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Metallic coatings — Electroplated coatings of cadmium on iron or steel

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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.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, International Standard ISO 2082 replaces ISO Recommendation R 2082-1971 drawn up by Technical Committee ISO/TC 107, *Metallic and other non-organic coatings*.

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The Member Bodies of the following countries approved the Recommendation:

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

The Member Body of the following country expressed disapproval of the Recommendation on technical grounds:

Germany

Metallic coatings — Electroplated coatings of cadmium on iron or steel

0 INTRODUCTION

This International Standard covers a range of coatings of cadmium for the protection of iron and steel against corrosion under various service conditions.

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

Passivation by chromate conversion coatings gives additional protection against corrosion and shall be applied unless there is reason to the contrary.

Articles to be painted may require alternative treatment such as phosphating to provide good adhesion.

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 2082 without this number is insufficient.

1 SCOPE AND FIELD OF APPLICATION

This International Standard applies to electroplated coatings of cadmium on iron or steel for protection against corrosion, 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.

This International Standard does not specify the surface condition of the basis metal prior to plating; agreement on the degree of roughness which is acceptable shall be reached between the interested parties.

Because of its toxicity, cadmium shall not be employed as a coating for any object intended for use as a food container or cooking utensil or for any object likely to come into contact with food or beverages. Attention is drawn to the danger arising from the welding or heating of cadmium because cadmium vapour is toxic.

2 REFERENCE

ISO 1463, *Metal and oxide coatings — Measurement of the thickness by microscopical examination of cross-sections.*

3 DEFINITION

For the purposes 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 number corresponding to the use of the part to be plated should be the subject of agreement between the interested parties.

4.2 Classification of coatings

The classification number comprises :

- the chemical symbol, Fe, for the basis metal (iron or steel);
- the chemical symbol for cadmium, Cd;
- a number indicating the minimum thickness (in micrometres) of the cadmium coating;
- the letter "c" indicating that passivation has been applied (to be omitted if agreed to the contrary — see section 6).

4.3 Coatings appropriate to each service condition number

The Table below shows the coating classification number and minimum thickness appropriate for each service condition number.

TABLE — Coatings of cadmium on iron or steel

Service condition number	Classification number	Minimum thickness μm
3	Fe/Cd 25c	25*
2	Fe/Cd 12c	12
1	Fe/Cd 5c	5

* Cadmium coatings thicker than 12 μm are normally not economical.

5 HEAT TREATMENT OF 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.

It is recommended that steels of tensile strength above 1 500 N/mm² (or corresponding hardness¹⁾) should not be electroplated with cadmium by conventional methods. It should also be noted that steels of tensile strength above 1 000 N/mm² (or corresponding hardness²⁾) require heat treatment to minimize this risk.

5.1 Stress relief before plating

Severely cold-worked steel parts, or parts made from steel of tensile strength of 1 000 N/mm² (or corresponding hardness²⁾) 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 before 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/mm² (or corresponding hardness²⁾) or greater, shall be heat treated after plating. Guidance is given in Annex A.

- 1) 45 HRC, 440 HV, 415 HB (approximate values).
- 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.

Where the heat treatment temperatures would be harmful, as for example to certain surface-hardened articles, it may be necessary to apply a lower temperature for a longer time.

6 PASSIVATION

Passivation by coloured or colourless chromate conversion coatings enhances the corrosion resistance of electroplated coatings of cadmium and shall be applied unless there is agreement to the contrary.

7 REQUIRED CHARACTERISTICS

7.1 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. The extent to which blisters can be tolerated on non-significant surfaces shall be the subject of agreement between the interested parties. On articles where a contact mark is inevitable, its position shall also be the subject of agreement between the interested parties.

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

7.2 Thickness

The number following the chemical symbol Cd indicates, in micrometres, the minimum thickness of the cadmium coating on the significant surface which shall satisfy the appropriate value in the Table of 4.3.

In the case of articles having a significant surface area of 100 mm² or greater, this minimum thickness shall be regarded as the minimum value of local thickness measured by the method given in ISO 1463, at points on the significant surface agreed between the interested parties, or at any point on the significant surface than 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 interested parties.

In the case of articles having a significant surface area less than 100 mm², this minimum thickness shall be regarded as the minimum value of average thickness measured by the method given in Annex B.

7.3 Adhesion

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

7.4 Continuity of passivation film

The passivation film shall be continuous over the cadmium surface. The presence of a colourless film shall be verified by the test method given in Annex D.

7.5 Adhesion of passivation film

The passivation film shall be adherent and coloured films shall be tested by one of the methods given in Annexes E and F.

