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Metallic coatings on metallic substrates – Electrodeposited and chemically deposited coatings – Review of methods available for testing adhesion (ISO 2819:2017); English version EN ISO 2819:2018, English translation of DIN EN ISO 2819:2018-09

Metallische Überzüge auf metallischen Grundwerkstoffen –
Galvanische und chemische Überzüge –
Überblick über Verfahren der Haftfestigkeitsprüfung (ISO 2819:2017);
Englische Fassung EN ISO 2819:2018,
Englische Übersetzung von DIN EN ISO 2819:2018-09

Revêtements métalliques sur bases métalliques –
Dépôts électrolytiques et dépôts par voie chimique –
Liste des différentes méthodes d'essai d'adhérence (ISO 2819:2017);
Version anglaise EN ISO 2819:2018,
Traduction anglaise de DIN EN ISO 2819:2018-09

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In case of doubt, the German-language original shall be considered authoritative.

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A comma is used as the decimal marker.

National foreword

This document (EN ISO 2819:2018) has been prepared by Technical Committee CEN/TC 262 "Metallic and other inorganic coatings, including for corrosion protection and corrosion testing of metals and alloys" (Secretariat: BSI, United Kingdom) in collaboration with Technical Committee ISO/TC 107 "Metallic and other inorganic coatings".

The responsible German body involved in its preparation was *DIN-Normenausschuss Materialprüfung* (DIN Standards Committee Materials Testing), Working Committee NA 062-01-61 AA "Measuring and test methods for coatings and coating systems*".*

The DIN documents corresponding to the international documents referred to in this document are as follows:

ISO 1520	DIN EN ISO 1520
ISO 2178	DIN EN ISO 2178
ISO 2409	DIN EN ISO 2409
ISO 4624	DIN EN ISO 4624
ISO 9211-4	DIN ISO 9211-4
ISO 10365	DIN EN ISO 10365
ISO 26443	DIN EN ISO 26443

Amendments

This standard differs from DIN EN ISO 2819:1995-01 as follows:

a) Clause 2 and Clause 3 have been added as set out in the ISO Directives Part 2;

b) notes relating to bibliographic references have been added in subclauses 4.5, 4.6, 4.11.2 and 4.12;

c) subclause 4.11 "Tensile test" has been revised and, in addition to the qualitative test, now also includes a quantitative test;

d) the Rockwell-C test has been added in subclause 4.15;

e) the scratch test has been added in subclause 4.16;

f) the cavitation test has been added in subclause 4.17;

g) Table 2 has been transferred to a new Clause 5 and the new tests have been included;

h) a Bibliography has been included.

Compared with DIN EN ISO 2819:2018-06, the following corrections have been made:

a) in subclause 4.4 "Peel test", the first sentence in the third paragraph "with an adhesion value of approximately 8 per 25 mm width" has been replaced by "with an adhesion value of approximately 8 N per 25 mm width";

b) the title of Figure A.1 has been changed to "Fixture for peening test specimen";

c) some editorial corrections have been made.

Previous editions

DIN EN ISO 2819: 1995-01, 2018-06

National Annex NA
(informative)

Bibliography

DIN EN ISO 1520, *Paints and varnishes — Cupping test*

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

DIN EN ISO 2409, *Paints and varnishes — Cross-cut test*

DIN EN ISO 4624, *Paints and varnishes — Pull-off test for adhesion*

DIN ISO 9211-4, *Optics and photonics — Optical coatings — Part 4: Specific test methods*

DIN EN ISO 10365, *Adhesives — Designation of main failure patterns*

DIN EN ISO 26443, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Rockwell indentation test for evaluation of adhesion of ceramic coatings*

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 2819

March 2018

ICS 25.220.40

Supersedes EN ISO 2819:1994

English Version

Metallic coatings on metallic substrates - Electrodeposited and chemically deposited coatings - Review of methods available for testing adhesion (ISO 2819:2017)

Revêtements métalliques sur bases métalliques - Dépôts électrolytiques et dépôts par voie chimique - Liste des différentes méthodes d'essai d'adhérence (ISO 2819:2017)

Metallische Überzüge auf metallischen Grundwerkstoffen - Galvanische und chemische Überzüge - Überblick über Verfahren der Haftfestigkeitsprüfung (ISO 2819:2017)

This European Standard was approved by CEN on 1 December 2017.

