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Magnesium and Magnesium Alloys

-- Paint coating selection guide for Magnesium surface spraying

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Tel: +862367179399 Email: International_Mg@163.com

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Foreword

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IMS Standards aim to serve the producing, testing, evaluations, and trades of the global magnesium and magnesium alloy industry, offer standard basis for multiple parties in the industrial chain, intensified technical requirements, and simplify negotiation processes. In the preparation of IMS standard, numbers of relevant data are referred, and the essence contents are extracted, then the targeted modifications are carried out according to the actual situation of magnesium industry. This standard is free on trial, and any parties of magnesium chain are sincerely invited to put forward amendments and suggestions for this standard, especially the technical contents. Please provide amendments and reasons, attaching the necessary proof issues, if possible.

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Magnesium and Magnesium Alloys
--Paint coating selection guide for Magnesium surface spraying

1 Scope

This standard specifies the structure and characteristics of various coatings, applicable environment and suitable coating, coating performance, test methods, quality certificate, and contents of purchase order (or contract).

This standard applies to the application and selection of magnesium alloy surface electrophoretic and spraying coating.

2 Normative References

The following documents are indispensable for the application of this document. For dated references, only the dated versions apply to this document. For undated references, the latest version (including all amendments) applies to this document.

a) Wrought aluminium alloy extruded profiles for architecture Part 3: Electrodeposition coating profiles

b) Wrought aluminium alloy extruded profiles for architecture Part 4: Powder coating profiles

c) Wrought aluminium alloy extruded profiles for architecture Part 5: Paint coating profiles

d) Guideline for the selection of coating types, tests and methods of assessing the performance of anodic oxide coatings and organic polymer coatings on aluminium and its alloys in architectural applications

e) Anodic oxide coatings and organic polymer coatings on aluminium and its alloys Part 2: Combined coating

f) Anodic oxide coatings and organic polymer coatings on aluminium and its alloys Part 3: Organic polymer coatings

g) Anodic oxide coatings and organic polymer coatings on aluminium and its alloys Part 4: Texture coatings

h) Anodic oxide coatings and organic polymer coatings on aluminium and its alloys Part 5: Function coatings

i) Acrilic electrodeposition pain for aluminium alloy extruded profiles for architecture

3 Structure and Characteristics of Various Coatings

3.1 Structure and characteristics of electrophoretic coating

The electrophoretic coating has high hardness, good abrasion resistance, good adhesion of the coating, excellent corrosion resistance, and excellent resistance to submembrane filamentous corrosion. The electrophoretic coating on the surface of the magnesium and magnesium alloy requires the necessary pretreatment. Pretreatment before electrophoretic coating or spraying coating has an important impact on the corrosion resistance and adhesion. Pretreatment includes anodizing oxidation and chemical conversion treatment. The thickness of the electrophoretic coating can be controlled accurately in the production process. The thickness of the coating is not only evenly distributed, but also can cover all positions on the surface of magnesium and magnesium alloy. The coating type, main components, and typical application of electrophoretic coating are shown in Table 1.

3.2 Structure and characteristics of spraying coating

Spraying coating mainly includes PVDF fluorocarbon paint, epoxy paint, polyester paint, acrylic polyurethane paint, and amino acrylic paint. The spraying coating on the surface of the magnesium and magnesium alloy requires the necessary pretreatment. Pretreatment before electrophoretic coating or spraying coating has an important impact on the corrosion resistance and adhesion. Pretreatment includes anodizing oxidation and chemical conversion treatment. The coating type, main components, and typical application of spraying coating are shown in Table 1.

Table 1 Coating type, main components, and typical application

<table>
<tr><th colspan="3">Coating type</th><th>The main components of the coating</th><th>Typical application of coating</th></tr>
<tr><td rowspan="2">Electrophoretic coating</td><td colspan="2">Transparent electrophoresis</td><td>Acrylic resin or epoxy resin</td><td>Electronic products, rail transit decorative parts, bathroom products, solar photovoltaic products, automobile decorative parts and building profiles</td></tr>
<tr><td colspan="2">Color electrophoresis</td><td>Acrylic resin or epoxy resin, color paste.</td><td>Solar photovoltaic products, auto parts, electronic products, and building profiles.</td></tr>
<tr><td>Spraying coating</td><td>PVDF Fluorocarbo n paint</td><td>Second coating</td><td>It's mainly composed of PVDF resin, generally with a monochromatic or pearlescent mica scintillation effect.</td><td>Curtain walls, profiled plates, doors and windows, and other products with excellent weatherability requirements and atmospheric corrosion resistance.</td></tr>
</table>

