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**NATIONAL STANDARD OF THE
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**Metallic and oxide coatings - Measurement of coating thickness
- Microscopical method
(English Translation)**

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1 Scope

This document describes a method for measuring the local thickness of metallic coatings, oxide films, and enamel or glass enamel coatings by examining cross-sections using an optical microscope.

This document applies to the measurement of thickness of metallic and oxide coatings.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

3.1

local thickness

The average value of the thickness measured a specified number of times within the reference surface.

[Source: GB/T 12334-2001, 3.4]

4 Principle

Cut a representative sample from the test sample; after inlaying, prepare the cross-section by appropriate techniques of grinding, polishing, and etching. Measure the thickness of the coating cross-section using a calibrated scale.

Note: Experienced metallographic workers are familiar with these techniques, while for less experienced operators, guidelines are provided in Chapter 5 and

Appendix A.

5.1 Surface roughness

If the surface of the coating or its substrate is rough, one or two interface lines in contact with the coating cross-section could be too irregular to permit accurate measurement (see A.6 in Appendix A).

5.2 Taper of cross-section

If the plane of the cross-section is not perpendicular to the plane of the coating to be measured, then the measured thickness will be greater than the actual thickness. For example, a verticality deviation of 10° will introduce a 1.5% uncertainty.

Note: B.1 in Appendix B provides guidelines on the taper of cross-sections.

5.3 Deformation of coating

During the process of mounting test samples and preparing cross-sections, excessively high temperatures and pressures may cause harmful deformation of soft or low-melting-point coatings; excessive grinding can also cause deformation when preparing cross-sections of brittle materials.

5.4 Chamfering of the coating edge

If the edge of the coating cross-section is chamfered, i.e. the coating cross-section and edges are not perfectly flat, the true thickness cannot be obtained by microscopic measurement. Incorrect mounting, grinding, polishing, and etching can all cause edge chamfering. Therefore, the test sample is usually overplated before mounting to minimize edge chamfering (see A.2).

5.5 Overplating

Overplating the sample to be tested protects the edges of the coating and avoid measurement errors when preparing the cross-section. During the surface treatment process before overplating, the loss of the coating material will result in a lower thickness measurement value.

5.6 Etching

Proper etching can produce a clear, narrow black line at the interface between two metals; excessive etching can make the boundary unclear or the line wider, causing measurement errors.

5.7 Covering

Improper polishing or soft metal overplating can cause one metal to cover another, resulting in a blurred interface between the coating and the substrate. To alleviate the effects of covering, cross-sections of the metal plating can be prepared repeatedly until the thickness measurements (see A.3 and A.5) show reproducibility, or a harder metal plating can be applied.

5.8 Magnification

For any given coating thickness, measurement uncertainty typically increases as the magnification decreases. When selecting the magnification, the field of view shall be 1.5 to 3 times the coating thickness.

5.9 Calibration of the micrometer

Uncertainties generated during the calibration of the micrometer will be reflected in the measurement results of the sample. Therefore, a suitable, traceable length measurement standard shall be used during the calibration process.

5.10.1 Micrometer eyepiece

The accuracy of measured using the micrometer eyepiece shall not exceed the accuracy of the eyepiece calibration. Measurements will be more accurate after the eyepiece is calibrated. Since calibration is affected by the operator, the eyepiece shall be calibrated by the measurement operator.

Repeated calibration of the micrometer eyepiece can reasonably be expected to yield an error of less than 1%. The distance between the two lines on the micrometer used for calibration shall be accurate to within 0.2 μm or 0.1%, whichever is greater.

Some micrometer eyepieces exhibit nonlinear image magnification characteristics, which can introduce uncertainties as high as 1% in short-distance measurements.

The return gap of the micrometer eyepiece during movement introduces uncertainty. To avoid this uncertainty, it is essential to ensure that the final movement of the crosshairs during alignment always faces the same direction.

5.10.2 Digital image processing

Industry-standard optical microscopes are equipped with a trinocular tube, a camera adapter, a digital camera connected to a computer with image capture and processing software, and objectives of various magnifications. The accuracy of the measurement will not exceed the accuracy of the length measurement function (a combination of hardware and software) after adjustment and calibration.

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