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Performance film for automotive glass

汽车玻璃用功能膜

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Performance film for automotive glass

1 Scope

This document specifies the terms and definitions, classification and marking, requirements, test methods, inspection rules, packaging, marking, transportation, storage, etc. of performance films for automotive glass.

This document is applicable to the performance film, which is mounted on the inner surface of the motor vehicle window glass and the surface of the interior partition glass. The performance film mounted on the glass surface of other vehicles can use this standard as a reference.

2 Normative references

The contents of the following documents constitute the essential provisions of this document through normative references in the text. Among them, for dated references, only the version corresponding to the date is applicable to this document; for undated references, the latest version (including all amendments) is applicable to this document.

GB/T 191 Packaging - Pictorial marking for handling of goods

GB/T 1040.1-2018 Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1:2012, IDT)

GB/T 2680-2021 Glass in building - Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors

GB/T 3979 Methods for the measurement of object color

GB/T 5137.1-2020 Test methods of safety glazing materials used on road vehicles - Part 1: Mechanical properties tests (ISO 3537:2015, MOD)

GB/T 5137.2-2020 Test methods of safety glazing materials used on road vehicles - Part 2: Optical properties tests (ISO 3538:1997, MOD)

GB/T 11942 Test method of chroma for colour building materials

GB/T 16422.2-2014 Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc sources (ISO 4892-2:2006, IDT)

GB/T 29061 Performance films for glass in building

Using the specimen in 6.4, according to the method specified in 5.13 of GB/T 2680-2021, measure the spectral transmittance and reflectance of the glass surface as well as the emissivity of the film surface, at 780 nm ~ 2500 nm. Calculate the total solar infrared thermal energy transmittance. Calculate the total solar infrared thermal rejection, according to formula (2), expressed as a percentage. For products with stated nominal values, calculate the difference between each measured value and the nominal value; for products without stated nominal values, calculate the difference between each measured value and the average value. When grading solar infrared rejection, take the average value of 3 specimens.

$$r_{\text{IR}} = 1 - g_{\text{IR}} \quad \dots\dots\dots (2)$$

Where:

r_{IR} - Total solar infrared thermal rejection;

g_{IR} - Total solar infrared energy transmittance.

6.9 Secondary image deviation

Attach 3 pieces of performance film to the inner surface of the windshield glass of the automobile, that meets the requirement for the deviation of the secondary image specified in GB 9656. The mounting method shall be in accordance with the provisions of GB/T 31848. Place it under the environment as specified in 6.1 for 7 days. It shall be tested, according to the method specified in Chapter 6 of GB/T 5137.2-2020.

6.10 Optical distortion

Attach 3 pieces of performance film to the inner surface of the windshield glass, that meets the optical distortion requirements stipulated in GB 9656. The mounting method shall be in accordance with the provisions of GB/T 31848. Place it under the environment as specified in 6.1 for 7 days. It shall be tested, according to the method specified in Chapter 7 of GB/T 5137.2-2020.

6.11 Color consistency

6.11.1 Specimen

Cut a specimen, which has a length of 1000 mm and a width equal to the package width, at any position within a packaging unit. Take 5 samples of 50 mm x 50 mm, from the four corners and the middle of the specimen. The outer edge of the specimen is 50 mm from the edge of the film, as shown in the figure 4.

According to the spectrophotometric colorimetric method specified in GB/T 3979, measure the spectral transmittance of the specimen, under the red, yellow, green light sources that meet the chromaticity requirements specified in GB 14887. Use the CIE 1931 standard chromaticity system, to calculate the chromaticity coordinates.

Visually observe the colors of warning signs, prohibition signs, instruction signs, that comply with the provisions of GB 5768.2-2009, through the specimen.

6.13 Haze

6.13.1 Specimen

Mount three pieces of 100 mm x 100 mm performance film, on the same size of 3 mm flat glass, which has a visible light transmittance of $89\% \pm 1\%$, to make a specimen. See Appendix B for the mounting method. Place the specimen under the conditions specified in 6.1 for at least 24 h before the test.

