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**Vitreous and porcelain enamels —  
Characteristics of enamel coatings  
applied to steel panels intended for  
architecture**

*Émaux vitrifiés — Caractéristiques des couches d'émail appliquées sur  
les panneaux d'acier destinés à l'architecture*

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 28722 was prepared by the European Committee for Standardization (CEN) (as EN 14431) and was adopted, under a special “fast-track procedure”, by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, in parallel with its approval by the ISO member bodies.

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# Vitreous and porcelain enamels — Characteristics of enamel coatings applied to steel panels intended for architecture

## 1 Scope

This International Standard specifies the requirements for enamel-coated, plane, cold-rolled, heavy- and light-gauge steel panels intended for interior and exterior architectural use.

It includes the functional and aesthetic characteristics and resistance to graffiti of these panels and the related coatings.

## 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.

ISO 105-J03, *Textiles — Tests for colour fastness — Part J03: Calculation of colour differences* (including Technical Corrigendum 1:1996 and Technical Corrigendum 2:2006)

ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°* (including Technical Corrigendum 1:1997)

ISO 4532, *Vitreous and porcelain enamels — Determination of the resistance of enamelled articles to impact — Pistol test*

ISO 8289:2000, *Vitreous and porcelain enamels — Low voltage test for detecting and locating defects*

ISO 15695, *Vitreous and porcelain enamels — Determination of scratch resistance of enamel finishes* (including Technical Corrigendum 1:2000)

ISO 28706-1:2008, *Vitreous and porcelain enamels — Determination of resistance to chemical corrosion — Part 1: Determination of resistance to chemical corrosion by acids at room temperature*

ISO 28706-2:2008, *Vitreous and porcelain enamels — Determination of resistance to chemical corrosion — Part 2: Determination of resistance to chemical corrosion by boiling acids, boiling neutral liquids and/or their vapours*

EN 101, *Ceramic tiles — Determination of scratch hardness of surface according to Mohs*

EN 10209:1996, *Cold rolled low carbon steel flat products for vitreous enamelling — Technical delivery conditions*

EN 14430, *Vitreous and porcelain enamels — High voltage test*

ASTM C 501, *Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser*

### 3 Terms and definitions

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

#### 3.1

**vitreous enamel**  
**porcelain enamel**

substantially vitreous, or glassy, inorganic coating bonded to metal by fusion at a temperature above 500 °C

NOTE 1 This coating can be applied for protective, functional and/or decorative purposes.

NOTE 2 It is produced by the application of powdered inorganic glass, dry or suspended in water, on to the metal surface, and its subsequent fusion bonding. The fused coating exhibits a cubic thermal expansion of between  $150 \times 10^{-7} /K$  and  $450 \times 10^{-7} /K$  in the temperature range 20 °C to 100 °C, the actual value varying specifically with the type of substrate and field of application.

#### 3.2

**enamelled heavy-gauge steel panel**

cold-rolled steel panel that is first formed and then enamelled, either individually or in batches

NOTE Commonly, the thickness of steel substrate for enamelled heavy-gauge steel panels is greater than 0,75 mm.

#### 3.3

**enamelled light-gauge steel panel**

panel made by cutting the porcelain- or vitreous-enamelled top skin material produced in the enamelled condition on a continuous coil coating line, and laminating it on to a suitable core material or sandwich which provides its shape and strength

NOTE Commonly the thickness of the steel for the top skin for enamelled light-gauge steel panels is 0,30 mm to 0,75 mm.

## 4 Requirements for enamelled heavy- and light-gauge steel panels

### 4.1 Steel

The steel to be enamelled shall conform to the requirements of EN 10209, unless otherwise agreed by the interested parties.

The steel thickness shall be more than 0,75 mm for enamelled heavy-gauge steel panels and from 0,30 mm to 0,75 mm for enamelled light-gauge steel panels.

### 4.2 Application of coating

A minimum of two layers of enamel shall be applied over the external panel surface and a minimum of one layer on the internal panel surface.

### 4.3 Final thickness of fired enamel

When determined using the method given in ISO 2178, the final enamel thickness on the faces of the panel shall be as given in Table 1.

Table 1 — Final thickness of fired enamel

Type of panel	Final enamel thickness	
	µm	
	External face	Internal face
Heavy gauge	180 to 500	≥ 100
Light gauge	75 to 275	≥ 60

The maximum thicknesses may be exceeded to achieve a particular aesthetic appearance, subject to agreement between the interested parties.