Coating type			The main components of the coating	Typical application of coating
		Third coating	It's mainly composed of PVDF resin generally with a metal effect. Ball-milled aluminium powder is used in the top coating of the coating to obtain the metal texture effect. Its metal texture is different from the pearlescent mica coating of the second coating. Because the aluminium powder is easy to oxidize or detach from, the coating surface needs to be protected by varnish to ensure comprehensive performance, which is better than the second coating.	Curtain walls, profiled plates, doors and windows, and other products with excellent weatherability and atmospheric corrosion resistance.
		Fourth coating	It's mainly composed of PVDF resin, generally with a metal effect and higher performance requirements. Based on the third coating, this coating is added with a UV-blocking coating.	Curtain walls, profiled plates, doors and windows, and other products with excellent weatherability and atmospheric corrosion resistance.
	Epoxy paint		It's mainly composed of epoxy resin.	Roof structure, air compressor, mechanical equipment, food containers, and magnesium alloy products for packaging and other products with good adhesion and anti-corrosion.
	Polyester paint		It's mainly composed of polyester resin.	Automobile wheel hub, ceiling, profiled plate, curtain wall, packaging box, magnesium alloy products, and other products with good mechanical performance and general wearability
	Acrylic polyurethane paint		It's mainly composed of acrylic resin.	Furniture, lighting, chassis and cabinet, compartment, aluminium veneer, magnesium alloy products, and other products with excellent transparency, good surface decoration, and good weatherability.
	Amino acrylic paint		It's mainly composed of acrylic resin and amino resin.	Furniture, lighting, chassis and cabinet, compartment, magnesium alloy products, and other products with excellent transparency, good surface decoration, and good weatherability.

4 Applicable Environment and Suitable Coating

Before selecting the coating type, the environmental condition shall be determined. The degradation of the coating performance in the service environment shall not corrode the product or affect the appearance of the product. The atmosphere is divided into four categories, i.e. industrial atmosphere, urban atmosphere, marine atmosphere, and rural atmosphere The environment also can be divided into the wet environment, ordinary environment, and dry environment according to humidity, and the difference between indoor and outdoor corrosion in the actual environment should be considered. The suitable electrophoretic coating and spray coating shall be selected according to the environment type concerning Table 2.

