INTERNATIONAL STANDARD 2179

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION · МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ · ORGANISATION INTERNATIONALE DE NORMALISATION

Electroplated coatings of tin-nickel alloy

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

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 2179 was drawn up by Technical Committee ISO/TC 107, *Metallic and other non-organic coatings*.

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

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

No Member Body expressed disapproval of the document.

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Electrodeposited tin-nickel alloy is a single-phase metastable compound, corresponding approximately to the formula SnNi. This compound is stable at ordinary temperatures but starts to recrystallize at elevated temperatures. The maximum safe working temperature of the deposit is 300 °C, although actual melting does not commence below 800 °C. The coating is hard (hardness about 700 HV) but inherently somewhat brittle, and it is generally inadvisable to carry out fabrication involving straining after plating. These coatings should not be applied to parts subject to deformation in service.

Tin-nickel can be deposited direct onto steel, copper and copper-base alloys, but on steel an undercoat is essential for outdoor service. Zinc-base alloys cannot be plated direct but must first be plated with copper. Zinc alloy die-castings that have been tin-nickel plated should never be returned for re-melting because of the risk of contaminating the melt with tin.

This International Standard has been prepared with a view to specifying qualities essential for the use of the coating as a hard, corrosion-resistant finish. For this purpose, low porosity of the coating is the most important requirement since the coating metal itself is not corroded, except in certain strongly acid environments.

The classification number is based on coating thickness, which is some guide to the expected porosity, but attention is drawn to the corrosion test required for the highest quality of coating. This corrosion test reveals porosity and also departures from the correct coating composition. It has been considered unnecessary to make provision for any additional check on coating composition.

In this International Standard the surface condition of the basis metal prior to plating is not specified and agreement shall be reached between the supplier and the purchaser regarding the degree of roughness of the basis metal that is acceptable.

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

IT IS ESSENTIAL THAT THE PURCHASER STATE THE SERVICE CONDITION NUMBER OR THE CLASSIFICATION NUMBER. MERELY TO ASK FOR PLATING TO BE CARRIED OUT IN ACCORDANCE WITH ISO 2179 WITHOUT THIS NUMBER IS INSUFFICIENT.

Electroplated coatings of tin-nickel alloy

1 SCOPE AND FIELD OF APPLICATION

This International Standard applies to electroplated coatings of 65/35 tin-nickel alloy on steel (or iron), copper and copper alloys or zinc alloys, except for the following :

– coatings applied to machine screw threads (with tolerance) ;

– coatings applied to sheet, strip or wire in the unfabricated form, or to coil springs.

2 REFERENCES

ISO/R 1462, *A method for the evaluation of the results of accelerated corrosion tests on coatings other than those anodic to the basis metal.*

ISO/R 1463, *Measurement of metal and oxide coating thicknesses by microscopical examination of cross-sections.*

3 DEFINITION

For the purpose of this International Standard 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 shall be the subject of agreement, and shall be indicated on drawings or by the provision of suitably marked samples.

4 CLASSIFICATION

4.1 Grading of service conditions

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

3 – severe

2 – moderate

1 – mild

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.

4.2 Classification of coatings

The classification number comprises :

– the chemical symbol for the basis metal (or for the principal metal if an alloy) as follows :

– Fe for steel (or iron);

– Cu for copper or copper alloy;

– Zn for zinc alloy;

– the chemical symbol for copper, Cu (when such an undercoat is used);

– the chemical symbol for tin-nickel alloy, Sn-Ni;

– a number indicating the minimum thickness (in micrometres) of the tin-nickel coating.

4.3 Coatings appropriate to each service condition number

Tables 1 to 3 show, for the various basis metals, the coating classification number appropriate for each service condition number.

TABLE 1 – **Coatings on steel (or iron)**

Service condition number	Classification number
3	Fe/Cu Sn-Ni 25[1)2)]
2	Fe/Cu Sn-Ni 15[1)2)]
1	Fe/Cu Sn-Ni 8[1)2)]
	Fe/Sn-Ni 8

1) Copper undercoat to be at least 8 μm thick.

2) By agreement between the purchaser and the supplier an undercoat of bronze, nickel or tin may be substituted.

TABLE 2 – **Coatings on copper or copper alloy**

Service condition number	Classification number
3	Cu/Sn-Ni 25
2	Cu/Sn-Ni 15
1	Cu/Sn-Ni 8

TABLE 3 – **Coatings on zinc alloy**

Service condition number	Classification number
3	Zn/Cu Sn-Ni 25[1)]
2	Zn/Cu Sn-Ni 15[1)]
1	Zn/Cu Sn-Ni 8[1)]

1) Copper undercoat to be at least 8 μm thick.

5 HEAT TREATMENT FOR STEEL

When required by the purchaser, heat treatment as described below shall be performed on certain steels to reduce the risk of damage by hydrogen embrittlement.

5.1 Stress relief before plating

Severely cold-worked steel parts or parts made from steel of tensile strength of 1 000 N/mm^2 (or corresponding hardness)[2)] or greater which have been ground or subjected to severe machining after tempering, shall normally be stress relieved. As a guide they may be maintained, preferably, at the highest temperature within the limit imposed by the tempering temperature for 30 min, or maintained at 190 to 210 °C for not less than 1 h.

