

# INTERNATIONAL STANDARD

# ISO 4042

Second edition  
1999-06-15

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## Fasteners — Electroplated coatings

*Éléments de fixation — Revêtements électrolytiques*

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## 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4042 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Subcommittee SC1, *Mechanical properties of fasteners*.

This second edition cancels and replaces the first edition (ISO 4042:1989) which has been technically revised.

Annexes D and E form a normative part of this International Standard. Annexes A, B, C, F and G are for information only.

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# Fasteners — Electroplated coatings

## 1 Scope

This International Standard specifies dimensional requirements for electroplated fasteners of steel or copper alloy. It specifies coating thicknesses and gives recommendations for hydrogen embrittlement relief for fasteners with high tensile strength or hardness and for surface-hardened fasteners.

This International Standard primarily concerns the electroplating of threaded fasteners, but it may also be applied to other threaded parts. For the applicability to screws that cut or form their own mating threads, see clause 8.

The specifications given in this International Standard may also be applied to non-threaded parts such as washers and pins.

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## 2 Normative references

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The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 965-1:1999, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data.*

ISO 965-2:1999, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose bolt and nut threads — Medium quality.*

ISO 965-3:1999, *ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional threads.*

ISO 1456:1988, *Metallic coatings — Electrodeposited coatings of nickel plus chromium and of copper plus nickel plus chromium.*

ISO 1458:1988, *Metallic coating — Electrodeposited coatings of nickel.*

ISO 1502:1996, *ISO general purpose metric screw threads — Gauges and gauging.*

ISO 2064:1996, *Metallic and other non-organic coatings — Definitions and conventions concerning the measurement of thickness.*

ISO 2081:1986, *Metallic coatings — Electroplated coatings of zinc on iron or steel.*

ISO 2082:1986, *Metallic coatings — Electroplated coatings of cadmium on iron or steel.*

ISO 3269:—<sup>1)</sup>, *Fasteners — Acceptance inspection.*

ISO 4520:1981, *Chromate conversion coatings on electroplated zinc and cadmium coatings.*

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests.*

ISO 9587:—<sup>2)</sup>, *Metallic and other inorganic coatings — Pre-treatments of iron or steel for reducing the risk of hydrogen embrittlement.*

ISO 15330:—<sup>2)</sup>, *Fasteners — Preloading test for the detection of hydrogen embrittlement — Parallel bearing surface method.*

### 3 Terms and definitions

For the purposes of this International Standard, the definitions given in ISO 2064 (in particular, the definitions of significant surface, measuring area, local thickness and minimum local thickness) and ISO 3269 together with the following, apply.

#### 3.1

##### **batch**

quantity of identical fasteners from the same manufacturing lot processed together at one time

#### 3.2

##### **production run**

those batches of parts processed continuously without any changes in coating techniques or constituents

#### 3.3

##### **batch average thickness**

calculated average thickness of a coating if it was uniformly distributed over the surface of the parts of the batch

#### 3.4

##### **baking**

process of heating parts for a definite time at a given temperature in order to minimize the risk of hydrogen embrittlement

#### 3.5

##### **baking duration**

time at which the parts are held at the specified temperature which they shall have completely reached

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<sup>1)</sup> To be published. (Revision of ISO 3269:1988)

<sup>2)</sup> To be published.

## 4 Dimensional requirements and gauging

### 4.1 Dimensional requirements before electroplating

Before coating, parts shall comply with the relevant International Standards if applicable or other standards as specified, except where threads or other features are specifically manufactured to allow, for functional reasons, the application of thicker coatings than are possible on normal threads.

Coating thicknesses which can be applied on ISO metric threads in accordance with ISO 965-1, ISO 965-2 and ISO 965-3 depend on the fundamental deviation available, which itself depends on the screw thread and the following tolerance positions:

- g, f, e for external threads;
- G for internal threads or H if required.

The tolerance positions apply prior to application of the electroplated coating.

### 4.2 Dimensional requirements after electroplating

After coating, ISO metric screw threads shall be gauged in accordance with ISO 1502 with a GO gauge of tolerance position h for external threads and H for internal threads.

Other product dimensions apply only before coating.

NOTE Care should be exercised where relatively thick coatings may affect dimensions with small tolerances as in the case of internal drives; in these cases an agreement should be made between the supplier and the purchaser.

The applicability of the recommended coatings to ISO metric threads is limited by the fundamental deviation of the threads concerned and hence, by the pitch and tolerance positions. The coating shall not cause the zero line (basic size) to be exceeded in the case of external threads, nor shall it fall below this line in the case of internal threads. This means that for an internal thread of tolerance position H, a measurable coating thickness can only be applied to the threads if the tolerance zone is not taken up to the zero line (basic size).

## 5 Other coating requirements

The electroplated coating shall comply with the provisions of the relevant International Standards (ISO 1456, ISO 1458, ISO 2081, ISO 2082) for the coating concerned in respect of appearance, adhesion, ductility, corrosion resistance, etc.