Table 2 Environment type and a suitable coating

Corrosion grade	Corrosion degree	Environment condition		Suitable coating — Coating code: electrophoretic coating	Suitable coating — Coating code: Spraying coating
C1	Extremely low	Outdoor	Cold or dry atmospheric environments with very low pollution and short wetting time, such as certain deserts, and Arctic and Antarctic centers.	EA21, EB16 and ES21 of Class II, EA21, EB16 and ES21 of Class III, EA21, EB16 and ES21 of Class IV	LAR25, LRAR25, LF2-25, LRF2-25, LF3-34, LRF3-34, LF4-55, LRF4-55
		Indoor	Space with low pollution, low humidity, and heating, such as offices, shops, schools, hotels, and museums.	EA2I, EB16, EC13 and ES21	LAR25, LRAR25, LF2-25, LRF2-25, LF3-34, LRF3-34, LF4-55, LRF4-55, LO15, LRO15, LA25, LA34, LRA15, LRA34, LAR25, LRAR25
C2	lower	Outdoor	A temperate environment with low pollution (SO_2 < 5 μg/m^3), such as rural areas and small towns; cold or dry atmospheric environment with short wetting time, such as desert.	EA21, EB16 and ES21 of Class II, EA21, EB16 and ES21 of Class III, EA21, EB16 and ES21 of Class IV	LAR25, LRAR25, LF2-25, LRF2-25, LF3-34, LRF3-34, LF4-55, LRF4-55
		Indoor	Unheated spaces with large temperature and humidity changes, low pollution, and less condensation, such as warehouses and gymnasiums.	EA2I, EB16, EC13 and ES21	LAR25, LRAR25, LF2-25, LRF2-25, LF3-34, LRF3-34, LF4-55, LRF4-55, LO15, LRO15, LA25
C3	medium	Outdoor	Temperate environments with medium pollution (SO_2: 5 μg/m^3 ~ 30 μg/m^3) or some areas slightly affected by chloride, such as urban areas, coastal areas with low chloride deposition, and tropical and subtropical areas with low pollution.	EA21, EB16 and ES21 of Class II, EA21, EB16 and ES21 of Class III, EA21, EB16 and ES21 of Class IV	LAR25, LRAR25, LF2-25, LRF2-25, LF3-34, LRF3-34, LF4-55, LRF4-55
		Indoor	Space with moderate condensation frequency and pollution during production, such as food processing plants, laundry, brewery, and milk factories.		
C4	higher	Outdoor	Temperate environments with high pollution (SO_2: 30 μg/m^3 ~ 90 μg/m^3) or some areas affected by chloride, such as polluted cities, industrial areas, coastal areas without strong impact of saline spray or deicing salt, and moderately polluted tropical and subtropical areas.	EA21, EB16 and ES21 of Class III, EA21, EB16 and ES21 of Class IV	LF2-25, LRF2-25, LF3-34, LRF3-34, LF4-55, LRF4-55 of Class II and III
		Indoor	Space with high condensation frequency and high pollution during production, such as chemical plants, swimming pools, seagoing ships, and shipyards.		
C5	Much higher	Outdoor	Temperate or subtropical environments with very high pollution (SO_2: 90 μg/m^3 ~ 250 μg/m^3) or some areas seriously affected by chlorides, such as industrial areas, coastal areas, and coastline coverage areas.	EA21, EB16 and ES21 of Class IV	LF3-34, LRF8-34, LF4-55, LRF4-55 of Class III
		Indoor	Space with very high condensation frequency and serious pollution during production, such as mines, industrial caves, and airtight sheds in tropical and subtropical regions.	EA21, EB16 and ES21 of Class III, EA21, EB16 and ES21 of Class IV	LF2-25, LRF2-25, LF3-34, LRF3-34, LF4-55, LRF4-55 of Class II and III

Corrosion grade	Corrosion degree	Environment condition		Suitable coating	
				Coating code	
				electrophoretic coating	Spraying coating
C6	Extremely high	Outdoor	Tropical and subtropical (extremely long wetting time) environments with very high pollution (SO_2: > 250 μg/m^3), including some associated factors and/or areas seriously eroded by chloride, such as extreme industrial areas, coastal and offshore areas, and areas occasionally affected by salt fog.	EA21, EB16 and ES21 of Class IV	LF3-34, LRF8-34, LF4-55, LRF4-55 of Class III
		Indoor	Space where condensation occurs continuously during production or is affected by high tide humidity for a long time and is highly polluted, such as the indoor unventilated shed in humid tropical areas where outdoor pollutants (including chlorides in the air and particles that can accelerate corrosion) can penetrate in.		

5 Coating Performance

5.1 General requirements

The performance shall be selected according to the characteristics of the coating. The performance selection of different coatings is shown in Table 3.

Table 3 Performance selection of different coatings

No.	Performance	Type of coating	
		Electrophoretic coating	Spraying coating
	Appearance quality	√	√
	Gloss	*	√
	Color and color difference	√	√
	Coating thickness	√	√
	Salt spray corrosion resistance	√	√
	Corrosion resistance to sulfur dioxide humid atmosphere	*	*
	Filiform corrosion resistance	*	*
	Machu corrosion resistance	×	*
	Humidity resistance	√	√

No.	Performance	Type of coating	
		Electrophoretic coating	Spraying coating
	Acid resistance	√	√
	Alkali resistance	√	*
	Mortar resistance	√	√
	Solvent resistance	√	√
	Detergent resistance	√	√
	Weatherability	√	√
	Coating hardness	√	√
	Abrasion resistance	√	√
	Impact resistance	×	√[a]
	Anti cupping	×	√[a]
	Bending resistance	×	√[a]
	Boiling water resistance	√	√
Note: "√" refers to the performance items that shall be selected, "*" refers to the performance items that shall be selected for specific purposes, "×" refers to the performance items that shall not be selected, and "a" indicates that the spray painted film layer for anodizing pretreatment is not applicable.			

5.2 Appearance Quality

5.2.1 Electrophoretic coating

The appearance of the electrophoretic coating is uniform, the transparent electrophoretic coating has a metallic texture, and the color electrophoretic coating has a bright color, the appearance quality of the electrophoretic coating requires that the coating after painting should be even and clean, without wrinkles, cracks, bubbles, flow marks, inclusions, stickiness, coating peeling, or other defects that affect use.