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European foreword

This document (EN ISO 2819:2018) has been prepared by Technical Committee ISO/TC 107 "Metallic and other inorganic coatings" in collaboration with Technical Committee CEN/TC 262 "Metallic and other inorganic coatings, including for corrosion protection and corrosion testing of metals and alloys" the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2018, and conflicting national standards shall be withdrawn at the latest by September 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 2819:1994.

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Endorsement notice

The text of ISO 2819:2017 has been approved by CEN as EN ISO 2819:2018 without any modification.

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).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 262, *Metallic and other inorganic coatings, including for corrosion protection and corrosion testing of metals and alloys*, in collaboration with ISO Technical Committee TC 107, *Metallic and other inorganic coatings*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 2819:1980), which has been technically revised.

The main changes compared to the previous edition are as follows:

— tensile test has been extended by centrifugal adhesion testing;

— Rockwell-C test has been added;

— scratch test has been added;

— cavitation test has been added;

— editorial changes and informative references to further existing standards have been made.

WARNING — When particular methods of adhesion testing are included in International Standards for individual coatings, they should be used in preference to the methods described in this document and should be agreed upon beforehand by the supplier and the purchaser.

1 Scope

This document specifies methods of checking the adhesion of electrodeposited and chemically deposited coatings. It is limited to tests of a qualitative nature.

This document does not describe certain tests that have been developed at various times 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 control tests for production parts. Some of these quantitative tests can, however, be useful in research and development work.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Methods of test

4.1 Burnishing test

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 cm^2 of the plated surface should be rubbed with a smooth implement for about 15 s. A suitable implement is a steel rod 6 mm in diameter with a smooth hemispherical end.

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. This test shall be limited to relatively thin deposits.

4.2 Ball burnishing test

Ball burnishing is frequently used for polishing, but it can be used also to test adhesion. Using a barrel or vibratory burnisher with steel balls about 3 mm in diameter and soap solution as lubricant, it is possible to produce blisters when the adhesion is very poor. The method is suitable for relatively thin deposits.

4.3 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 than thick coatings.

One test can be performed using a tube 150 mm long, with 19 mm internal diameter, as the reservoir for round iron or steel shot (0,75 mm diameter approximately) connected to a nozzle. Compressed air is brought to the apparatus with a pressure of 0,07 MPa to 0,21 MPa[1)] and the distances between the nozzle and the specimen are 3 mm to 12 mm.

Another test, that appears to be the most suitable for checking the adhesion of electroplated coatings of silver during production of coatings from 100 µm to 600 µm in thickness, is described in Annex 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.

4.4 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 × 10 mm wide × 0,5 mm thick, is bent at right angles 10 mm from one end and the shorter limb soldered flat to the coated surface. A load is 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 might 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, whose adhesive side is applied to the coating under test, using a fixed-weight roller, care being taken to exclude all air bubbles. After an interval of 10 s, the tape is removed by applying a steady pulling force to the tape, 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 mm^2.

4.5 File test

A piece sawn off a coated article is held in a vice and a coarse mill file (one set of serrations only) is applied to the cut in such a manner as to attempt to raise the coating. The file is used in the direction 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.

NOTE See also ASTM B571.

1) 1 MPa = 1 MN/m^2.

4.6 Grinding and sawing tests

Grind an edge of the coated specimen with a grinding wheel with the direction of cutting from the basis metal to the deposit. If adhesion is poor, the deposit is 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.

NOTE See also ASTM B571.

4.7 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.

Another type of “chisel test” is combined with the “saw test”. The test is made 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 is 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 or may not be used. The chisel test is not suitable for soft coatings such as zinc or cadmium.

4.8 Scribe and grid test

Using a hardened steel scribe that has been ground to a sharp 30° point, two parallel lines are scribed at a distance apart of about 2 mm. In scribing the two lines, enough pressure shall be applied to cut through the coating to the basis metal in a single stroke. If any part of the coating between the lines breaks away from the basis metal, the coating shall be deemed to have failed the test.

