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GB/T 45345-2025

Metallic and other inorganic coatings - DC magnetron sputtered silver coatings for engineering purposes - Measurement of coating adhesion

金属及其他无机覆盖层 工程用直流磁控溅射银镀层 镀层附着力的测量

(ISO 21164:2018, MOD)

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WARNING -- The use of this document may involve harmful materials, dangerous operating procedures and equipment. This document does not mention all safety-related issues during use. Before use, the user of this document is responsible for establishing appropriate safety and health measures and determining its compatibility with relevant laws.

1 Scope

This document describes the test methods for adhesion of DC magnetron sputtered silver coatings for electrical, electronic, optical and other engineering applications.

This document applies to the measurement of adhesion of DC magnetron sputtered silver coatings on sheets and flat objects.

This document does not apply to the measurement of adhesion of DC magnetron sputtered silver coatings on threads, strips or wires.

This document does not specify the state and surface roughness of the substrate material before deposition. Therefore, it is the purchaser's responsibility to specify the surface roughness of the substrate to meet the product requirements.

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.

GB/T 3138 Metallic and other inorganic coatings - Surface treatment, metallic and other inorganic coatings - Vocabulary (GB/T 3138-2015, ISO 2080:2008, IDT)

GB/T 5270 Metallic coatings on metallic substrates - Electrodeposited and chemically deposited coatings - Review of methods available for testing adhesion (GB/T 5270-2024, ISO 2819:2017, MOD)

GB/T 12334 Metallic and other inorganic coatings - Definitions and conventions concerning the measurement of thickness (GB/T 12334-2001, ISO 2064:1996, IDT)

3 Terms and definitions

For the purpose of this document, the terms and definitions defined in GB/T 3138 and GB/T 12334 and the following apply.

3.1

sputtering

Process in which high-speed ions bombard the target material to produce particles, which can cause the target metal material particles to be deposited on the surface of the substrate.

3.2

adhesion

Interface force between the coating and the substrate, composed of atomic bonding forces, mechanical bonding forces or both.

4 Test methods for adhesion

4.1 Friction polishing test

Use an agate knife with a diameter of 6 mm and a smooth hemispherical end as a friction polishing tool, select an area with an effective surface area of no more than 6 cm^2, and rub it quickly and steadily for 15 s with a suitable polishing tool. The pressure used during friction shall be able to wipe off the coating in each stroke, but not so large as to cut the coating. Use a low-power microscope to check the sample coating, as the friction continues, the blisters continue to grow, break or even peel off, indicating that the adhesion of the coating is poor.

This test method is not applicable to the silver coatings with a thickness greater than 10 μm.

4.2 Roller polishing test

Unless the purchaser specifies dry polishing, the sample shall be wet polished for 40 min on a suitable polishing machine. Use a hexagonal rubber-lined polishing drum with a diameter of 250 mm and polish at a speed of 25 r/min. Use a low-power microscope to check whether the sample has blistering or peeling. The tested sample shall not have blistering or peeling.

If the roller polishing test method is acceptable, the entire batch of coated parts can be tested by this method. Only coated parts that fail the test will be scrapped.

4.3 Peeling test

It shall operate according to the peeling test method specified in GB/T 5270.

At a temperature not higher than the normal welding temperature, a tinned steel strip or brass strip with a size of approximately 10 mm× 75 mm× 0.5 mm is welded straight to the silver coating surface, ensuring that the weld length is approximately 15 mm. The solder contains about 60 % tin, 38 % lead, and 2 % silver. It shall use non-corrosive rosin-based flux. The coating shall not blister during welding. Then apply a force at right angles to the sample and sufficient to pull the strip apart. Use a low-power microscope to check whether the sample has peeling of coating. The sample shall not have peeling of coating, and the failure shall only occur in the solder strip layer.

4.4 Bending test

It shall operate according to the bending test method specified in GB/T 5270.

Place the sample in a bending test device with a radius of curvature of 4 mm (or in the jaws of a vise), bend the sample 90°, and then bend it back to its original shape, repeat 3 times. Use a low-power microscope to check whether the coating has peeling. The sample shall be able to withstand 3 bends without peeling of coating. If the coating does not peel, coating failure caused by microscopic or macroscopic cracking of the substrate shall not be a reason for rejection.

4.5 Thermal shock test

It shall operate according to the thermal shock test method specified in GB/T 5270.

Place the sample in an oven at 200 ℃ ~ 300 ℃ and heat for about 30 min, then soak and quench in water at room temperature. Use a low-power microscope to check whether the coating has blistering or peeling. The coating shall not have blistering or peeling.

4.6 Nano scratch test

4.6.1 General

This test method is suitable for evaluating the adhesion of sputtered silver coatings with a thickness of 0.5 μm ~ 1.5 μm on steel or copper substrates. The results refer to qualitative tests only. This test method may damage the substrate.

4.6.2 Scratch test equipment

It is recommended to use a sphero-conical diamond indenter with a radius of 2 μm for nano scratch test.

Among them, the instantaneous curvature radius $R(h)$ of the sphere top corresponding to any indentation depth h measured by the sphero-conical diamond indenter from the

f) test load and loading rate;

g) adhesion.

NOTE: The scratching speed is the relative movement speed of the indenter and the coating, which is determined by the test load, loading rate, and scratch length.

5 Test report

The purchaser shall provide the following information in the contract or order:

a) serial number GB/T 45345 of this document;

b) the nature, surface state, and type of finishing of the base metal (when these factors may affect the performance and/or appearance of the coating);

c) the required surface roughness, preferably the purchaser provides samples that meet the surface roughness requirements;

d) requirements for thickness and adhesion tests;

e) any special requirements for the base coating;

f) electrical properties and test methods of the coating;

g) if density correction is required for thickness calculation, provide the density of the silver coating.

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