



**SLOVENSKI STANDARD**  
**oSIST prEN ISO 4042:2017**  
**01-julij-2017**

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**Mehanski vezni elementi - Sistemi galvanskih prevlek veznih elementov (ISO/DIS 4042:2017)**

Fasteners - Electroplated coating systems (ISO/DIS 4042:2017)

Verbindungselemente - Galvanisch aufgebrachte Überzugssysteme (ISO/DIS 4042:2017)

Fixations - Systèmes de revêtements électrolytiques (ISO/DIS 4042:2017)

**Ta slovenski standard je istoveten z: prEN ISO 4042**

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**ICS:**

21.060.01	Vezni elementi na splošno	Fasteners in general
25.220.40	Kovinske prevleke	Metallic coatings

**oSIST prEN ISO 4042:2017**

**en,fr,de**



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## Fasteners — Electroplated coating systems

*Fixations — Systèmes de revêtements électrolytiques*

ICS: 21.060.01

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<b>Contents</b>	<b>Page</b>
<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>vi</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>2</b>
<b>3 Terms and definitions</b> .....	<b>3</b>
<b>4 General characteristics of the coating</b> .....	<b>4</b>
<b>5 Corrosion protection and testing</b> .....	<b>10</b>
<b>6 Dimensional requirements and testing</b> .....	<b>13</b>
<b>7 Mechanical and physical properties and testing</b> .....	<b>18</b>
<b>8 Applicability of tests</b> .....	<b>19</b>
<b>9 Designation system</b> .....	<b>19</b>
<b>10 Ordering requirements for electroplating</b> .....	<b>24</b>
<b>11 Storage conditions</b> .....	<b>24</b>
<b>Annex A (informative) Design aspects and assembly of coated fasteners</b> .....	<b>25</b>
<b>Annex B (informative) Hydrogen embrittlement consideration</b> .....	<b>33</b>
<b>Annex C (informative) Corrosion protection related to chromate conversion coatings</b> .....	<b>38</b>
<b>Annex D (informative) Coating thickness and thread clearance for ISO metric screw threads</b> .....	<b>39</b>
<b>Annex E (informative) Coating systems tested in accordance with ISO 9227, NSS — Evaluation of cabinet corrosivity for the neutral salt spray test</b> .....	<b>47</b>
<b>E.1 Introduction</b> .....	<b>47</b>
<b>E.2 Purpose</b> .....	<b>47</b>
<b>E.3 Frequency of controls</b> .....	<b>47</b>
<b>E.4 Operating conditions</b> .....	<b>47</b>
<b>E.5 Corrosivity results</b> .....	<b>53</b>
<b>Annex F (informative) Obsolete designation codes for electroplated coatings on fasteners according to ISO 4042:1999</b> .....	<b>57</b>
<b>Bibliography</b> .....	<b>60</b>

## ISO/DIS 4042:2017(E)

### 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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is ISO/TC 2/SC 14, *Surface coatings*.

This second edition cancels and replaces the first edition (ISO 4042:1999) completely. The main technical changes are the following:

- application to all fasteners, including self-tapping and thread forming screws, washers, rivets, clips, etc.,
- focus on coatings designed for corrosion protection of fasteners,
- application to electroplated coatings with or without additional layers (conversion coating, sealant, top coat, lubricant),
- specification of minimum corrosion resistance (white corrosion and red rust),
- inclusion of up-to-date knowledge about hydrogen embrittlement and prevention measures,
- definitions specified in separate standard ISO 1891-2,
- concerning corrosion tests, inclusion of sulfur dioxide test (Kesternich) and calibration of neutral salt spray test (NSS),

- inclusion of gaugeability and assemblability requirements,
- for thickness determination, addition of adequate test methods and deletion of the batch average thickness,
- new designation system for all coating systems
- specification for mechanical and physical properties and related test methods,
- information about design aspects and assembly of coated fasteners
- information for coating thickness and thread clearance for ISO metric screw threads
- information about evaluation of cabinet corrosivity for the neutral salt spray test

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**ISO/DIS 4042:2017(E)****Introduction**

The revision of this International Standard takes into account new developments related to hexavalent chromium free passivations, application of sealants and top coats, requirements for functional properties as well as results of research work to minimize the risk of hydrogen embrittlement.

Consequently, this standard was completely revised.

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# Fasteners — Electroplated coating systems

## 1 Scope

This International Standard specifies requirements for electroplated coatings and coating systems on steel fasteners. The requirements related to dimensional properties also apply to fasteners made of copper or copper alloys.