One variation of the test is to draw a square with a grid of 1 mm side and observe whether the coating peels from the basis metal within this area.

NOTE See also ISO 9211-4 cross-hatch test for optical coatings and ISO 2409 for varnishes.

4.9 Bending test

The bend test consists in bending or flexing the coated products. The extent and nature of the distortion will vary with the basis metal, the shape, the nature of the coating and the relative thickness of the two layers.

The test is usually carried out by hand or with pliers, bending the specimen as sharply as possible first to one side then to the other, until the specimen breaks. The rate and the radius of bending can be controlled using suitable machines. The test produces a shearing stress between the basis metal and the deposit; if the deposit is ductile, the shearing force is much reduced because the coating flows and the basis metal can even break without the coating loosening.

A brittle deposit can crack but even so, the test can give some information about the adhesion; the fracture shall be inspected to determine whether the deposit peeled or can be removed with a knife or chisel.

Any sign of peeling, chipping or flaking is taken as indication of poor adhesion.

The coated specimen can be distorted with the coating on either the inside or the outside of the specimen. The behaviour of the coating is normally observed on the outside layer, although in some cases, further information may be gained by examining the inside of the bend.

4.10 Twisting (winding) test

In this test, the specimens (normally strips and wires) are twisted around a mandrel. Each part of the test can be standardized: the length and width of the strip, the rate of bending, the uniformity of bending movement and the diameter of the rod around which the piece is twisted.

Any sign of peeling, chipping or flaking is taken as indication of poor adhesion.

The coated specimen can be distorted with the coating on either the inside or the outside of the specimen. The behaviour of the coating is normally observed on the outside layer, although in some cases, further information may be gained by examining the inside of the bend.

4.11 Tensile test

4.11.1 Tensile test as qualitative test as a measure of adhesion in terms of a classification

This is suitable only for certain types of coated article. The article is stressed in tension until it breaks. Some cracking of the coating will normally be evident near to the fracture, but no detachment of the coating from the basis metal shall be visible. This type of test is carried out by means of a tensile testing machine and requires an appropriate two-sided clamping of the coated article.

4.11.2 Tensile test as quantitative test for the determination of assembly strength in N/mm^2

This is suitable only for certain planar coated articles, planar reference blocks or planar witness samples. A test stamp glued on the coated article, reference block or witness sample is pulled-off the coated substrate unless special adhesive-bonded coated joints are directly tested under tensile stress conditions. Given that the failure occurs at the coating/substrate interface, adhesive strength under tensile load can be derived in N/mm^2. In the case of other failure patterns, the adhesive strength is larger than the assembly strength in N/mm^2. A macroscopic and/or microscopic inspection of the failure pattern is recommended. This test is carried out either as single-sample test by means of a tensile testing machine or as multiple-sample test by means of a centrifuge.

NOTE See also EN 13144, ISO 4624, EN 15870 for tensile test arrangements and ISO 10365 for failure pattern.

4.12 Thermal shock test

The adhesion of many deposits can be determined by heating the coated specimen and then suddenly cooling it. The principle involved in this test is the difference in coefficient of expansion between the coating and the basis metal.

It is therefore applicable when the coefficient of expansion of a coating is appreciably different from that of the basis metal. The test is performed by heating the specimen in an oven for a sufficient time to achieve the appropriate temperature shown in Table 1. The temperature shall be maintained within ±10 °C. Metals that are sensitive to oxidation shall be heated in an inert or reducing atmosphere or in suitable liquids.

Table 1 — Thermal shock test temperatures

Basis metal	Coating metal	
	Chromium, nickel, nickel + chromium, copper and tin-nickel	Tin
Steel	300 °C	150 °C
Zinc alloys	150 °C	150 °C
Copper and copper alloys	250 °C	150 °C
Aluminium and aluminium alloys	220 °C	150 °C

The specimen shall then be quenched in water at room temperature. No separation, for example by blistering, flaking or exfoliation, of the coating from the basis metal shall occur.

It should be mentioned that heating generally improves the bond strength of electrodeposits so that any test method that requires heating of the test piece does not give a correct indication of the bond strength "as plated".

