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Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

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Contents

	Page
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Classification and symbols	1
5 Application process	2
5.1 General	2
5.2 Structure, shape and surface condition of sprayed product	2
5.3 Pretreatment	2
5.4 Thermal spraying	2
5.5 Post-treatment	2
5.6 Outdoor thermal spraying work	3
6 Quality	3
6.1 General	3
6.2 Common quality	3
6.3 Quality according to intended use	4
7 Test methods	7
7.1 General	7
7.2 Appearance test	7
7.3 Structure of coating cross-section test	7
7.4 Coating thickness test	8
7.5 Adhesive strength test	8
7.6 Coating hardness test	8
7.7 Thermal shock resistance	9
7.8 Corrosion resistance test	10
7.9 Electrical insulation test	11
8 Inspection	11
9 Marking	11
Annex A (informative) Working standard	12
Annex B (informative) Wear resistance test	21

Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS H 8304:2014** is replaced with this Standard.

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Ceramic sprayed coatings

1 Scope

This Japanese Industrial Standard specifies ceramic sprayed coatings (hereafter referred to as sprayed coatings) applied to metallic substrates such as parts and products, for the purposes of giving the wear resistance, corrosion resistance, heat resistance, heat insulation, electrical insulation, etc.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS C 2110-2 *Solid electrical insulating materials—Test methods for electric strength—Part 2: Tests using direct voltage*

JIS G 3101 *Rolled steels for general structure*

JIS H 8200 *Thermal spraying terms*

JIS H 8250 *Graphical symbol for thermal spraying*

JIS H 8260 *Powders for thermal spraying*

JIS H 8261 *Wires, rods and cords for flame and arc thermal spraying*

JIS H 8302 *Build-up thermal spraying*

JIS H 8401 *Methods of thickness measurement for sprayed coatings*

JIS H 8402 *Test methods of tensile adhesive strength for thermal-sprayed coatings*

JIS H 8451 *Testing methods for thermal cycle and thermal shock resistance of thermal barrier coatings*

JIS Z 2244 *Vickers hardness test—Test method*

JIS Z 2371 *Methods of salt spray testing*

JIS Z 8402-6 *Accuracy (trueness and precision) of measurement methods and results—Part 6: Use in practice of accuracy values*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS H 8200** apply.

4 Classification and symbols

The classification and symbols of sprayed coatings shall be as follows.

- a) The symbols indicating the thermal spraying, thermal spraying method, symbols of thickness and post-treatment shall be in accordance with **JIS H 8250**.
- b) The symbols indicating the classification of sprayed coatings shall be as follows.

- 1) Symbol indicating the classification of oxide powders and phosphate powders given in Table 12 of **JIS H 8260**
- 2) Symbol indicating the classification of oxide ceramics given in Table 9 of **JIS H 8261**

For the material which cannot be categorized only by a symbol, a hyphen and a code number shall be suffixed to the symbol for identification. For the sprayed coating for wear resistance specified in **6.3**, the symbol indicating the classification of sprayed coatings and the symbol with a number indicating the grade shall be used.

5 Application process

5.1 General

The sprayed coatings shall be so processed that the requirements specified in **5.2** to **5.6** are satisfied, with attention to the safety and health at all times (see relevant regulations).

An example of working standard for thermal spraying is given in Annex A for reference.

5.2 Structure, shape and surface condition of sprayed product

The structure and shape of products or parts to which thermal spraying is applied shall not cause uncoated area of spray particles due to dead angles, deformation nor defective ventilation in the thermal spraying work of product inner surface. The substrate surface should be free from significant deposit of oils and fats etc. and noticeable oxidized scales, rusts, flaws etc.

5.3 Pretreatment

The substrate surface before thermal spraying shall be sufficiently cleaned and roughened by degreasing-cleaning, oil-removal, oxide-removal and by abrasive-blasting using an adequate blasting material. Immediately before the thermal spraying, the surface shall be dried and be free from contaminants, such as dusts, oils and fats, oxidized scales and rusts. Depending on the intended use of sprayed product, a pretreatment (such as threading method, grooving method, knurling method, slotting method or undercoat spraying) which improves the adhesiveness shall be performed.

5.4 Thermal spraying

The application of thermal spraying shall be completed before the clean/dry condition on the substrate surface of sprayed product is maintained and the surface oxidation is visually observed. The air used for thermal spraying or cooling shall be clean and dry. Where necessary, preheating shall be carried out for removing water and relaxing the thermal stress of the coating. The spraying angle shall be possibly a right angle and at least 45°. If necessary, the thermal spraying shall be carried out cooling.

5.5 Post-treatment

According to the intended use of sprayed product, the sealing treatment, heating treatment, machining treatment, chemical treatment etc. shall be carried out for improvement of coating function. The sealing treatment shall be carried out either by

chemical conversion of coating surface or by using an appropriate sealer to fill the pores of coating.

5.6 Outdoor thermal spraying work

In the outdoor thermal spraying work, the protective measures against rain and wind, such as a safe protective sheet shall be taken because the maintaining conditions of thermal spraying materials, thermal spraying facility or the like depend on the weather and it is possible to give adverse effects on the coating quality of sprayed product.

6 Quality

6.1 General

The sprayed coatings shall satisfy both the common quality and the quality according to intended use, given in Table 1.

