electrical voltage, which is needed that a certain current can flow through an electrical conductor

Note 1 to entry: The unit is ohm (Ω).

3.3
specific electrical resistivity
property of material, which is the result of the electrical resistance in a homogenous part with a constant current intensity distribution across the constant cross-section and length of the conductor and an ohmic resistance

Note 1 to entry: The specific electrical resistance, see Formula (2), depends on the temperature of material and is the reciprocal value of the electrical conductivity ($\rho = 1/\sigma$). The unit is ohm metre ($\Omega \times m$).

$$\rho = R \times \frac{A}{L} \tag{2}$$

where

ρ is the specific electrical resistivity in $\Omega \times m$;

R is the ohmic resistance;

A is the constant cross-section of the conductor;

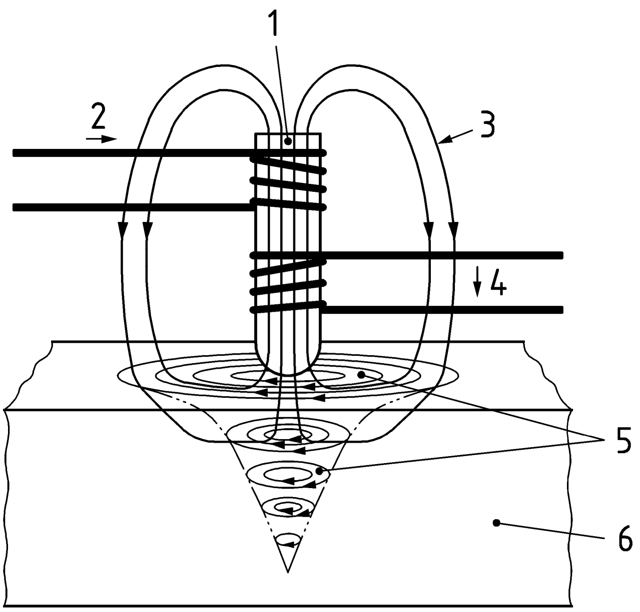
L is the length of the conductor.

4 Measuring process

4.1 Measuring method

Measuring of the absolute value of the electrical conductivity takes place usually by a current voltage measurement. However, this method is usually applied in laboratories only.

If the electrical conductivity shall be determined in a component on site, primarily eddy current processes are applied. To measure the electrical conductivity of non-magnetic metals, such as aluminium, copper, brass, titanium, chrome-nickel-steel, etc. Therefore, the phase-sensitive eddy current measurement procedure is very suitable. By that, the measuring probe fed from a generator with alternating current of a certain frequency is to be put to the object to be measured or to be brought into small distance to its surface. This exciter current generates a magnetic field of high frequency, which induces eddy currents in the material to be tested (in this case the coating respectively the base material), their intensity and penetration depth depend on its electrical conductivity. On the other hand the magnetic field induced by eddy currents overlaps the generating field. The generated resulting magnetic field is detected by a measuring coil. By that, the induced voltage is a function of the electrical conductivity of the object to be measured and can be used as a signal for its measuring. See Figure 1.



Key

1 ferrite core of the probe

2 exiting current

3 high frequency magnetic alternating field

4 measuring signal

5 eddy current induced

6 electrically conductive non-ferrous-alloy

Figure 1 — Phase-sensitive eddy current measuring method

Using the phase-sensitive eddy current measurement procedure the phase changing between exciter current and measuring signal is to be transferred into a conductivity value. This measuring value is independent from the distance between the probe and the coating surface for a certain arrangement, which depends on the type of the probe. By that, a non-contactable determination of the conductivity can be applied also using this method, for example, below a varnish or a synthetic material coat. Using an adequate measuring frequency the influence of the surface roughness remains low.

4.2 Calibration standard

Using the phase-sensitive eddy current measurement procedure the measuring value found in the component will be compared to the calibration standard as a reference standard, which conductivity is very well known. Standards for calibration of the measuring instrument are available for the whole conductivity range. Usually, they are also supplied from the measuring instrument producer.

Because the calibration standards are subject to changes in properties due to use they have to be recalibrated at regular time periods or to be replaced.