NOTE 1 In other cases, the diffusion of the coating into the basis metal can create a brittle layer so that the peeling of the coating is caused by fracture rather than non-adhesion.

NOTE 2 See also ASTM B571 that discusses also other coating metals and temperatures.

4.13 Drawing test

Drawing tests are most generally used on coated sheet metal. The most common are the "Erichsen cupping test" and the "Romanoff flanged cap test".

NOTE For a full description of the cupping method, see ISO 1520.

They produce a deformation of the deposit and basis metal into a cup or flanged depression by means of some sort of plunger.

In the Erichsen test, a ball-shaped plunger 20 mm in diameter is pushed into the specimen with a speed of 0,2 mm/s to 6 mm/s to a desired depth with a suitable hydraulic device. Poorly adherent deposits peel or flake from the basis metal after a few millimetres distortion, while adherent deposits exhibit no peeling, even when the basis metal has been cracked by the penetrating mandrel.

The apparatus for the Romanoff test consists of an ordinary press with a set of adjustable dies for drawing a flanged cap. The flange is 63,5 mm in diameter and the cap 38 mm in diameter. The depth of the cap is adjustable from 0 mm to 12,7 mm. The specimens are usually tested to a point that will fracture the cap. The intact part of the draw shows how drawing affects the structure of the deposit. These methods are used specially for deposits of the harder metals, such as nickel or chromium.

In all cases, the results shall be cautiously interpreted since the ductilities of both the deposit and basis metal are involved.

4.14 Cathodic test

The coated part is made cathodic in a solution from which only hydrogen is evolved. Blistering of the coating may take place due to pressure of gaseous hydrogen which diffuses through certain coatings and accumulates at the site of any discontinuities between the coating and the basis metal.

The test is performed using a 5 % solution of sodium hydroxide (ρ = 1,054 g/ml) and treating the specimen for 2 min with a current density of 10 A/dm^2 at 90 °C. Small blisters form at points where adhesion is poor. If the coating is still free from blisters 15 min afterwards, the adhesion may be regarded as good. Alternatively, a solution of sulphuric acid (mass fraction of 5 %) can be used at 60 °C with a current density of 10 A/dm^2. Weakly adherent coatings develop blisters in 5 min to 15 min under these conditions.

The electrolytic test is limited in application to coatings that are permeable to cathodically discharged hydrogen. Nickel or nickel-chromium coatings react satisfactorily to the test if they are weakly adherent. Coatings of metals such as lead, zinc, tin, copper or cadmium are not suitable for testing by this method.

4.15 Rockwell-C test

As described in ISO 26443, a Rockwell indentor is used for indentation on a coating/substrate system. The observed delamination behaviour after load removal in terms of delamination pattern is correlated to four quality classes of adhesion HF1 to HF4.

4.16 Scratch-test

As described in EN 1071 (all parts), the instrumented scratch test makes use of an indentor at constant or progressive load conditions during scratching. The critical load L_{c_2} is taken as measure of coating adhesion.

4.17 Cavitation test

As described in ASTM G32, this erosion test may also be associated with adhesion as measured by the degree of coverage as a result of cavitational load.

5 Summary

Table 2 shows all methods listed in this document.

It indicates the suitability of each test for some of the most usual 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 4.1) may render an article unacceptable and the thermal shock test (see 4.12) may produce unacceptable metallurgical changes.

Table 2 — 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		*		*	*					

Table 2 *(continued)*

Adhesion test	Coating metal									
	Cadmium	Chromium	Copper	Nickel	Nickel + chromium	Silver	Tin	Tin-nickel alloy	Zinc	Gold
Rockwell C-test	*	*		*	*			*	*	
Scratch test	*	*		*	*		*	*	*	
Cavitation test	*	*	*	*	*	*	*	*	*	*

Annex A
(informative)

Determination of adhesion of silver deposits (100 µm to 600 µm): shot-peening method

A.1 General

This test method is used to evaluate the adhesion on steel of silver deposits of thicknesses between 100 µm and 600 µm. The results refer to qualitative tests only. The method does not destroy the parts on which the adhesion of the coating is satisfactory.

