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R 2093

ELECTROPLATED COATINGS OF TIN

1st EDITION

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For each individual country the only valid standard is the national standard of that country.

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BRIEF HISTORY

The ISO Recommendation R 2093, *Electroplated coatings of tin,* was drawn up by Technical Committee ISO/TC 107, *Metallic and other non-organic coatings,* the Secretariat of which is held by the Ente Nazionale Italiano di Unificazione (UNI).

Work on this question led to the adoption of Draft ISO Recommendation No. 2093, which was circulated to all the ISO Member Bodies for enquiry in October 1970.

The Draft was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Israel	Sweden
Chile	Italy	Switzerland
Czechoslovakia	Netherlands	Thailand
France	New Zealand	U.A.R.
Germany	Portugal	United Kingdom
Greece	Romania	U.S.S.R.
Hungary	South Africa, Rep. of	
India	Spain	

No Member Body opposed the approval of the Draft.

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

FOREWORD

This ISO Recommendation covers a range of coatings of tin applied by electro-deposition to fabricated articles of ferrous and some non-ferrous metals to protect them against corrosion and to facilitate soldering.

The minimum thickness requirements apply only to those portions of the significant surface that can be touched by a ball 20 mm in diameter.

Attention is drawn to the possibility of interdiffusion between tin coatings and copper alloys, slow at room temperature and more rapid at elevated temperatures. This may lead to darkening and impairment of solderability of thin coatings after long storage. With such thin coatings, provision is made for the use of an undercoat to act as a diffusion barrier but users should consider the use of a thicker coating when solderability has to be maintained over a period of years.

When tin coatings are used with the primary purpose of restraining galvanic corrosion between two dissimilar metals, it will usually be sufficient to choose the class appropriate to the conditions of service for a coating on the less noble metal.

IT IS ESSENTIAL THAT THE PURCHASER STATE EITHER THE BASIS METAL AND THE SERVICE CONDITION NUMBER, OR THE CLASSIFICATION NUMBER.

MERELY TO ASK FOR PLATING TO BE CARRIED OUT IN ACCORDANCE WITH ISO RECOMMENDATION R 2093 WITHOUT THIS NUMBER IS INSUFFICIENT.

ISO Recommendation R 2093 October 1971

ELECTROPLATED COATINGS OF TIN

1. SCOPE AND FIELD OF APPLICATION

This ISO Recommendation applies to electroplated coatings of not less than 99.5 % of tin on steel (or iron), and copper or copper alloys. It also applies to coatings brightened by fusion after electrodeposition, the process being known as flow-brightening (or flow-melting). It does not apply to

- coatings applied to machine screw threads (with tolerance);
- coatings applied to sheet, strip or wire in the unfabricated form, or to coil springs.

This ISO Recommendation does not specify surface condition of the basis metal prior to plating; agreement on the degree of surface roughness of the basis metal which is acceptable should be reached between the purchaser and the supplier.

2. DEFINITION

For the purposes of this ISO Recommendation the following definition applies :

Significant surface. The part of the surface which is essential to the appearance or serviceability of the article and which is to be covered, or is covered, by the coating.

When necessary, the significant surface should be the subject of agreement, and should be indicated on drawings, or by the provision of suitably marked samples.

3. CLASSIFICATION

3.1 Grading of service conditions

The service condition number indicates the severity of the service conditions in accordance with the following scale :

4 – exceptionally severe (such as contact with food or water where a complete cover of tin has to be maintained against corrosion and abrasion)

3 – severe

2 – moderate

1 – mild (including applications where solderability is the main requirement)

The letter "f" should be added after service condition number 1 when a flow-brightened coating is to be indicated.

These designations are conventional and it is recommended that the choice of the service condition corresponding to the use of the part to be plated should be the subject of agreement between the purchaser and the supplier.

3.2 Classification of coatings

The classification number comprises :

- the chemical symbol for the basis metal (or for the principal metal if an alloy) as given below, followed by an oblique stroke :
  - Fe for steel (or iron);
  - Cu for copper or copper alloy;
- the chemical symbol for tin, Sn;
- a number indicating the minimum thickness (in micrometres) of the tin coating;
- (where appropriate) the letter "f", indicating that the coating has been flow-brightened.

