BS EN 2535:2011

BSI Standards Publication

Aerospace series — Vacuum deposition of cadmium

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee ACE/65, Non-metallic materials for aerospace purposes (excluding textiles).

A list of organizations represented on this committee can be obtained on request to its secretary.

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Aerospace series - Vacuum deposition of cadmium

Série aérospatiale - Cadmiage sous vide

Luft- und Raumfahrt - Aufdampfen von Kadmium im Vakuum

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EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 2535:2011) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

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of an identical text or by endorsement, at the latest by December 2011, and conflicting national standards shall be withdrawn at the latest by December 2011.

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1 Scope

This European Standard defines the method for depositing cadmium layers according to the vacuum deposition process, for use in aerospace construction.

According to this process, cadmium metal is vaporised under vacuum and deposited directly on the base material with an interlayer. The coating produced in this way is ductile and electrically conductive.

This standard should be applicable whenever referenced.

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.

EN 2828, *Aerospace series — Adhesion test for metallic coatings by burnishing*

EN 9100, *Aerospace series - Quality management systems - Requirements (based on ISO 9001:2000) and Quality systems - Model for quality assurance in design, development, production, installation and servicing (based on ISO 9001:1994)*

EN ISO 1463, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method*

EN ISO 2082, *Metallic and other inorganic coatings - Electroplated coatings of cadmium with supplementary treatments on iron or steel (ISO 2082:2008)*

EN ISO 2177, *Metallic coatings — Measurement of coating thickness — Coulometric method by anodic dissolution (ISO 2177:2003)*

EN ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method (ISO 2178:1982)*

EN ISO 2819, *Metallic coatings on metallic substrates — Electrodeposited and chemically deposited coatings — Review of methods available for testing adhesion (ISO 2819:1980)*

ISO 4520, *Chromate conversion coatings on electroplated zinc and cadmium coatings*

EN ISO 9227, *Corrosion test in artificial atmospheres — Salt spray tests*

ISO 4520, *Chromate conversion coatings on electroplated zinc and cadmium coatings*

3 Purpose of process

This process enables any hydrogen absorption to be avoided.

It ensures protection against corrosion, in particular for steels of R_m max. > 1 450 MPa. It may be beneficial to tensile bolts of R_m max. > 1 250 MPa.

4 Limitation of process use

The contact of cadmium-plated parts with titanium, titanium alloys, fuels and fuel line shall be avoided at temperature < 150 °C.

5 Terms and definitions

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

5.1
batch
parts of the same nature (form, size, material), treated at the same time .

5.2
pre-production part
parts manufactured according to a given definition and which are representative of the production process

5.3
R_m max.
maximum value of the tensile strength range which is defined in the standard on the steel to be treated

6 Thickness

Unless otherwise specified in the product standard or definition document, the thicknesses are:

— Class A: 10 µm to 20 µm (normal thickness)

— Class B: 7 µm to 14 µm (for parts with close tolerances or for bolts with a thread diameter > 3,2 mm)

— Class C: 5 µm to 10 µm (for bolts with a thread diameter ≤ 3,2 mm)

7 Apparatus and materials

7.1 Vacuum enclosure

The vacuum enclosure shall contain the following equipment:

— a variable heating system for vaporisation of the cadmium;

— a rotating device to achieve a regular coating;

— a vaporising dish;

— a glow system and a vacuum gauge as well as an inspection window.

Furthermore, a pump system is required, allowing a vacuum of at least $6{,}65 \times 10^{-3}$ Pa to be reached.

7.2 Deposition material

The cadmium used for deposition shall be at least 99,95 % pure. The mercury content shall not exceed the maximum level of 0,004 %.

The quality shall be confirmed by certificate.

7.3 Masking material

The masking materials used, such as masking varnishes, lead or textile tapes, paper or aluminium foils shall not release gases during the process.

8 Information for the processor

In addition to the designation in clause 19, the following information shall be stated:

a) number of the substrate standard and metallurgical condition of the substrate;

b) surface to be treated;

c) non specific coating thicknesses of the cadmium coating and tolerances;

d) if post-treatment by chromating does not have to be carried out.

9 Condition of parts prior to processing

9.1 General

Unless otherwise specified, all machining operations, moulding, brazing and welding treatments as well as heat treatments, shall be completed before plating.

9.2 Stress relief treatment

The conditions for stress relief treatment of steel parts shall be determined according to the nature and hardness of the material. A slight discoloration by superficial oxidation is permitted. Shot peening, if required, shall be carried out after stress relief treatment.

