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**Vitreous and porcelain enamels —  
Production of specimens for testing  
enamels on sheet steel, sheet  
aluminium and cast iron**

*Émaux vitrifiés — Production d'éprouvettes pour l'essai des émaux  
sur la tôle d'acier, la tôle d'aluminium et la fonte*





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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](http://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](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 107, *Metallic and other inorganic coatings*.

This second edition cancels and replaces the first edition (ISO 28764:2008), of which it constitutes a minor revision.

# Vitreous and porcelain enamels — Production of specimens for testing enamels on sheet steel, sheet aluminium and cast iron

**WARNING** — This International Standard calls for the use of substances and/or procedures that may be injurious to health if adequate safety measures are not taken. This International Standard does not address any health hazards, safety or environmental matters associated with its use. It is the responsibility of the user of this International Standard to establish appropriate health, safety and environmentally acceptable practices and take suitable actions for any national and international regulations. Compliance with this International Standard does not of itself confer immunity from legal obligations.

## 1 Scope

This International Standard specifies a method for the production of specimens suitable for testing vitreous and porcelain enamel coatings.

It specifies two different specimens:

- specimens taken from production articles;
- specially produced specimens.

**NOTE** Only the specially produced specimens can be used when the loss in mass per unit area of the enamel coating is to be determined quantitatively, as specimens cut from enamelled articles can reduce the accuracy of the test method.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2746, *Vitreous and porcelain enamels — High voltage test*

## 3 Designation

Specimens prepared in accordance with this International Standard shall have the following designation:

Specimen: ISO 28764-(substrate)

where a steel substrate is designated by A, a cast iron substrate by B and an aluminium substrate by C.

**EXAMPLE** The designation of a specimen prepared in accordance with this International Standard using a steel substrate is:

Specimen      ISO 28764-A

## 4 Specimens from production articles

### 4.1 Requirements for the articles used

The specimens shall be taken from a production article that has been produced using the normal production parameters. Reworked articles shall not be used as a source of specimens.

## 4.2 Shape and dimensional requirements

The specimens shall be circular or square, with a diameter or side length of  $105 \text{ mm} \pm 5 \text{ mm}$ .

The specimens shall normally be taken only from flat areas of the enamelled articles. For enamelled aluminium specimens, however, on which only the adherence is to be determined using the procedure given in ISO 13805[1], other shapes may be used.

## 4.3 Preparation

Before cutting specimens off a production article, the enamel shall be removed by grinding along the cutting line on both surfaces (i.e. front and back) of the production article down to the base metal. The width of the zone from which the enamel shall be removed shall be the width of the cutting tool plus 2 mm on each side.

NOTE Grinding machines operating with corundum or diamond stones are suitable for removing the enamel.

# 5 Specially produced specimens

## 5.1 Shape, dimension and substrate requirements

### 5.1.1 General

The specimens shall be made from a substrate that can be enamelled and shall be flat, circular or square plates with a diameter or side length of  $105 \text{ mm} \begin{smallmatrix} +5 \\ -10 \end{smallmatrix} \text{ mm}$ .

If a specimen is intended to hang during weighing and/or enamelling, the specimen shall be provided with a hole to enable it to be hung. The hole shall be approximately 2,5 mm in diameter with its centre either 3 mm from the edge of a circular test plate or 3 mm from the corner of a square test plate.

### 5.1.2 Steel substrate

The sheet steel to which the enamel is applied shall be of an appropriate enamelling quality for the enamelling process used and its thickness shall normally be between 0,3 mm and 3,0 mm.

Other thicknesses may be used if agreed between the interested parties; if other thicknesses are used (i.e. thicknesses not within the range 0,3 mm to 3 mm) the thickness shall be clearly reported with every test result obtained.

Condition the metal for enamelling using any recognized method, but use the same method, substrate quality and substrate thickness if the specimens are provided for comparison purposes.

In the case of fish-scale testing, take steel strips a minimum of 100 mm wide from across the whole width of the steel coil.

NOTE 1 EN 10209[2] describes the steel quality required when enamelling cold-rolled steel using different processes.

NOTE 2 Clause B.2 of EN 10209:2013[2] describes the fish-scale test.

### 5.1.3 Cast iron substrate

The cast iron to which the enamel is applied shall be of enamelling quality.

The specimens may be specially cast plates or plates cut from a cast iron bar with a minimum thickness of 2,5 mm. If the mass of cut specimens is to be determined in order to determine the loss in mass of the enamel coating, and the mass exceeds the carrying capacity of the analytical balance, the thickness may be reduced by machining.

Condition the metal for enamelling using any recognized method, but use the same method, substrate quality and substrate thickness if the specimens are provided for comparison purposes.

Completely ferritized grey cast iron is suitable. Pre-annealing between 700 °C and 850 °C for 10 min to 15 min may be used in order to achieve the ferritization.

