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**Test method for resistance of anodic
oxidation coatings on aluminium and
aluminium alloys to cracking by
deformation**

ICS 25.220.40; 77.120.10

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aluminium alloys, light alloys, non-ferrous alloys

Reference number : JIS H 8684 : 1997 (E)

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In the event of any doubts arising as to the contents,
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Test method for resistance of anodic oxidation coatings on aluminium and aluminium alloys to cracking by deformation

Introduction This Japanese Industrial Standard has been prepared on the basis of the 1st edition of **ISO 3211**, *Anodizing of aluminium and its alloys—Assessment of resistance of anodic oxide coatings to cracking by deformation* published in 1977 without any modification in technical contents.

1 Scope This Japanese Industrial Standard specifies the test method for the resistance of anodic oxidation coatings (hereafter referred to as “coatings”) to cracking by deformation which the coatings on the products of aluminium and aluminium alloys (hereafter referred to as “products”) may undergo.

Remarks 1 The normative reference to this Standard is as follows.

JIS H 0201 *Glossary of terms used in the surface treatment of aluminium*

2 The International Standard corresponding to this Standard is as follows.

ISO 3211:1977 *Anodizing of aluminium and its alloys—Assessment of resistance of anodic oxide coatings to cracking by deformation*

2 Definition The definition of main terms used in this Standard shall be as follows in addition to those defined in **JIS H 0201**.

elongation percentage Elongation of coatings at the position of cracking by bending of test piece. The higher percentage elongation stands for the better performance of resistance to cracking.

3 Test Method

3.1 Overview In this method, clamp one end of the test piece with a clamping screw on the apparatus shown in Attached Fig. 1, bend the test piece along a spiral strip, read the index corresponding to the region where the first cracks appear in the coating, and determine the percentage elongation of the test piece.

3.2 Instrument The instrument consists of a spiral strip graduated in indexes (¹), a mount and clamping screws (²).

The radius of curvature at each index show in Table 1 shall be obtained by the following formula.

Notes (¹) A spiral strip, graduated in indexes, made of metal such as stainless steel shall be provided with a smooth and continuous curvature surface.

(²) Clamping screws are fitted with each side adjacent to indexes 1 and 18 on the spiral strip. Hard rubber or the like is used on the surface that remains in contact with the test piece.

$$R = 210 - 10E$$

where R : radius of curvature (mm)

E : index

Table 1 Index and radius of curvature

Index (E)	Radius of curvature (R) mm	Index (E)	Radius of curvature (R) mm
1	200	10	110
2	190	11	100
3	180	12	90
4	170	13	80
5	160	14	70
6	150	15	60
7	140	16	50
8	130	17	40
9	120	18	30

3.3 Test piece The test piece shall be as follows:

- (1) **Sampling portion** The test piece shall be taken from the significant surface of products ⁽³⁾. When some product is not suitable for the test, the test may be performed by a substitute test piece. In this case, the substitute shall be representative of the product. Raw material ⁽⁴⁾ and coating treatment conditions ⁽⁵⁾ for the substitute shall be equal to those for the product.
- (2) **Shape** The dimensions of the test piece shall be about 250 mm multiplied by 20 mm.
Thickness of the evenly flat test piece shall be not more than 5 mm ⁽⁶⁾.
- (3) **Treatment before Test** The test piece shall be cleaned, depending upon its contamination, with a fresh and soft cloth immersed with appropriate solvent ⁽⁷⁾.

Notes ⁽³⁾ Test pieces should not have any cracks on surface.

⁽⁴⁾ The composition of raw material, manufacturing conditions (class and temper grade of material), and surface condition before treatment shall, as a rule, be the same as those of the products.

⁽⁵⁾ For the reflection of operational effects on the test piece, pretreatment, and treatment of the coatings shall be performed together with the products using the same bath and under the same conditions.

⁽⁶⁾ Although the thickness of test piece fulfills the requirements, in the case where the thickness of the test piece is remarkably thin, no cracks may occur, and, in the case where it is remarkably thick, cracks occur whole surface of the test piece. It is not possible to obtain the elongation percentage in such condition.

- (⁷) It includes acetone, ethyl alcohol, ethyl ether, methyl ethyl ketone, etc. Such solvents that may corrode the test piece and form protective film shall not be used.

3.4 Operation Operation shall be carried out in the sequence described below.

- (1) Clamp one end of the test piece with either (⁸) of the clamping screws on both ends of the apparatus with the significant surface outward.

Note (⁸) In the case of the test being carried out by clamping the test piece with the clamping screw adjacent to index 1, if the test piece falls out of a spiral strip prior to the appearance of cracks, clamp the test piece with the clamp screw adjacent to index 18.