7.6 Corrosion resistance of colourless passivation film

Colourless passivation films shall be tested in accordance with the method given in Annex G. After the passivated article has been subjected to two cycles of the humidity test, there shall be no breakdown of the film, or any appearance of white corrosion products. Slight staining may be ignored.

NOTE — When heat treatment is required after plating it is usual to passivate after the heat treatment process. This is because many passivation films are affected by heat. In any event, tests on passivation films shall be made after heat treatment.

7.7 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 service condition number denoting the severity of the condition the coating is required to withstand (see 4.1) or the classification number of the particular coating required (see 4.2). The purchaser shall also indicate any heat treatment required before and after plating.

8 SAMPLING

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

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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/mm ²	mm	h
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 h of plating
	Over 40	Requires experimental determination

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ANNEX B
DETERMINATION OF AVERAGE THICKNESS¹⁾

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B.1 STRIPPING SOLUTION

Dissolve 20 g of antimony trioxide in 1 000 ml of cold hydrochloric acid ($d = 1,16$ to $1,18$).

B.2 PROCEDURE

Accurately determine the area of the plated part. If the article is of complex shape, an area shall be agreed between the interested parties. Degrease it with an organic solvent, for example trichloroethylene, dry thoroughly and weigh to an accuracy of 1/10 000. Then totally immerse it in the stripping solution and turn it over so that the solution has free access to all surfaces. After the effervescence has ceased, remove the sample immediately, wash, wipe to remove the loose coating of antimony and immerse in clean acetone to remove any trapped water. Then remove the sample, dry by the process previously used, and re-weigh.

B.3 CALCULATION

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

$$\frac{116 \times 10^3 (m_1 - m_2)}{A}$$

where

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

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

A is the area of coating, in square millimetres.

NOTE – The above calculation assumes a density of 8,6 g/cm³ for cadmium.

1) The presence of a passivation film can be ignored in making this test.

ANNEX C

BURNISHING TEST FOR ADHESION¹⁾

Rub an area of not more than 650 mm² of the plated surface rapidly and firmly with a smooth metal implement for 15 s.

The pressure shall be sufficient to burnish the coating at every stroke, but not so great as to cut the deposit. Poor adhesion will be shown by the appearance of a loose blister which grows as rubbing is continued. If the quality of the deposit is also poor, the blister may crack and the plating will peel away from the basis metal.

More than one area may be tested if desired.

ANNEX D²⁾

TEST FOR PRESENCE OF PASSIVATION FILM

Prepare a test solution consisting of 50 g of lead acetate (hydrated) in 1 l of distilled or de-ionized water.

Place 1 drop of this test solution on the surface and allow it to remain there for 5 s. After this period, remove the drop by blotting gently, taking care not to disturb any deposit that may have formed.

A dark deposit or black stain is indicative of the absence of a passivation film.

For comparative purposes, a surface that is known not to have been passivated may be similarly treated.

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ANNEX E²⁾

PAPER TEST FOR ADHESION OF COLOURED PASSIVATION FILMS

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The adhesion of a coloured passivation film is tested by rubbing the surface with soft white tissue paper. Failure is indicated by the appearance of anything more than a faint stain on the paper.

ANNEX F²⁾

ERASER TEST FOR ADHESION OF COLOURED PASSIVATION FILMS

Rub the chromated surface with a gritless gum eraser (art-gum) for 2 or 3 s (about 10 strokes) using normal hand pressure and a stroke approximately 50 mm long. The passivation film shall not be removed or worn through to the underlying metal as a result of this treatment.

1) This method should be regarded as tentative until adhesion testing has been studied by Technical Committee ISO/TC 107.

2) a) These methods are valid until the adoption of an International Standard relating to passivation.

b) Before subjecting a chromate conversion coating to any test, it shall be aged at room temperature in a clean environment for at least 24 h after the passivation treatment.

ANNEX G¹⁾

HUMIDITY TEST FOR COLOURLESS PASSIVATION FILMS

G.1 APPARATUS

G.1.1 **Insulated chamber**, fitted with a fan to circulate the air in the chamber.

G.1.2 **Non-metallic and non-corrosive support**, for the specimen near the centre of the chamber.

G.2 TEMPERATURE OF TEST

The test shall be conducted at a temperature of 55 ± 2 °C, followed by cooling to 30 °C.

G.3 HUMIDITY

The relative humidity shall be not less than 95 % with condensation.

G.4 TEST CYCLE

Subject the article to the above-mentioned temperature and humidity conditions for 16 h continuously. Turn off the source of heat while maintaining circulation of the air. Allow the temperature to fall to 30 °C and keep the article at this temperature for 5 h.

Examine the article after each cycle.

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