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oSIST prEN ISO 4042 rev:2020

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Vezni elementi - Sistemi galvanskih prevlek veznih elementov (ISO/DIS 4042:2019)

Fasteners - Electroplated coating systems (ISO/DIS 4042: 2019)

Verbindungselemente - Galvanisch aufgebrachte Überzugsysteme (ISO/DIS 4042:2019)

Fixations - Systèmes de revêtements électrolytiques (ISO/DIS 4042: 2019)

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

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ICS:

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

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Fasteners — Electroplated coating systems

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Foreword

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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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This document was prepared by Technical Committee ISO/TC 2, *Fasteners*, Subcommittee SC 14, *Surface coatings*.

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This fourth edition cancels and replaces the third edition (ISO 4042:2018), which has been technically revised. The main changes compared to the previous edition are as follows:

— introduction of a statement in Clause 1 (Scope) that requirements of ISO 4042 for electroplated fasteners supersede other general ISO standards dealing with electroplating;

— extension of the scope to all threaded fasteners;

— all references to ISO 2081 and ISO 19598 removed;

— improvement of the descriptions of the reference test areas (including Figure 2) in 6.4.

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Introduction

ISO 4042:1999 was completely revised to take 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, and the revision was published in 2018.

The last editions of ISO 2081 (2018) as well as ISO 19598 (2016), which are general standards for electroplating, are not adequate to cover the requirements for electroplated fasteners dealt with in ISO 4042, especially with regards to hydrogen embrittlement and baking. Therefore a new revision was necessary to delete all references to these two standards to avoid any contradictions.

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Fasteners — Electroplated coating systems

1 Scope

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

It also specifies requirements and gives recommendations to minimize the risk of hydrogen embrittlement; see 4.4 and Annex B.

It mainly applies to fasteners with zinc and zinc alloy coating systems (zinc, zinc-nickel, zinc-iron) 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).

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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 document only for dimensional requirements related to fasteners with ISO metric threads.

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The requirements of this document for electroplated fasteners supersede other general ISO standards dealing with electroplating.

This document applies to bolts, screws, studs and nuts with ISO metric thread, to other threaded fasteners 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 document does not specify requirements for properties such as weldability or paintability.

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 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 1891-2, *Fasteners — Terminology — Part 2: Vocabulary and definitions for coatings*

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*

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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 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 8991, *Designation system for fasteners*

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

ISO 15330, *Fasteners — Preloading test for the detection of hydrogen embrittlement — Parallel bearing surface method*

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

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

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ISO 16228, *Fasteners — Types of inspection documents*

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)*

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:

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

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

3.1
reference panel
reference material that is to be exposed to check the corrosivity level of the test cabinet used for fastener testing

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.

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Commonly used electroplated coatings for fasteners are given in Table 1 in relation with their main purposes. Additional information, such as designation or decorative aspects, can be found in other relevant ISO standards listed in the last column of Table 1.

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

Coating metal(s)		Nature	Main purpose of the coating for	ISO standard
Symbol	Element			
Zn	Zinc	Metal	P/D/F	—
ZnNi	Zinc-nickel	Alloy	P/D/F	ISO 15726
ZnFe	Zinc-iron	Alloy	P/D/F	ISO 15726
Cd	Cadmium [a]	Metal	P/F	ISO 2082
Ni	Nickel	Metal	D/F	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	Alloy	F/P	—

P corrosion **p**rotection

F **f**unctional properties

D **d**ecorative properties (colour, aspect)

[a] Cadmium is restricted or prohibited for many applications (remaining cadmium users are predominantly military and aerospace industries).

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4.2 Build-up of basic electroplated coating systems

Figure 1 shows basic electroplated coating systems.

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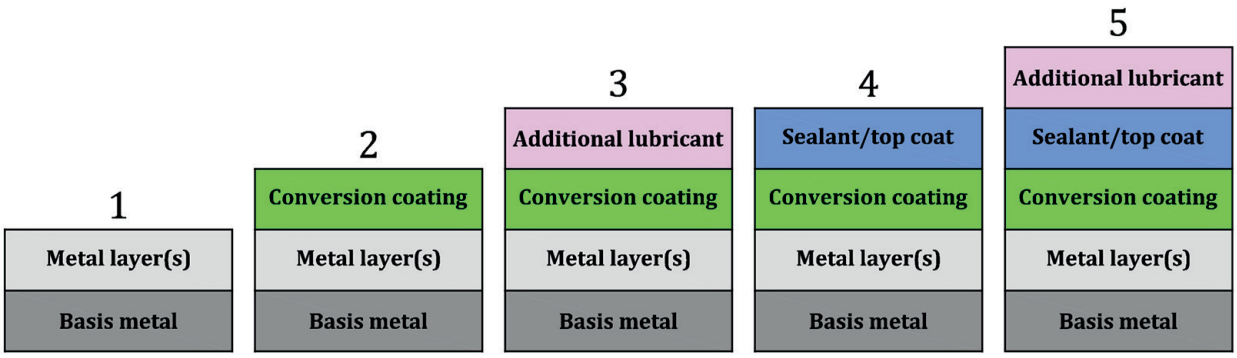

Key

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 chromatation (chromium VI containing). The conversion coating can also provide better adhesion for additional layer(s) and/or additional colour/paint.