- (2) Bend the test piece progressively over the spiral strip in such a way that the test piece remains in contact with the spiral stripe.
- (3) Mark the region where the first cracks appear in the coatings. Reset the test piece on the instrument and record the index corresponding to the region where the first existence of cracks viewing from index 1. If the cracks are difficult to detect, the bent test piece should be immersed in the solution of copper sulphate given in Table 2.

Table 2 Composition of immersion solution and immersion condition

Item		Conditions
Composition	Copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)	20 g
	Hydrochloric acid (density: 1.18 g/ml)	20 ml
	Deionized water	1 000 ml
Temperature of solution		20 °C
Immersion time		5 min

3.5 Assessment Assess the appearance of cracks on the coating visually and take the reading on the index to one place of decimal.

The resistance to cracking shall be assessed by the elongation percentage A obtained from following formula. In the case where thickness of all test pieces is equal, the resistance to cracking may be assessed by the radius of curvature R .

$$A = \frac{100a}{2R + a}$$

where A : percentage elongation (%)
 a : thickness of test piece (mm)
 R : radius of curvature (mm)

3.6 Record The following items shall be recorded:

- (1) Percentage elongation or radius of curvature
- (2) Class and temper grade of raw material of product
- (3) Thickness of test piece and thickness of coating

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(4) Rolling or extruding direction of test piece

Informative reference: Example of record

(1) Percentage elongation: 0.50 (radius of curvature: 198 mm)