A.2 Test equipment

A.2.1 Peening equipment

Normal compressed air or centrifugal-type shot-peening equipment.

A.2.2 Shot

Spherical steel shot of average diameter 0,4 mm and hardness not less than 350 HV. Dimensions are determined by screening and shall correspond to those given in Table A.1.

Inspection of shot dimensions shall be performed by screening at least once a week on a sample of 100 g of shot taken from the peening nozzles.

Table A.1 — Dimensions of screen mesh

Screen mesh mm	**Shot held** %
0,707	≤10
0,420	≥85
0,354	≥97

A.3 Procedure

Before peening, submit all parts to stress relieving by heating at (190 ± 10) °C for 2 h.

Mask all surfaces that are not to be peened.

Measure the thickness of the silver using a non-destructive method (for example, according to ISO 2178). Discard the parts where silver thickness is less than 100 µm or greater than 600 µm and those where the difference between the maximum and minimum thickness is 125 µm or more. Mark all acceptable parts with their maximum thickness and group them in lots in which the difference in maximum thickness is 125 µm or less.

Peen the silver-plated surfaces at the minimum peening intensity shown in Figure A.1 relative to the maximum measured thickness. Peening intensity shall be regulated by tests on an Almen A specimen (see A.5) before beginning treatment of each lot.

Control of peening intensity shall be done on an Almen A specimen at least once an hour.

Remove the mask from the surfaces that have not been peened.

Inspect the peened surface visually; it should be completely peened. If there are non-peened areas, treatment shall be repeated.

Check that no steel shot has been trapped in the coating. Remove any residual shot by means of air blowing.

A.4 Evaluation

Examine the silver-plated surface carefully with normal corrected vision. Where adhesion has been poor, bubbles or blisters will form during the test on the silver deposit or the coating itself will be detached.

A.5 Regulation of peening intensity

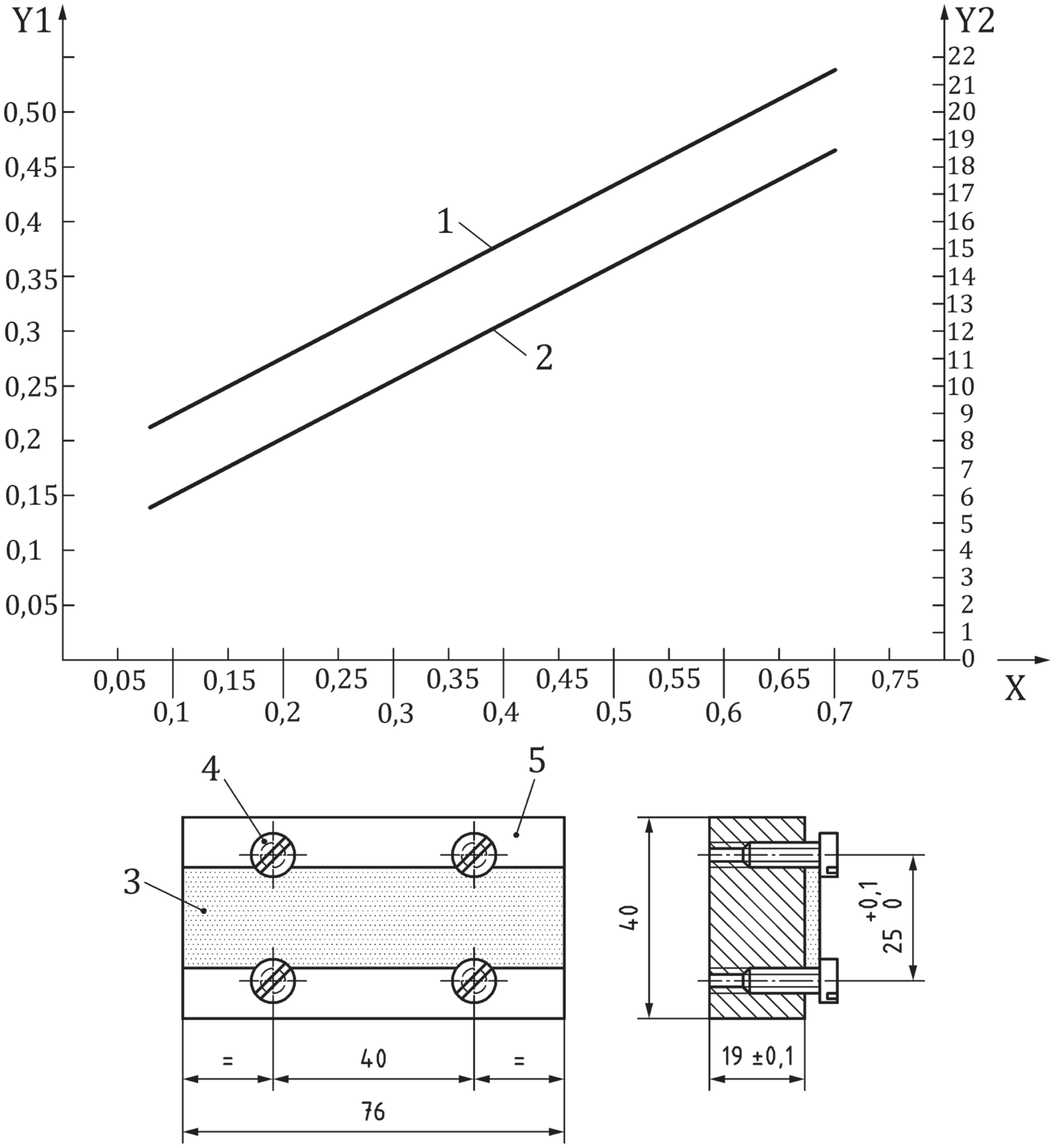
Use a test specimen from carbon steel sheet, with hardness range of 400 HV 30 to 500 HV 30 and thickness of 1,6 mm, which has been cut to a size of (76 ± 0,2) mm × (19 ± 0,1) mm and ground to a thickness of (1,30 ± 0,02) mm (Almen A specimen).

