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Metallic and other inorganic coatings — Test method for the friction coefficient measurement of chemical conversion coatings

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Foreword

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This document was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 8, *Chemical conversion coatings*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The forming properties of sheet metals are highly dependent on the friction that is generated with the dies during the forming process.

Therefore, there is a need to measure the frictional characteristics of the surface of sheet metals.

The measured friction coefficient can change depending on the test conditions and the apparatus status. Moreover, if the apparatus has not been configured properly, it is difficult to ensure reliability and reproducibility. Many traditional methods cause deformation or breakage of the test pieces because of the pressure of the friction block (and its perpendicular pressure to the specimens). In addition, there is no International Standard for metallic coatings, other inorganic coatings and chemical conversion coatings.

This document gives an advanced method that can accurately measure the friction coefficient without deformation of the test pieces during the test.

The test results can vary depending on the test conditions, e.g. surface state, normal force, sliding velocity, temperature. Therefore, it is important that the test conditions are specified.

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Metallic and other inorganic coatings — Test method for the friction coefficient measurement of chemical conversion coatings

1 Scope

This document specifies a test method to measure the friction coefficient of chemical conversion coating sheet products and coiled products.

This document is applicable to measure or compare the friction properties of hot-dip galvanized, lubricated and resin coated steel sheet, when tested under the same conditions.

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 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 27831-1, *Metallic and other inorganic coatings — Cleaning and preparation of metal surfaces — Part 1: Ferrous metals and alloys*

IEC 60648, *Method of test for coefficients of friction of plastic film and sheeting for use as electrical insulation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 377, IEC 60648 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
friction
resisting force that arises when a surface of one substance slides, or tends to slide, over an adjoining surface of itself or another substance

Note 1 to entry: Between surfaces of solids in contact there may be two kinds of friction.

3.2
sliding coefficient of friction
μ_k
resistance that opposes the force required to move one surface over another at a variable, fixed or predetermined speed

3.3
test piece
part of a sample or rough specimen, with specified dimensions, machined or un-machined, brought to a required condition for submission to a given verification test

4 Apparatus

Use a sled type tester consisting of the following apparatus, as shown in Figure 1.

4.1 Table, located over the sled so that the test piece can be moved in both a horizontal and vertical direction.

4.2 Sled, a device for moving the table in a horizontal direction.

4.3 Clamp, a device for fixing the test piece in a longitudinal direction.

4.4 Stopper, a device for fixing the test piece in a width direction.

4.5 Test piece holder, a place for putting the test piece.

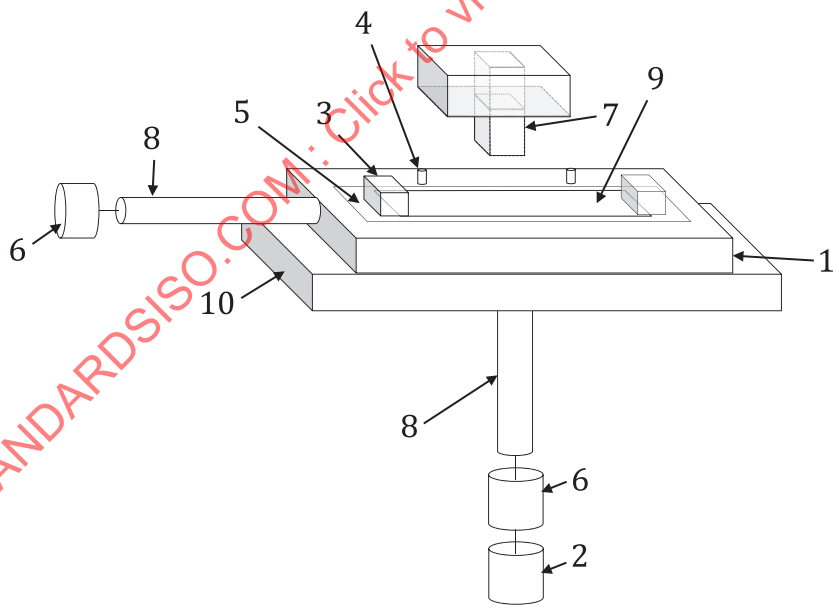
4.6 Friction block, which is perpendicularly positioned for pressing the test piece. It has a curvature at the edge to prevent tilting when the test piece moves.

