

Methods of test for

Metallic and related coatings —

Part 8: Measurement of coating
thickness of metallic coatings: X-ray
spectrometric methods

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Surface Coatings (other than Paints) Standards Policy Committee (SRC/-) to Technical Committee SRC/39, upon which the following bodies were represented:

- Aluminium Federation
- Aluminium Finishing Association
- Association of Manufacturers of Domestic Electrical Appliances
- Association of Metal Sprayers
- British Industrial Fasteners Federation
- British Jewellers' Association
- Department of Trade and Industry (National Physical Laboratory)
- Institute of Corrosion
- Institute of Metal Finishing
- Metal Finishing Association
- NDT Trade Association
- Royal Society of Chemistry
- Society of Motor Manufacturers and Traders Limited

This British Standard, having been prepared under the direction of the Surface Coatings (other than Paints) Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 28 June 1991

© BSI 08-1999

First published October 1976 (withdrawn May 1988)
Second edition June 1991

The following BSI references relate to the work on this standard:
Committee reference SRC/39
Draft for comment 88/54708 DC

ISBN 0 580 19740 9

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
National foreword	ii
1 Scope	1
2 Definitions	1
3 Principle	2
4 Apparatus	4
5 Factors that influence the measurement results	5
6 Calibration of instrument	8
7 Procedure	9
8 Measurement uncertainty	9
9 Test report	10
Annex A (normative) Measuring ranges typical for some common coating materials	11
Figure 1 — Relationship between intensity of count rate and coating thickness	3
Figure 2 — Relationship between mass per unit area and normalized count rate	4
Figure 3 — Schematic representations of energy dispersive systems with their essential major components	5

National foreword

This Part of BS 5411, prepared under the direction of the Surface Coatings (other than Paints) Standards Policy Committee, is identical with ISO 3497, “*Metallic coatings — Measurement of coating thickness — X-ray spectrometric methods*”, which was prepared by Technical Committee TC 107, Metallic and other non-organic coatings, of the International Organization for Standardization (ISO), with the active participation and approval of the UK.

BS 5411-8:1976 had become seriously out of date and, to prevent users being misled, has already been withdrawn. The present edition therefore reflects the considerable changes that have taken place in equipment and techniques during the intervening years.

Further Parts of BS 5411 have been published as follows:

- *Part 1: Definitions and conventions concerning the measurement of thickness;*
- *Part 2: Review of methods for the measurement of thickness;*
- *Part 3: Eddy current method for measurement of coating thickness of non-conductive coatings on non-magnetic basis metals;*
- *Part 4: Coulometric method for the measurement of coating thickness;*
- *Part 5: Measurement of the local thickness of metal and oxide coatings by the microscopical examination of cross-sections;*
- *Part 6: Vickers and Knoop microhardness tests;*
- *Part 7: Profilometric method for measurement of coating thickness;*
- *Part 9: Measurement of coating thickness of electrodeposited nickel coatings on magnetic and non-magnetic substrates: magnetic method;*
- *Part 10: Review of methods available for testing adhesion of electrodeposited and chemically deposited metallic coatings on metallic substrates;*
- *Part 11: Measurement of coating thickness of non-magnetic metallic and vitreous or porcelain enamel coatings on magnetic basis metals: magnetic method;*
- *Part 12: Beta backscatter method for measurement of thickness;*
- *Part 13: Chromate conversion coatings on zinc and cadmium;*
- *Part 14: Gravimetric method for determination of coating mass per unit area of conversion coatings on metallic materials;*
- *Part 15: Review of methods of measurement of ductility;*
- *Part 16: Scanning electron microscope method for measurement of local thickness of coatings by examination of cross-sections.*

NOTE *Typographical error.* The following typographical error occurs in 4.1. In line 1 “radial should be “radio-”.

Additional information This Part describes methods of test only and should not be used or quoted as a specification. Reference to this Part should state that the method of test used is in accordance with BS 5411-8.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 11 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

1.1 This International Standard specifies methods for measuring the thickness of metallic coatings by the use of X-ray spectrometric methods.

These methods permit the simultaneous measurement of some 3-layer systems.

1.2 The measuring methods to which this International Standard applies are fundamentally ones which determine the mass per unit area. Using a knowledge of the density of the coating material, the results of measurements can also be expressed as linear thickness of the coating.

1.3 The practical measurement ranges of given coating materials are largely determined by the acceptable measurement uncertainty and may differ depending upon the instrument system and operating procedure used. A table of typical ranges for common materials is given in Annex A.

CAUTION — Problems concerning personnel protection against X-rays are not covered by this International Standard. For information on this important aspect, reference should be made to current ISO and national publications, and local regulations, where these exist.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1

X-ray fluorescence (XRF)

the secondary radiation occurring when a high intensity incident X-ray beam impinges upon a material placed in the path of the incident beam. The secondary emission has wavelengths and energies characteristic of that material

2.2

intensity of fluorescent radiation

the radiation intensity measured by the instrument, expressed in counts (radiation pulses) per second

2.3

normalized intensity, I_n

the ratio of the difference in intensity obtained from a coated specimen and an uncoated substrate material, and the difference obtained from a material of thickness equal to or greater than the saturation thickness (see 2.4) and an uncoated substrate material, all measured under the same conditions. This is given by

$$\frac{I_e - I_o}{I_s - I_o}$$

where

I_e is the intensity obtained from the coated specimen;

I_o is the intensity obtained from uncoated substrate material;

I_s is the intensity obtained from a material of thickness equal to or greater than the saturation thickness.

this variable is independent of measurement and integration time, and intensity of the exciting (incident) radiation. The geometric configuration and the energy of the exciting radiation can influence the normalized count rate

2.4

saturation thickness

the thickness that, if exceeded, will not produce any detectable change in fluorescent intensity

NOTE 1 Saturation thickness depends upon the energy or wavelength of the fluorescent radiation, density and atomic number of the material and on the angle of incident and fluorescent radiation with respect to the surface of the material.

2.5

intermediate coating

those coatings that lie between the top coating and the basis material and are of thicknesses less than saturation for each of the coatings

NOTE 2 Any coating lying between the top coating and the basis material (substrate) and having a thickness above saturation should itself be considered the true substrate since the material under such a coating will not affect measurement and can be eliminated for measurement purposes.

2.6

count rate

the number of radiation pulses recorded by the instrument per unit time (see 2.2)