5.2.2 Spraying coating

The appearance of the spraying coating is rich in color, diverse textures, and free of metal texture. The appearance quality of the spraying coating is required to be free of wrinkles, cracks, bubbles, flow marks, pockmarks, inclusions, stickiness, coating peeling, and other defects.

5.3 Gloss

The gloss of the coating is divided into high gloss, medium gloss, and low gloss. The use position shall be considered for the selection of gloss to avoid light pollution. As the gloss meter is not suitable for measuring the gloss of coating containing metal pigment, there is no requirement for transparent coating (such as electrophoretic coating coated with varnish), but this performance can be selected for electrophoretic coating with special requirements for coating gloss.

5.4 Color and color difference

The color and color difference of electrophoretic coating and spraying coating with surface decoration function are important detection items The uneven color will affect the decoration.

5.5 Coating thickness

The coating thickness not only has an important impact on the corrosion resistance of the product but also has an impact on the decoration, impact resistance, cupping resistance, and bending resistance of the product. In addition, it is also an important factor in determining the production cost of magnesium alloy products.

5.6 Salt spray corrosion resistance

Salt spray corrosion resistance is to investigate the environmental corrosion resistance of the coating, which is a common performance to evaluate the corrosion resistance of the coating. This performance is useful for investigating the corrosion situation and the service life of the coating in the marine environment.

5.7 Corrosion resistance to sulfur dioxide humid atmosphere

The corrosion resistance to sulfur dioxide in the humid atmosphere is investigating the corrosion situation and the service life in areas with industrial pollution or acid rain. Therefore, this performance can be considered in areas with serious industrial pollution or acid rain.

5.8 Filiform corrosion resistance

The filiform corrosion resistance is to investigate the corrosion performance under the coating. Filiform corrosion often occurs at certain temperature and humidity conditions, where the coating is weak or damaged under the induction of an appropriate amount of acid, alkali, or salt. Filiform corrosion can occur in coastal or industrial environments, often starting from scratch. This performance can be considered for use in areas prone to filiform corrosion.

5.9 Machu corrosion resistance

Machu corrosion resistance is to investigate the corrosion performance of organic polymer sprayed profiles undercoating. Machu corrosion resistance is generally not specified for the electrophoretic coating.

5.10 Humidity and heat resistance

Humidity and heat resistance are to investigate the stability of spraying coating under high temperature and humidity environments. Humidity and heat resistance apply to both electrophoretic coating and spraying coating.

5.11 Acid resistance

Acid resistance is to investigate the resistance of the spraying coating to acid corrosion. Products with poor acid resistance may have defects that affect the use, such as serious discoloration of the coating and bubbles. The hydrochloric acid test is a commonly used evaluation method to investigate the acid resistance of the electrophoretic coating and spraying coating, while the nitric acid test is a method to evaluate the acid resistance of fluorocarbon coating.

5.12 Alkali resistance

Alkali resistance is to investigate the corrosion resistance of the spraying coating to alkaline substances. Products with poor alkali resistance may have defects that affect the use, such as severe discoloration of the coating and bubbles. Alkali resistance test is usually conducted with sodium hydroxide solution, which is an evaluation method used to investigate the alkali corrosion resistance of the coating. Alkali resistance test can also conveniently evaluate the curing effect of the electrophoretic coating, so the alkali resistance test is required for the electrophoretic coating.

5.13 Mortar resistance

Mortar resistance is to investigate the resistance of spraying coating to mortar erosion.

5.14 Solvent resistance

The solvent resistance test is to check whether the coating is completely cured and to investigate whether the curing conditions of the electrophoretic coating and spraying coating during production meet the curing conditions required by the coating. It shall be noted that the performance of the coating may also affect the solvent resistance.

5.15 Detergent resistance

Detergent resistance is to investigate the resistance of the coating to detergent erosion. Magnesium and magnesium alloy products for construction will be exposed to various detergents or cleaning agents, and the detergent resistance of the coating has practical significance.

