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Application News

Spectrophotometric Analysis No.A424

Determination of Solar Reflectance of Paint Film in Accordance with JIS K5602

When light that is radiated from the sun (solar radiation) reaches the surface of the earth, not only does it pass through window glass to raise the indoor temperature, after being absorbed and accumulated in the roof material and wall material of the building, it is discharged as heat both inside and outside of the building whether it is day or night. Therefore, construction of roofs and rooftops using paint coatings with high solar reflectance significantly enhances cooling efficiency and effectively reduces the urban heat island phenomenon.

JIS K5602 "Determination of reflectance of solar radiation by paint film" is a test method used for evaluating the solar reflectance of such paint coatings. Here we introduce the measurement of solar reflectance of paint film according to this test method. Other articles that we have published regarding solar reflectance include one for glass plate, Application News No. A404 "Glass Plate Analysis in Accordance with JIS R3106," and another for glazings, No. A412 "Analysis of Adhesive Films for Glazings Conducted in Accordance with JIS A5759."

■ Measurement of Spectral Reflectance

Reflectance measurement is conducted in the wavelength range of 300-2500 nm using a UV-VIS-NIR spectrophotometer equipped with an integrating sphere. A fluorine resin standard white plate calibrated by an official agency is used as the standard sample, and light is irradiated onto the sample from the lamp at an angle of incidence not exceeding 15°. The sample is prepared by coating a hiding power test paper with test paint, however, when using baking finish type paints, it is acceptable to perform coating on a material other than the hiding power test paper.

■ Calculation of Solar Reflectance

The solar reflectance is obtained by multiplying the measured spectral reflectance by the weight coefficient to calculate the average weighting. In that case, the solar reflectance is determined for each of 3 wavelength regions, the region from ultraviolet to visible (300-780 nm), the near infrared region (780-2500 nm), and the entire wavelength region (300-2500 nm). The standard sunlight weight coefficient is specified in JIS K5602.

$$\rho_e = \frac{\sum_{\lambda}[(E\lambda \times \Delta\lambda) \times \rho(\lambda)]}{\sum_{\lambda}(E\lambda \times \Delta\lambda)} \quad (1)$$

ρ_e : Solar reflectance (%)
$\rho(\lambda)$: Spectral reflectance (%)
$E\lambda \times \Delta\lambda$: Standard sunlight weight coefficient (W/m²)
λ : Wavelength (nm)

■ Measurement of Solar Reflectance due to Paint Film

We conducted measurement of 3 types of paint films (paint films 1-3) coated on the hiding power test paper. For measurement we used the UV-3600 UV-VIS-NIR spectrophotometer with the ISR-3100 integrating sphere attached, and the analytical condition shown in Table 1. Fig. 1 shows the sample mounted in the instrument, and Fig. 2 shows the measurement results.

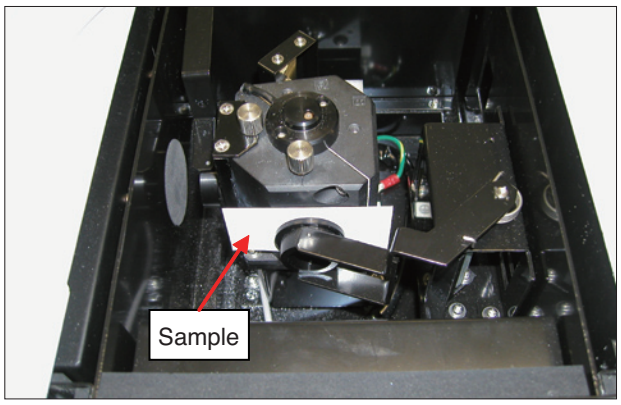

Fig. 1 Photograph of a Sample Mounted on ISR-3100

It is clear from Fig. 2 that paint film 1 generates lower reflectance than the other two films over the entire wavelength region. Paint film 2 shows the same level of reflectance as paint film 3 in the near infrared region above 1200 nm, but from 1200 nm into the visual region, the reflectance is lower than that of paint film 3.
Next, we obtained the solar reflectance values for each of the paint films from the obtained spectral reflectance and equation (1). Table 2 shows calculated results for each of the wavelength regions.
For the calculation we used "the Solar Reflectance Calculation Excel Macro for Paint Film" special software developed specifically for solar reflectance measurement according to JIS K5602. This is a macro program which, by just selecting the measured spectral reflectance data, automatically calculates the solar reflectance at each wavelength region on Excel®(1), while at the same time displays the spectral reflectance spectra.

< Acknowledgment >
The measurement samples introduced here were kindly provided by the Marketing Group at Dai Nippon Toryo Co., Ltd, General Paints Section, Architectural Coating Dept.

(1) Excel is a registered trademark or trademark of the Microsoft Corporation.

Table 1 Analytical Conditions of UV-VIS-NIR Spectrophotometer

Analytical Instrument	: UV-3600, ISR-3100 (Integrating sphere accessory)
Angle of Incidence	: 8°
Measurement Wavelength Range	: 300 nm - 2500 nm
Scan Speed	Medium
Sampling Pitch	: 0.5 nm
Slit Width	: (20) nm
Lamp Switching Wavelength	: 290 nm
Grating Switching Wavelength	: 720 nm
Detector Switching Wavelength	: 870 nm

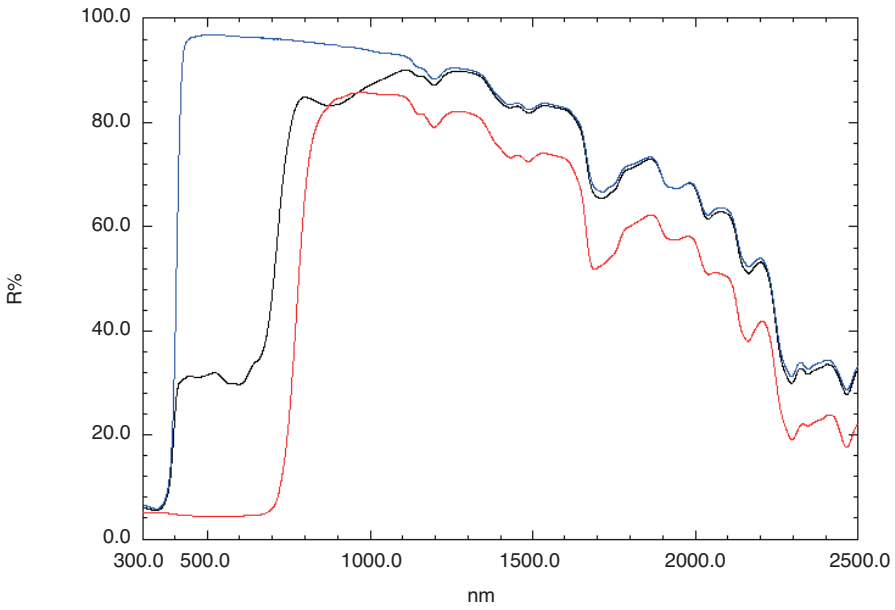

Fig. 2 Reflectance Spectra of Paint Films

Table 2 Results for Solar Reflectance of Paint Film

Sample	Near UV-VIS Region 300-780 nm	Near Infrared Region 780-2500 nm	Entire Wavelength Region 300-2500 nm
Paint film 1	7.72 %	74.67 %	36.78 %
Paint film 2	37.51 %	81.80 %	56.48 %
Paint film 3	89.07 %	87.13 %	88.12 %

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