International Standard ISO 6719

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Anodized aluminium and aluminium alloys — Measurement of reflectance characteristics of aluminium surfaces using integrating-sphere instruments

Aluminium et alliages d'aluminium anodisés — Mesurage des caractéristiques de réflectivité des surfaces d'aluminium à l'aide d'instruments intégrateurs sphériques

First edition — 1986-08-15

UDC 669.718.915 : 535.346.1 **Ref. No. ISO 6719-1986 (E)**

Descriptors : aluminium, aluminium alloys, oxidation, anodizing, tests, determination, reflection factor, test equipment, reflectometric analysis.

Price based on 6 pages

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 6719 was prepared by Technical Committee ISO/TC 79, *Light metal and their alloys.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Anodized aluminium and aluminium alloys — Measurement of reflectance characteristics of aluminium surfaces using integrating-sphere instruments

1 Scope and field of application

This International Standard specifies a method of measuring the total and diffuse luminous reflectance characteristics of aluminium surfaces, using integrating-sphere instruments.

The method is equally applicable to the measurement of specular reflectance (principal gloss value), specularity, and diffuseness.

2 Reference

ISO 7724/2, *Paints and varnishes — Colorimetry — Part 2: Colour measurement.*

3 Principle

Measurement, by means of an integrating-sphere instrument, of the total and diffuse reflected light at different angles of incidence close to the normal to the surface of a test specimen.

4 Apparatus

4.1 General

Instruments[1] for the measurement of reflectance (reflectometers) of metallic surfaces consist of

- a suitable light source;
- an integrating sphere;
- a photo-electric cell;
- a signal multiplier;
- recording, indicating, or computing equipment.

The incident light beam is allowed to fall onto the specimen and is reflected into a sphere, the interior of which is white, where it is automatically integrated. The average light flux, as measured by the photometer, is a measure of the quantity of the reflected light. Figures 1 to 4 show the optical systems of typical instruments for measuring reflectance. The spectral product of the light source, spectral filters, and spectral response of the light detector shall closely simulate the spectral product of the CIE source C (or D65) and the spectral luminous efficiency $V(\lambda)$ for photopic vision.

4.2 Geometrical specifications of the apparatus

4.2.1 Integrating sphere

The interior of the sphere, coated white and fitted with a device to permit measurement of reflectance, either including or excluding specular reflectance, serves to collect the reflected light flux.

Any diameter of sphere is satisfactory, provided that the total port area does not exceed 5 % of the total internal surface.

The internal surface shall be diffusing and of a highly reflective white for the whole of the visible spectrum. The entrance and specimen ports of the instrument shall be centred on the same great circle with more than 170° of arc between their centres. The specimen port shall subtend 8° ± 1° of arc in relation to the centre of the entrance port. The irradiating beam shall pass through the centreline of the entrance and specimen ports. A photometer shall be positioned on the sphere at 90° ± 0,5° from the entrance port.

4.3 Specular included (ϱ) and specular excluded (ϱ_d) determinations

4.3.1 Pivotable sphere

In the pivotable-sphere type of instrument (figures 1 to 3), the sphere can turn about a vertical axis passing through the specimen port, rotating 9° ± 1° to provide for the measurements of specular included or total reflectance (ϱ) and specular excluded or diffuse reflectance (ϱ_d).

1) Information on suppliers of apparatus can be obtained from the ISO Central Secretariat.

4.3.2 Fixed sphere (type 1)

In the fixed-sphere type 1 instrument, the specimen is held so that the incident beam falls on it at an angle of 9° ± 1° to the normal. A port, of the same dimensions as the entrance port, is provided so as to accept the specular reflection. Interchangeable caps are provided for this port, a black one to absorb the specular reflection for diffuse reflectance (ϱ_d) measurements and one coated with the same material as the inside of the sphere for total reflectance (ϱ) measurements.

4.3.3 Fixed sphere (type 2)

In the fixed-sphere type 2 instrument (figure 4), the sphere is fixed and only the specimen can be inclined. A wedge, as shown in figure 4, designed to exclude ambient light and white coated like the sphere interior, allows adjustment of the angle of the specimen surface. For measurement of diffuse reflectance (ϱ_d), the specimen surface is adjusted to be perpendicular to the incident beam. For measurement of total reflectance (ϱ), the specimen surface is inclined at 9° ± 1° from the normal incident beam by insertion of the wedge.

4.4 Irradiating beam

The light beam shall be substantially unidirectional with a maximum angle of any ray being less than 3° from the axis of the beam. It shall not be vignetted at either port.

