



**International
Standard**

ISO 23100

**Decorative physical vapor
deposition (PVD) coatings on
kitchen and sanitary ware fittings —
Specification and test methods**

**First edition
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Foreword

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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 document 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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This document was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 9, *Physical vapor deposition coatings*.

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

Physical vapor deposition (PVD) is a group of dry coating technologies used for decorative coating, tool coating and other substrate coatings under a vacuum environment. During the PVD process, the target material is transferred atom by atom from solid phase to vapor phase and back to solid phase as a thin film coating on the substrate. Thus, PVD is an eco-friendly technique which can produce coatings with a variety of colour, textures, and functions over traditional methods.

The PVD process is capable of producing bright and hard coatings on many metals and plastic substrates. A luxurious metallic finish and a wide range of colours can be obtained using various metal sputtering targets, such as chromium, zirconium, titanium, titanium—aluminium alloys and niobium. Therefore, PVD coatings have become a popular choice for decorative finishes for many products where durability, aesthetics and functionality are important considerations. In particular, PVD coatings are well established as decorative coatings on kitchen and sanitary wares.

Decorative PVD coatings are applied to the surface of objects in order to get better appearance and longer durability. Common kitchen and sanitary substrate including copper alloy, zinc alloy, stainless steel, aluminium alloy and ABS. The colour of PVD coating can include gold, bronze, rose gold, silver, black, smoke grey, copper, brown, purple, blue, wine red and others.

This document specifies and recommends test methods for discoloration resistance, corrosion, abrasion, and adhesion of the decorative PVD coatings applied on kitchen and sanitary wares.

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Decorative physical vapor deposition (PVD) coatings on kitchen and sanitary ware fittings — Specification and test methods

1 Scope

This document specifies the performance and test methods of decorative physical vapor deposition (PVD) coatings on kitchen and sanitary ware fittings.

This document is applicable to performance evaluation for decorative PVD coatings on kitchen and sanitary ware fittings.

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 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 10289:1999, *Methods for corrosion testing of metallic and other inorganic coatings on metallic substrates — Rating of test specimens and manufactured articles subjected to corrosion tests*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 10289 and the following 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

CIELAB value

three-dimensional, approximately uniform colour space, produced by plotting, in rectangular coordinates L^* , a^* , b^*

[SOURCE: ISO/TS 21331:2020, 3.3.5]

3.2

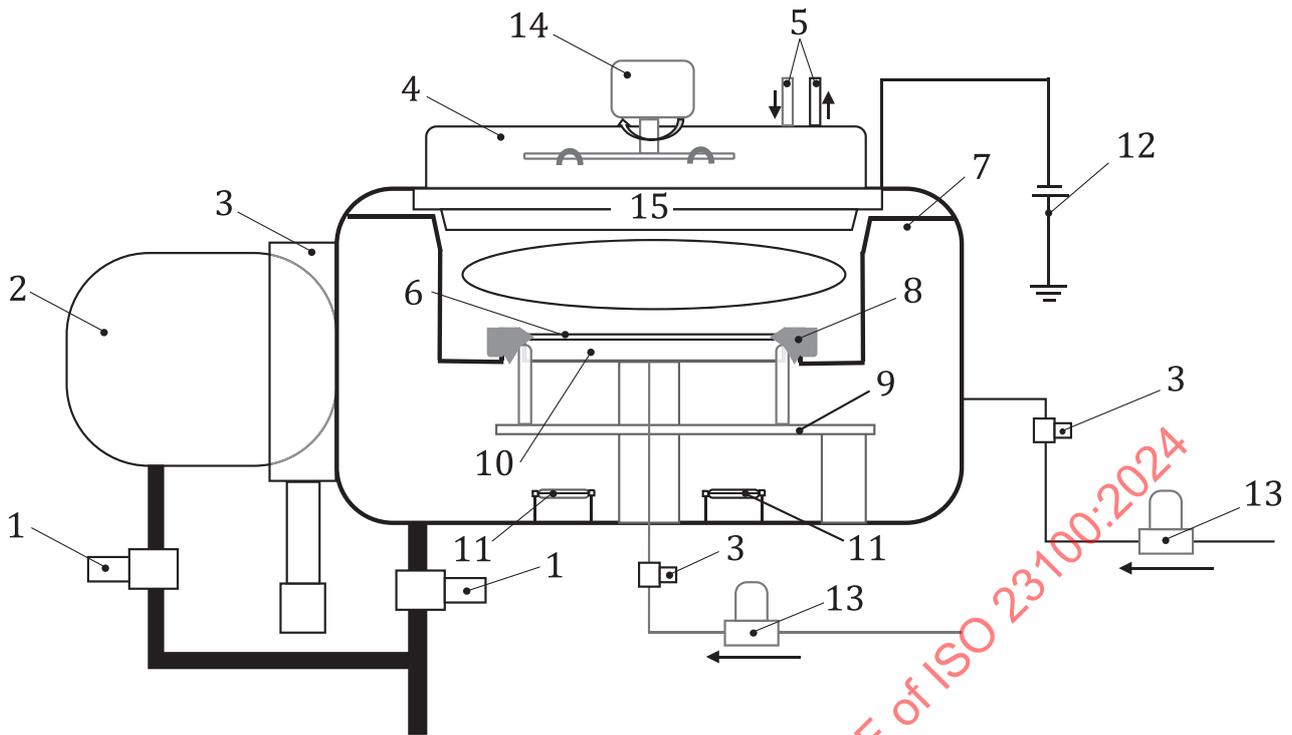
discoloration resistance

ability of a material to maintain its original colour or appearance despite exposure to external factors that may cause discoloration, fading or staining