10 Process schedule

Unless otherwise specified, the following process schedule is mandatory:

a) degreasing;

b) abrasive blasting;

c) degreasing (if necessary, e.g. to remove any abrasive residues);

d) suspension in the device;

e) evacuation of the enclosure;

f) ionic etching (sputter cleaning) (if necessary);

g) deposition;

h) flooding and venting of the enclosure;

i) removal;

j) chromating;

k) preservation or application of paint.

11 Pre-treatment

NOTE Chemical or electrochemical process such as acid pickling, electrolytic cathodic degreasing or processes causing hydrogen embrittlement are not permitted for steels of R_m max. > 1 450 MPa.

11.1 Degreasing

The parts shall be cleaned by appropriate and qualified organic solvents.

NOTE After pre-treatment the parts shall be coated within 4 h. Otherwise, the parts shall be stored for a short time either under vacuum, in an inert gas atmosphere, in anydrous ethanol, or in anydrous acetone.

11.2 Abrasive blasting

The parts shall be cleaned by abrasive blasting in such a way that the surface is of a uniform mat appearance. For this operation, care shall be taken to see that the compressed air is de-oiled by a special filter.

Parts cleaned by abrasive blasting shall not be rougher than specified in the design documents for the finished cadmium-plated surface.

After grit blasting, all parts shall be cleared of blasting medium residues, e.g. by blowing with oil free compressed air.

Where wet blasting is used, the part shall be carefully dried after treatment.

12 Treatment

12.1 Suspension and clamping of parts

The parts shall be placed in such a way that a regular deposition is ensured, if necessary by means of appropriate supporting jigs. Attachment magnets may also be used for attachment, but this requires demagnetisation of the parts after the cadmium-plating process. The parts may undergo the treatment several times to ensure a regular coating at the required thickness.

For each batch, the required test samples shall be put in the deposition device at the same time.

12.2 Evacuation of the enclosure (primary vacuum)

Evacuation shall be carried out until a vacuum of at least $1{,}33 \times 10^{-2}$ Pa is obtained.

12.3 Sputter cleaning

Before starting the deposition operation, ionic etching shall be applied with a suitable inert gas (e.g. argon) to obtain a final cleaning of the parts. The part is used as a cathode. The current and etching time shall be selected according to the installation and the geometry of the part in order to ensure optimum cleaning.

12.4 Deposition

Before starting the actual deposition process, the operational vacuum shall be regulated according to the specific characteristics of the part. The deposition times for the required coating thickness shall be determined by preliminary tests.

The deposition’s progress, especially the performance of the rotating system, shall be monitored during the process.

It is permissible to re-load the vaporising dish several times with cadmium to obtain particularly thick layers. However, if the vacuum in the chamber has been disturbed, the vacuum shall be restored to its operational level before any further deposition.

12.5 Flooding, venting

After deposition, clean dry air shall be admitted to the enclosure. The enclosure shall not be opened until the external pressure has been reached and it has been assured that no molten cadmium remains in the vaporising dish.

12.6 Removal

When the enclosure has been opened and during removal, the parts shall not be touched with bare hands. The parts shall only be handled with clean gloves until their final treatment (e.g. chromating, greasing, oiling) is complete. The same standard of hygiene is required for storage surfaces or packaging.

13 Post-treatment

13.1 Chromating

A post-treatment by chromating shall be carried out according to EN 2437 within 8 h following the deposition. If parts are not to be chromated, this shall be indicated in the design documents. The colour is specified according to ISO 4520 — class 2-C.

13.2 Additional protection

The nature and type of any additional protection after cadmium-plating shall be specified in the design document.

14 Removal of the coating

14.1 Chemical process

Defective cadmium coatings shall be chemically removed with a solution which does not attack the basic material (e.g. 100 g/l to 300 g/l ammonium nitrate solution at ambient temperature for approximately 10 min).

The parts are then thoroughly rinsed in clean water and dried.

14.2 Mechanical process

It is preferable to remove the cadmium coating by abrasive blasting, as this method avoids any embrittlement by hydrogen absorption.

Care shall be taken during abrasive blasting so that the part is handled in such a way as to ensure uniform removal.

However, this method shall only be used in self-contained installations.

15 Required characteristics

15.1 Appearance

All the surfaces coated under vacuum shall be of a regular mat appearance, however, a mother-of-pearl type surface is not a cause for rejection.

