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Anti-reflective Coated Glass for Photovoltaic Modules

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Anti-reflective Coated Glass for Photovoltaic Modules

1 Scope

This standard specifies the terms and definitions, materials, requirements, test methods, inspection rules, marking, packaging, transportation and storage of anti-reflective coated glass for photovoltaic modules (hereinafter referred to as anti-reflective coated glass).

This standard is applicable to single-side anti-reflective coated glass used for crystalline silicon photovoltaic modules, and may serve for reference for other anti-reflective coated glass for photovoltaic modules.

2 Normative References

The following referenced documents are indispensable for the application 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.

GB/T 1771-2007	<i>Paints and Varnishes - Determination of Resistance to Neutral Salt Spray</i>
GB/T 2828.1	<i>Sampling Procedures for Inspection by Attribute - Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-lot Inspection</i>
GB/T 6739-2006	<i>Paints and Varnishes - Determination of Film Hardness by Pencil Test</i>
GB/T 8170	<i>Rules of Rounding Off for Numerical Values & Expression and Judgment of Limiting Values</i>
GB/T 9056	<i>Metal Ruler</i>
GB/T 9266-2009	<i>Determination of Scrub Resistance of Film of Architectural Paints and Coatings</i>
GB 15763.2-2005	<i>Safety Glazing Materials in Building - Part 2: Tempered Glass</i>
GB 15763.3-2009	<i>Safety Glazing Materials in Building - Part 3: Laminated Glass</i>
GB/T 22523	<i>Feeler Gauge</i>
GJB 150.12A-2009	<i>Laboratory Environmental Test Methods for Military Material - Part 12: Sand and Dust Test</i>
JB/T 2369	<i>Reading Microscope</i>
IEC 60068-2-78	<i>Environmental Testing - Part 2-78: Tests - Test Cab: Damp Heat, Steady State</i>
IEC 61215-2005	<i>Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval</i>

3 Terms and Definitions

5.12 Humidity and freezing resistance

Mean decrease of the effective solar transmittance after test shall not be greater than 1% and the film shall be free from obvious shedding, peeling and wrinkling.

5.13 Heat and humidity resistance

Mean decrease of the effective solar transmittance after test shall not be greater than 1% and the film shall be free from obvious shedding, peeling and wrinkling.

5.14 Ultraviolet resistance

Mean decrease of the effective solar transmittance after test shall not be greater than 1% and the film shall be free from obvious shedding, peeling and wrinkling.

5.15 Sand and dust resistance

Mean decrease of the effective solar transmittance after test shall not be greater than 1% and the film shall be free from obvious shedding, peeling and wrinkling.

5.16 Impact resistance

The specimen shall not be damaged after test.

5.17 Fragment state

The minimum quantity of fragments of each specimen within any area (50mm×50mm) shall not be less than 40, and a small amount of fragment strips with the length not exceeding 100mm are allowed to exist.

5.18 Shot-bag impact performance

The specimen must meet the requirements either a) or b);

a) Where the glass is broken, the total mass of the 10 largest fragments of each specimen shall not exceed the mass of specimen with 65cm² in area, and the length of any glass fragment without through crack reserved in frame shall not exceed 120mm;

b) Where the drop height of shot-bag is 1200mm, the specimen shall not be damaged.

5.19 Heat impact resistance

Anti-reflective coated glass shall be resistant to a temperature difference of 200°C without damage.

6 Test Methods

6.1 Dimension and its permissible deviation

6.1.1 Dimension inspection

Dimensions shall be measured with a steel ruler or steel tape with the minimum scale of 1mm.

6.1.2 Permissible deviation of diagonal line

The length of two diagonal lines of glass shall be measured with steel tape and the deviation of diagonal line shall be calculated according to Formula (1).

$$\Delta l = |l_1 - l_2| \dots\dots\dots (1)$$

Where,

Δl — the deviation of diagonal line, mm;

l_1 and l_2 — the length of two diagonal lines, mm.

6.1.3 Permissible deviation of thickness and thickness difference

The external micrometer or instrument with precision of 0.01mm shall be adopted for the measurement at the midpoints of the four sides 15mm away from the glass sheet sides. The arithmetic mean value of measuring results is the thickness which is rounded off to two digits after the decimal point (in mm). The difference between thickness and nominal thickness is calculated. The thickness difference between the same glass is the difference between the maximum value and the minimum value of the four measurement values.

6.2 Appearance quality

Product is taken as specimen, place the specimen vertically at the position 600mm away from the screen in an environment not affected by external light. The screen is black and opaque, and it is equipped with several 40W fluorescent lamps which are arranged with a spacing of 300mm. The observer shall be 600mm away from the specimen, with included angle between sight and specimen of $0^\circ \sim 60^\circ$, observe it back and forth as shown in Figure 1.