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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.

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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 recognized standard and/or a specification by agreement with the customer.

4.4 Internal hydrogen embrittlement

4.4.1 General

If the three following conditions are **concurrently** present for fasteners:

— with high tensile strength or hardness or which have been case-hardened and tempered or cold worked to high hardness,

— which are under tensile stress,

— which have absorbed hydrogen,

there is a risk of Internal Hydrogen Embrittlement (IHE), see annex B.

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

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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 AND No baking necessary	Supplemental process verification and/or product testing with regard to IHE OR Baking (at the choice of the fastener manufacturer)	Supplemental process verification and/or product testing with regard to IHE AND Baking (baking temperature and duration shall be specified)
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 and no baking are necessary.

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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), baking is not required provided supplemental process verification and/or product testing with regard to IHE have been performed. However, the purchaser is free to require baking generally.

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For fasteners in this specified hardness range, electroplating does not pose a risk of IHE. In case of a failure in a product test, it cannot be assumed that baking the parts would have prevented such failure: the metallurgical and physical conditions of the fastener material should be investigated for non-conformances. For more information, see B.4.

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.

The 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 electroplatings (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 electroplatings, studies have shown similar benefits as for alkaline zinc-nickel electroplating, however more data is necessary with regard to baking avoidance.

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4.4.5 Fasteners in accordance with ISO 898-1, ISO 898-2 and ISO 898-3

For fasteners in accordance with ISO 898-1, ISO 898-2 and ISO 898-3, Tables 3, 4 and 5 apply.

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

	Property class		
Bolts, screws and studs in accordance with ISO 898-1	≤ 9.8	10.9	12.9 and 12.9
Measures related to IHE	**A**	**B**	**C**
	No supplemental process verification or product testing with regard to IHE AND No baking necessary	Supplemental process verification and/or product testing with regard to IHE OR Baking	Supplemental process verification and/or product testing with regard to IHE AND Baking a
	—	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
[a] For alkaline zinc-nickel electroplatings (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.			

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Table 4 — Measures related to IHE for nuts in accordance with ISO 898-2

	Property class	
Nuts in accordance with ISO 898-2	**≤ 12**	
	Nuts with specified maximum hardness < 360 HV	Nuts with specified maximum hardness ≥ 360 HV [a]
Measures related to IHE	**A**	**B**
	No supplemental process verification AND No baking necessary	Supplemental process verification with regard to IHE OR Baking
	—	At the choice of the fastener manufacturer
	See 4.4.2	See 4.4.3
[a] Only: — for regular nuts (style 1) with fine pitch thread, property class 10, and — for high nuts (style 2) with fine pitch thread, property class 12, and diameters above 16 mm.		

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Table 5 — Measures related to IHE for flat washers in accordance with ISO 898-3

	Property class		
Flat washers in accordance with ISO 898-3	≤ 200HV	300HV	380HV
Measures related to IHE	**A**	**B**	**C**
	No supplemental process verification AND No baking necessary	Supplemental process verification with regard to IHE OR Baking	Supplemental process verification with regard to IHE AND Baking a
	—	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	See 4.4.4

[a] For alkaline zinc-nickel electroplatings (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.

4.4.6 Baking and test requirements for case-hardened and tempered screws

Case-hardened and tempered fasteners include self-tapping screws (see ISO 2702), thread-forming screws for metallic materials, self-drilling screws (see ISO 10666) and screws for soft materials (e.g. plastic, wood). The surface of these screws is usually intentionally hardened to fulfil their specific functions.

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The susceptibility to IHE of case-hardened and tempered screws depends not only on core hardness; see B.3.

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Requirements for case-hardened and tempered fasteners (except for self-tapping screws and screws for soft materials) are specified in Table 6.

Requirements for self-tapping screws and screws for soft materials are specified in Table 7.

Testing with regard to IHE for case-hardened and tempered screws with core hardness above 370 HV (**C** in Table 6) and for self-tapping screws above 390 HV (**C** in Table 7) shall be performed in accordance with ISO 15330 or ASME B18.6.3.

Table 6 — Measures related to IHE for case-hardened and tempered screws (except self-tapping screws and screws for soft materials)

	Core hardness	
	≤ 370 HV	**> 370 HV**
Measures related to IHE	**B**	**C**
	Supplemental process verification with regard to IHE AND Product testing and/or baking	Supplemental process verification with regard to IHE AND Baking AND Product testing for each manufacturing lot [a]
	At the choice of the fastener manufacturer	Baking temperature and duration shall be specified (see also B.4)

[a] For alkaline zinc-nickel electroplatings (and nickel content from 12 % to 16 %), product testing shall be considered as part of in-process control (not mandatory for each manufacturing lot).

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