This International Standard also specifies requirements and gives recommendations to minimize the risk of hydrogen embrittlement, see 4.4 and Annex B.

This International Standard mainly applies to zinc and zinc alloy coating systems (zinc, zinc-iron, zinc-nickel) and cadmium, primarily intended for corrosion protection and other functional properties:

- with or without conversion coating;
- with or without sealant;
- with or without top coat;
- with or without lubricant (integral lubricant and/or subsequently added lubricant).

Specifications for other electroplated coatings and coating systems (tin, tin-zinc, copper-tin, copper-silver, copper, silver, copper-zinc, nickel, nickel-chromium, copper-nickel, copper-nickel-chromium) are included in this standard only for dimensional requirements related to fasteners with ISO metric threads.

National regulations for the restriction or prohibition of certain chemical elements and compounds shall be taken into account in the countries or regions concerned.

Although other ISO standards specify various electroplating processes, the requirements of this International Standard supersede other ISO standards for electroplating of fasteners, unless otherwise agreed at the time of the order.

This International Standard applies to bolts, screws, studs and nuts with ISO metric thread, to fasteners with non-ISO metric thread, and to non-threaded fasteners such as washers, pins, clips and rivets.

Information for design and assembly of coated fasteners is given in Annex A.

This International Standard does not specify requirements for properties such as weldability or paintability.

**ISO/DIS 4042:2017(E)****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 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

ISO 898-2, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread*

ISO/DIS 898-3, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 3: Washers*

ISO 898-5, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 5: Set screws and similar threaded fasteners with specified hardness classes — Coarse thread and fine pitch thread*

ISO 965-1, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data*

ISO 965-2, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads — Medium quality*

ISO 965-3, *ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional screw threads*

ISO 10666, *Drilling screws with tapping screw thread — Mechanical and functional properties*

ISO 1456, *Metallic and other inorganic coatings — Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium*

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

ISO 1502, *ISO general-purpose metric screw threads — Gauges and gauging*

ISO 2081, *Metallic and other inorganic coatings — Electroplated coatings of zinc with supplementary treatments on iron or steel*

ISO 2082, *Metallic and other inorganic coatings — Electroplated coatings of cadmium with supplementary treatments on iron or steel*

ISO 2093, *Electroplated coatings of tin — Specification and test methods*

ISO 2177, *Metallic coatings — Measurement of coating thickness — Coulometric method by anodic dissolution*

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

ISO 2702, *Heat-treated steel tapping screws — Mechanical properties*

ISO 3231, *Paints and varnishes — Determination of resistance to humid atmospheres containing sulfur dioxide*

ISO 3497, *Metallic coatings — Measurement of coating thickness — X-ray spectrometric methods*

ISO 3613:2010, *Metallic and other inorganic coatings — Chromate conversion coatings on zinc, cadmium, aluminium-zinc alloys and zinc-aluminium alloys — Test methods*

ISO 4521, *Metallic and other inorganic coatings — Electrodeposited silver and silver alloy coatings for engineering purposes — Specification and test methods*

ISO 6988, *Metallic and other non organic coatings — Sulfur dioxide test with general condensation of moisture*

ISO 7085, *Mechanische und funktionelle Anforderungen von einsatzgehärteten und angelassenen metrischen gewindefurchenden Schrauben (withdrawn)*

ISO 8991, *Designation system for fasteners*

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

ISO 15726, *Metallic and other inorganic coatings — Electrodeposited zinc alloys with nickel, cobalt or iron*

ISO 16047, *Fasteners — Torque/clamp force testing*

ISO 16228, *Fasteners — Inspection documents*

ISO 19598, *Metallic coatings — Electroplated coatings of zinc and zinc alloys on iron or steel with supplementary Cr(VI)-free treatment*

ISO 21968, *Non-magnetic metallic coatings on metallic and non-metallic basis materials — Measurement of coating thickness — Phase-sensitive eddy-current method*

ASME B18.6.3, *Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)*

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ASTM F1940, *Standard Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners*

DIN 50969-2, *Prevention of hydrogen-induced brittle fracture of high-strength steel building elements — Part 2: Test methods*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1891-2 and the following apply.

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>

#### 3.1

##### reference panel

reference material that is to be exposed to check the corrosivity level of the test cabinet used for fastener testing

## ISO/DIS 4042:2017(E)

## 4 General characteristics of the coating

## 4.1 Coating metals or alloys and main purposes

Electroplated coating systems for steel fasteners are primarily applied for corrosion protection and functional properties, such as torque/clamp force relationship.