The incident light beam shall have a circular cross-section concentric with the specimen port and shall have an annulus of 1,3° ± 0,1° subtended at the entrance port. On reflection from a first surface mirror, the specular-excluded beam shall be concentric with the centre of the port when the sphere is in the specular-excluded position. The mirror-reflected beam shall have a concentric circle with the port and shall have an annulus of 0,6° ± 0,2° subtended at the level of the exit port. The exit port shall have the same size as the annulus and shall be at most greater by 0,1°.

NOTE — The dimensions of this beam can be most easily measured at a point at a distance corresponding to the diameter of the integrating sphere beyond the sphere with no obstruction at either port. However, this will not ensure alignment when specularly reflected.

4.5 Housing

A housing shall prevent ambient light from entering the entrance port.

5 Calibration and operation

5.1 General

The instrument shall be operated and calibrated in accordance with the manufacturer's instructions.

5.2 Reference standards

5.2.1 A white primary standard shall be employed consisting of a pressed barium sulfate powder tablet prepared in accordance with ISO 7724/2.

5.2.2 The zero of the instrument shall be calibrated using a black surface or light trap standard by recording the values of total and diffuse reflectance. A black velvet textile surface should read 0,2 to 0,5 % total reflectance.

5.2.3 A first surface mirror, calibrated for both total and diffuse reflectance against the primary standard, shall be used as a working standard. The total reflectance shall be greater than 90 % and diffuse reflectance 0,2 to 1,5 %.

6 Measurement

Take three measurements of both total and diffuse reflectance on the surface for each specimen orientation. Orientate the specimen at angles of 0°, 45° and 90° between the machine direction of the specimen and the plane of measurement (optical plane) of the instrument. Calculate the average values.

7 Calculation of reflectance values

7.1 Specularity

Compute the specular reflectance ratio, R_d, as follows:

$$R_d = \frac{\varrho_r}{\varrho}$$

$$\varrho_r = \varrho - \varrho_d$$

where

ϱ_r is the average specular reflectance (or principal gloss value);

ϱ is the average total reflectance;

ϱ_d is the average diffuse reflectance.

7.2 Diffuseness

Compute the diffuse reflectance ratio, D, as follows:

$$D = \frac{\varrho_d}{\varrho}$$

8 Calculation of directionality

8.1 Record separately the measurements made at angles of 0° and 90° (see clause 5) to the machine direction of the specimen. 0° is defined as with (w) and 90° as against (a) the machine direction.

Compute $R_{d,w}$ and $R_{d,a}$ as in 7.1. For surfaces primarily of a diffuse nature, use the D value.

8.2 Compute the directionality, as a percentage, as follows:

$$\text{Directionality} = \frac{R_{d,w} - R_{d,a}}{R_{d,w}} \times 100$$

9 Test report

The test report shall include the following information:

a) a reference to this International Standard;

b) description or other identification of the specimens and the methods of preparing the specimens;

c) the type of instrument used, including the manufacturer's name and model.

d) the average specular reflectance (or principal gloss) value, the average total reflectance value, and the average diffuse reflectance value;

e) the specularity or diffuseness value;

f) the directionality.

