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Electrical insulating materials – Determination of electrolytic corrosion caused by insulating materials – Test methods

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Matériaux isolants électriques – Détermination de la corrosion électrolytique en présence de matériaux isolants – Méthodes d'essais

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CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions.....	7
4 General description of the test method.....	8
5 Test specimens.....	8
5.1 General.....	8
5.2 Cut surfaces of rigid materials (blocks, plates, sheets or semi-finished materials).....	9
5.3 Cast, moulding, injection and pressed materials.....	9
5.4 Cut surfaces of flexible films, foils and thin sheets.....	9
5.5 Adhesive tapes.....	10
5.6 Flexible sleeving and tubing.....	10
5.7 Lacquers and insulating varnishes.....	10
5.8 Cleanliness of contact surfaces.....	10
5.9 Number of test specimens.....	11
6 Test strips.....	11
6.1 General.....	11
6.2 Preparation of the test strips.....	11
6.3 Cleanliness of test strips.....	12
7 Test device.....	12
8 Test conditions.....	14
9 Test procedure.....	14
10 Evaluation.....	14
10.1 General evaluation.....	14
10.2 Visual inspection of the test strips.....	15
10.3 Tensile strength of test strips.....	15
11 Evaluation of corrosion on copper strips.....	16
12 Test report.....	17
Annex A (normative) Tables for the evaluation of corrosion on brass and aluminium strips.....	18
Annex B (informative) Notes on visual evaluation.....	20
Annex C (informative) Copper wire tensile strength method.....	21
Figure 1 – Test specimen of rigid material, for example textile laminate.....	8
Figure 2 – Test specimen of flexible material, for example flexible films, foils etc.....	10
Figure 3 – Test strip.....	12
Figure 4 – Test device for determining electrolytic corrosion.....	13
Figure C.1 – Apparatus for determining electrolytic corrosion of rigid insulating material.....	23
Figure C.2 – Apparatus for determining electrolytic corrosion of flexible insulating material.....	23

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Table 1 – Degrees of corrosion of copper strips	16
Table A.1 – Degrees of corrosion of brass strips	18
Table A.2 – Degrees of corrosion of aluminium strips	19

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL INSULATING MATERIALS –
DETERMINATION OF ELECTROLYTIC CORROSION
CAUSED BY INSULATING MATERIALS –
TEST METHODS

FOREWORD

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International Standard IEC 60426 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

This second edition cancels and replaces the first edition, published in 1973, and constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

- experience has indicated the need for improved description of the experimental method. It describes a revised procedure for the visual and tensile strength test method that overcomes the limitations of the first edition;
- one older method of the first edition has partly been maintained in the informative annex.

This bilingual version, published in 2010-01, corresponds to the English version.

The text of this standard is based on the following documents:

FDIS	Report on voting
112/45/FDIS	112/55/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under “<http://webstore.iec.ch>” in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
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INTRODUCTION

Electrical insulating materials at high atmospheric humidity and under influence of electric stress may cause corrosion of metal parts being in contact with them. Such electrolytic corrosion is dependent upon the composition of the insulating material and the character of the metal; it is influenced by temperature, relative humidity, nature of the voltage and the time of exposure. Direct voltage produces much more rapid and extensive corrosion than alternating voltage. Corrosion is more pronounced at the positive electrode.

Not only copper but also most other metals, except the noble metals such as platinum or gold, are subject to electrolytic corrosion. Electrolytic corrosion, however, is usually determined with insulating materials in contact with copper, brass or aluminium. Copper, however, is a basic metal and most frequently used in electrotechnical, teletechnical and electronic equipment, especially for current conducting parts and therefore it was chosen as a basic test metal. Other metals may be used when needed for special purposes, but the results may differ from those described in this method.

Electrolytic corrosion may cause open-circuit failure in electrical conductors and devices. It may promote low resistance leakage path across or through electrical insulation and the products of corrosion may otherwise interfere with the operation of electrical devices, i.e. may prevent operation of contacts, etc.