3.3 Coatings appropriate to each service condition number

Tables 1 and 2 show, for the various basis metals, the coating classification number and minimum thickness appropriate for each service condition number.

TABLE 1 – Coatings of tin on steel (or iron)

Service condition number	Classification number	Minimum thickness μm
4	Fe/Sn 30	30
3	Fe/Sn 20	20
2	Fe/Sn 12	12
1	Fe/Sn 4	4
1f	Fe/Sn 4f	4*

* The local thickness should not exceed 8 μm. The use of an undercoat of copper, bronze or nickel is advantageous but the thickness of tin should not be reduced if an undercoat is used.

TABLE 2 – Coatings of tin on copper or copper alloy

Service condition number	Classification number	Minimum thickness μm
4	Cu/Sn 30	30
3	Cu/Sn 15	15
2	Cu/Sn 8	8
1	Cu/Sn 4	4*
1f	Cu/Sn 4f	4**

* For brass basis metal, an undercoat of 2 μm of copper, bronze or nickel should be used.

** The local thickness should not exceed 8 μm.

For brass basis metal, an undercoat of 2 μm of copper, bronze, or nickel should be used.

5. REQUIRED CHARACTERISTICS

5.1 Appearance

Over the significant surface, the plated article should be free from clearly visible plating defects such as blisters, pits, roughness, cracks or unplated areas, and should not be stained or discoloured. The extent to which blisters can be tolerated on non-significant surfaces should be the subject of agreement between the supplier and purchaser. On articles where a contact mark is inevitable, its position should also be the subject of agreement between the supplier and the purchaser.

The article should be clean and free from damage. The plated surface should be of a smooth texture and free from nodules. Flow-brightened coatings should be free from de-wetted areas. If necessary, a sample showing the required finish should be supplied or approved by the purchaser.

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* 45 HRC, 440 HV, 415 HB (Approximate values).

** 30 HRC, 295 HV, 280 HB (Approximate values).

When specified by the purchaser, coatings should be tested for solderability by the method given in Annex E. The tin coating is considered to be solderable if, after testing, it shows a uniform coating of solder that is visibly free from discontinuities or breaks (for example "de-wetting", uncoated or black areas). When specified by the purchaser, coatings on copper or copper alloy should be subjected before testing to the preliminary artificial ageing treatment described in Annex E.

NOTE. – The object of this preliminary treatment is to demonstrate whether articles may be expected to retain their solderability during long periods of storage.

5.6 Manner of specifying requirements

When ordering articles to be plated in accordance with this ISO Recommendation, the purchaser should state, in addition to the number of the ISO Recommendation, either the classification number of the particular coating required (see clause 3.2) or the basis metal and the service condition number denoting the severity of the conditions it is required to withstand (see clause 3.1).

6. SAMPLING

The method of sampling should be agreed between the contracting parties.

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* Other methods of thickness determination may be suitable for control purposes but are not mentioned in this ISO Recommendation.

ANNEX A

GUIDANCE ON HEAT TREATMENT OF STEEL PARTS AFTER PLATING

TABLE 3 – **Times and temperature for heat treatment**

Tensile strength	**Maximum sectional thickness of part**	**Minimum period at 190 to 210 °C**
N/mm^2	mm	hours
1000 to 1150	Less than 12	2
	12 to 25	4
	Over 25	8
1150 to 1400	Less than 12	4
	12 to 25	12
	25 to 40	24 Heating to commence within 16 hours of plating
	Over 40	Requires experimental determination

ANNEX B

DETERMINATION OF AVERAGE THICKNESS

B.1 STRIPPING SOLUTION

Dissolve 20 g of antimony trioxide in 1000 ml of cold hydrochloric acid (d = 1.16 to 1.18).

B.2 PROCEDURE

Carefully clean a plated part of known area, free it from grease by means of a suitable solvent treatment, throughly dry it and weigh it to an accuracy of 1 part in 10 000. Sufficient area of sample should be taken to give a loss in mass on stripping of at least 0.2 g of tin.

