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Test method for spectral transmittance of quartz glass

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3 Terms and definitions

The document defines no terms of its own; the terms of GB/T 13962 on optical instruments and of JC/T 2205 on quartz glass apply.

4 Principle

Spectral transmittance, which the document notes is also called spectral transmission or spectral light transmission, is measured on a spectrophotometer over a stated wavelength range. At each wavelength it is the ratio of the intensity of the light passing through the specimen to the intensity of the light falling on it, expressed as a percentage.

5 Apparatus

The spectrophotometer is held to a maximum permitted wavelength error of ± 1.0 nm in the ultraviolet and ± 4.0 nm in both the visible and the near infrared, and to a maximum permitted transmittance error of ± 1.0 per cent in the ultraviolet and in the visible; no transmittance figure is set for the near infrared.

Where the geometry is normal illumination with normal collection, written as 0 degrees over 0 degrees, the angle between the axis of the illuminating beam and the normal to the specimen surface is not to pass 10 degrees, and the angle between any ray of that beam and the axis is not to pass 5 degrees.

Where the geometry is normal illumination with diffuse collection including the specular component, written as 0 degrees over di, an integrating sphere is needed, preferably of at

least 150 mm diameter, fitted inside so that directly transmitted and once transmitted light cannot reach the detector.

A specimen holder is called for when a curved specimen cannot otherwise be held with the incident light perpendicular to the measured spot. It has to be stiff and hard to deform, with its upright face square to its base, to sit steadily in the specimen beam of the spectrophotometer, and to hold the specimen upright without letting it twist. A note observes that the size of holder needed varies with the size of the specimen chamber and of the specimen, and points to the example given in the annex.

An aperture is called for when the incident spot has to be made smaller. It has to be stiff and hard to deform, to stand square in the specimen beam, and to carry a central slit or hole that narrows the spot to less than the measured area of the specimen; it may be, for instance, a series of 2 mm thick metal plates with central slits or holes of suitable width. Vernier calipers or other measuring instruments are to read to 0.02 mm or finer.

6 Test specimens

A flat specimen is preferably longer than 40 mm and wider than 5 mm, with a thickness between the two measured faces preferably under 10 mm; the difference between the largest and the smallest thickness across the measured face is to stay under 0.5 mm. One piece is needed.

A curved specimen is preferably taller than 40 mm. A tube of 20 mm diameter or less is cut along its diameter into half tubes and any one length of half tube is taken; where the diameter is under 12 mm, meaning an inside diameter under 12 mm for thick walled quartz tube, a specimen of more than 12 mm diameter made from the same raw material by the same process is preferably used instead. From a tube of more than 20 mm diameter a specimen is cut with a chord length preferably between 20 mm and 40 mm. One piece is needed.

Examined by eye in daylight, the measured faces are to be free of scratches, score marks, bubbles, air lines and other defects that would affect the measurement, unless something else has been agreed. Where the two measured faces are cut faces they are to be mechanically polished. They are to be kept clean, and may be cleaned by wiping with absolute ethanol, by rinsing with deionised water and wiping or drying, or in an ultrasonic cleaner followed by wiping or drying.

7 Test procedure

The geometry is chosen first, either normal illumination with normal collection or normal illumination with diffuse collection including the specular component.

For a flat specimen the thickness of the measured face is taken at not fewer than three points with vernier calipers and the arithmetic mean, rounded to one decimal place, is

recorded as the specimen thickness. The spectrophotometer is switched on and left to warm up for not less than 10 min, the wavelength range and interval and the other parameters are set, and the instrument is adjusted as its manual directs. Under normal collection the specimen is placed in the specimen beam near the focal plane of the incident beam, with the light perpendicular to the measured spot; under diffuse collection it is placed hard against the entrance port of the integrating sphere. Where the specimen is smaller than the incident spot, an aperture is put in front of it and the spot adjusted so that all of it falls on the measured area. The scan is then started and the transmittance curve recorded.

For a curved specimen the thickness is taken at both ends and the arithmetic mean, rounded to one decimal place, is recorded. Warm-up and instrument setting follow the flat case. The instrument is then set to a visible wavelength and the spot is adjusted and watched: under normal collection by narrowing the instrument slit or fitting an aperture in front of the specimen and looking at the image of the spot cast on flat graph paper held near the focal plane, and under diffuse collection by fitting an aperture and looking at the image at the entrance port of the sphere, in both cases until the spot is the right size. A note adds that a curved specimen of more than 20 mm diameter needs no spot adjustment. The instrument is then adjusted again as its manual directs. The specimen is set with its concave face towards the source: under normal collection it stands upright in the beam near the focal plane, its convex face against the holder where a holder is needed, with the light perpendicular to the measured spot; under diffuse collection its convex face is placed hard against the entrance port of the sphere. The scan is then started.

8 Data processing and report

The curve and the data may be treated in either of two ways, as required. The transmittance at a stated wavelength may be read off and recorded, rounded to one decimal place unless something else has been agreed. Or a mean over a stated wavelength range may be calculated, the transmittance values at the agreed wavelength interval being summed and divided by their number, again rounded to one decimal place unless something else has been agreed.

The report gives at least the name, size and number of specimens; the number of the document the test follows; the wavelength range and interval; the measuring geometry, the results and the measured specimen thickness; anything about the measurement that needs saying; and the report number, the test date and the name and model of the instrument.

A Annex A, incident spot size and specimen holder

An informative annex explains that the incident spot differs in height and width from one instrument to another, that a spot shorter than the specimen does not affect the result, and that spot width is therefore the quantity that matters. On a curved specimen a suitable spot width keeps the incident light close to perpendicular to the measured spot and so cuts

down the refraction and reflection the curvature causes.

Two tables of recommended widths are given, in millimetres, against specimen diameter. Under normal illumination with normal collection the spot width is not to pass 1.0 mm for diameters above 6 mm up to 12 mm, and not to pass 2.1 mm for diameters above 12 mm up to 20 mm. Under normal illumination with diffuse collection the spot width is not to pass 1.0 mm for diameters above 6 mm up to 8 mm, 2.1 mm for diameters above 8 mm up to 10 mm, and 3.4 mm for diameters above 10 mm up to 20 mm.

The annex also explains why a holder is offered: a small diameter specimen is strongly curved, and if it twists as it is set down the refraction or reflection that follows will affect the result. A drawing of one holder is given in plan and elevation, its shape and dimensions being offered for reference only.