In addition, other functional properties or decorative properties can be specified, see Annex A.

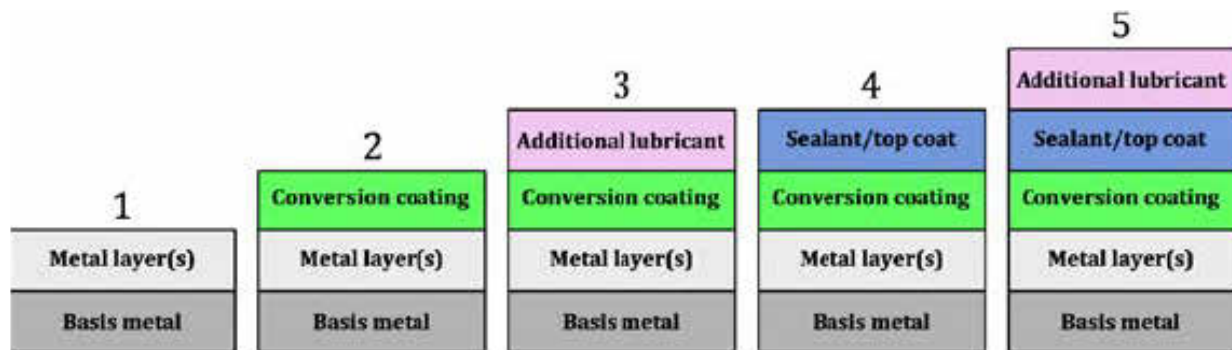
Table 1 shows commonly used electroplated coatings in relation with their main purposes and references to related ISO standards, which give additional general information not covered by this International Standard, e.g. for designation. The requirements of this standard supersede the specifications of ISO standards listed in Table 1 for the purpose of fasteners.

**Table 1 — Electroplated coatings in accordance with their main purposes and related ISO standards**

Symbol	Coating metal(s)		Nature	Main purpose of the coating for fasteners	ISO standard
	Element				
Zn	Zinc		Metal	P / D / F	ISO 2081, ISO 19598
ZnNi	Zinc-nickel		Alloy	P / D / F	ISO 15726, ISO 19598
ZnFe	Zinc-iron		Alloy	P / D / F	ISO 15726, ISO 19598
Cd	Cadmium <sup>a</sup>		Metal	P / F	ISO 2082
Ni	Nickel		Metal	D	ISO 1456
Ni+Cr	Nickel-chromium		Multi-layer	D	ISO 1456
Cu+Ni	Copper-nickel		Multi-layer	D	ISO 1456
Cu+Ni+Cr	Copper-nickel-chromium		Multi-layer	D	ISO 1456
CuZn	Brass		Alloy	D	—
CuSn	Copper-tin (bronze)		Alloy	F	—
Cu	Copper		Metal	F / D	—
Ag	Silver		Metal	F / D	ISO 4521
CuAg	Copper-silver		Alloy	F	—
Sn	Tin		Metal	F	ISO 2093
SnZn	Tin-zinc		Metal	F / P	—
P Corrosion Protection F Functional properties D Decorative properties (colour, aspect)					
<sup>a</sup> Cadmium is restricted or prohibited for many applications (remaining cadmium users are predominantly military and aerospace industries).					

## 4.2 Build-up of basic electroplated coating systems

Figure 1 shows basic electroplated coating systems.



### Key

- 1 only metal layer(s)
- 2 metal layer(s) + conversion coating
- 3 metal layer(s) + conversion coating + additional lubricant
- 4 metal layer(s) + conversion coating + sealant/top coat
- 5 metal layer(s) + conversion coating + sealant/top coat + additional lubricant

**Figure 1 — Basic electroplated coating systems (schematic)**

A conversion coating increases corrosion protection on zinc, zinc alloys and cadmium coatings. It may be a passivation (chromium VI free) or a chromatisation (chromium VI containing). The conversion coating may also provide better adhesion for additional layer(s) and/or additional colour/paint.

An additional sealant/top coat (with or without integral lubricant) may be chosen to increase corrosion resistance and to achieve other specific properties (e.g. torque/clamp force properties, resistance to chemicals, mechanical resistance, aspect, colour, thermal stability, increased electrical resistance, UV radiation resistance). The selection of the nature of a sealant or top coat should be based on desired additional properties.

