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Metallic coatings — Corrosion test method for decorative chrome plating under a de-icing salt environment

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CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 7, *Corrosion tests*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Decorative, electrodeposited nickel-chromium and copper-nickel-chromium coatings, built up with a multilayer nickel system including micro-discontinuous nickel, are applied to manufactured articles to enhance their appearance and corrosion resistance.

These coating systems are characterized by unique corrosion mechanisms. Once corrosion begins, the nickel layer gets dissolved preferentially (especially in the case of a bright nickel layer): it acts as an anode with respect to chromium (which is intended to act as a cathode). In addition, lots of tiny pores or cracks in the micro-discontinuous layer distribute the corrosion current throughout the whole surface. In this way the amount of current at a given corrosion site is substantially lowered, creating minor pits that remain for a longer time invisible to the naked eye. In addition, the corrosion penetration through the bright nickel layer is reduced, especially when a more noble semi-bright nickel layer shields it from the substrate or the copper underlayer.

An additional different corrosion phenomenon is caused during winter by de-icing salts, especially calcium chloride. This particular corrosion phenomenon is characterized by slightly yellow and less shiny spots on the surface, caused by the complete dissolution of the chromium layer and the partial deterioration of the microporous nickel layer. In this situation, the bright nickel layer remains intact. Such corrosion phenomena are predominantly occurring in areas with cold winter conditions and the use of calcium chloride as de-icing agent in combination with dirt dust deposits.

Unfortunately, this corrosion phenomenon cannot be tested and evaluated using existing corrosion test methods [e.g. salt spray (see ISO 9227) and Corrodokote test].

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Metallic coatings — Corrosion test method for decorative chrome plating under a de-icing salt environment

1 Scope

This document specifies the apparatus, reagents, and procedure to assess the corrosion resistance of chromium electroplated parts in the presence of de-icing salts (especially calcium chloride) in the laboratory.

This method is primarily applicable to decorative parts plated with chromium, especially to exterior (automobile) parts electroplated with nickel-chromium or copper-nickel-chromium.

This document simulates a special corrosion in the presence of hygroscopic and corrosive de-icing salt and conductive mud with a high salt concentration on chromium electroplated deposits during winter.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

3 Terms and definitions

ISO/FDIS 24284

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

de-icing salt

chemical sprayed to control ice and snow on the roads

EXAMPLE Sodium chloride (rock salt), calcium chloride, and magnesium chloride.

4 Apparatus

4.1 The apparatus shall consist of a humidity chamber, specimen supports, provision for heating the chamber, and provision for air circulation in the chamber. The humidity chamber shall maintain constant temperature ($60\text{ °C} \pm 3\text{ °C}$) and humidity ($30\% \pm 5\%$).

4.2 The design shall be such that drops of moisture (possibly accumulating on the roof or walls of the chamber, or on the specimen supports) do not fall on the test specimens.

4.3 The construction materials shall not affect the test.

5 Test slurry

5.1 Preparation of the calcium chloride (CaCl₂) solution

Prepare a saturated calcium chloride solution. Dissolve calcium chloride dihydrate (CaCl₂.2H₂O, CAS 10035-04-8, ≥ 99 %) at 40 °C, at more than the saturation amount (approximately, 175 g of CaCl₂.2H₂O in 100 ml of deionized water). For example:

- a) prepare 100 ml of deionized water in accordance with ISO 3696, grade 3, in a beaker;
- b) put more than 175 g of CaCl₂.2H₂O into the beaker;
- c) mix well using, for example, a magnetic stirrer or a glass rod.

5.2 Preparation of the slurry (paste)

Collect supernatant fluid from the concentrated CaCl₂ solution; then, add the required amount of kaolin into the solution. The proportion of concentrated CaCl₂ solution to Kaolin shall be 5 ml to 3 g. Mix well using a magnetic stirrer or a glass rod. Check the pH of the slurry. The final slurry should have a pH of 3,0 to 4,0 and a thick consistency.