## 5 Functional characteristics of enamel coating

### 5.1 Adherence test

When determined in accordance with the procedure given in EN 10209:1996, Annex D, the adherence of the enamel to the metallic substrate shall be at least Class 3.

The test shall be carried out on pieces fired in parallel to the production panels. Because the adherence is influenced by refiring processes, the test shall be performed after the final firing.

### 5.2 Porosity test

The enamel coat shall not contain defects which could give rise to localized corrosion. When tested in accordance with EN 14430, or method A or B of ISO 8289:2000, the number of open pores detected shall have the limits given in Table 2.

NOTE No open-pore limit is specified for dry interior applications.

Table 2 — Limits for open pores

Method	Pores m <sup>2</sup>
EN 14430	max. 10
ISO 8289:2000, method A	max. 5
ISO 8289:2000, method B	max. 10

When used for exterior building parts, the back and edges of the panel shall be adequately protected from corrosion. In the case of heavy-gauge panels, particular attention shall be given to the protection or concealment of edges within the design and the enamel application. For light-gauge panels, particular attention shall be given to the protection or concealment of cut edges during panel assembly or installation.

### 5.3 Abrasion resistance

When determined using the Taber apparatus in accordance with ASTM C 501, using S 33 emery paper and a 1 kg weight, the resistance to abrasion, given as the loss in mass after 1 000 revolutions, shall be a maximum of 0,1 g.

This test shall not serve as guidance for assessing loss in gloss.

## 5.4 Impact resistance

Determine the resistance to impact using the method given in ISO 4532.

When activating the pistol with a force of 20 N, there shall be no damage over 2 mm in diameter after 24 h.

NOTE The mark of the striking bolt is not regarded as damage (see ISO 4532).

## 5.5 Surface hardness (Mohs)

When determined using the method given in EN 101, the Mohs surface hardness shall be a minimum of 5.

## 5.6 Scratch resistance

When determined using the method given in ISO 15695, the scratch resistance shall be a minimum of 7 N.

NOTE The minimum limit for metallic finishes and silk-screened finishes is 4 N.

## 5.7 Flatness

Finished flat heavy-gauge panel faces with core material shall have a maximum deflection of 0,5 % in the convex direction when measured perpendicular to the nominal plane of the panel face. Deflection in the concave direction shall be limited to less than 0,25 % from the actual plane of the panel face.

These percentages refer to the values of the largest diagonal or to the diameter of the panel. Panels shall be measured in the position in which they will be installed.

For finished flat light-gauge panel faces with core material, these deflections shall be restricted to a maximum of 0,15 % in both directions.

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## 5.8 Acid resistance

When tested in accordance with Clause 9 of ISO 28706-1:2008, enamel coatings for exterior and interior environments shall have a minimum of class A acid resistance.

When tested in accordance with Clause 10 of ISO 28706-2:2008, enamel coatings for exterior environments shall have a maximum mass loss of 18,5 g/m<sup>2</sup>.

## 6 Aesthetic characteristics of enamel coating

### 6.1 Surface appearance

All aspects of the condition of the surface (such as orange peel and mottling) shall be specified by agreement between the interested parties.

The enamelled surface shall be visually examined either in natural light or in D65 artificial daylight in accordance with ISO 105-J03. The surface shall be examined from a minimum distance of 1,5 m, or at the distance at which the fixed panel would normally be viewed, whichever is the greater. The enamelled surface exposed to the atmosphere shall be free from defects liable to change the general appearance of the panel.

### 6.2 Gloss

Reference specimens or levels of gloss shall be agreed between the interested parties.

When measured with a gloss meter using the method given in ISO 2813, the variation in test results shall not exceed 10 gloss units from the agreed level.



### 6.3 Colour

Colours of exposed surfaces of components, colour tolerances and surface textures shall conform to the colour samples agreed by the interested parties.

Conformity can be determined visually, using methods agreed by the interested parties, or using suitable equipment (a colorimeter or spectrometer).

Stencilling, screen printing, brushing on and other recognized forms of decoration shall be carefully executed as agreed by the interested parties.

NOTE Decorative processes developed for use in the production of architectural vitreous-enamelled components can be employed to produce designs, lettering and other effects.

## 7 Resistance to graffiti

After eight days of ageing at room temperature, inks, varnishes, lacquers and paints shall be easily removable with suitable solvents without any visible change in the gloss or colour of the enamel surface.

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