5.16 Weatherability

Weatherability is to investigate the ultraviolet light resistance of the coating under the action of various factors of the natural climate, which reflects the ability of the electrophoretic coating or spraying coating to resist the destruction of climatic conditions such as humidity, rain, dew, wind, frost and maintain its original performance under the sunlight. Products with good weather ability have long service life and durable color. After the products with poor weather ability are used outdoors for some time, the surface coating may have large color changes, high gloss loss rate, and thin coating, which will affect its decorative performance, and even may have pulverization, cracking, blistering, rust, mold spots, spots, contamination, coating peeling and other phenomena. There are many factors affecting the weather ability of products, including the performance of coatings, production process conditions of oxidation coloring, curing temperature and time of coating, color and performance of pigments, etc.

5.17 Coating hardness

Coating hardness is an important physical performance of the coating, which directly affects some important performance for coating applications, such as wearability, friction resistance, and product cleaning difficulty. Electrophoretic coating and spraying coating usually require this performance.

5.18 Abrasion resistance

Abrasion resistance of the electrophoretic coating and spraying coating is closely related to the quality and use of the coatings. It can reflect the potential ability of the coating to resist abrasion and the ability to resist wind and sand. It is an important performance of electrophoretic coating and spraying coating.

5.19 Adhesion

Adhesion of electrophoretic coating and spraying coating is used to evaluate the adhesion between coating and substrate. Adhesion is a key performance related to service life. Adhesion of coating is closely related to production process and production process control. At the same time, the quality of the coating may also affect adhesion.

5.20 Impact resistance

Impact resistance is to evaluate the performance of the coating against cracking or peeling off from the metal substrate using the fixed weight falling on the sample and causing deformation. The impact resistance of the coating is related to many factors, such as the pretreatment process before spraying, coating thickness, and punch diameter of the impact instrument. The impact resistance is only applicable to the spraying coating.

5.21 Cupping resistance

Cupping resistance is to evaluate the anti-cracking or anti-peeling performance of the coating by gradually deforming the sample. The cupping resistance is only applicable to the spraying coating.

5.22 Bending resistance

Bending resistance refers to the process of bending a sample around a cylindrical axis and observing the changes in the film layer to evaluate its resistance to cracking or detachment from a metal substrate. The anti-bending property is only applicable to spray painted film layers.

5.23 Boiling water resistance

Boiling water resistance is to investigate the water resistance of the electrophoretic coating and spraying coating.

6 Test methods

6.1 Appearance quality test method

The visual inspection method shall be used to check the appearance quality. The natural light source or artificial (D65 or D50) standard light source shall be used as the light source. The viewing point shall be perpendicular to the surface of the sample or at an angle of 45° to the vertical line. The viewing distance for decorative coating shall be usually 0.5 m, and for architectural coating shall be usually 3 m.

6.2 Gloss measurement method

Gloss measurement shall be carried out with a gloss meter, which usually has 20°, 60°, and 85° geometry to measure the gloss of the coating. 20° geometry can give better resolution to the high gloss coating (i.e., the coating with 60° specular gloss higher than 70 units); 85° geometry can give better resolution for low gloss coating (i.e., the coating with 60° specular gloss less than 10 units); 60° geometry applies to all coatings. Because the gloss measured by different geometry is different, the geometry of the gloss meter shall be determined before the gloss measurement. 60° geometry has a wide range of applications, so it is generally selected for the gloss measurement of coating.

6.3 Color and Color Difference Inspection Method

There are two main inspection methods for color and color difference: (1) visual colorimetric method; and (2) instrument inspection method. The visual colorimetric method applies to the inspection of color and color difference of all coatings, while the instrument inspection method is generally not applicable to the inspection of color and color difference of non-monochromatic coating in fluorocarbon paint spraying coating, acrylic paint spraying coating, or electrophoretic coatings coated with varnish. When the visual colorimetric method is used to check the color and color difference, lighting conditions, observation angle, observation distance, and other conditions shall be considered.

6.4 Coating thickness test method

Coating thickness shall be measured with an instrument, generally an eddy current instrument.

6.5 Salt spray corrosion test method

There are three main types of salt spray corrosion tests: (1) neutral salt spray test; (2) acetic acid salt spray test; and (3) copper accelerated acetic acid salt spray test. Copper accelerated acetic acid salt spray test has an obvious accelerated corrosion effect on electrophoretic coating and can significantly shorten the salt spray corrosion test time of electrophoretic coating. However, because the conditions of the acetic acid salt spray test are closer to the natural state than those of the copper accelerated acetic acid salt spray test, the acetic acid salt spray test is also used to test the salt spray corrosion resistance of the electrophoretic coating. Fluorocarbon paint spraying coating and acrylic paint spraying coating are prone to corrosion under the coating. Therefore, a neutral salt spray test or acetic acid salt spray test can better evaluate the salt spray corrosion resistance of samples after drawing cross lines on the surface of samples.