For example:

- a) take 50 ml of supernatant fluid from 100 ml of concentrated CaCl₂ solution;
- b) add 30 g of kaolin (CAS 1332-58-7, CP grade) to the solution;
- c) mix well using, for example, a magnetic stirrer or a glass rod.

The calcium chloride solution can be stored in an airtight container; however, it is recommended to store it for no more than one week.

NOTE If the pH of the final slurry is outside of the indicated range (3,0 to 4,0), it is necessary to check for the presence of undesirable impurities in either the kaolin, salt or water, or all.

6 Procedure

Clean the test piece using an acetone- or alcohol-soaked clean soft cloth or wipes. Draw three circles with diameters of 18 mm (or areas of 254 mm²) on the test piece using an oil-based pen (see [Figure 1](#)). Each circle should be separated from the others by a space of at least 1 cm in all directions. Any shapes of the chrome-plated pieces (real parts or test specimen) with flat area on which it is possible to draw three circles shall be fine as the test pieces. Place each test piece on a calibrated electronic scale (minimum accuracy = 0,01 g). Take the well-mixed slurry using a pipette; then, gradually drop the slurry within the first circle until reaching a weight of 0,12 g to 0,15 g.

Re-set the weight measured by the electronic scale to 0; then, gradually drop the slurry in the next circle until reaching again a weight of 0,12 g to 0,15 g. Spread the slurry lightly and evenly within the circle area using a glass rod (see [Figure 2](#)).

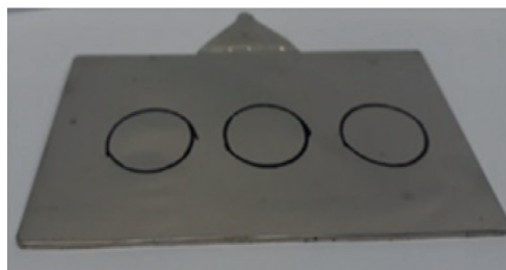


Figure 1 — Test piece with drawn circles

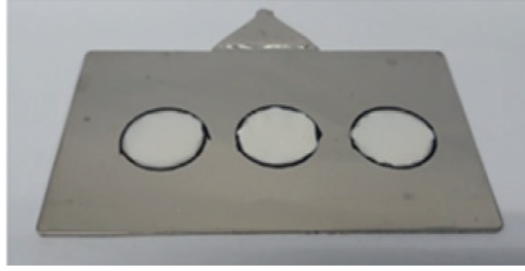


Figure 2 — Paste-coated test piece

Place the test piece horizontally into a humidity chamber without spilling over the slurry. The humidity chamber shall be set at constant temperature ($60\text{ °C} \pm 3\text{ °C}$) and humidity ($30\% \pm 5\% \text{ RH}$) for the test period. The period of test and the number of test specimens shall be specified and agreed upon by the requestor and the laboratory prior to the start of the test. Expose completely all the test pieces to the test environment and place them so that they do not interfere with each other. After the specified testing time, take out the test piece from the humidity chamber. Clean the paste using a clean soft cloth or sponge under running tap water and allow it to dry using tissues, dry clothes, or an air drier.

NOTE 1 Test pieces mentioned in this clause include not only sample test pieces but also real components.

NOTE 2 A graphic representation of the procedure for the de-icing salt corrosion test is given in [Annex A](#).

7 Evaluation of the results

The criteria for the evaluation of the test results shall be given in the specifications of the coating or product tested.

In a typical application of this test the tested area is inspected under $10\times$ magnification and the observed appearance defects are assessed. An example of a typical evaluation method is given in [Annex B](#).

8 Test report

Unless otherwise prescribed in the specifications, the test report shall contain the following information:

- a) a specification of the plating type, the thickness of each layer, the type of chromium layer;
- b) the number of test specimens;
- c) the preparation method used for the test specimens;
- d) the method used to clean the specimens after the test;
- e) the temperature and relative humidity inside the humidity chamber;
- f) the exposure period;
- g) photographs of different areas of the specimens (at $10\times$ magnification) taken before and after the test.

Annex A
(informative)

Graphical procedure of de-icing salt corrosion test

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