4.7 Load cell.

4.8 Pressure device, a device that gives a load perpendicular to the specimen.

4.9 Horizontal driving device, which controls the sliding speed for the friction test.

4.10 Vertical driving device, which moves the sled delivery system in a vertical direction.



Key

1	table	6	load cell
2	pressure device	7	friction block
3	clamp	8	driving device
4	stopper	9	test piece
5	test piece holder	10	sled

Figure 1 — Apparatus

5 Test piece

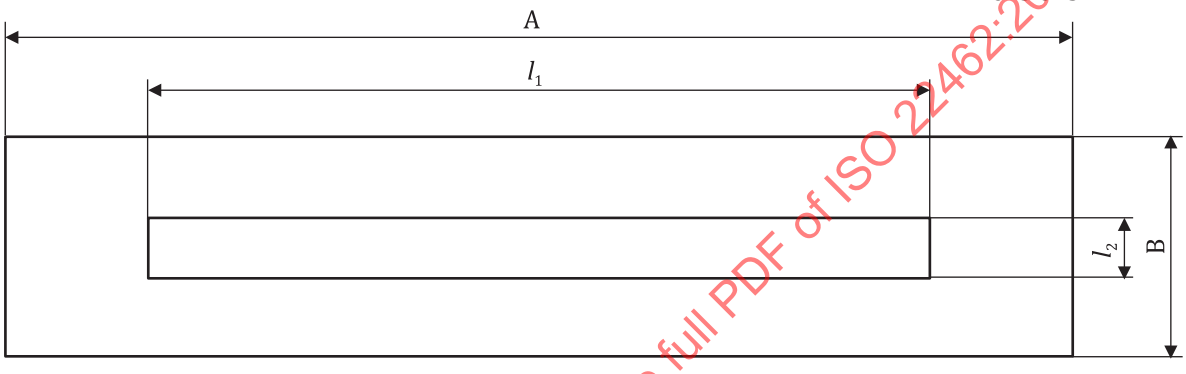
5.1 Dimensions of the test piece

The test piece should be cut from the sample in a transverse or longitudinal direction. In general, the test is carried out in a transverse direction. The test direction information shall be provided.

The shape and dimensions of the test piece shall be in accordance with Figure 2.

If a test piece is short, it cannot have enough travel distance to get a friction coefficient within allowable error limits during the test. A friction coefficient is changed by travel distance. The travel distance has to be specified.

Dimensions in millimetres



l_1	l_2
100	10

Key

A test piece width
B test piece length
l_1 travel distance
l_2 friction block width

Figure 2 — Test piece

5.2 Preparations

Before testing, the test pieces shall be prepared in accordance with ISO 27831-1.

Contaminants on the surface of the test pieces shall be eliminated.

When a load is applied to the test pieces, the load shall be checked with sensitive paper to verify the uniform load. If the load isn't applied to the constant area equally, uncertainty of the test results can be increased.

6 Test conditions

6.1 General

Conduct the tests at (23 ± 10) °C and (50 ± 10) % relative humidity. Follow the temperature and humidity guidelines of the mechanical test.

6.2 Test parameters

6.2.1 Normal load: the load value of Newtons at the friction test contact. The load is maintained constantly during the friction test and is set to 300 N or 600 N or 1 800 N. It is recommended to restrict the normal load according to the strength of the test pieces to prevent deformation of the test pieces.

6.2.2 Sliding velocity: the relative sliding speed between the contacting surfaces in metres per minute. It affects the temperature and lubricant behaviour during tests. The sliding velocity is set to 0,2 metres per minute.

6.2.3 Travel distance, in metres. The travel distance used in a friction test should be adequate to ensure equilibrium friction conditions. If the frictional force continuously increases or decreases during the test, it means that a longer travel distance is needed.

