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Non-conductive coatings on non-magnetic basis metals — Measurement of coating thickness — Eddy current 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 2360 was drawn up by Technical Committee ISO/TC 107, *Metallic and other non-organic coatings.*

It was approved in December 1971 by the Member Bodies of the following countries:

Austria	Israel	Spain
Egypt, Arab Rep. of	Italy	Sweden
France	Netherlands	Switzerland
Germany	New Zealand	Thailand
Hungary	Romania	United Kingdom
India	South Africa, Rep. of	U.S.S.R.

No Member Body expressed disapproval of the document.

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Non-conductive coatings on non-magnetic basis metals — Measurement of coating thickness — Eddy current method

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the method of using eddy current instruments for the non-destructive measurement of the thickness of a non-conductive coating on a non-magnetic basis metal.

Although this method will apply to measurements of most oxide coatings produced by anodizing, it will not be applicable to all conversion coatings, some of which are too thin to be measured by this method (see section 6).

These instruments work on the principle that a high frequency electromagnetic field generated in the probe system of the instrument will produce eddy currents in a conductor upon which the probe is placed, and that the amplitude of these currents is a function of the thickness of the non-conductive coating present between the conductor and the probe.

2 REFERENCE

ISO 2178, *Non-magnetic metallic and vitreous or porcelain enamel coatings on magnetic basis metals — Measurement of coating thickness — Magnetic method.*

3 FACTORS AFFECTING THE MEASURING ACCURACY

The following factors may affect the accuracy of a coating thickness measurement:

3.1 Coating thickness

Inherent in the method is a measuring uncertainty. For thin coatings, this uncertainty is constant and independent of the coating thickness, and for a single measurement is not less than 0.5 μm;

For coating thicknesses greater than about 25 μm, this uncertainty is proportional to the coating thickness.

3.2 Electrical properties of the basis metal

Eddy current measurements are affected by the electrical conductivity of the basis metal. Heat treatments often change the conductivity of this metal.

3.3 Basis metal thickness

For each instrument, there is a critical thickness of the basis metal above which the measurements will not be affected by an increase in the thickness of the basis metal. Since this thickness depends on both the measuring frequency of the probe system and the electrical conductivity of the basis metal, its value shall be determined experimentally, if not specified by the manufacturer.

In general, for a given measuring frequency, the higher the conductivity of the basis metal the smaller is its critical thickness. For a given basis metal, the higher the measuring frequency the smaller is the critical thickness of the basis metal.

3.4 Edge effect

The method is sensitive to abrupt changes in the 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 a measurement.

3.5 Curvature

The 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. Therefore, measurements made on curved specimens will not be valid unless the instrument is specifically calibrated for such a measurement.

3.6 Surface roughness

Measurements are influenced by the surface topography of the basis metal and of the coating. Therefore, it is necessary, on a rough surface, to make a greater number of measurements at different positions to obtain a mean value that is representative of the average coating thickness.

If the basis metal is rough, it may also be necessary to check the zero of the instrument at several positions on a sample of the uncoated, rough, basis metal. If there is not an uncoated similar basis metal, the coating of the test specimen shall be stripped with a solution which does not attack the basis metal.

3.7 Foreign particles

The probes of eddy current instruments shall make physical contact with the test surface and are, therefore, sensitive to

foreign material that prevents intimate contact between the probe and the surface of the coating.

3.8 Pressure

The pressure with which the probe is applied to the test specimen affects the instrument readings and shall therefore be maintained constant.

3.9 Positioning of the probe

The instrument probe shall be placed perpendicularly to the specimen surface at the point of measurement.

4 CALIBRATION OF INSTRUMENTS

4.1 General

Before use, each instrument shall be calibrated in accordance with the instructions of the manufacturer, employing suitable thickness standards.

During use, the calibration shall be checked at frequent intervals, at least once an hour. Attention shall be given to the factors listed in section 3 and to the procedures described in section 5.

4.2 Calibration standards

Calibration standards of known thickness are available either as foils, or as coated specimens.

4.2.1 *Calibration foils*

4.2.1.1 The calibration foils used for the calibration of eddy current instruments are generally made of plastics materials.

They are advantageous for calibration on curved surfaces, and are more readily available than coated standards.

4.2.1.2 To prevent measurement errors, it is necessary to ensure that intimate contact is established between the foil and the substrate. Resilient foils shall be avoided if possible.

Calibration foils are subject to indentation and shall, therefore, be replaced frequently.

4.2.2 *Coated standards*

These calibration standards consist of non-conductive coatings of known, uniform thickness permanently bonded to the substrate material.

4.3 Verification

4.3.1 The basis metal of the calibration standards shall have electrical properties similar to those of the basis metal of the coated test specimen. To confirm their suitability, a comparison of the readings obtained with the basis metal of the bare standard and that of the test specimen is recommended.

4.3.2 The basis metal thickness for the test and the calibration shall be the same if the critical thickness, defined in 3.3, is not exceeded. When possible, back up the basis metal of the standard or of the test specimen with a sufficient thickness of similar material to make the readings independent of the basis metal thickness.

4.3.3 If the test specimen is soft and thin, it is subject to indentation by the probe. Because of this, and despite the use of special probes or fixtures, measurements on such specimens may sometimes become impossible.

4.3.4 If the curvature of the coating to be measured is such as to preclude calibration on a flat surface, the curvature of the coated standard, or of the substrate on which the calibration foil is placed, shall be the same as that of the test specimen.

5 MEASURING PROCEDURE

Each instrument shall be operated in accordance with the instructions of the manufacturer.

The calibration of the instrument shall be checked, at the test site, each time the instrument is put into service, and at frequent intervals during use at least once an hour, to assure proper performance.

The following precautions shall be observed:

5.1 Basis metal thickness

Check whether the basis metal thickness exceeds the critical thickness. If not, either use the back-up method mentioned in 4.3.2, or make sure that the calibration has been made on a standard having the same thickness and electrical properties as the test specimen.

5.2 Edge effects

Measurements shall not be made close to an edge, hole, inside corner, etc., of a specimen, unless the instrument is specifically calibrated for such a measurement.

5.3 Curvature

Measurements shall not be made on a curved surface of a specimen, unless the instrument is specifically calibrated for such a measurement.

5.4 Number of readings

Because of normal instrument variability, it is necessary to make several readings at each position. Local variations in coating thickness may also require that a number of measurements be made in any given area; this applies particularly to a rough surface.

5.5 Surface cleanliness

Before making measurements, any foreign matter such as dirt, grease, and corrosion products shall be cleaned from the surface without removing any coating material.

6 MEASURING ACCURACY

The measuring accuracy depends on the nature, operation and calibration of the apparatus. It shall permit the determination of the coating thickness within ± 10 % of its true thickness. When measuring coating thicknesses of less than 5 μm it is advisable to take the mean of several readings. It may be impossible to obtain this accuracy with coatings less than 3 μm in thickness.

7 NOTE

Although, theoretically, this test method can be used for measurements on a magnetic basis metal, its use for this application is not recommended. In such cases the magnetic method outlined in ISO 2178 should be used.