Immerse it totally in the stripping solution and turn it over so that the liquid has free access to all surfaces. A fresh portion of the stripping solution should be used in each test; at least 100 ml of the solution should be used to remove 1 g of tin.

Allow the sample to remain in the solution for a period of 1 minute after gas evolution has ceased.

Remove the parts, wash it immediately in running water, mop it with a wet soft cloth or cotton wool swab to remove the black powdery deposit of antimony, dry it and reweigh.

B.3 CALCULATION

Thickness of tin coating, in micrometres, is given by the formula :

$$\frac{137 \times 10^3 (m_1 - m_2)}{A}$$

where

m_1 is the original mass of the sample, in grammes;

m_2 is the final mass of the sample, in grammes;

A is the area of coating, in square millimetres.

NOTE. – The above calculation assumes a density of 7.30 g/cm³ for tin.

ANNEX C

QUENCHING TEST FOR ADHESION

Heat a plated article for 1 hour in an oven at a temperature of 185 ± 10 °C.

Then quench the article in water at room temperature, withdraw it and examine the coating for blistering and other signs of poor adhesion.

CAUTION. This test may have an adverse effect on the mechanical properties of the article tested.

ANNEX D

SULPHUR DIOXIDE POROSITY TEST

D.1 PRINCIPLE

Exposure to a moist atmosphere containing a low concentration of sulphur dioxide causes no corrosion of tin but causes spots of corrosion product to appear at discontinuities in the coating.

If the sulphur dioxide concentration in the atmosphere is too high, the corrosion product formed is too fluid to permit easy observation of pore sites. The method given here, which depends on the production of sulphur dioxide from the reaction between sodium thiosulphate and sulphuric acid within the test chamber, ensures suitable conditions for the development of immobile corrosion products at discontinuities.

D.2 APPARATUS

D.2.1 *Test cabinet*, consisting of a chamber fitted with a lid or door, and preferably made of glass or a transparent plastics material. The size should be sufficient to accommodate the test specimens with their lowest part at least 75 mm above the surface of a solution occupying at least one-fiftieth of the total capacity.

The closure of the vessel and other joints should be gas-tight but need not be capable of resisting pressure. A glass plate makes an adequate joint on the lubricated ground edges of a glass tank.

The cabinet should be of uniform cross-section and the solution placed in it should cover the base completely.

D.2.2 *Glass or plastics stand* inside the cabinet to support the specimens under test. The significant surfaces may be inclined at any angle but it may be desirable to choose the same inclination for similar articles.

D.3 CORROSIVE MEDIUM

The corrosive medium should be moist air containing sulphur dioxide. Such a medium is obtained in a closed chamber above a solution occupying one-fiftieth of the capacity of the chamber. It can be prepared by adding 1 part by volume of 0.1 N sulphuric acid to 4 parts of a solution containing 10 g of sodium thiosulphate crystals in 1 litre of water.

D.4 TEMPERATURE OF TEST

The test should be conducted at 20 ± 5 °C taking precautions against rapid temperature fluctuation in the course of the test.

D.5 PROCEDURE

Before the test, clean the specimens with an organic solvent (for example, trichloroethylene), wipe with a lint-free cloth and allow to attain room temperature.

Introduce into the test cabinet a volume of aqueous sodium thiosulphate solution equal to one-fiftieth of the volume of the cabinet. Suspend the test specimens above this solution on non-metallic supports with the surfaces of the specimens not less than 25 mm apart, nor less than 25 mm from any wall of the cabinet and not less than 75 mm from the surface of the sodium thiosulphate solution.

Add to the sodium thiosulphate solution a volume of 0.1 N sulphuric acid equal to a quarter of the volume of the thiosulphate solution and seal the cabinet, keeping it shielded from draughts or other causes of rapid temperature fall. The addition of the sulphuric acid may be made before the test specimens are placed in position provided that the cabinet is closed within 5 minutes of the addition of the acid.

Leave the specimens in the closed cabinet for 24 hours. After removing the specimens from the corrosive atmosphere, allow them to dry without wiping or cleaning in any way and then examine them.