
**Metallic coatings — Test methods for
electrodeposited gold and gold alloy
coatings —**

Part 3:
Electrographic tests for porosity

*Revêtements métalliques — Méthodes d'essai des dépôts
électrolytiques d'or et d'alliages d'or —*

Partie 3: Détermination électrographique de la porosité

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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 3, *Electrodeposited coatings and related finishes*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 262, *Metallic and other inorganic coatings*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 4524-3:1985), which has been technically revised.

The main change compared to the previous edition is as follows: due to currently strong restrictions on the use of cadmium, the cadmium sulphide paper test prescribed by the last edition of this document has been deleted.

A list of all parts in the ISO 4524 series can be found on the ISO website.

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.

Metallic coatings — Test methods for electrodeposited gold and gold alloy coatings —

Part 3: Electrographic tests for porosity

1 Scope

This document specifies four electrographic tests for assessing the porosity of electrodeposited gold and gold alloy coatings for engineering, and decorative and protective purposes.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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/>

4 Nioxime paper test

4.1 Applicability

This method is suitable for the examination of gold coatings on undercoats of nickel or tin-nickel alloy.

4.2 Materials

4.2.1 General

During the test, use only reagents of recognized analytical grade and only distilled water or water of equivalent purity.

4.2.2 Nioxime paper

Soak filter or duplicating paper for 10 min in an 8 g/l solution of nioxime (cyclohexan-1,2-dione dioxime).

Remove the excess solution by blotting and hang the paper up to dry.

4.2.3 Moistened blotting paper

Soak a good quality white blotting paper in water and dry it to a degree that consistently produces sharply defined electrograms.

4.3 Procedure

Lightly brush the electroplated coating to remove loose dust and debris, then degrease it in 1,1,1-trichloroethane vapour or other suitable solvent.

Moisten a piece of the nioxime paper (4.2.2) with water. Remove excess water by blotting. Place the treated nioxime paper on the electroplated specimen (which acts as the anode). On the other face of the nioxime paper, place a piece of the moistened blotting paper (4.2.3), followed by a high purity clean aluminium or stainless steel platen (which acts as the cathode). Compress the assembly so that the pressure between the nioxime paper and the specimen is uniform and between 1,4 MPa and 1,7 MPa. While under compression, pass a smooth ripple-free d.c. current from a source not exceeding 12 V. Set the current density initially at 7,5 mA/cm² of the anode area and pass for 30 s.

Expose the electrogram produced on the nioxime paper to ammonia vapour and then allow to dry. The presence of any defect in the electroplated coating is revealed by a corresponding pink stain on the paper. When electroplated on copper, defects in the nickel or tin-nickel undercoat are revealed as green stains.

5 Dye-transfer paper test 1

5.1 Applicability

This method is suitable for the examination of gold coatings on copper.

5.2 Materials

5.2.1 General

During the test, unless otherwise stated, use only reagents of recognized analytical grade and only distilled water or water of equivalent purity.

5.2.2 Dye-transfer paper

Soak a piece of dye-transfer paper for 30 min in a freshly prepared solution containing 0,01 mol/l of sodium chloride (NaCl) and 0,01 mol/l of sodium carbonate (Na₂CO₃) made by dissolving 0,58 g of sodium chloride and 1,06 g sodium carbonate together in 1 l of water. Remove the excess solution with blotting paper.

NOTE Dye-transfer paper can be obtained from some suppliers of photographic materials.

5.3 Procedure

Remove loose dirt and debris from the electroplated coating with a soft brush and then degrease it in 1,1,1-trichloroethane vapour or other suitable solvent.

Place a piece of the damp dye-transfer paper (5.2.2) emulsion side down on the electroplated specimen (which acts as the anode), followed by a high purity clean aluminium or stainless steel platen (which acts as the cathode). Compress the assembly so that the pressure between the dye-transfer paper and the specimen is uniform and between 1,4 MPa and 1,7 MPa. While under compression, apply a fixed potential of 4 V d.c. for 30 s. Remove the dye-transfer paper and develop it in a saturated ethanolic solution of dithiooxamide for 30 s. Dissolve 0,25 g of dithiooxamide in 100 ml of ethanol by gentle warming; if necessary, filter when cold before use.

Wash the electrogram produced in cold running water and allow to dry. The presence of any defect in the plated coating is revealed by a corresponding dark olive-green stain on the paper.

It is essential that the test papers produced in carrying out the test be rinsed in hot water and carefully dried, on completion of the tests.

It is advisable to use tweezers for immersing the paper in the dithiooxamide solution because it can produce persistent black stains on the fingers.