6.13.2 Test device

The haze meter and abrasion meter shall comply with the provisions of GB/T 5137.1-2020.

6.13.3 Measurement

The initial haze shall be measured according to the method specified in 7.5.3 of GB/T 5137.1-2020. Then the specimen shall be cleaned and ground 100 rotations, according to the method specified in Chapter 7 of GB/T 5137.1-2020. Measure the haze after abrasion. Calculate the difference between the haze after abrasion and the initial haze.

6.14 Maximum tensile force at break and elongation at break

6.14.1 Specimen

Take 3 performance films of 200 mmx (25 mm $\pm$ 0.5 mm), as shown in Figure 5. It shall ensure that the edges of the specimen are neat and smooth without gaps. It shall be placed, at least 24 hours, under the conditions specified in 6.1, before the test.

6.17 Aging resistance

6.17.1 Specimen

According to the method in 6.15.1, respectively attach three 250 mm x (25 ± 0.5) mm performance films, to a 3 mm flat glass which is 125 mm x 50 mm AND has a visible light transmittance of 89% ± 1%, to make specimen. It shall be placed under the conditions specified in 6.1, for at least 7 days before the test.

6.17.2 Test device

The aging test chamber includes an irradiation system, a temperature control system, and a blackboard temperature measuring device. The light source of the irradiation system shall meet the requirements of GB/T 16422.2-2014, being equipped with the arc lamp with daylight filter or equivalent light source. The irradiance of the specimen surface is $1000 \text{ W/m}^2 \pm 75 \text{ W/m}^2$ in a wider passband (300 nm ~ 800 nm), or $110 \text{ W/m}^2 \pm 5 \text{ W/m}^2$ in a wide passband (300 nm ~ 400 nm), or $0.93 \text{ W/m}^2 \pm 0.02 \text{ W/m}^2$ in a narrow passband 340nm. The temperature of the blackboard inside the chamber is $63 \text{ }^\circ\text{C} \pm 3 \text{ }^\circ\text{C}$.

6.17.3 Measurement

Measure the visible light transmittance and ultraviolet transmittance of the specimen, according to 6.4 and 6.6, respectively. Measure the solar infrared direct transmittance of the specimen, according to the method specified in 5.13 of GB/T 2680-2021. Then put the specimen glass face up into the aging chamber. Take it out after continuous irradiation for 600 h. After standing for 24 hours under the conditions specified in 6.1, make observation. Then measure the visible light transmittance and ultraviolet transmittance of the specimen, according to 6.4 and 6.6. Measure the solar infrared direct transmittance of the specimen, according to the method specified in 5.13 of GB/T 2680-2021. Respectively calculate the visible light transmittance, ultraviolet transmittance, solar infrared direct transmittance difference. Measure the bonding force, according to 6.15.3.

6.18 Combustion resistance

6.18.1 Specimen

Attach three pieces of 300 mm x 76 mm performance film on a 3 mm flat glass, which is the same size, to make a specimen. See Appendix B for the attachment method. Place at least 7 days, under the conditions specified in 6.1, before the test.

6.18.2 Test device

The test device shall comply with the provisions of GB 8410.

6.18.3 Measurement

7.3.2 Exit-factory inspection

7.3.2.1 Appearance quality, size deviation, visible light transmittance

If the above-mentioned items meet the requirements of acceptance number in the exit-factory inspection sampling plan, which is formulated by the enterprise, the item is considered qualified.

7.3.2.2 Other inspection items to be determined through negotiation by supplier and purchaser

If all specimens required by each inspection item meet the requirements, the item is considered qualified.

7.3.2.3 Comprehensive judgment

If all the items required in 7.3.2.1 and 7.3.2.2 are qualified, the exit-factory inspection of this batch of products is considered to be qualified. If there is one unqualified item, this batch of products fail the exit-factory inspection.