6.6 Sulfur dioxide humid atmosphere corrosion test method

As the corrosion rate of sulfur dioxide humid atmosphere corrosion test mainly depends on the concentration and temperature of SO_2, this test aims to accelerate the corrosion by increasing the concentration and temperature of SO_2. Before the test, the cross lines deep into the substrate shall be drawn on the surface of the sample with a knife, then the sample shall be placed in the test chamber, 0.2 L sulfur dioxide gas shall be introduced, and the temperature in the test chamber shall be heated to 40 °C ± 3 °C within 1.5 hours. 24 hours is one test cycle and a total of 24 test cycles shall be conducted.

6.7 Filiform corrosion resistance test method

The surface of the sample shall be scratched in the specified way, and a small amount of hydrochloric acid shall be introduced to the scratch by exposing the sample to saturated hydrochloric acid vapor. Then the sample shall be placed in a test chamber with a temperature of 40 °C ± 2 °C and a relative humidity of 82% ± 3% and taken out for result evaluation after the specified time.

6.8 Machu test method

Machu corrosion solution contains 50 g/L sodium chloride, 10 g/L glacial acetic acid, and 5 mL/L hydrogen peroxide (30%). pH value, test temperature, and test time shall be 3.0 ~ 3.3, 37 °C ± 1 °C, and 48 h, respectively. Before the test, the cross lines deep into the substrate shall be drawn on the surface of the sample with a knife, the sample shall be immersed in the test solution for 24 hours, 5 mL/L hydrogen peroxide (30%) shall be added, the pH value shall be adjusted to 3.0 ~ 3.3 with sodium hydroxide or glacial acetic acid, and the test shall continue until the specified period is reached. The sample after the test shall be free of corrosion beyond 0.5 mm distance from the scribing line.

6.9 Damp heat test method

The sample shall be placed in a constant temperature and humidity chamber with pre-adjusted temperature and relative humidity for test, and taken out to check the damage to the sample surface after the specified time. When hanging the sample in the constant temperature and humidity chamber, mutual contact between the surfaces to be tested shall be avoided. When checking the sample in the test cycle, direct contact with the surface of the tested sample by hand shall be avoided.

6.10 Acid resistance test method

6.10.1 Hydrochloric acid test method

10 drops (1 + 9) of hydrochloric acid test solution shall be dropped on the coating surface of the sample, covered with a watch glass, and placed at an ambient temperature of 18 °C ~ 27 °C for 15 minutes.

The change of the coating surface shall be visually inspected after taking down the watch glass and rinsing it with tap water.

6.10.2 Nitric acid test method

100 mL of analytical pure nitric acid (p=1.40 g/mL) shall be injected into a 200 mL large mouth bottle, the sample coating face shall be covered down on the bottle mouth, kept for 30 min, taken down, rinsed with tap water, wiped dry and inspected after placing for 1 h. The test shall be conducted in an environment with a temperature of 18 °C ~ 27 °C and a relative humidity of less than 50%.

6.11 Alkali resistance test method

The glass (or synthetic resin) ring with an inner diameter of 32 mm and a height of 30 mm shall be fixed on the coating surface of the sample with vaseline or paraffin. 5 g/L sodium hydroxide solution shall be injected into 1/2 of the ring height. The ring mouth shall be covered with a glass plate or synthetic resin plate, kept at an ambient temperature of 20 °C ± 2 °C for a specified time, cleaned with water, placed for 1 h, and a circle with a diameter of 30 mm shall be drawn concentric with the ring on the surface of the sample. The corrosion in the circle shall be observed with a 10 ~ 15 times magnifying glass and graded according to observation.

6.12 Mortar resistance test method

Mortar shall be mixed with 75 g of construction lime, 225 g of dry sand, and about 100 g of deionized water, placed on the surface of the sample, stacked into a cylindrical shape with a diameter of 15 mm and a thickness of 6 mm, placed in an environment with a temperature of 38 °C ± 3 °C and a relative humidity of 95% ± 5% for 24 hours. The apparent condition of the sample surface shall be visually inspected by removing the mortar, wiping off the residue on the surface with a wet cloth, and drying in the air.