#### 5.1.4 Aluminium substrate

The aluminium to which the enamel is applied shall be of enamelling quality. Aluminium sheet specimens shall have a thickness between 2 mm and 3 mm.

Condition the metal for enamelling using any recognized method, but use the same method, substrate quality and substrate thickness if the specimens are provided for comparison purposes.

NOTE The following aluminium alloys are suitable for sheet substrates if their Mg content is below a mass fraction of 0,01 %:

— alloys EN AW-1050A, EN AW-3003 and EN AW-4006 as described in EN 573-3.<sup>[3]</sup>

#### 5.1.5 Other substrates

For vitreous and porcelain enamels used on other substrates, the substrate used and the conditioning parameters shall be agreed between the interested parties.

### 5.2 Enamelling of specimens

#### 5.2.1 General

The normal processing steps of the enamelling process, i.e. those used in that particular process, shall be followed and no extra steps (such as repair enamelling or extra firing) shall be used for the production of the specimen.

Care shall be taken to ensure that there is a minimum of build-up of enamel around the edges of the specimen. The enamel applied can, therefore, be wiped, using a suitable method, from the edges to a width of 2 mm or 3 mm after drying and before fusing the specimen.

Comparative specimens shall be of the same nominal thickness. The maximum difference in thickness between all comparative specimens shall be less than 15 %.

In all cases, the thickness of the enamel coating applied to the test specimen shall be that normally used in the enamelling of the production article.

#### 5.2.2 Steel enamelling

##### 5.2.2.1 Application

The enamel shall be applied to one or both sides of the specimen. When the loss in mass per unit area of the enamel coating is to be determined quantitatively, the specimen shall be enamelled on both sides.

##### 5.2.2.2 Direct-on enamels

When in practice the usual application consists of one coat only, one coat shall be applied. In cases where additional coatings are a necessary part of the finish, these coatings shall also be applied.

##### 5.2.2.3 Cover coat enamels

If a ground coat is applied prior to application of the cover coat, this may be dipped or sprayed on to both sides of the specimen so that an agreed coating thickness is applied.

After drying, fusing and cooling of the ground-coated specimen, the cover coat shall be applied to one of the ground-coated sides of the specimen.

The same number of cover coats that are considered to be usual practice in the enamelling of the production article shall be applied to the test specimen.

NOTE 1 For most purposes, one cover coat is standard procedure, but in some cases two or three coats are considered to be usual practice.

NOTE 2 When enamelling containers and items of apparatus that are to be used in the chemical industry, it is usual to apply even more layers of cover coat.

### **5.2.3 Cast iron enamelling**

#### **5.2.3.1 Direct-on enamels**

The enamel shall be applied to one side of the specimen in accordance with usual practice in the enamelling of the production article.

The same number of cover coats that are considered to be usual practice in the enamelling of the production article shall be applied to the test specimen.

#### **5.2.3.2 Cover coat enamels**

A ground coat may be dusted, sprayed or applied electrophoretically on to one side of the specimen.

After drying and fusing of the specimen, the cover coat shall be applied to the ground-coated side only.

For most purposes, two cover coats are standard procedure for dry processing (dusting) and one cover coat is standard procedure for wet processing but, in cases where more cover coats are considered to be usual practice, additional coats shall be applied.

### **5.2.4 Aluminium enamelling**

If one coat of the enamel slip is required, it shall be applied to one surface of the specimen by spraying. After firing at a temperature of  $560\text{ }^{\circ}\text{C} \pm 20\text{ }^{\circ}\text{C}$ , the thickness of the coating shall be  $60\text{ }\mu\text{m} \pm 10\text{ }\mu\text{m}$ .

For most purposes, one coat is standard procedure. If a second coat is required, for example for inspecting appearance, the total thickness of the coating shall not exceed  $80\text{ }\mu\text{m}$ .

### **5.2.5 Enamelling of other substrates**

The enamelling parameters shall be agreed between the interested parties.

## **5.3 Surfaces of enamelled specimens**

The specimens shall be checked by visual inspection for freedom from defects. When inspected in this way, the surfaces of the enamelled specimens shall be flat and free from defects such as blisters, burn-off, chipping, copperheads, cracking, crazing, fire-tool marks, fish-scales, spalling and tearing.

For vitreous and porcelain enamels used for containers and items of apparatus that are to be used in the chemical industry, an extra surface inspection for freedom from weak areas and pinholes shall be carried out using the high-voltage method given in ISO 2746. The voltage used for the test shall be agreed between the interested parties.



## Bibliography

- [1] ISO 13805, *Vitreous and porcelain enamels for aluminium — Determination of the adhesion of enamels on aluminium under the action of electrolytic solution (spall test)*
- [2] EN 10209:2013, *Cold rolled low carbon steel flat products for vitreous enamelling — Technical delivery conditions*
- [3] EN 573-3, *Aluminium and aluminium alloys — Chemical composition and form of wrought products — Part 3: Chemical composition and form of products*

