

Author

Steve Upstone

PerkinElmer, Inc.
Seer Green, UK

Measurement of Total Solar Reflectance of Paint Panels using PerkinElmer UV/Vis/NIR Spectrophotometers and UV WinLab Software

Paint manufacturers are interested in the reflectivity of their products. This characteristic involves properties in both the visible region where color is important as well as extending into the Near Infrared (NIR) region where the properties of the paint with respect to solar radiation are important. In particular, the most important aspect is the degree of reflectivity. The

paint may be designed to retain heat, in which case a low total solar reflectance (TSR) may be required. Alternatively, a high total solar reflectance may be desirable if the purpose of the paint is to prevent the treated surface from heating up.

The range over which measurement is made is generally between either 280 or 300 nm and 2500 nm. The upper limit is normally dictated by the fact that an integrating sphere is required to measure the reflectance and the most commonly used material used in these accessories is Spectralon® which is a proprietary white sintered PTFE material which absorbs strongly above 2500 nm

The total solar reflectance calculation requires taking the raw reflectance data and applying solar weighting factors for each wavelength collected. These factors and calculations are contained within the respective norms (e.g. ASTM® G 173). It would be possible to perform these calculations by taking the raw data and using a spreadsheet but this is tedious – particularly if the number of samples is large – and less convenient in a QC environment where an instant result is more convenient.

UV WinLab™ v6 has a powerful in-built calculator which allows these types of calculations to be performed automatically and placed in a customized report.

Some spectra for typical paint samples are given in Figure 1.

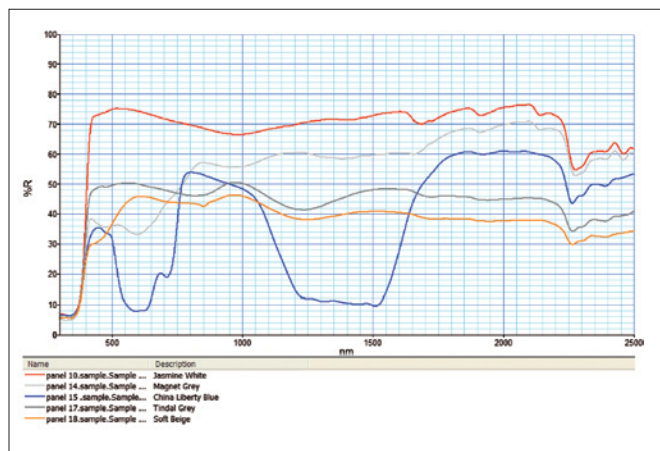


Figure 1. Reflectance spectra of painted panels (measured using LAMBDA 950 and 150 mm integrating sphere).

Current Standards

Table 1 is a summary of the most commonly used standards for measuring and/or calculating total solar reflectance in paints. Most manufacturers have now embraced the new ASTM® G173 standard but the others are still in use despite being officially withdrawn.

Output of Results

A typical report (generated using the method and template that is available from PerkinElmer on request) is shown in Figure 2.

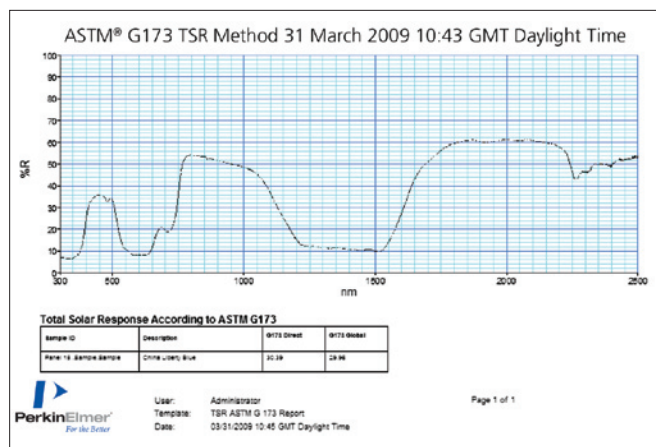


Figure 2. UV WinLab Report of TSR according to ASTM® G 173.

The calculations and report are generated automatically and do not require any additional intervention by the user. It is also possible to import previously generated UV WinLab data into the method to allow re-calculation. This method is also compatible with some types of data generated in previous generation PerkinElmer UV software packages (please check with us for confirmation).

Recommended Instrumentation

It is possible to measure TSR using either a 150 mm or 60 mm integrating sphere. The 150 mm sphere gives near theoretical accuracy due to its construction and low port fraction. The LAMBDA™ 750 with 60 mm integrating sphere will give values to within around 2% of theoretical values. This makes it suitable for quality control applications where this uncertainty can be factored into the pass/fail criteria.

We recommend the InGaAs based integrating sphere for situations where extremely low noise is required or where sample throughput is very high (as the scan speed on the InGaAs sphere is around 5x faster for an equivalent result to PbS in the NIR region).

Table 1		
Standard	Title	Notes
ASTM® G173 ⁽¹⁾ (2003 revised in 2006)	Standard Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37 degree Tilted Surfaces	Replaces withdrawn ASTM® E891 and 892
ASTM® E903 (1996)	Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres	Withdrawn – no equivalent
ASTM® E891-87 & E892-87, ASTM® G159	Standard Tables for Terrestrial Solar Spectral Irradiance at Air Mass 1.5 for a 37 degree Tilted Surface	Withdrawn – replaced by G173

The systems we recommend are:

LAMBDA 950 or **LAMBDA 1050** UV/Vis/NIR Spectrophotometer (with v6 UV WinLab) **150 mm Integrating Sphere** (either L6020204 PMT/PbS or L6020322 PMT/InGaAs versions). *Please note that the PMT/InGaAs sphere is compatible with both the LAMBDA 950 and 1050.*

Or

for routine QC applications as indicated earlier in this note, **LAMBDA 750** UV/Vis/NIR Spectrophotometer (v6 UV WinLab) **60 mm PMT/PbS Integrating Sphere** (L6020203, there is no 150 mm sphere or PMT/InGaAs option for the LAMBDA 750). There is also a dedicated sphere-only version of the LAMBDA 750 – the LAMBDA 750S.

The earlier LAMBDA 900 (with either 60 mm or 150 mm PMT/PbS integrating spheres but not the InGaAs equivalents) can also be used for this analysis but it will be necessary to upgrade the operating software and firmware to the latest specification.

References

1. ASTM® G173 (www.astm.org)
2. Renewable Resources Data Center (www.nrel.gov/rrredc/) and <http://rrredc.nrel.gov/solar/spectra/am1.5/>