6.13 Solvent resistance test method

6.13.1 Static method

A cotton strip shall be dipped in the solvent (Xylene is used for electrophoretic coating and butanone is used for fluorocarbon coating.), saturated, placed on the sample, and kept for 30 seconds. The softening of the coating surface and other changes shall be inspected after taking off the cotton strip, washing the sample with tap water, wiping it dry, and placing it at room temperature for 2 hours.

6.13.2 Wiping Method I

A cotton strip shall be dipped in solvent (Butanone is used as a solvent for fluorocarbon paint spraying coating.), saturated, gently wiped back and forth on the surface of the sample along the same straight path 30 times within 30 seconds, and taken off. The coating surface shall be inspected after taking off the cotton strip, washing the sample with tap water, wiping it dry, and placing it at room temperature for 2 hours. The test results shall be divided into four grades: (1) Grade 1 coating is very dark and soft; (2) Grade 2 coating is very dark and can be scratched with fingernails: (3) Grade 3 coating has a slight loss of gloss (less than 5 gloss units); (4) Grade 4 coating has no obvious change and no scratch by fingernail. Among them, Grade 3 and Grade 4 are qualified, and Grade 1 and Grade 2 are unqualified.

6.13.3 Wiping Method II

At room temperature, a 1 kg heavy hammer head (The contact area between the weight and the sample surface is about 150 mm^2.) wrapped with at least six layers of medical gauze shall be dipped in solvent (Xylene is used as the solvent for the electrophoretic coating and butanone is used as the solvent for the fluorocarbon paint spraying coating.), saturated, and wiped back and forth 100 times along the same straight path on the sample surface at the rate of one round trip per second (One round trip is counted as one cycle.). The gauze shall be kept wet during the test. It shall be visually inspected whether the organic polymer coating after the test is wiped off.

6.14 Detergent resistance test method

The concentration of detergent solution used in the detergent resistance test is 30 g/L, contains 53% sodium pyrophosphate, 19% anhydrous sodium sulfate, 20% sodium dodecylbenzene carbonate, 7% sodium silicate hydrate, and 1% anhydrous sodium carbonate. The sample shall be put in the detergent test solution for 72h at 38 °C ± 1 °C, then taken out and wiped dry. The coating surface shall be visually inspected for bubbles, covered with adhesive tape with an adhesive force greater than 10 N/25 mm, and pressed to drain the air under the adhesive tape. The adhesive tape shall be quickly pulled up at an angle perpendicular to the coating surface, and it shall be inspected whether the coating falls off.

6.15 Weatherability test method

6.15.1 Natural exposure weathering test method

To objectively and fairly evaluate the weatherability of products, the exposure field shall be established in the area that can represent the most severe climate types or in the place where the tested product is used.

6.15.2 Manual accelerated weather Ability test method

There are three kinds of artificially accelerated weather ability tests: (1) artificially accelerated weather ability test with the fluorescent ultraviolet lamp; (2) artificially accelerated weather ability test with a xenon arc lamp; (3) artificially accelerated weather ability test with a carbon arc lamp. As the spectral distribution of xenon lamps is more similar to that of sunlight, it is also more widely used. Electrophoretic coating and fluorocarbon paint spraying coating are more often tested for wearability by manual accelerated weather ability test with a xenon arc lamp, while the accelerated weather ability test with fluorescent ultraviolet lamp using UV-B313 lamp is faster.

6.16 Coating hardness test method

There are two kinds of coating hardness tests: (1) indentation hardness test; and (2) pencil hardness test. The indentation hardness test is more suitable for relatively thicker coating, while the pencil hardness test is more suitable for relatively thinner coating. Therefore, the pencil hardness test is usually used to detect electrophoretic coating, fluorocarbon coating, and acrylic coating with low coating thickness.

6.17 Abrasion resistance test method

In the test, the abrasion coefficient of the coating shall be measured by the sand falling tester to evaluate the abrasion resistance of the coating. There are generally two kinds of abrasives used in this test, one is No. 80 black silicon carbide, and the other is standard sand. To ensure the accuracy of the test results, the test abrasives shall be dry, the relative humidity of the laboratory shall not be greater than 80%, and attention shall be paid to avoiding the wind. No. 80 black silicon carbide shall be used as the abrasive for electrophoretic coating and standard sand shall be used as the abrasive for fluorocarbon coating.