Metal ruler with division value of 1mm complying with GB/T 9056 and reading microscope with division value of 0.01mm complying with JB/T 2369 are adopted for measuring length and width.

6.6.4 Test procedures

6.6.4.1 Push the sharp point of the pencil on the coating surface by at least 7mm according to the procedures of 9.1~9.5 in GB/T 6739-2006.

6.6.4.2 After 30s, wipe it up with nonwoven fabric dipped with absolute ethanol; after drying, inspect the specimen surface under 200× microscope, observe whether there is visible scratch on the specimen surface.

6.6.4.3 If there is no scratch, repeat the test in the area which is not tested, replace the pencil with relatively high hardness until a scratch with length at least 3mm appears.

If a scratch with length exceeding 3mm appears, decrease the pencil's hardness, repeat the test until the scratch with length exceeding 3mm no longer appears.

6.6.4.4 Conduct parallel determination twice. If the two determination results are inconsistent, repeat the test.

6.6.5 Result expression

If a scratch with length exceeding 3mm does not appear on anti-reflective coated glass, the hardness of the hardest pencil is taken as the pencil hardness of the specimen.

6.7 Scrub resistance test

6.7.1 Test purpose

Determine attenuation of the effective solar transmittance τ and appearance change condition after the specimen is subject to certain strength of scrub test.

6.7.2 Specimen

Anti-reflective coated glass with dimension of 300mm×300mm or 430mm×150mm made of the same raw material and under the same process condition as the product is taken as the specimen, 3 pieces in total.

6.7.3 Apparatus and materials

Apparatus and materials shall meet the requirements of GB/T 9266-2009.

6.7.4 Test procedures

6.7.4.1 Put the side with membrane of the specimen upward to be in direct contact with the brush, conduct scrub resistance test according to the method in GB/T 9266-2009, 400 times of

reciprocating brushing in total.

6.7.4.2 After the test is completed, take out the sample, clean it with deionized water first and then absolute ethyl alcohol, place in a drying oven at $(110\pm 10)^{\circ}\text{C}$ for half an hour and cool to room temperature for measurement.

6.7.5 Result expression

Before and after the end of the test, respectively determine the effective transmittance τ of the uniformly distributed 5 points in the test area, then calculate the mean value. Finally calculate the difference between the mean values of the effective solar transmittance τ of each specimen before and after brushing resistance test.

6.8 Acid resistance test

6.8.1 Test purpose

Determine attenuation of the effective solar transmittance τ and appearance change condition after anti-reflective coated glass is subject to certain strength of acid environment.

6.8.2 Specimen

Product is taken as the specimen, or anti-reflective coated glass with dimension of $300\text{ mm}\times 300\text{ mm}$ made of the same raw material and under the same process condition as the product is taken as the specimen, 3 pieces in total.

6.8.3 Materials and reagents

Hydrochloric acid solution with concentration of 1 mol/L .

6.8.4 Test procedure

6.8.4.1 Immerse all the specimen in 1 mol/L hydrochloric acid at $(23\pm 2)^{\circ}\text{C}$ for 24h.

6.8.4.2 After the test is completed, take out the specimen, clean it with deionized water first and then absolute ethyl alcohol, place in a drying oven at $(110\pm 10)^{\circ}\text{C}$ for half an hour and cool to room temperature for measurement.

6.8.5 Result expression

Before and after the test is completed, respectively measure the effective solar transmittance τ in 5 areas in Figure 2 according to the requirements of 6.5, then calculate the mean value. Finally, calculate the difference between the mean values of the effective solar transmittance τ of each specimen before and after the test.

Product is taken as the specimen, or anti-reflective coated glass with dimension of 300mm×300mm made of the same raw material and under the same process condition as the product is taken as the specimen, 3 pieces in total.

6.10.3 Apparatus

Apparatus shall meet the requirements specified in Annex B.2.1.

6.10.4 Test procedures

6.10.4.1 Carry out heat cycle test according to the procedures in B.2.2 of Annex B, with 200 cycles.

6.10.4.2 After the test is completed, take out the specimen, clean it with deionized water first and then absolute ethyl alcohol, place in a drying oven at $(110\pm 10)^{\circ}\text{C}$ for half an hour and cool to room temperature for measurement.

6.10.5 Result expression

Before and after the test is completed, respectively measure the effective solar transmittance τ in 5 areas in Figure 2 according to the requirements of 6.5 and calculate the mean value. Finally, calculate the difference between the values of the effective solar transmittance τ of each specimen before and after the test.

6.11 Humidity and freezing resistance test

6.11.1 Test purpose

To determine the attenuation of the effective solar transmittance τ as well as appearance changes of anti-reflective coated glass, after it suffers from high temperature and high humidity as well as subsequent subzero temperature.

6.11.2 Specimen

Product is taken as the specimen, or anti-reflective coated glass with dimension of 300mm×300mm made of the same raw material and under the same process condition as the product is taken as the specimen, 3 pieces in total.