4 Decorative PVD coating process

4.1 Principle

The source material is heated to evaporate, and a plasma of metal atoms are formed. These atoms then travel through the vacuum chamber and deposit onto the substrate, forming a thin film. The thickness of the film could be controlled by adjusting the time and rate of deposition. The decorative PVD coatings process is shown in [Figure 1](#).



Key

- | | | | |
|---|----------------|----|---|
| 1 | roughing valve | 9 | lifter |
| 2 | cryo pump | 10 | pedestal |
| 3 | gas valve | 11 | bake out lamp |
| 4 | magnet | 12 | DC power |
| 5 | cooling water | 13 | mass flow controller (where the gas enters) |
| 6 | wafer | 14 | motor |
| 7 | shield | 15 | target |
| 8 | clamp ring | | |

Figure 1 — Equipment diagram of the decorative PVD coating process

4.2 Coating process

4.2.1 Pre-treatment

Clean surfaces ensure good adhesion of the coating. Pre-treat and clean the substrate of the kitchen and sanitary ware fittings by the following procedures (each procedure takes 5 min to 30 min):

- a) alkali degreasing
- b) washing with deionized water
- c) acid activation
- d) washing with deionized water

4.2.2 Coating

The coating shall be prepared using the following recommended procedures:

- a) Pump down the chamber to a background pressure between $1,0 \times 10^{-2}$ Pa and $1,0 \times 10^{-4}$ Pa, and a small amount of reaction gas (ex. methane or acetylene as a carbon source, N_2 for nitride and O_2 for oxide) is introduced to create a low-pressure environment.
- b) The voltage shall be adjusted between 30 V to 500 V.
- c) Place the substrate inside the PVD vacuum chamber along with the source material, which is typically a metal or an alloy in the form of a target.

NOTE The final appearance of decorative coatings on kitchen and sanitary ware fittings can be further enhanced by applying post-treatment processes, such as polishing.

5 Requirements

5.1 Discoloration resistance

The test shall be conducted in accordance with the requirements specified in [6.1](#). The rating standards of discoloration are divided into four levels. The relevant rating standards are shown in [Table 1](#).

Table 1 — Rating standards of ΔE

| Level | Discoloration |
|-------|-------------------------|
| 1 | $\Delta E \leq 0,5$ |
| 2 | $0,5 < \Delta E \leq 1$ |
| 3 | $1 < \Delta E \leq 2$ |
| 4 | $2 < \Delta E \leq 3$ |

5.2 Abrasion resistance

PVD coating with different friction cycles shall not wear through the exposed substrate. The test shall be conducted in accordance with the requirements specified in [6.2](#). The rating standards of friction cycles shall be divided into four levels. The relevant rating standards are shown in [Table 2](#).

Table 2 — Rating standards of the friction cycles

| Level | Friction cycles |
|-------|-----------------|
| 1 | 2 500 |
| 2 | 2 000 |
| 3 | 1 500 |
| 4 | 1 000 |

5.3 Corrosion resistance

The performance of corrosion is divided into four levels according to test time, specified in [Table 3](#). When tested in accordance with [6.3](#) and [Table 3](#), the visible surface of the product after installation shall not be lower than the appearance rating (R_A) 9 given in ISO 10289:1999, Table 1.

Table 3 — Test time

| Level | Test time |
|-------|-----------|
| 1 | 72 h |
| 2 | 48 h |
| 3 | 36 h |
| 4 | 24 h |

5.4 Adhesion

5.4.1 Metal substrate

The test shall be conducted in accordance with the requirements specified in 6.4.1. Observe the sample after the test to see whether there are cracks, peelings or foaming and fill the test record in detail. No separation, for example by cracks, peelings or foaming, of the coating from the metal substrate shall occur.

5.4.2 Organic substrate

The test shall be conducted in accordance with the requirements specified in 6.4.2. Observe the sample after the test to see whether there are cracks, peelings or foaming and fill the test record in detail. No separation, for example by cracks, peelings or foaming, of the coating from the organic substrate shall occur.

6 Test methods

6.1 Discoloration resistance

CIELAB value of samples shall be measured by spectrophotometer. The light source of the spectrophotometer shall be D65. The observation angle between the sample and the spectrophotometer shall be 10°.