## 6 Hydrogen embrittlement relief

In cases of parts

- with high tensile strength or hardness or which have been surface hardened,
- which have absorbed hydrogen and
- are under tensile stress

there is the risk of failure due to hydrogen embrittlement.

When the core or surface hardness is above 320 HV, process investigation shall be conducted using a test to detect hydrogen embrittlement, for example the "Parallel bearing surface method" in accordance with ISO 15330, to be sure that the process with regard to embrittlement is under control. If embrittlement is discovered, modification of the manufacturing process will be necessary, such as the inclusion of a baking process (see informative annex A for more information).

For fasteners of hardness in excess of 365 HV, a written agreement should exist between the customer and manufacturer to define how to manage the risk. If written agreement does not exist, the manufacturer shall process the parts in accordance with his recommended practices to reduce the risk of hydrogen embrittlement.

**Complete elimination of hydrogen embrittlement cannot be assured. If a reduced probability of encountering hydrogen embrittlement is desired, alternative procedures should be evaluated.**

NOTE Investigations are proceeding to develop methods for the reduction of hydrogen embrittlement.

## 7 Corrosion protection

The corrosion protection of an electroplated coating depends to a considerable extent on its thickness. In addition to greater coating thickness, a chromate conversion treatment can be specified for increased corrosion protection on zinc and cadmium coatings.

Contact with other metals and materials, the frequency and duration of wetting and service temperatures may influence the protective performance of coatings and expert advice is essential when uncertainties of choice arise.

Coatings of Zn and Cd applied to ferrous substrates are less electropositive than the steel base metal and consequently provide cathodic protection. In contrast, Ni and Cr coatings are more electropositive than the steel base metal and may intensify part corrosion where the coating is damaged or pitted.

Cadmium coatings are dealt with in ISO 2082.

Zinc coatings are dealt with in ISO 2081.

Nickel coatings are dealt with in ISO 1458.

Nickel + chromium and copper + nickel + chromium coatings are dealt with in ISO 1456.

Chromate conversion treatments are dealt with in ISO 4520.

NOTE Information on salt spray corrosion protection performance of metallic coatings is given in informative annex B.

## 8 Applicability to fasteners that cut or form their own mating threads

All recommended coatings may be applied to screws that cut or form their own mating threads such as wood screws, self tapping screws, self drilling screws and thread forming screws. The maximum value for batch average thickness given in Table 1 may be ignored unless otherwise specified.

## 9 Specification of coating thickness

The local and batch average thicknesses corresponding to the nominal coating thicknesses recommended in the relevant International Standards for electroplating are given in Table 1.

In order to reduce the risk of interference on assembly of threads with electroplated coatings, the coating thickness shall not exceed one-quarter of the fundamental deviation of the thread. These values are specified in Table 2.

NOTE For accommodation of thick coatings guidance is given in informative annex C.

The effective coating thicknesses measured according to one of the methods specified in clause 10 shall comply with the values specified in Table 1.



Table 1 — Coating thicknesses

Thicknesses in micrometres

Nominal coating thickness	Effective coating thickness		
	Local <sup>a</sup> min.	Batch average <sup>b</sup> min.                      max.	
3	3	3	5
5	5	4	6
8	8	7	10
10	10	9	12
12	12	11	15
15	15	14	18
20	20	18	23
25	25	23	28
30	30	27	35

<sup>a</sup> For measuring local thickness see 10.1.  
<sup>b</sup> For measuring batch average thickness see 10.2.

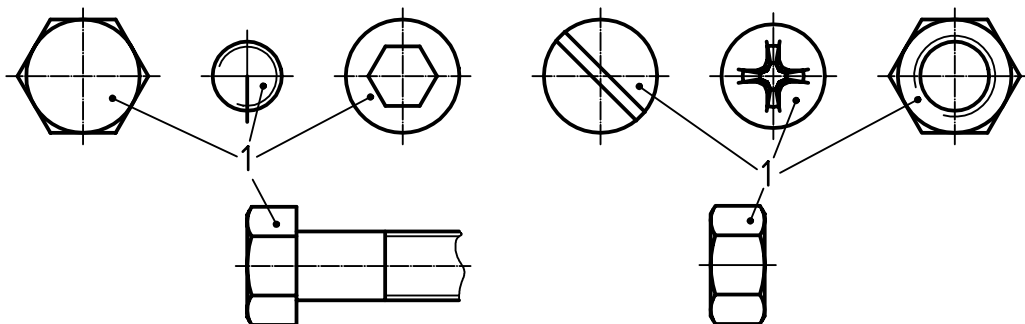
In the case of batch average thickness measurement and if the threaded parts have nominal lengths  $l > 5d$ , smaller nominal thicknesses than those specified in Table 1 shall be applied, see Table 2.

## 10 Measurement of coating thickness ISO 4042:1999

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### 10.1 Local thickness

The local thickness shall be not less than the minimum thickness specified in the order, and shall be measured using one of the methods specified in the International Standard for the coating being applied. Thicknesses on bolts, screws and nuts shall only be measured on the test surfaces shown in Figure 1.



