

STANDARDS AUSTRALIA

RECONFIRMATION

OF

AS 2331.4.1—2001

Methods of test for metallic and related coatings

Method 4.1: Physical tests—Qualitative adhesion tests

RECONFIRMATION NOTICE

Technical Committee MT-009 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

Certain documents referenced in the publication may have been amended since the original date of publication. Users are advised to ensure that they are using the latest versions of such documents as appropriate, unless advised otherwise in this Reconfirmation Notice.

Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 20 March 2017.

The following are represented on Technical Committee MT-009:

Australasian Institute of Surface Finishing
Australian Chamber of Commerce and Industry
Australian Industry Group
Australian Steel Institute
Bureau of Steel Manufacturers of Australia
Galvanizers Association of Australia
Galvanizing Association of New Zealand
New Zealand Metal Roofing Manufacturers

NOTES

Australian Standard™

Methods of test for metallic and relating coatings

Method 4.1: Physical tests—Qualitative adhesion tests

PREFACE

This Standard has been prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee MT-009, Metal Finishing, to supersede AS 2331.4.1—1981. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard. The objective of this revision is to upgrade the requirements so that they closely align with ISO 2819:1980, *Metallic coatings on metallic substrates—Electrodeposited and chemically deposited coatings—Review of methods available for testing adhesion*.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

METHOD

1 SCOPE

This Standard describes methods for checking the adhesion of electrodeposited and chemically deposited coatings. It is limited to tests of a qualitative nature. Table 1 indicates the suitability of each test for some of the common types of metallic coatings. Most of the tests described are capable of destroying both the coating and the article being tested, but some destroy the coating only. Even if the adhesion of the coating is found to be satisfactory on articles not destroyed in testing, it should not be assumed that the articles are undamaged. For example, the burnishing test (see Clause 3.1) may render an article unacceptable and the thermal shock test (see Clause 3.12) may produce unacceptable metallurgical changes.

This Standard does not describe tests that have been developed to give a quantitative measure of adhesion of metallic coating to a substrate, since such tests require special apparatus and considerable skill in their performance which renders them unsuitable as quality tests for production parts. Some of these quantitative tests may, however, be useful in research and development work.

NOTES:

- 1 When particular methods of adhesion testing are included in Standards for individual coatings, they should be used in preference to the methods described in this Standard and should be agreed upon beforehand by the supplier and the purchaser.
- 2 The test procedures described in this Standard do not necessarily include all of the precautions required to satisfy health and safety aspects. Care should be taken to ensure that the procedures are carried out only by people who have received suitable training. Guidance in the handling and use of hazardous chemicals is given in AS/NZS 2243.1 and AS/NZS 2243.2.
- 3 Base metal variations of yield and hardness may cause misinterpretations in the test results.

TABLE 1
ADHESION TESTS APPROPRIATE FOR VARIOUS COATING METALS

Adhesion test	Coating metal									
	Cadmium	Chromium	Copper	Nickel	Nickel + chromium	Silver	Tin	Tin-nickel alloy	Zinc	Gold
Burnishing	*		*	*	*	*	*	*	*	*
Ball burnishing	*	*	*	*	*	*	*	*	*	*
Peeling (soldering method)			*	*		*		*		
Peeling (adhesive method)	*		*	*		*	*	*	*	*
File			*	*	*			*		
Chisel		*		*	*	*		*		
Scribe	*		*	*	*	*	*		*	*
Bending and twisting		*	*	*	*			*		
Grinding and sawing		*		*	*			*		
Tension	*		*	*	*	*		*	*	
Thermal shock		*	*	*	*		*	*		
Extrusion (Erichsen)		*	*	*	*			*		
Extrusion (Flanged cap)		*	*	*	*	*		*		
Shot-peening				*		*				
Cathodic treatment		*		*	*					

* Indicates suitability.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

2331 Methods of test for metallic and related coatings

2331.1.3 Method 1.3: Local thickness tests—Magnetic method

AS/NZS

2243 Safety in laboratories

2243.1 Part 1: General

2243.2 Part 2: Chemical aspects

3 METHODS OF TEST

3.1 Burnishing test

This test applies to relatively thin deposits. If plated parts are subjected to burnishing in a localized area, the deposit will tend to work-harden and absorb frictional heat. If the coating is thin, separation of the coating from the basis metal as blisters will occur under these conditions in areas of poor adhesion.

When the shape and size of the part permit, an area of not more than 6 cm² of the plated surface shall be rubbed with a smooth implement, such as a steel rod of 6 mm diameter with a smooth hemispherical end, for about 15 s.