Electronic equipment operating under conditions of high humidity and elevated temperature may be particularly subjected to failure from electrolytic corrosion. Therefore, the selection of insulating materials, which do not produce electrolytic corrosion, is important for such applications.

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The test method described in this second edition replaces two separate methods of the first edition – visual and tensile strength method. The former tensile strength method of the first edition, using copper wires, has been maintained in an informative annex. It must be emphasized that the advantage of this new method is that the same strip used for visual inspection is next used for the tensile strength test in opposite to the method described in the first edition. Therefore the correlation between tensile strength and visual examination is more obvious.

ELECTRICAL INSULATING MATERIALS – DETERMINATION OF ELECTROLYTIC CORROSION CAUSED BY INSULATING MATERIALS – TEST METHODS

1 Scope

This standard determines the ability of insulating materials to produce electrolytic corrosion on metals being in contact with them under the influence of electric stress, high humidity and elevated temperature.

The effect of electrolytic corrosion is assessed in one test by using consecutively two methods:

- visual semi-quantitative method consisting in comparing visually the corrosion appearing on the anode and cathode metal strips, with those given in the reference figures.

This method consists of the direct visual assessment of the degree of corrosion of two copper strips, acting as anode and cathode respectively, placed in contact with the tested insulating material under a d.c. potential difference at specified environmental conditions. The degree of corrosion is assessed by visually comparing the corrosion marks on the anode and cathode metal strips with those shown in the reference figures;

- quantitative method, which involves the tensile strength measurement, carried out on the same anode and cathode metal strips after visual inspection.

An additional quantitative test method for determining electrolytic corrosion, which involves tensile strength measurement of copper wire, is described in the informative Annex C.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60068-3-4:2001, *Environmental testing – Part 3-4: Supporting documentation and guidance – Damp heat tests*

IEC 60454-2:—, *Pressure-sensitive adhesive tapes for electrical purposes – Part 2: Methods of test*¹

3 Terms and definitions

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

3.1

electrolytic corrosion

kind of galvanic corrosion caused by joint action of external source of d.c. potential and some substances included in some organic materials in presence of high humidity and elevated temperature

¹ To be published.

3.2

test strip

a) positive

a metal strip connected with positive pole of direct current source which forms the anode in the contact system: metal – insulating material

b) negative

a metal strip connected with negative pole of direct current source which forms the cathode in the contact system: metal – insulating material

3.3

surface of contact

a) of tested material

part of insulating material specimen which is in direct contact with metal strips

b) of metal strip

part of metal strip (positive or negative) which is in direct contact with insulating material specimen

4 General description of the test method

The test consists of applying specified environmental conditions and a d.c. potential difference to two parallel copper strips 3 mm apart, acting as the anode and the cathode respectively. The insulating material under test (test specimen) is placed across these two strips. In order to obtain a good and uniform contact between the metal strips and the material under test, the test specimen is pressed to the strips by a cylindrical loading tube.

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5 Test specimens

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5.1 General

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The preparation of the specimens depends on the type of material and the form in which it is supplied. The shape and dimensions of the test specimen are shown in Figure 1. Procedures for the preparation of the test specimen are reported beneath (5.2 to 5.7).