An additional lubricant may be applied to adjust or amend the torque/clamp force relationship.

## 4.3 Coating systems and coating processes

The type and geometry of the fasteners should be considered when selecting a coating system and the related coating process, see Annex A, as well as hydrogen embrittlement considerations, see Annex B.

The electroplating process shall be under control, in accordance with a recognised standard and/or a specification by agreement with the customer.

## ISO/DIS 4042:2017(E)

## 4.4 Internal hydrogen embrittlement

## 4.4.1 General

In cases of fasteners:

- with high tensile strength or hardness or which have been case-hardened and tempered or cold worked to high hardness, **and**
- which are under tensile stress, **and**
- which have absorbed hydrogen,

there may be a risk of Internal Hydrogen Embrittlement (IHE).

The susceptibility to IHE increases with increasing hardness of the fastener material. Appropriate measures for prevention of IHE for quenched and tempered fasteners depending on hardness are specified in Table 2. For fasteners in accordance with ISO 898-1, ISO 898-2 and ISO 898-3, Tables 3, 4 and 5 apply.

**Table 2 — Measures related to IHE for quenched and tempered fasteners with regard to hardness**

360 HV	390 HV	
A	B	C
No supplemental process verification or product testing with regard to IHE <b>AND</b> No baking necessary	Supplemental process verification and/or product testing with regard to IHE <b>OR</b> Baking <i>(at the choice of the fastener manufacturer)</i>	Supplemental process verification and/or product tests with regard to IHE <b>AND</b> Baking <i>(Baking temperature and duration shall be specified)</i>
See 4.4.2	See 4.4.3 and B.6	See 4.4.4 and B.6

## 4.4.2 Fasteners with hardness below 360 HV

When electroplating fasteners with specified maximum hardness below 360 HV (A in Tables 2, 3, 4 and 5) no supplemental process verification with regard to IHE is necessary.

## 4.4.3 Fasteners with hardness equal to and above 360 HV and up to 390 HV

When electroplating fasteners with specified maximum hardness equal to and above 360 HV and up to and including 390 HV (B in Tables 2, 3, 4 and 5) and provided supplemental process verification and/or product testing with regard to IHE have been performed, baking is not required. In any case the purchaser is free to specify baking.

NOTE Fasteners in this specified hardness range are not normally susceptible to IHE. In case of a failure in a product test, it cannot be assumed that baking the parts would have prevented such failure. In such a case, the metallurgical and physical conditions of the fastener material should be investigated.

#### 4.4.4 Fasteners with hardness above 390 HV

When electroplating fasteners with specified maximum hardness above 390 HV (C in Tables 2, 3 and 5), baking is required; see B.4 for minimum recommended baking temperature and duration.

Following exemptions apply:

- for fasteners which are not specified to be under tensile stress by design or standard (e.g. set screws in accordance with ISO 898-5), baking is not required (see B.2),
- induction hardened ends (e.g. for thread forming screws) shall not be considered for determining measures related to IHE in relation to Table 2, because they are normally not subjected to tensile stress provided that the end protrudes through the mating thread.

For alkaline zinc-nickel electroplating (and nickel content from 12 % to 16 %), it is possible to avoid baking because of low risk of IHE (see B.3). The decision not to carry out baking shall be based on testing (see B.6) and be agreed between the supplier and the purchaser.

NOTE For acid zinc-nickel electroplating, studies have shown similar benefits as for alkaline zinc-nickel electroplating, however more data are necessary with regard to baking avoidance.

**Table 3 — Measures related to IHE for fasteners in accordance with ISO 898-1**

	Property class		
	≤ 9.8	10.9	12.9 and <u>12.9</u>
Bolts, screws, studs in accordance with ISO 898-1			
<b>Measures related to IHE</b>	<b>A</b>	<b>B</b>	<b>C</b>
	No supplemental process verification or product testing with regard to IHE <b>AND</b> No baking necessary	Supplemental process verification and/or product testing with regard to IHE <b>OR</b> Baking	Supplemental process verification and/or product testing with regard to IHE <b>AND</b> Baking <sup>a</sup>
	—	At the choice of the fastener manufacturer	Baking temperature and duration shall be specified (see also B.4)
	See 4.4.2	See 4.4.3 and B.6	See 4.4.4 and B.6
<sup>a</sup> For alkaline zinc-nickel electroplating (and nickel content from 12 % to 16 %), the decision not to carry out baking shall be based on testing (see B.6) and be agreed between the supplier and the purchaser.			