Examine the appearance of the sample before the test and measure its CIELAB value (label as L_0^* , a_0^* , b_0^*). The samples shall be reasonably arranged in the constant temperature water bath test chamber. Maintain enough space between the sample and the walls of water bath test chamber. Select the boiling test condition according to the standard specification. Soak in distilled water at $60 \pm 0,5$ °C for 24 h and take out. After the test, take the sample out of the water bath test chamber and measure the sample's CIELAB value (label as L^* , a^* , b^*) after the surface is dried. Calculate ΔE using [Formula \(1\)](#).

$$\Delta E = \sqrt{(L^* - L_0^*)^2 + (a^* - a_0^*)^2 + (b^* - b_0^*)^2} \quad (1)$$

where

ΔE is the colour difference;

L^* , a^* , b^* are the measure of the lightness, the red-green and yellow-blue axes in colour space before test;

L_0^* , a_0^* , b_0^* are the measure of the lightness, the red-green and yellow-blue axes in colour space after test.

6.2 Abrasion resistance

6.2.1 Brush requirements

The brush base plate shall be constructed from aluminium alloy, measuring 40 mm × 90 mm × 13 mm. Each brush shall contain 54 bristle holes, with each hole having a diameter of $3,0 \pm 0,3$ mm. There shall be a total of 12 rows, arranged in a way that every consecutive row follows an alternative 4 and 5 bristle holes, as illustrated in [Figure 2](#). There shall also have 11 rows of 39 feed holes through the brush, each hole having a

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diameter of $3,0 \pm 0,2$ mm, adjacent to each bristle hole and arranged in such a way that each consecutive row follows an alternative 4 and 3 feed holes. The total mass of the fixture and brush shall be 450 ± 10 g.

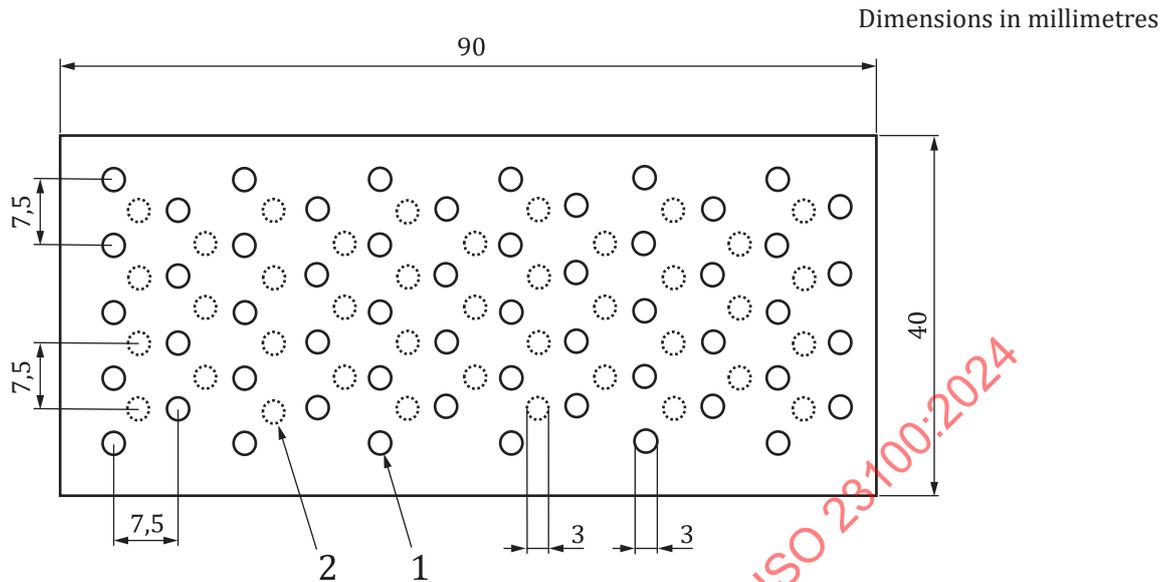


Figure 2 — Dimension of the brush base plate

6.2.2 Mud preparation

Mix 3,75 g of sodium carboxymethyl cellulose, 15 g trisodium phosphate and 675 g 160# quartz powder into 750 ml distilled water and stir evenly. The bottom of mud container shall feature an automatic stirring device to maintain mud granular materials in the suspended state.

6.2.3 Test procedure

The mud flow rate shall be controlled to be at the range of 3,0 to 3,5 ml/min. The defoaming agent shall be added to eliminate any bubbles that may already exist in slurries. The brush moves back and forth once in a cycle. The moving frequency of the brush shall be 37 ± 2 cycles per minute, and the distance of a cycle shall be 600 mm ($300 \text{ mm} \times 2$).

6.3 Corrosion resistance

The acetic acid salt spray test shall be conducted according to ISO 9227. A salt solution containing 50 ± 5 g/L of sodium chloride shall be used. The temperature shall be maintained at 35 ± 1 °C and the pH value should be between 3,1 and 3,3.

6.4 Adhesion

6.4.1 Metal substrate

Examine the appearance of samples before the test. The sample shall be reasonably arranged in an oven. Maintain enough space between the sample and the walls of the oven for air circulation. Select the test conditions according to [Table 4](#) and place the sample in the corresponding temperature conditions for 60 min. After then, quench the sample in water at 25 ± 2 °C for 2 min.