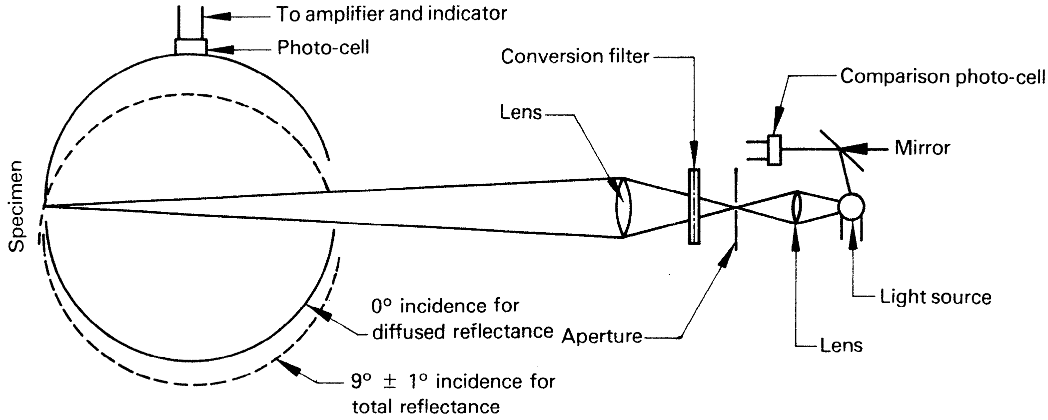


Figure 1 — Schematic optical plan of a pivotable-sphere reflectometer

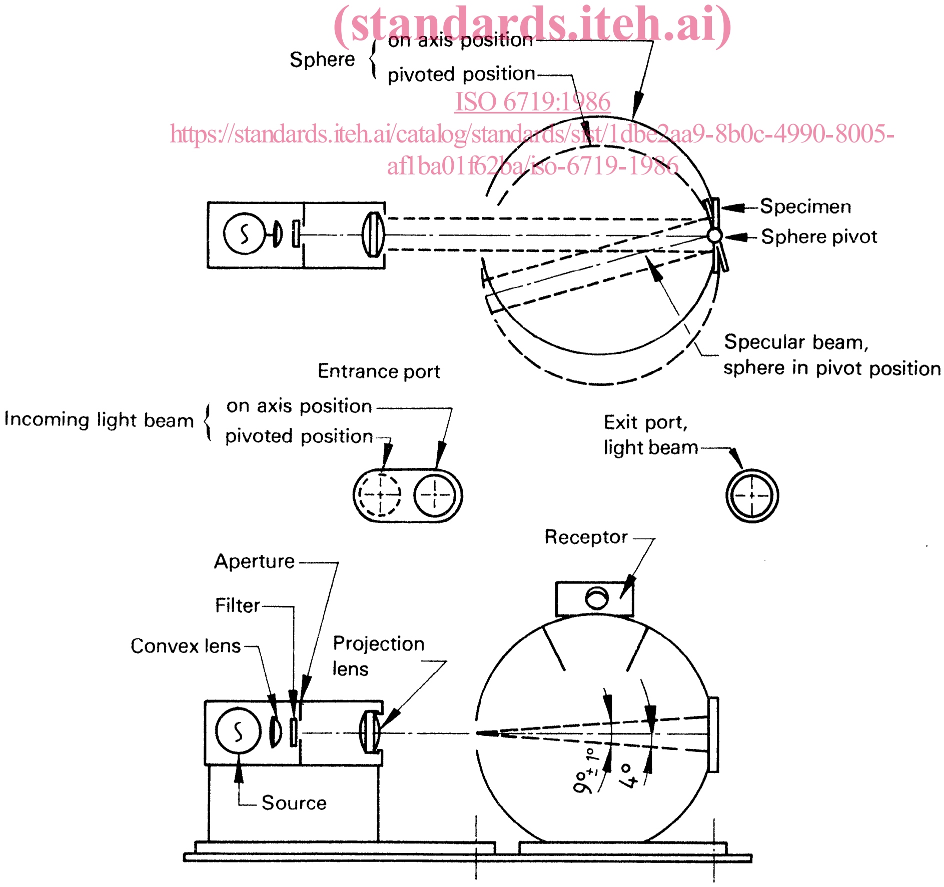


Figure 2 — Geometry of a pivotable-sphere reflectometer

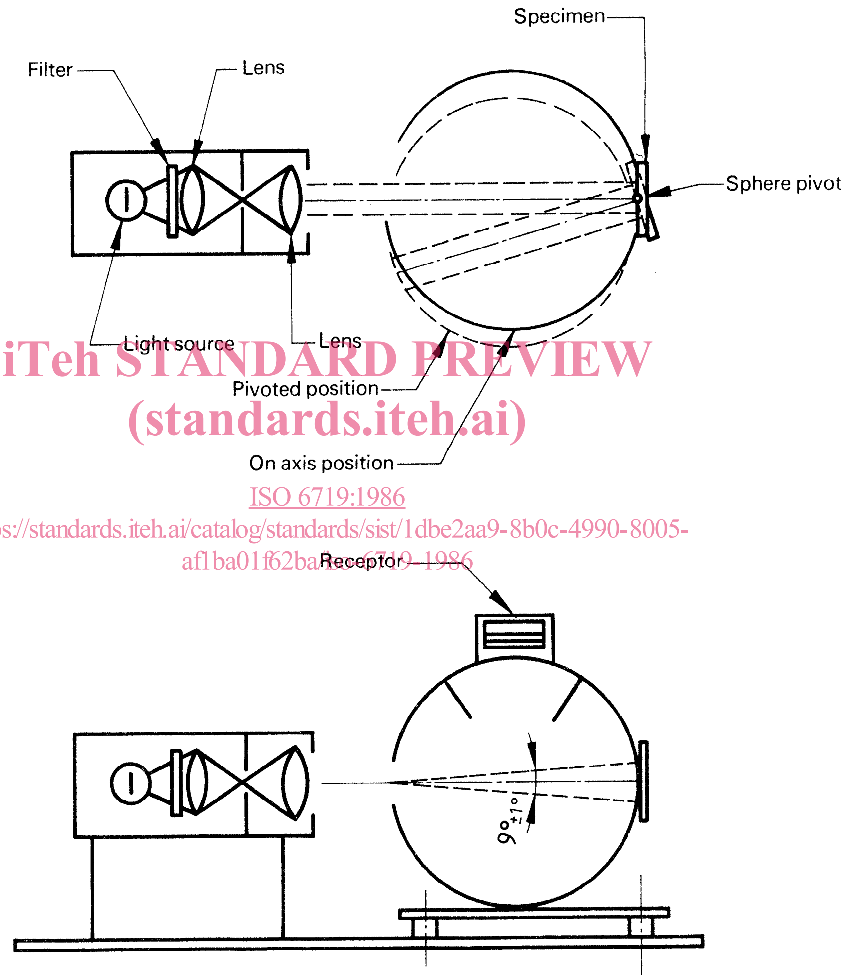