8 Marking, packaging, transportation, storage

8.1 Marking

Packaging marks shall comply with the provisions of GB/T 191. It shall include product name, mark, factory name, factory address, trademark, specification, quantity, batch number, production date, implemented standards. It shall be marked with words such as "handle with care, avoid rain, avoid moisture".

8.2 Packaging

The product is packaged in sealed moisture-proof packaging. The packaging materials shall comply with relevant national standards.

8.3 Transportation

Product transportation shall comply with relevant national regulations.

Rainproof and sunscreen measures shall be taken during transportation.

8.4 Storage

The product is stored in a well-ventilated, rain-proof, moisture-proof, fire-proof place.

Appendix B

(Normative)

Mounting method of performance film sample

B.1 Mounting conditions

Except for specific requirements, mounting shall be carried out in a clean, dust-free, airtight room, at a temperature of $15\text{ }^{\circ}\text{C} \pm 25\text{ }^{\circ}\text{C}$ and a relative humidity of 50% ~ 75%.

B.2 Mounting tools

Cleaning installation fluid, watering can, cleaning scraper, wiper, water squeezing shovel, Teflon water squeezing sheet, film cutting knife, film cutting guide and ruler, lint-free absorbent paper towels, etc.

B.3 Mounting

B.3.1 Glass cleaning

Clean the glass. Remove the stains on the glass surface. Use a cleaning scraper to scrape off the dirt, if necessary. Use a lint-free absorbent paper towel, to wipe the glass, to ensure it is clean.

B.3.2 Mounting

B.3.2.1 Lamination

Remove the protective film from the cut performance film. Spray cleaning installation liquid evenly on the installation rubber surface and glass surface. Cover the film. Spray the cleaning installation liquid on the surface of the performance film. Use a wiper, to scrape back and forth on the performance film, in the horizontal direction for 2 ~ 3 times, to make the performance film stick to the correct position.

B.3.2.2 Water squeezing

Spray the cleaning installation liquid on the surface of the performance film again. First, move a squeeze shovel, starting from the top of the performance film, in the up, down, left, right direction. Squeeze the whole piece of glass, at the same pressure, angle, overlapping movements, to remove the cleaning installation fluid remaining between gap between the performance film and the glass. Before the final extrusion, use a film cutter to cut off the possible excess of the edge of the performance film. Then use a lint-free paper towel, to wrap the Teflon water squeeze sheet, to squeeze out the residual water using a steady force. At the same time, keep changing the position of the paper

Appendix C

(Normative)

Determination of formaldehyde emission in performance films for automotive glass by bag method - Solution absorption - phenol reagent spectrophotometry

C.1 Measuring range

This method is suitable for the determination of formaldehyde emission in performance films for automotive glass.

The detection limit of this method is 0.027 μg ; the lower limit of determination is 0.108 μg . When the specimen area is 0.18 m^2 , the inflated volume of the sampling bag is 5.0 L, the sampling volume of the absorption liquid is 1.0 L, THEN, the minimum detection concentration of the method is 0.001 mg/m^2 , the minimum quantitative concentration is 0.003 mg/m^2 .

C.2 Method principle

Use the bag method, to put the performance film for automotive glass into the sampling bag. Heat it at 60 $^{\circ}\text{C}$, to make free formaldehyde dissipate in the sampling bag. Use a large bubble absorption tube filled with phenol reagent, to collect gas samples. Formaldehyde reacts with phenol reagent, to produce azine. In acidic solution, azine is oxidized by iron ions to a blue compound, which is quantified by measuring the absorbance, at a wavelength of 630 nm by a spectrophotometer.

C.3 Reagents and materials

Unless otherwise stated, analytically pure chemical reagents in compliance with national standards are used for analysis; the distilled water is used for experiments.

C.3.1 Phenol reagent (3-methyl-2-benzothiazole hydrazone hydrochloride) solution, 1 g/L: Put it in a brown bottle. Store it in the refrigerator. This liquid is colorless and transparent. It gradually becomes red after standing and becomes darker. It can be stored for about 3 months (it is light red). If it is stored for a long time, small brownish red precipitates will appear, which can still be used after filtration; however, the background value of absorbance will increase.