6.11.3 Apparatus

Apparatus shall meet the requirements specified in B.3.1 of Annex B.

6.11.4 Test procedures

6.11.4.1 Carry out humidity-freezing test according to the procedures in B.3.2 of Annex B, with 10 cycles.

6.11.4.2 After the test is completed, take out the specimen, clean it with deionized water first and then absolute ethyl alcohol, place in a drying oven at $(110\pm 10)^{\circ}\text{C}$ for half an hour and cool to room temperature for measurement.

6.11.5 Result expression

Before and after the test is completed, respectively measure the effective solar transmittance τ in 5 areas in Figure 2 according to the requirements of 6.5 and calculate the mean value. Finally, calculate the difference between the values of the effective solar transmittance τ of each specimen before and after the test.

6.12 Humidity and heat resistance test

6.12.1 Test purpose

To determine the attenuation of the effective solar transmittance τ as well as appearance changes of anti-reflective coated glass, after it suffers from long-term moisture vapor transmission.

6.12.2 Specimen

Product is taken as the specimen, or anti-reflective coated glass with dimension of $300\text{mm}\times 300\text{mm}$ made of the same raw material and under the same process condition as the product is taken as the specimen, 3 pieces in total.

6.12.3 Test procedures

6.12.3.1 Carry out the test according to IEC 60068-2-78. Put the specimen under room temperature without any pretreatment into climatic chamber.

6.12.3.2 Carry out the test under the following severe conditions:

—Test temperature: $(85\pm 2)^{\circ}\text{C}$;

—Relative humidity: $(85\pm 5)\%$;

—Test duration: 1000h.

6.12.3.3 After the test is completed, take out the specimen, clean it with deionized water first and then absolute ethyl alcohol, place in a drying oven at $(110\pm 10)^{\circ}\text{C}$ for half an hour and cool to room temperature for measurement.

To determine the attenuation of the effective solar transmittance τ after it suffers from certain intensity of dust blowing, sand blowing and dust falling.

6.14.2 Apparatus and materials

Sand and dust test chamber as well as sand and dust in accordance with GJB 150.12A-2009.

6.14.3 Specimen

Product is taken as the specimen, or anti-reflective coated glass with dimension of 300mm×300mm made of the same raw material and under the same process condition as the product is taken as the specimen, 3 pieces in total.

6.14.4 Test procedures

6.14.4.1 Carry out dust blowing, sand blowing and dust falling procedures according to the requirements specified in GJB 150.12A-2009. Thereinto, the dust blowing test concentration is $(10.6 \pm 7) \text{g/m}^3$ and the dust blowing speed is 8.9m/s; the sand blowing concentration is $(1.1 \pm 0.3) \text{g/m}^3$, the sand blowing speed is 18m/s ~ 29m/s and the sand blowing duration is 90min.

6.14.4.2 Take out the specimen, blow the sand and dust on its surface with wind, flush with distilled water and dry it in natural environment.

6.14.5 Result expression

Before and after the test is completed, respectively measure the effective solar transmittance τ in 5 areas in Figure 2 according to the requirements of 6.5, then calculate the mean value. Finally, calculate the difference between the values of the effective solar transmittance τ of each specimen before and after the test.

6.15 Impact resistance test

6.15.1 Specimen

Anti-reflective coated glass with dimension of $610^{+5}_{-0} \text{mm} \times 610^{+5}_{-0} \text{mm}$ made of the same raw material and under the same process condition as the product is taken as the specimen, 6 pieces in total.

6.15.2 Test devices

Test devices shall meet the requirements specified in Annex A, GB 15763.3-2009. The impact surface is kept level, with the film-coated side upwards.

6.15.3 Test procedures

Carry out the test according to the procedures of 6.5.3, GB 15763.2-2005.

6.16 Fragment state

6.16.1 Specimen

Product is taken as the specimen, 4 pieces in total.

6.16.2 Test devices

Any device capable of reserving the fragment pattern.

6.16.3 Test procedures

Carry out the test according to the procedures of 6.6.3, GB 15763.2-2005.

6.17 Shot-bag impact performance

6.17.1 Specimen

Product is taken as the specimen, or anti-reflective coated glass with dimension of 1930^{+5}_0 mm $\times$ 864^{+5}_0 mm made of the same raw material and under the same process condition as the product is taken as the specimen, 4 pieces in total.

6.17.2 Test devices

Test devices shall meet the requirements specified in Annex B, GB 15763.3-2009.

6.17.3 Test procedures

Carry out the test according to the procedures of 6.7.3, GB 15763.2-2005.

6.18 Heat impact resistance

6.18.1 Specimen

Anti-reflective coated glass with dimension of 300mm $\times$ 300mm made of the same raw material and under the same process condition as the product is taken as the specimen, 4 pieces in total.

6.18.2 Test procedures

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