Dimensions in millimetres

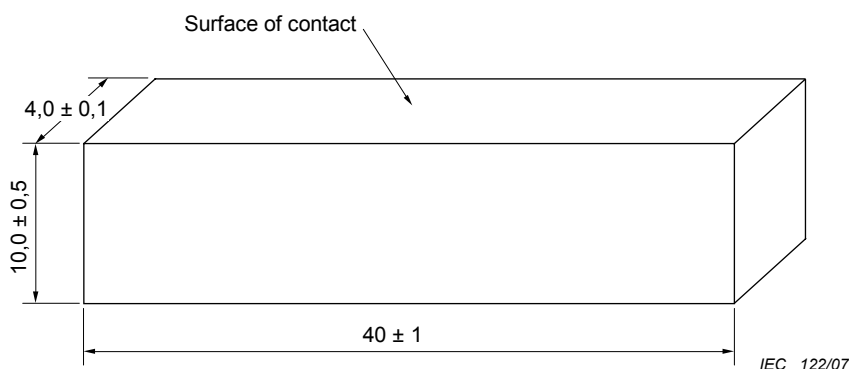


Figure 1 – Test specimen of rigid material, for example textile laminate

5.2 Cut surfaces of rigid materials (blocks, plates, sheets or semi-finished materials)

The test specimens shall be cut out or machined from the tested material to a thickness of 4 mm, by means of a dry method without the use of cutting oils or lubricants and without overheating or damaging them. It is recommended to take several test specimens from various layers of the product.

It is permissible to use the test specimens of thickness smaller than 4 mm, but not smaller than 2 mm.

The contact surface of the test specimen shall be smoothed using abrasive paper. Care should be taken to keep parallelism of the opposite surfaces of the test specimen, in order to assure a good contact of the test specimen to the metal strips. The surface of contact should not show any flaws, cracks, inclusions or bubbles.

The abrasive paper shall not contain any contaminations causing a bad corrosion index, for example halogen components.

5.3 Cast, moulding, injection and pressed materials

From insulating materials delivered in the form of liquid resin, moulding powder or granules, the test specimens shall be made in shapes and dimensions as shown in Figure 1. The specimens shall be made by casting or pressing in a special mould, following exactly the technological instruction recommended by the manufacturer of the tested material.

The test specimen and surface of contact shall be prepared as given in 5.2.

5.4 Cut surfaces of flexible films, foils and thin sheets

Test specimens of these products shall be made up in layers to form small packs placed between suitable holding plates of insulating material not causing electrolytic corrosion itself, for example polymethylmethacrylate (Plexiglas®²). The preferred thickness of holding plates is 1 mm ± 0,2 mm.

The thickness of a pack should be approximately of 4 mm or 2 mm, depending on the thickness of the tested foils. The value of 4 mm is recommended in the case of the single foil thickness being less than 2 mm and more than 0,5 mm, whereas that one of 2 mm is recommended if the single foil thickness is less than 0,5 mm.

These test blocks shall be compressed with screws made of the same material as holding plates and then machined to the appropriate shape as shown in Figure 2. The material to be tested should protrude 0,2 mm to 0,5 mm beyond the holding plates.

² Plexiglas® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.

Dimensions in millimetres

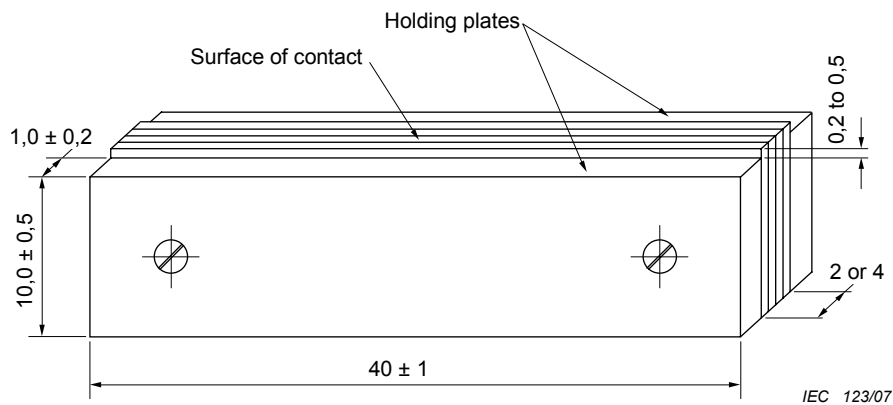


Figure 2 – Test specimen of flexible material, for example flexible films, foils etc.

Apart from this, the particulars given in 5.2 apply.

5.5 Adhesive tapes

For adhesive tapes the method of Clause 7 of IEC 60454-2 is recommended.

5.6 Flexible sleeving and tubing

Sleeving and tubing (both varnished fabric and extruded) are slit open, so as to make flat sheets, which can then be prepared as for films (see 5.4).