C.3.2 Absorption solution: Use water to dilute 5 mL of phenol reagent solution (C.3.1), to make it to 100 mL. Prepare it before use.

C.3.3 Ferric sulfate solution, 10 g/L: Weigh 1 g of ferric ammonium sulfate $[\text{NH}_4\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}]$, superior grade. Dissolve it in 0.1 mol/L hydrochloric acid solution. Dilute to 100 mL. Store it in a brown bottle. It can be stored for 6 months in

D.3.2 Internal standard solution: $\rho = 2000 \mu\text{g/mL}$ or $2500 \mu\text{g/mL}$, commercially available certified internal standard solution (special for analysis of volatile organic compounds).

D.3.3 4-Bromofluorobenzene (BFB): $\rho = 50 \mu\text{g/mL}$.

For GC-MS performance test. Take an appropriate amount of chromatographically pure 4-bromofluorobenzene (BFB), to prepare it in a certain volume of methanol (D.3.1).

D.3.4 Standard stock solution: $\rho = 1000 \mu\text{g/mL}$.

Purchase a chromatographically pure target compound. Take a certain volume. Use methanol (D.3.1), to dilute it, to configure it as a standard stock solution of $1000 \mu\text{g/mL}$. Commercially available certified mixed standard solutions are also available.

D.3.5 Nitrogen: Purity $\geq 99.999\%$.

Oxygen and organic filters shall be installed in the carrier gas path. These filters shall be replaced periodically, according to the manufacturer's instructions.

D.3.6 High-purity nitrogen: Purity $\geq 99.999\%$.

D.3.7 Sampling bag: Made of polyvinyl fluoride (PVF), which has a capacity of 10 L, equipped with a gas inlet/outlet valve, sealed with PE strips.

D.3.8 Adsorption tube: Made of stainless steel, which has an inner diameter of 5 mm.

Combination 1 adsorption tube: Tenax GR and Carbopack B are installed inside, the lengths of which are 30 mm and 25 mm, respectively.

Combination 2 adsorption tubes: Carbopack B and Carboxen 1000 are installed inside, the lengths of which are 30 mm and 10 mm, respectively.

Combination 3 adsorption tubes: Carbopack C, Carbopack B, Carboxen 1000 are installed inside, the lengths of which are 13 mm, 25 mm, 13 mm, respectively. OR use another product with the same functionality.

D.3.9 Adsorbent: Tenax GR (specific surface area $35 \text{ m}^2/\text{g}$), Carbopack B (specific surface area $100 \text{ m}^2/\text{g}$), Carbopack C (specific surface area $10 \text{ m}^2/\text{g}$), Carboxen 1000 (specific surface area $1200 \text{ m}^2/\text{g}$), or other equivalent adsorbents such as domestic GDX-502 (specific surface area $170 \text{ m}^2/\text{g}$), GDX-201 (specific surface area $510 \text{ m}^2/\text{g}$), GDX-101 (specific surface area $330 \text{ m}^2/\text{g}$), etc. The particle size of commonly used adsorbents is generally 60 mesh $\sim$ 80 mesh.

D.4 Instruments and equipment

D.4.1 Constant temperature test chamber: The temperature control accuracy is $\pm 2^\circ\text{C}$.

D.4.2 Gas chromatograph: It has capillary column split/splitless inlet, capable of electronic pressure control of carrier gas, with programmable temperature rise.

D.4.3 Mass spectrometer: Electron impact (EI) ionization source, which is capable of scanning from 35 a mu to 270 amu, within 1 second. It has NIST mass spectrum library, manual/automatic tuning, data acquisition, quantitative analysis, spectral library search and other functions.

D.4.4 Chromatographic column: 100% methyl polysiloxane capillary column (column-1) or equivalent, which has an inner diameter of 0.18 mm, 0.25 mm, 0.32 mm, a film thickness of 1.0 μm, a length of 20 m ~ 60 m, can be selected according to needs.