#### Key

1 Measurement area

Figure 1 — Measuring area for local coating thickness measurement on fasteners

Table 2 — Upper limits of coating thicknesses for ISO metric threads

Pitch <i>P</i> mm	Nominal diameter for coarse pitch thread <sup>a</sup> <i>d</i> mm	Internal thread						External thread										
		Tolerance position G			Tolerance position g			Tolerance position f			Tolerance position e							
		Funda- mental deviation	Coating thickness max.	Funda- mental deviation	b	c	Funda- mental deviation	b	c	Funda- mental deviation	b	c	Coating thickness max.	b	c			
		μm	μm	μm	All nominal lengths	Nominal length, <i>l</i> μm	μm	All nominal lengths	Nominal length, <i>l</i> μm	μm	Funda- mental deviation	All nominal lengths	Nominal length, <i>l</i> μm	μm	Funda- mental deviation	All nominal lengths	Nominal length, <i>l</i> μm	μm
0,2		+17	3	-17	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0,25	1; 1,2	+18	3	-18	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0,3	1,4	+18	3	-18	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0,35	1,6 (1,8)	+19	3	-19	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0,4	2	+19	3	-19	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0,45	2,5 (2,2)	+20	5	-20	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0,5	3	+20	5	-20	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0,6	3,5	+21	5	-21	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0,7	4	+22	5	-22	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0,75	4,5	+22	5	-22	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0,8	5	+24	5	-24	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1	6 (7)	+26	5	-26	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1,25	8	+28	5	-28	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1,5	10	+32	8	-32	8	8	8	8	8	8	8	8	8	8	8	8	8	8
1,75	12	+34	8	-34	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2	16 (14)	+38	8	-38	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2,5	20 (18; 22)	+42	10	-42	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3	24 (27)	+48	12	-48	12	12	12	12	12	12	12	12	12	12	12	12	12	12
3,5	30 (33)	+53	12	-53	12	12	12	12	12	12	12	12	12	12	12	12	12	12
4	36 (39)	+60	15	-60	15	15	15	15	15	15	15	15	15	15	15	15	15	15
4,5	42 (45)	+63	15	-63	15	15	15	15	15	15	15	15	15	15	15	15	15	15
5	48 (52)	+71	15	-71	15	15	15	15	15	15	15	15	15	15	15	15	15	15
5,5	56 (60)	+75	15	-75	15	15	15	15	15	15	15	15	15	15	15	15	15	15
6	64	+80	20	-80	20	20	20	20	20	20	20	20	20	20	20	20	20	20

NOTE Additional fundamental deviations for threads which can be specially manufactured to accommodate thick coatings are given in Table C.1.

<sup>a</sup> Information for coarse pitch threads is given for convenience only. The determining characteristic is the thread pitch.

<sup>b</sup> Maximum values of coating thickness if local thickness measurement is agreed.

<sup>c</sup> Maximum values of coating thickness if batch average thickness measurement is agreed.

## 10.2 Batch average thickness

Batch average thickness shall be measured by the method described in normative annex D. Exceeding the maximum batch average thickness shall not cause rejection if the coated thread is accepted by an appropriate GO gauge (H or h).

## 10.3 Agreement on test method

Unless otherwise specified, local thickness shall be measured.

NOTE Most screws and bolts are electroplated in bulk in barrels and as a consequence the greatest coating thickness is always at both extremities of the parts. This effect is increased the longer the screw or bolt is in relation to its diameter and tends to reduce the coating thickness that can be accepted by a specified pitch size.

## 11 Sampling for thickness tests

Sampling for thickness measurement shall be carried out in accordance with the requirements of ISO 3269.

## 12 Ordering requirements for electroplating

When ordering threaded components to be electroplated in accordance with this International Standard, the following information shall be supplied to the electroplater:

- a) The coating designation and, if required, the International Standard for the desired coating.
- b) The material of the part and its condition, e.g. heat treatment, hardness or other properties, which may be affected by the coating process.
- c) The stress relieving conditions, if any, for stress relieving prior to electroplating.
- d) The requirement, if any, for precautions to be taken against the risk of hydrogen embrittlement (see clause 6).
- e) Preference, if any, for batch average thickness measurement (see clause 10).
- f) Any requirement for selective electroplating or reduction of thread dimensions.
- g) Reference to the brightness or dullness; unless otherwise specified, bright finish shall be supplied.
- h) Supplementary coating requirements, for example subsequent lubrication.

## 13 Designation

Fasteners shall be specified according to the appropriate product standards. The designation of the surface coating shall be added to the product designation according to the specification of ISO 8991<sup>[1]</sup> and shall be in accordance with

- System A: see code system in normative annex E or
- System B: see coating classification code described in ISO 1456 (nickel-chromium and copper-nickel-chromium), ISO 2081 (zinc), ISO 2082 (cadmium) and ISO 4520 (chromate conversion coatings).

For examples of coating designations, see informative annex F.