Some steels which have been carburized, flame-hardened or induction-hardened and subsequently ground would be impaired by the treatment given above as guidance and shall instead be stress relieved at a lower temperature; for example, at 170 °C for not less than 1 h.

5.2 Heat treatment after plating

Components subject to fatigue or sustained loading stresses in service and made from severely cold-worked steels or from steels of tensile strength of 1 000 N/mm^2 (or corresponding hardness)[2)] or greater shall be heat treated after plating. Guidance is given in Annex A.

Where the proposed temperature of heat treatment would be harmful, for example for some surface-hardened parts, a lower temperature for a longer time may be required.

6 REQUIRED CHARACTERISTICS

6.1 Appearance

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

The article shall be clean and free from damage. When necessary, a sample showing the required finish shall be supplied or approved by the purchaser.

6.2 Thickness

The number following the chemical symbol Sn-Ni indicates, in micrometres, the minimum thickness of the tin-nickel deposit which shall satisfy the appropriate value in Table 1, Table 2 or Table 3.

This minimum thickness shall be regarded as the minimum value of local thickness measured by the method given in ISO/R 1463, particular attention being given to the requirements for overcoating, at points on the significant surface agreed between the purchaser and supplier or at any point on the significant surface that can be touched by a ball 20 mm in diameter.[3)]

If the design of the article is such that it cannot at all points be touched by a 20 mm ball, the minimum thickness permitted on specified areas shall be agreed between the purchaser and the supplier.

6.3 Adhesion

The coating shall continue to adhere to the basis metal when subjected to the test given in Annex B.

6.4 Porosity

Coatings having a thickness of 25 μm and greater shall be subjected to the porosity test given in Annex C and the results evaluated according to the procedure described in that Annex.

By agreement between the purchaser and the supplier, thinner coatings may be subjected to the porosity test for 24 h, but with an agreed rating number for the evaluation of results.

6.5 Manner of specifying requirements

When ordering articles to be plated in accordance with this International Standard, the purchaser shall state, in addition to the number of the International Standard, either the classification number of the particular coating required (see 4.2) or the basis metal and the service condition number denoting the severity of the conditions it is required to withstand (see 4.1).

7 SAMPLING

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

2) 30 HRC, 295 HV, 280 HB (Approximate values)

3) Other methods of thickness determination may be suitable for control purposes but are not mentioned in this International Standard.

ANNEX A

GUIDANCE ON HEAT TREATMENT OF STEEL PARTS AFTER PLATING

Tensile strength	Maximum sectional thickness of part	Minimum period at 190 to 210 °C
N/mm²	mm	hours
1 000 to 1 150	Less than 12	2
	12 to 25	4
	Over 25	8
1 150 to 1 400	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

QUENCHING TEST FOR ADHESION

Heat a plated article for 1 h in an oven at the temperature appropriate to the basis metal given below, with a tolerance of ± 10 °C :

- steel 300 °C
- copper or copper alloy 250 °C
- zinc alloy 150 °C

Then quench the article in water at room temperature and inspect the coating for signs of blistering or cracking.

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

ANNEX C

SULPHUR DIOXIDE POROSITY TEST

C.1 PRINCIPLE

Exposure to a moist atmosphere containing a low concentration of sulphur dioxide causes no corrosion of tin-nickel alloy of the correct composition 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 provided, 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.

C.2 APPARATUS

C.2.1 Test cabinet, consisting of a chamber fitted with a lid or door and preferably made of glass or of a transparent plastics material. The size shall 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 shall 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 shall be of uniform cross-section and the solution placed in it should cover the base completely.

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

C.3 CORROSIVE MEDIUM

The corrosive medium shall be moist air containing sulphur dioxide, produced in the test cabinet by a solution 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.

C.4 TEMPERATURE OF TEST

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

C.5 PROCEDURE

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

Introduce into the test cabinet a volume of aqueous sodium thiosulphate solution (10 g/l) equal to one-fiftieth of the volume of the cabinet. Suspend the test specimens above this solution on the non-metallic supports with the surfaces of the specimens not less than 25 mm apart, not 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 min of the addition of the acid.

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

NOTE – After removal from the corrosive atmosphere the specimens may be held for a few minutes over a solution of ammonia. This promotes solidification of moist corrosion product and facilitates the distinction between corrosion products from a steel base and a copper undercoating. Without exposure to ammonia, the corrosion products from steel and from copper or copper alloys are initially both greenish brown but that from steel darkens as it dries to a deep brown. Exposure to ammonia changes the colour of the products from copper or copper alloys to blue.

C.6 EVALUATION

Examine each specimen for spots or cracks at which the coating is penetrated, with resulting corrosion of the basis metal. If, on any specimen, any spot or crack has an area greater than 2.5 mm^2 the specimen fails the test.

Evaluate the results of the test on each specimen in accordance with ISO/R 1462.

If the rating number is less than 9 the specimen fails the test.

If a specimen with a significant surface area greater than 50 000 mm^2 is being tested, in addition find the 50 mm × 50 mm area showing the greatest number of corrosion spots. Count the number (N) of 5 mm squares in this area that are occupied by corrosion spots.

If N is 10 or more, the specimen fails the test.