5.7 Lacquers and insulating varnishes

The lacquer or insulating varnish to be tested shall be applied in the manner recommended by the manufacturer to the surface of a test specimen of shape as shown in Figure 1 and described in 5.2. The base material of the test specimen shall be a corrosion free plastic such as polymethylmethacrylate.

In case of solvent incompatibility or a baking temperature being too high for the base material, another suitable base material such as cast, hot cured corrosion free epoxy resin or glass shall be used. If the lacquer or insulating varnish is designed to contribute freedom from corrosion to another material, a test specimen of that material shall be used.

The tested lacquer or varnish shall be sprayed, dipped or otherwise coated to the desired thickness and baked, if necessary, as specified or according to the directions of the manufacturer.

If the thickness of coating is not determined by specification or direction of the manufacturer, it shall be of $(30 \pm 10) \mu\text{m}$.

5.8 Cleanliness of contact surfaces

When preparing and handling the test specimens, any soiling of the test surfaces, for example by perspiration from the hands, shall be avoided. The specimens shall be touched only with a pair of tweezers or with protecting gloves made of materials free from corrosion (e.g. polyethylene). After the test specimens have been machined or cut, their surfaces shall be cleaned with a soft brush. Before cleaning, the brush shall be rinsed in ethanol (96 %) and then dried.

After the cleaning procedure, the surface of contact shall not show any foreign particles, residues of oil or grease, no mould residues, etc.

5.9 Number of test specimens

At least five test specimens made from the same material shall be tested at the same time.

A specific sampling procedure may be desired. If necessary, such a sampling procedure should be specified and used.

6 Test strips

6.1 General

The test strips shall be made of 0,1 mm thick, semi-hard copper of purity 99,9 Cu. Their dimensions are 10 mm wide and 200 mm long. The test strips shall be flat, without bends and burrs at the edges as well as any other mechanical defects or impurities on the test surface, which may have influence on the test results.

NOTE Test strips of brass or aluminium can be made in the same way.

6.2 Preparation of the test strips

From each new reel of strip (sold as a semi-finished product) the first several decimetres of the strip shall be rejected and then the suitable number of strip segments, each 200 mm long, shall be cut-off.

Copper strips shall be degreased with a low boiling point organic solvent (e.g. acetone or hexane) and then etched. Etching shall be carried out at laboratory temperature, with a solution of the following composition: sulphuric acid (1,82) with a mass fraction of 73 %, nitric acid (1,33) with a mass fraction of 26 %, sodium chloride with a mass fraction of 0,5 % and hard carbon black with a mass fraction of 0,5 %. The time of etching shall be between 20 s to 60 s. All strips, which are destined for one set of testing, shall be etched at the same time. The coarseness of the strip surface can be controlled by adjustment of the etching time until the copper strip has an even dull sheen. The strips shall then be washed in distilled water, then dipped in ethanol and dried with blotting paper.

NOTE Unevenness of the surface of the strip may influence the discolouration and may lead to a wrong evaluation. A surface, which is evenly dull, shows a discolouration of greater intensity than a surface, which is slightly corroded, semi-dull or brilliant.

After degreasing and etching, both ends of the strip shall be reeled loose to the shape as shown in Figure 3.

So prepared test strips shall be immediately (within 20 min) mounted in the test device, ready for the test procedure, as shown in Figure 4.

Dimensions in millimetres

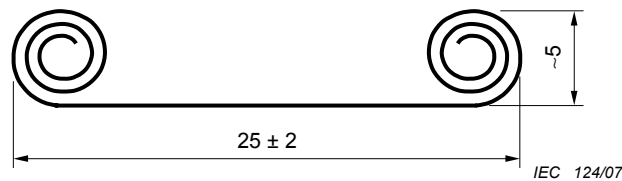


Figure 3 – Test strip

6.3 Cleanliness of test strips

After degreasing and etching, the strips should not be touched with bare hands. When handling the strips, a pair of tweezers should be used and the reeling of the ends of the test strip should be done using protective gloves.