NOTE The tests described in [Clause 5](#) are more sensitive than those given in [Clause 4](#), i.e. microporosity is more easily detected.

6 Dye-transfer paper test 2

Follow the procedure described in [Clause 5](#) but use a developing solution consisting of a 0,5 % (mass fraction) ethanolic solution of nioxime (cyclohexan-1,2-dione dioxime).

The presence of any defect in the electroplated coating is revealed by a corresponding pink stain on the paper. When plated on copper, defects in the nickel or tin-nickel undercoat are revealed as green stains.

It is essential that the test papers produced in carrying out the test be rinsed in hot water and carefully dried, on completion of the tests.

The tests described in [Clause 4](#) do not call for an electrolyte to be used and rely on ions from the test paper and backing paper to provide conductivity. In some cases, it is necessary to soak the test papers in a solution of a suitable electrolyte, for example for dye transfer paper (see [Clause 5](#)) in a 0,1 mol/l solution of sodium nitrate (NaNO_3).

NOTE 1 The dye-transfer paper test 2 is an alternative to the test described in [Clause 4](#).

NOTE 2 The tests described in [Clause 6](#) are more sensitive than those given in [Clause 4](#), i.e. microporosity is more easily detected.

7 Electrographic gelatine film test

7.1 Principle

The determination of the porosity of different metal coatings on different basis metals or intermediate metallic layers by means of an electrolytic process in an electrolyte thickened with gelatine and containing a suitable indicator, with which ions from the basis metal form coloured reaction products.

The method may be considered as a variant of electrography which usually is carried out with the aid of a paper soaked in a special test solution. Compared with electrography, this method has some advantages; it can be used also on curved surfaces, and the coloured spots do not spread from the pores to the same extent.

7.2 Reagents

During the test, unless otherwise stated, use only reagents of recognized analytical grade and only distilled water or water of equivalent purity.

7.2.1 Gelatine

Prepare a 10 % (mass fraction) solution of gelatine at 60 °C with careful stirring to ensure that no air enters the solution.

Store the gelatine solution in a cold place.

7.2.2 Electrolyte solution

Prepare by mixing 20 ml of ammonia solution ($\rho = 0,88 \text{ g/ml}$) with 80 ml of water.

7.2.3 Dimethylglyoxime, indicator solution

Prepare a saturated solution of dimethylglyoxime in ethanol.

7.3 Testing solution

Add, whilst stirring, 35 ml of the electrolyte solution (7.2.2) and 20 ml of the indicator solution (7.2.3) to 950 g of gelatine solution (7.2.1) at 27 °C to 30 °C, taking care to avoid entrainment of air. Pour the mixture into the electrolysis vessel and leave to cool to the working temperature, 22 °C to 23 °C.

NOTE Owing to variations in the quality of the gelatine, no exact working temperature can be indicated. The temperature is, however, suitable for the purposes of this test if a metal sheet which has been dipped in the test solution retains, on removal from the solution, a coating 1-mm thick.

7.4 Apparatus

7.4.1 **Water-bath**, fitted with a thermostat for indirect temperature control of the test solution.

7.4.2 **Stirring device**.

7.4.3 **Inner tank**, for electrolysis in the test solution.

The tank shall be made of glass or acid-proof steel. The electrodes (cathodes) shall be made of platinum gauze or gold and have at least the same area as the part to be tested (the anode). The cathodes shall be placed on opposing sides in the test vessel and shall be isolated from the vessel. The electrode distance between the anode and each of the cathodes shall be approximately 50 mm.

7.4.4 **Rectifier**.

7.5 Procedure

7.5.1 Electrolytic process

Immerse the sample in the testing solution (7.3) between the electrodes. Parts of the sample which are not coated with the test metal shall be masked before the dipping. Alternatively, immerse only the parts of the object which are coated with the test metal.

Connect the sample as anode. Carry out the electrolysis for 20 s at a current density of 1,0 mA/cm².

7.5.2 Drying

When the sample has been removed from the electrolyte, leave the gelatine coating to dry at room temperature for about 30 min; alternatively, accelerated drying may be carried out for about 15 min in an air stream at room temperature. The sample shall remain in the horizontal position.

7.5.3 Evaluation

Examine the surface for pores. Pores in the coating appear as coloured spots, often having a strongly marked centre point of a diameter of 0,2 mm.

The colour of the spots depends upon either the substrate or the undercoat, or both, upon which the gold or gold alloy coating has been applied; it can be red with dark red centre spots on nickels or green with dark green centre spots on copper or copper alloys.

NOTE When using nickel as an undercoat on copper or copper alloys, green spots with dark green points appear if the porosity extends to the basis metal.