Table 1 Common quality and quality according to intended use

Application	Common quality				Quality according to intended use			
	Appearance	Structure of coating cross-section	Coating thickness	Adhesive strength	Coating hardness	Thermal shock resistance	Corrosion resistance	Electrical insulation
Wear resistance	○	○	○	○	○	—	—	—
Heat resistance and heat insulation	○	○	○	○	—	○	—	—
Corrosion resistance	○	○	○	○	—	—	○	—
Electrical insulation	○	○	○	○	—	—	—	○

6.2 Common quality

6.2.1 Appearance

The appearance shall be tested according to **7.2**, and the surface of coating shall be uniform in texture and free from cracks, blisters, exfoliations, spatters, deposit of foreign matters and other defects detrimental to use.

6.2.2 Structure of coating cross-section

The structure of coating cross-section shall be tested according to **7.3**, and the sprayed particles shall show uniform dispersion, and there shall be free from defects such as cracks and detrimental contaminants (foreign matters) or voids at the boundary between the substrate surface and the coating.

6.2.3 Coating thickness

The coating thickness shall be tested according to **7.4**, and be as agreed between the purchaser and the manufacturer.

6.2.4 Adhesive strength

The adhesiveness between the coating and the substrate surface shall be tested according to **7.5**, and the adhesive strength shall be that specified in Tables 2 to 4, or that agreed, according to the intended use, between the purchaser and the manufacturer.

6.3 Quality according to intended use

6.3.1 Coating thickness (sprayed coating for wear resistance)

The coating hardness of sprayed coating for wear resistance shall be tested according to **7.6**, and be that specified in Tables 2 to 4, or that agreed, according to the intended use, between the purchaser and the manufacturer. However, for aluminium oxide sprayed coatings (Al_2O_3), aluminium oxide/titanium oxide sprayed coatings ($\text{Al}_2\text{O}_3\text{-TiO}_2$ 97 3A) and chromium oxide sprayed coatings ($\text{Cr}_2\text{O}_3\text{A}$ and Cr_2O_3) that belong to plasma sprayed coatings, the grades of Class 1 and Class 2 shall be set based on the sprayed coating hardness, and each hardness shall be as specified in Table 2.

The test method of wear resistance is given in Annex B for reference.

6.3.2 Thermal shock resistance (sprayed coatings for heat resistance and sprayed coatings for heat insulation)

The thermal shock resistance of sprayed coating for heat resistance and heat insulation shall be tested according to **7.7**, and there shall be no cracks, peelings or exfoliations of coating.

6.3.3 Corrosion resistance (sprayed coatings for corrosion resistance)

The corrosion resistance of sprayed coatings for corrosion resistance shall be tested according to **7.8**. In the salt spray test specified in **7.8.2**, it shall be judged whether the resistance conforms to the test result specified in **JIS Z 2371** or complies with the agreement between the purchaser and the manufacturer. In the immersion method specified in **7.8.3**, there shall be no blisters, peelings and rusts.

6.3.4 Electrical insulation (sprayed coatings for electrical insulation)

The electrical insulation of sprayed coating for electrical insulation shall be tested according to **7.9**, and be not less than 10 kV/mm, or be with the dielectric strength agreed between the purchaser and the manufacturer.

Table 2 Adhesive strength and hardness of plasma sprayed coatings

Classification	Code number	Symbol	Adhesive strength of sprayed coating MPa	Hardness of sprayed coating HV
Aluminium oxide sprayed coatings	12.1	Al ₂ O ₃ -1	20.0 min.	1 000 or over (Class 1)
		Al ₂ O ₃ -2		800 or over to and excl. 1 000 (Class 2)
Aluminium oxide/titanium oxide sprayed coatings	12.2A	Al ₂ O ₃ -TiO ₂ 97 3A-1	14.0 min.	900 or over (Class 1)
		Al ₂ O ₃ -TiO ₂ 97 3A-2		800 or over to and excl. 900 (Class 2)
	12.3	Al ₂ O ₃ -TiO ₂ 87 13	30.0 min.	800 or over
	12.4	Al ₂ O ₃ -TiO ₂ 60 40	20.0 min.	750 or over
Aluminium oxide/chromium oxide sprayed coatings	12.7	Al ₂ O ₃ -Cr ₂ O ₃ 98 2	20.0 min.	750 or over
	12.8	Al ₂ O ₃ -Cr ₂ O ₃ 90 10		
	12.9	Al ₂ O ₃ -Cr ₂ O ₃ 50 50		
Chromium oxide sprayed coatings	12.20A	Cr ₂ O ₃ A-1	30.0 min.	1 100 or over (Class 1)
		Cr ₂ O ₃ A-2		900 or over to and excl. 1 100 (Class 2)
	12.21	Cr ₂ O ₃ -1		1 100 or over (Class 1)
		Cr ₂ O ₃ -2		900 or over to and excl. 1 100 (Class 2)
Titanium oxide sprayed coatings	12.30A	TiO ₂ 98A	20.0 min.	700 or over
Zirconium oxide sprayed coatings	12.40	ZrO ₂ -CaO 95 5	20.0 min.	— ^{a)}
	12.40A	ZrO ₂ -CaO 93 7A		
	12.41	ZrO ₂ -CaO 90 10		
	12.42	ZrO ₂ -CaO 70 30		
	12.43A	ZrO ₂ -MgO 76 24A		
	12.44A	ZrO ₂ -Y ₂ O ₃ 92 8A	22.0 min.	
	12.44B	ZrO ₂ -Y ₂ O ₃ 88 12B		
	12.45	ZrO ₂ -Y ₂ O ₃ 80 20		
	12.46	ZrO ₂ -SiO ₂ 65 35	20.0 min.	
	12.47	ZrO ₂ -CeO ₂ -Y ₂ O ₃ 68 25 3	22.0 min.	
	12.48A	ZrO ₂ A	20.0 min.	
Note ^{a)} Not used for wear resistance, hence the hardness of sprayed coating is not specified.				