6.18 Adhesion test method

An adhesion test is usually conducted with the grid cut method, which is used to evaluate the resistance of the coating to detach from the substrate when the coating penetrates the substrate with a right-angle grid pattern. The cutting spacing is related to the coating thickness. The cutting spacing is 1 mm, 2 mm, and 3 mm when the coating thickness is 0 μm ~ 60 μm, 60 μm ~ 120 μm and 120 μm ~ 250μm, respectively. The grid cut method does not apply to the coating with a thickness greater than 250μm or the coating with texture.

6.19 Impact resistance test method

There are two main types of impact resistance tests: (1) positive impact test (the weight directly impacts the inspected surface); and (2) recoil test (the weight impacts the back of the inspected surface). The diameter of the punch used in the test is 16 mm, and the mass of the weight is 1000 g ± 1 g. During the test, the tested surface of the sample shall be upward for the positive impact test or downward for the recoil test. The distance between the impacted part of the sample and the edge shall not be less than 15 mm, and the distance between the edges of each impact point shall not be less than 15 mm. Then the weight shall be dropped freely at an appropriate height and directly impacted on the sample, to produce a pit with a depth of 2.5 mm ± 0.3 mm. Then the change of the pit and the surrounding coating shall be inspected.

6.20 Cupping resistance test method

The cupping resistance test can be conducted according to the specified indentation depth to assess whether the coating is qualified. The indentation depth can also be gradually increased to determine the minimum depth when the coating just cracks or starts to detach from the substrate.

6.21 Bending resistance test method

The bending resistance test can be conducted according to the specified cylindrical shaft diameter to assess whether the coating is qualified. The test can also be carried out with cylindrical shafts (the diameter of cylindrical shafts ranges from large to small) to determine the minimum diameter when the coating just cracks or starts to detach from the substrate.

6.22 Boiling water resistance test method

The duration of the boiling water resistance test and whether the test is pressurized have an impact on the test results. Generally, the 5 h normal pressure boiling water resistance test shall be adopted for the electrophoretic coating.

7 Quality Certificate

7.1 Quality certificate of electrophoretic coating

Each batch of stock solution shall be attached with a product quality certificate, which shall indicate:

a) Supplier name;

b) Product name;

c) Batch number and production date;

d) Weight or number of pieces;

e) All analysis and inspection results (including factory inspection results and recent type inspection results of non-factory inspection items) and the seal of the supplier's quality inspection department;

f) Number of this standard.

7.2 Quality certificate of spraying coating

To ensure the reliability of the quality (especially weather ability and corrosion resistance) of the spraying coating, the contents of the quality certificate shall be negotiated with the coating manufacturer, and the contents of the quality certificate shall at least include:

a) Executive standard number;

b) Product name;

c) Manufacturing technology Construction technology, including curing temperature and curing time;

d) Density of coating paint;

e) The fineness of coating paint;

f) Viscosity of coating paint;

g) Solids of coating paint;

h) Types of pigment;

i) Mass fraction of PVDF resin in the resin (fluorocarbon coating);

j) Volatile organic compound content of coating paint;

k) Neutral salt spray test results, impact resistance test, and other test results of coatings paints.

8 Contents of Purchase Order (or Contract)

8.1 Contents of the electrophoretic coating purchase order (or contract)

The purchase order (or contract) for the stock solution of this standard shall include the following contents:

a) Product name;

b) Type of stock solution;

c) Viscosity and density of stock solution;

d) Net weight;

e) Special requirements for viscosity, density, and solids of stock solution;

f) Weatherability, alkali resistance, grade of ultraviolet salt spray joint test of composite coating, and grade or special requirements of other composite coating performance;

g) Special requirements for solid content, swimming force, coulomb efficiency, pH value, conductivity, amine value, an acid value of working fluid;

h) Number of this standard;

i) Other requirements.

8.2 Content of spraying coating purchase order (or contract)

Relevant technical requirements shall be presented in the purchase order (or contract) after the selection of spraying coating is completed. The following contents shall be indicated in the purchase order (or contract) for spraying coating.

a) Executive standard number;

b) Product name;

c) Type of coating;

d) Weatherability and other coating performance grades or requirements;

e) Net weight;

f) Other special requirements.