D.4.5 Thermal desorption device: It can perform secondary thermal desorption on the adsorption sampling tube. Bring the carrier gas for desorption gas, into the gas chromatograph. The desorption temperature, desorption time, flow rate can be adjusted; the cold trap can realize quick temperature rise. Cold traps generally use semiconductor refrigeration. The part connected to the gas chromatograph of the thermal desorption device and the gas pipeline in the instrument shall use silanized stainless steel tubes, which can be heated uniformly, at least between 50 °C and 150 °C.

D.4.6 Adsorption tube aging device: The maximum temperature shall reach above 400 °C; the maximum carrier gas flow rate can reach at least 100 mL/min; the flow rate can be adjusted.

D.4.7 Oil-free sampling pump: The sampling flow rate shall be able to reach 20 mL/min ~ 500 mL/min. The sampling pump should adopt a sampling pump, which has a constant mass flow control; the flow accuracy shall not be lower than 2.5%.

D.4.8 Calibration of the flow meter: It can accurately measure the flow rate, within 5 mL/min ~ 500 mL/min; the flow rate accuracy shall not be lower than 2%; an electronic mass flow meter should be used.

D.4.9 Micro-syringes: 1.0 μL, 5.0 μL, 10.0 μL, 25.0 μL, 50.0 μL, 100 μL.

D.4.10 Vacuum pump: At least able to reach a negative pressure of 1.0 Pa x 10⁵ Pa.

D.4.11 Automatic inflation device for sampling bags: The inflation flow rate is 0.1 L/min ~ 50 L/min; the accuracy shall not be lower than 2.5%.

D.5 Sample collection

D.5.1 Bag method - Absorption tube sampling

D5.1.1 Sampling bag preparation: Set the temperature of the constant temperature test chamber to 90 °C. Heat the empty chamber for 0.5 h ~ 1 h. Stretch the sampling bag. Put it into the test chamber and heat it for more than 12 h. Test the background result of the sampling bag, before each use. When the blank value of the sampling bag is lower

Install the aged adsorption tube, on the thermal desorption standard sample loading platform (note that the inlet end of the adsorption tube faces the syringe). Use a micro-syringe, to take 1.0 μL of the prepared mixed standard solution. Inject it into the blank adsorption tube. At the same time, add 1.0 μL of 50 $\mu\text{g/mL}$ internal standard use solution (diluted with D.3.2). Use 50 mL/min N_2 , to purge the adsorption tube for 2 min. Quickly remove the adsorption tube. Use sealing caps, to seal the two ends of the adsorption tube, to obtain standard series of adsorption tubes, which have a content of 5.0 ng, 10.0 ng, 20.0 ng, 50.0 ng, 100 ng, respectively. The internal standard content of each adsorption tube is 50 ng.

D.6.2.2 Drawing of standard curve

Put the adsorption tubes of the standard curve series into the thermal desorption instrument. Perform analysis and determination, from low concentration to high concentration in sequence, according to the instrument reference conditions (D.6.1). According to the mass ratio of target/internal standard and the characteristic mass ion peak area (or peak height) ratio of target/internal standard, use the least square method or the relative response factor, to draw the standard curve.

D.6.3 Sample analysis

Referring to the standard sample loading step, add 50 ng of internal standard substance to the adsorption tube of the collected sample. Perform TD-GCMS analysis on the sample, according to the instrument reference conditions (D.6.1).

D.6.3.1 Qualitative analysis

Qualitative by retention time and mass spectrum comparison.

D.6.3.2 Quantitative analysis

According to the external standard method, the internal standard curve method or the mean value of the average relative response factor of each point of the curve (the relative standard deviation of the relative response factor $\leq 30\%$, the relative response factor ≥ 0.010), calculate the content of the target component.

D.6.4 Blank test

Follow the same procedure as the sample analysis, to analyze the blank sample.

D.7 Calculation and presentation of results

D.7.1 Calculation of release amount

The release amount of benzene series in the performance film for automotive glass is calculated, according to formula (D.1):

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