The cadmium layer shall not have any blisters, pores, cracks, contamination or irregularities.

It shall not have any powdery or dark areas.

15.2 Thickness of the layer

It shall correspond to the indications defined in the design documents.

15.3 Adhesion

The layer of cadmium shall satisfy the adhesion test according to 16.1.3.

15.4 Corrosion resistance

— Cadmium-plated and chromated parts shall not show any white stains of corrosion within 96 h, nor rust within 336 h.

— Non-chromated cadmium-plated parts shall not show signs of rust within 240 h.

16 Inspection

16.1 Inspection of vacuum deposited parts and samples

16.1.1 Appearance

All parts shall be submitted to a visual examination.

16.1.2 Inspection of the thickness of the coating

The thickness of the coating is determined using the following methods:

— magnetic inductance method, see EN ISO 2178[1)]

— microscopic determination, see EN ISO 1463;

— by stripping and weighing, see EN ISO 2082;

— coulometric method by anodic dissolution, see EN ISO 2177.

16.1.3 Adhesion test

For this test and for each batch, at least one test panel shall be vacuum deposited at the same time. The test pieces shall be suspended at a representative place in the vacuum deposition enclosure.

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1) Only for cadmium-plated areas which may be in contact with a 20 mm ball.

The test shall be carried out according to EN 2828 (burnishing test) or to EN ISO 2819 (cross-wire test).

16.1.4 Corrosion test for steel

Corrosion resistance shall be tested according to EN ISO 9227 by a salt spray test using a solution of 5 % sodium chloride.

For this test, pieces with a coating thickness corresponding to class B shall be prepared by vacuum deposition at the same time as the parts at a representative place in the enclosure and shall then be chromated.

Material: test pieces of annealed steel with a carbon content of between 0,1 % and 0,18 % are to be used.

Dimensions of the test pieces: (70 × 150 × 1,0-2,0) mm

NOTE All the edges of the test pieces shall be masked with suitable masking materials after cadmium coating and before exposure to the salt spray.

17 Quality assurance

17.1 Approval of the processor

See EN 9100.

17.2 Process approval

The processor shall carry out:

— the plating on pre-production parts and/or test pieces determined by agreement between the processor and purchaser;

— the tests specified in this standard, unless otherwise agreed between the processor and purchaser.

When the test results have been recognized as satisfactory by the purchaser, he shall give his written approval to start production.

The process schedule shall not be changed without previous agreement from the purchaser.

17.3 Acceptance

During production, parts and/or samples which have been coated under the same conditions as the parts shall undergo testing.

Unless otherwise specified, the whole batch shall be submitted to visual examination (see 15.1).

Unless otherwise specified, adhesion tests (see 16.1.3) are to be carried out at a rate of one part or one sample per batch.

Unless otherwise specified, the thickness of the coating shall be measured (see 16.1.2) by sampling according to EN ISO 2859-1:

— code letter of the sample size, table 1, special inspection level S3;

— single sampling plan for a more thorough examination;

— acceptable quality level (AQL) 1,5.

The frequency and nature of other subsequent tests shall be determined by agreement between the processor and the purchaser.

17.4 Reprocessing

Retouching of parts not meeting the requirements is not permitted.

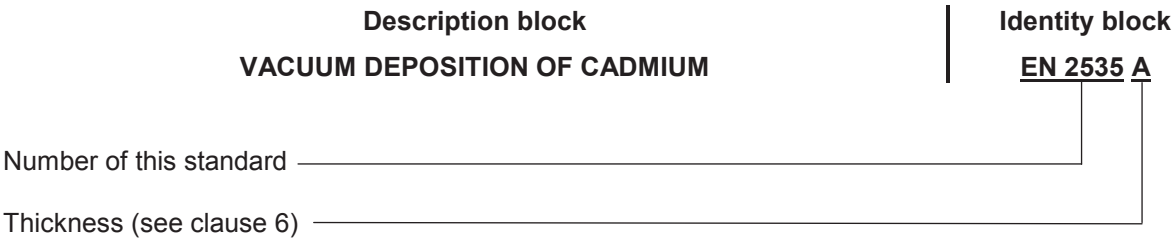
Upon agreement from the purchaser, the parts not meeting the requirements shall be stripped of cadmium (see clause 13) and retreated.

18 Health, safety and environmental aspects

National laws and legal provisions shall be respected.

19 Designation

EXAMPLE



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BSI Group Headquarters

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