The deviation from flatness shall not exceed an arc height of 38 µm when measured as specified below.

With the specimen rigidly held in the fixture shown in Figure A.1, peen it on the exposed side.

After peening, remove the specimen from the fixture and measure the curvature of the unpeened surface with a depth gauge, the specimen being supported on four 5 mm diameter balls forming a rectangle 32 mm × 16 mm. Align the gauge symmetrically on the specimen with its centre stylus at the centre of the specimen. Measure the arc height at the centre of the specimen over the gauge length of 32 mm, measuring to the nearest 25 µm. The conditions of peening are then adjusted, if necessary, to give the required arc height.

Dimensions in millimetres



Key

1	max. arc height	X	silver thickness, mm
2	min. arc height	Y1	Almen A — arc height, mm
3	specimen	Y2	peening intensity Almen gauge reading, mm
4	steel set screws, Ø 4 mm to 5 mm		
5	body, tool steel		

NOTE For further explanation, see SAE J 442 a,

Figure A.1 — Fixture for peening test specimen

Bibliography

[1] ISO 1520, *Paints and varnishes — Cupping test*

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

[3] ISO 2409, *Paints and varnishes — Cross-cut test*

[4] ISO 4624, *Paints and varnishes — Pull-off test for adhesion*

[5] ISO 9211-4, *Optics and photonics — Optical coatings — Part 4: Specific test methods*

[6] ISO 10365, *Adhesives — Designation of main failure patterns*

[7] ISO 26443, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Rockwell indentation test for evaluation of adhesion of ceramic coatings*

[8] EN 1071 (all parts), *Advanced technical ceramics — Methods of test for ceramic coatings*

[9] EN 13144, *Metallic and other inorganic coatings — Method for quantitative measurement of adhesion by tensile test*

[10] EN 15870, *Adhesives — Determination of tensile strength of butt joints*

[11] ASTM G32, *Standard Test Method for Cavitation Erosion Using Vibratory Apparatus*

[12] ASTM B571, *Standard Practice for Qualitative Adhesion Testing of Metallic Coatings*

[13] SAE J 442 a, *Test strip, holder and gage for shot peening*