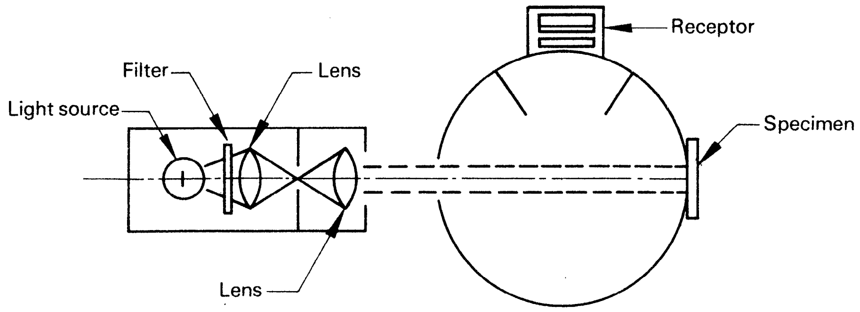
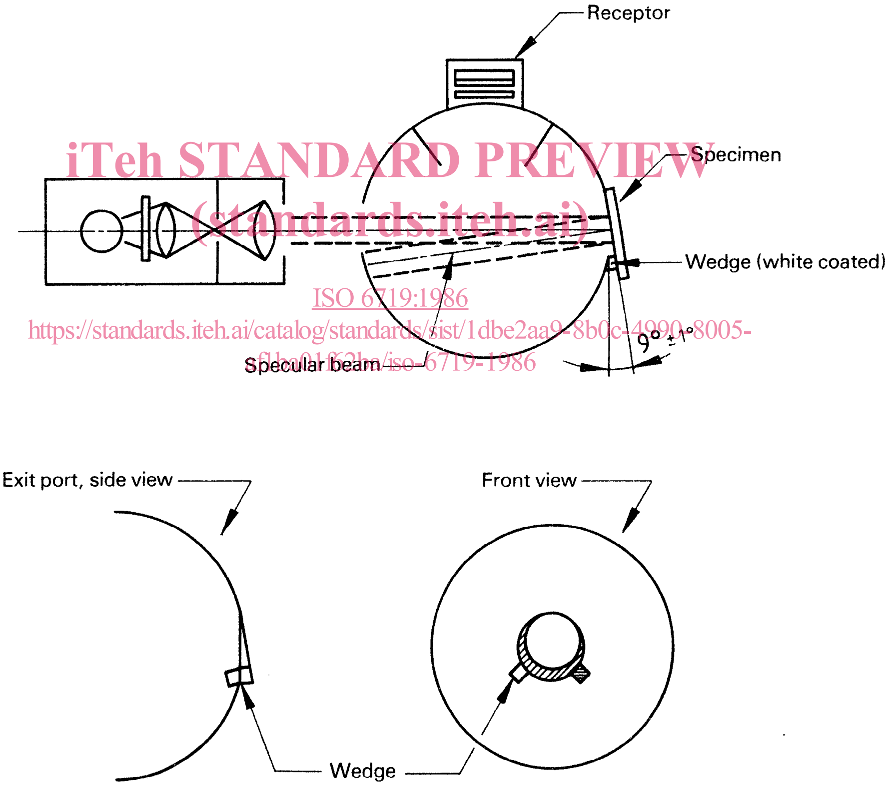


Figure 3 — Geometry of a pivotable-sphere reflectometer



Specular excluded



Specular included

Figure 4 — Geometry of fixed-sphere (type 2), specimen-inclining reflectometer