6.2.4 Friction block material. The roughness and hardness of the friction block shall be defined. These aspects affect the contact area under the same normal force and flow of the lubricant during tests.

6.2.5 Contact area, which shall always be set the same in order to maintain the same contact pressure under the same normal force.

NOTE 1 The scatter of results can increase when the contact area is decreased or the travel distance is shortened.

NOTE 2 In general, the more the contact area of friction block is decreased, the more the scatter of the normal load is increased, which is caused by the variation of the contact area.

7 Test procedure

Cut the material to the specified size for the test.

Before the test, clean the test pieces and the friction block with a proper solvent and dry them at room temperature. Using this process, all dirt and foreign matter are removed. An alkaline solution shall not be performed during the treatment process because chemical conversion coatings can be broken down by alkali. After cleaning, spread a few drops of lubricant on the surface of the test pieces and then wipe them with a clean cloth.

Set the speed and normal force to desirable values. The testing table moves in longitudinal and transverse directions when the test starts. Therefore, it is recommended to check whether the test table is in the correct position. Place and fix the test pieces on the test piece holder. The test piece holder is necessary to support and fix the test piece at a designated position during the test. It is essential to keep a flat surface to apply the load uniformly. To ensure test reliability, there should be no gap between the test piece holder and the test piece. Check whether the necessary contact condition is satisfied between the test piece and the friction block.

Begin testing when a normal force is applied on the test pieces and a desired load is reached. The normal force shall be maintained constantly during the test duration. The travel distance should be secured.

After each test, remove the test pieces and clean off any loose wear debris on the friction block. Record the normal force and friction force during travelling. Calculate the sliding coefficient of friction, μ_k, as shown by Formula (1). The ratio of friction force to normal force between two bodies in contact.

$$\mu_k = F/N \tag{1}$$

where

F is the friction force, in N;

N is the normal force, in N.

Repeat the test at least five times under the same test conditions. Under each condition, the result of the first test should be excluded from the average.

There will be rolling friction between the table and the sled. To minimize rolling friction, it is required to apply oil periodically. After the test, check the rolling friction through the data output device.

Unless specified otherwise, the conditions shall be as shown in Table 1.

Table 1 — Test conditions

Parameters	Test conditions
Normal force	300 N, 600 N, 1 800 N
Contact area	30 mm^2 w 10 mm × D 3 mm
Sliding velocity	0,2 m/min
Travel distance	0,1 m
Friction block material	X153CrMoV12[a]
Friction block roughness	Ra 0,1 µm
Coating type of friction block	CrN
Type of lubricant	Base oil[b]
Lubricant viscosity	Outer panel: 2,7 mm^2/s, 40 °C Inner panel: 14,0 mm^2/s, 40 °C
Amount of oiling	2 000 mg/m^2
Temperature	(23 ± 10) °C
Relative humidity	(50 ± 10) %

[a] The conversion standards for relative X153CrMoV12 are D2, SKD11, STD11, etc. X153CrMoV12 is referenced in ISO 4597.

[b] Typical lubricant products for steel sheets are Quaker Houghton's Ferrocote 6130, Fuchs' Anticorit PL 3802-39 S, Fuchs' Anticorit RP 4107 S, Buhmwoo's BW-70PS or 80HG, Houghton's Tectyl RP 955 or RP-953EG, etc. These are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

The amount of lubricant varies depending on the number of wipes. In cases where the amount of lubricant varies, the amount of lubricant shall be measured before the test.

8 Test report

The test report shall contain the following information:

a) the International Standard used (including its year of publication);

b) detailed information about the test conditions, including the sliding velocity, travel distance, sliding direction, normal load, contact area, properties of friction block (e.g. material, roughness, hardness), lubricant viscosity, the spread amount of oiling, the product name of the lubricant and the coating properties of the test pieces;

c) the relative humidity and temperature;

d) the number of times the test was repeated;

e) the results of the tests, including the determination value and the mean value of all the tests;