The pressure shall be sufficient to burnish the coating at every stroke but not so great as to cut the coating. Poor adhesion is indicated by the appearance of a blister which grows as the rubbing is continued.

If the mechanical properties of the coating are poor, the blister may crack and the coating will peel from the basis metal.

3.2 Ball burnishing test

Ball burnishing is frequently used for polishing, but it can be used also to test adhesion. The test shall be performed using a barrel or vibratory burnisher with steel balls of about 3 mm in diameter and a soap solution as lubricant. When the adhesion is very poor, blisters may be formed in the deposit. The method is suitable for relatively thin deposits.

3.3 Shot peening test

There are some variations of the principle by which the hammering action of iron or steel balls, allowed to fall by gravity or forced by means of a pressure air stream onto the surface to be tested, produces deformation of the deposit.

If the coating is poorly bonded, it will become blistered. Usually, the intensity of peening necessary to cause non-adherent coatings to blister varies with the coating thickness, thin coatings requiring less intensity than thick coatings.

One such test can be performed using a tube 150 mm long and of 19 mm internal diameter, as the reservoir for round iron or steel shot (0.75 mm diameter approximately), that is connected to a nozzle. Compressed air at a pressure of 0.07 to 0.21 MPa shall be used to apply the shot. The distance between nozzle and specimen shall be maintained at between 3 and 12 mm.

Another test, that is probably the most suitable for checking the adhesion of electroplated coatings of silver during production of coatings 100 to 600 µm in thickness, is specified in Appendix A and employs a standard air-operated cabinet of the type used for shot-peening steel parts.

If the silver is poorly bonded, it will extend or flow and become blistered.

3.4 Peel test

This test is suitable for coatings less than 125 μm thick on substantially flat surfaces. A strip of tinned mild steel or brass, approximately 75 mm long $\times$ 10 mm wide $\times$ 0.5 mm thick, shall be bent at right angles 10 mm from one end and the shorter limb soldered flat to the coated surface. A load shall be applied to the free limb and normal to the soldered surface. The coating will be detached from the substrate if the adhesion is weaker than the soldered joint. If the adhesion of the coating is greater than this, however, failure will occur in the soldered joint or within the thickness of the coating.

This method is not widely used because the temperature reached during the soldering operation could alter the adhesion. Alternatively, the test can be performed using an adhesive of hard-setting synthetic resin of adequate tensile strength in place of solder.

Another test (the tape test) employs an adhesive cellulose tape, with an adhesion value of approximately 8 N per 25 mm width. The adhesive side of this tape shall be applied to the coating under test, using a fixed-weight roller, due care being taken to exclude all air bubbles. After an interval of 10 s, the tape shall be removed by applying a steady pulling force, perpendicular to the surface of the coating. The adhesion of the coating shall be such that there is no evidence of detachment of the coating. This test is particularly used for testing adhesion of coatings on the conductors and contacts of printed circuits. Coated conductors shall be tested over an area of at least 30 mm².

3.5 File test

A piece sawn off a coated article is held in a vice and a coarse mill file (one set of serrations only) shall be applied to the cut in such a manner as to attempt to raise the coating. The filing direction shall be from the basis metal to the coating, at an angle of approximately 45° to the coated surface. No detachment of the coating shall occur. This test is not suitable for very thin coatings and for soft coatings such as zinc or cadmium.

3.6 Grinding and sawing tests

An edge of the coated specimen shall be ground with a grinding wheel, the direction of cutting being from the basis metal to the deposit. If adhesion is poor, the deposit will be torn from the base. A hacksaw can be substituted for the grinder. It is important to saw in such a direction that a force is applied that tends to separate the coating from the basis metal. Grinding and sawing tests are especially effective on harder coatings such as nickel and chromium.

3.7 Chisel test

The chisel test is normally used on coatings of considerable thickness (greater than 125 μm).

One variation of the test is to place a sharp chisel at the back of a coating overhang, and give it a sharp hammer blow. If the adhesion is good, the coating will break away or be cut through without the bond between basis metal and coating being affected.

The chisel test can be combined with the saw test. The test shall be carried out by sawing the specimen perpendicular to the coating; if the adhesion is not very good, failure immediately becomes evident. In cases where there appears to be no separation at the fracture, a sharp chisel shall be used to try to raise the coating at the edge. If the coating can be peeled from the edge for an appreciable distance, poor or weak adhesion is indicated. The cutting edge of the chisel shall be sharpened prior to each test.

Thinner coatings can be tested by substituting a knife for the chisel and light tapping with a hammer may be used, if required. The chisel test is not suitable for soft coatings such as zinc or cadmium.