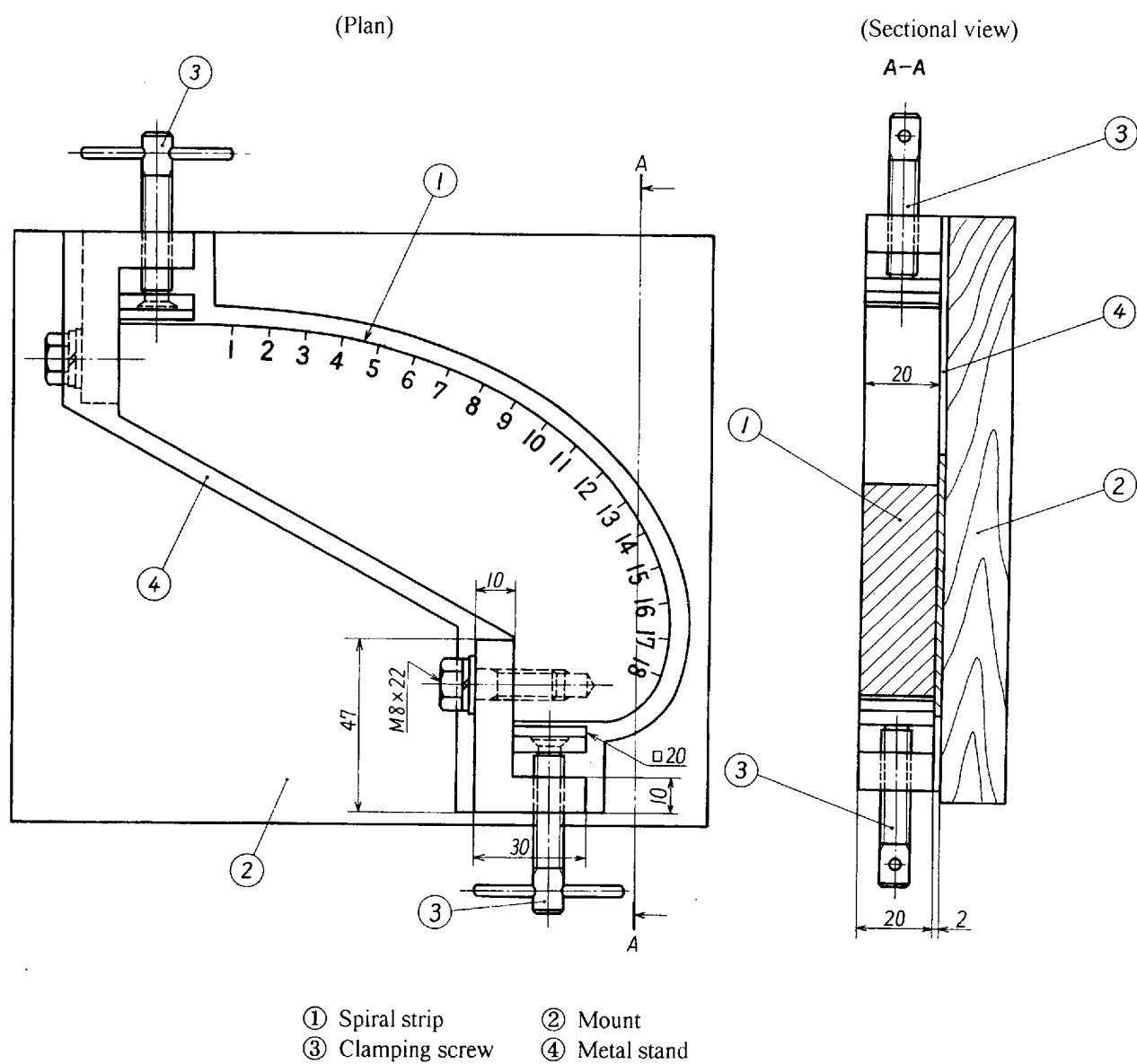
(2) Raw material: A1100P—H14

(3) Thickness of test piece: 2 mm

Thickness of coating: 3 μm

(4) Rolling or extruding direction of test piece: Parallel

Unit: mm



Attached Fig. 1 Measuring instrument for resistance to cracking

Reference

(This table does not constitute provisions of JIS H 8684 : 1997.)

Comparison of JIS and corresponding ISO

JIS number and title		ISO number and title			
JIS H 8684	<i>Test method for resistance of anodic oxidation coatings on aluminium and aluminium alloys to cracking by deformation</i>	ISO 3211:1977 <i>Anodizing of aluminium and its alloys -- Assessment of resistance of anodic oxide coatings to cracking by deformation</i>			
Comparison item	(I) Content specified in JIS	(II) ISO number	(III) Content specified in ISO	(IV) Difference between JIS and ISO	(V) Reason why the conformity between JIS and ISO is difficult and measures to be taken in future.
Specification item					
(1) Scope	○ Anodic oxidation coatings	ISO 3211:1977	○ Applies to thin coatings (less than 5 μm in thickness)	=	As it is revealed that coatings of 5 μm or more in thickness is also applicable according to the purpose of use, and assessment can also be made by confirmation test, a proposal to ISO is under consideration.
(2) Test method	○		○ Same as JIS	=	
• Instrument	• Obtain the radius of curvature at each index. $R=210-10E$ R : radius of curvature E : index				
• Dimension of test piece	250 mm × 20 mm Maximum thickness 5 mm		• Same as JIS	=	Unit of measurement used in ISO is cm. JIS is mm. It is described in the note of JIS that cracks shall not appear on test piece during sampling.
(3) Operation	○		○	=	
	• Clamp the test piece with either of clamping screws on both ends of apparatus with significant surface outward.		• Clamp one end of the test piece with clamp screw adjacent to index 18 with the significant surface outward.		
	• Bend the test piece progressively over the spiral strip.		• Same as JIS	=	
	• Mark the region of cracks.		• Same as JIS	=	

6.

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Comparison of JIS and corresponding ISO (concluded)

Comparison item	(I) Content specified in JIS	(II) ISO number	(III) Content specified in ISO	(IV) Difference between JIS and ISO	(V) Reason why the conformity between JIS and ISO is difficult and measures to be taken in future.
Specification item					
(3) Operation (continued)	- If the cracks are difficult to detect, immerse the test piece into the following solution. - Copper sulphate 20 g - Hydrochloric acid 20 ml - Deionized water 1 000 ml - Temperature of solution 20 °C - Immersion time 5 min - Assess visually and read the index to one place of decimal.	ISO 3211:1977	Same as JIS	≡	
(4) Assessment	- Express by radius of curvature R and percentage elongation A. $A=100a / (2R+a)$ A : Percentage elongation a : Thickness of test piece (cm) R : Radius of curvature (cm)		Assess visually and read the index.	≡	
(5) Record	- Percentage elongation or radius of curvature - Class and temper grade of raw material of product - Thickness of test piece and thickness of coating - Rolling or extruding direction of test piece		Same as JIS	≡	In JIS, percentage elongation is mainly taken for assessment.
			- Reference of method used - Method of assessment and its result - Any unusual features - Any operation not included in ISO	=	

Remarks 1 Symbol ○ in the small columns of (I) and (III) in the above Table indicates as follows :

○ : relevant item is specified.

2 Symbols such as ≡ and = in the small column of (IV) in the Table indicate as follows :

≡ : "identical" Its technical content is identical to that of the ISO.

= : "equivalent" Technical content of its part corresponding to the international standard is equivalent to that of the said international standard. There are minor technical deviations and/or editorial deviations.

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

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