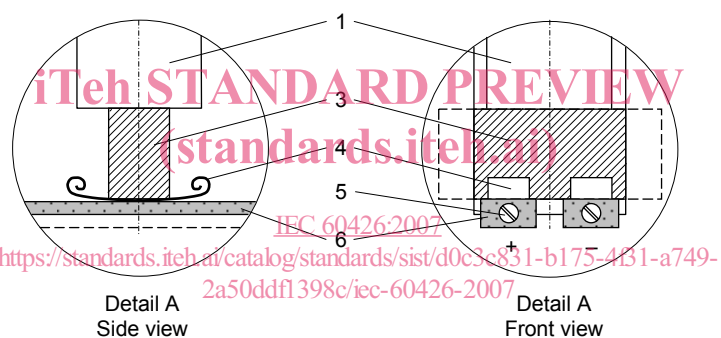
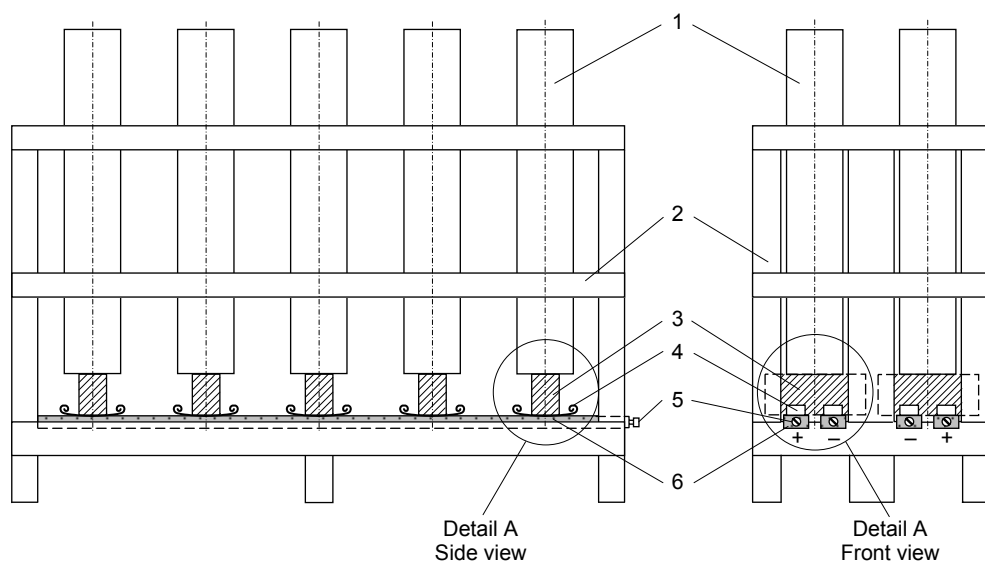
7 Test device

The test device shall be made of materials not causing corrosion, for example of polymethylmethacrylate (Plexiglas®³). The test device shall enable simultaneous testing of all test specimens processed from one batch of insulating material (no less than five specimens).

The pressure of the test specimen onto the test strips shall be 10 N/cm^2 . The pressure is achieved by setting a cylindrical tube (made from materials not causing corrosion) on the test specimen and filled with the appropriate amount of lead shot, to assure the desired pressure.

The recommended test device is shown in Figure 4.

³ Plexiglas® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.



- | | |
|--|---------------------|
| 1 cylindrical tubes (loading tubes) | 2 supporting frame |
| 3 test specimens (insulating material) | 4 metal test strips |
| 5 connecting terminals | 6 copper electrodes |

IEC 125/07

Figure 4 – Test device for determining electrolytic corrosion

Before beginning each test and mounting test specimens, the test device shall be cleaned in order to remove any corrosive residues from the previous test. Metal contacting parts shall be carefully degreased and cleaned. Other parts of the test apparatus shall be carefully wiped with a cloth dampened with ethanol.

In the test device, a cylindrical tube presses a test specimen against two adjacent copper electrodes 10 mm in width, arranged 4 mm apart. The two test strips are placed between the test surface of the specimen and along two copper electrodes, as shown in Figure 4 (Detail A).