

Test Methods for Solar Characteristics of Building Materials with UV-Vis-NIR Spectroscopy

Methods, calculations, and reports for ASTM standards performed with the Agilent Cary 5000 and 7000 UV-Vis NIR spectrophotometers

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Abstract

In this application note, an end-to-end method using an Agilent Cary 5000 UV-Vis spectrometer with an Agilent External DRA-2500 attachment was demonstrated to measure the UV-Vis spectrum of four painted aluminum coupons following the standard methods described in ASTM E903-20 and E1980-11r19. The optical properties of the samples were calculated and reported within the Agilent Cary WinUV software. Overall, the demonstrated method represents an ideal solution for high-throughput research and development of building materials.

Introduction

In modern building design, the choice of materials for facades, roofing, and paving has enormous consequences for the comfort of a building's occupants as well as the energy efficiency of its cooling and heating systems. From the effect of the roofing pitch to the color and texture of building cladding, understanding the optical properties of a material in terms of the solar radiation wavelength range is imperative for determining whether it is fit for a particular application.

To determine useful optical and thermal information about various materials, standard methods have been developed by national and international groups that aim to provide reproducible data that can be compared across different materials and test laboratories. These methods generally aim to characterize the absorptance, reflectance, and transmittance of materials in the solar wavelength region (~ 300 to 2,500 nm) and use various spectroscopic techniques and instrumentation.

The example provided in this application note uses two ASTM standard methods and the Cary 5000 UV-Vis spectrophotometer with an external diffuse reflectance accessory (DRA)—the External DRA-2500—to determine two important solar material properties of painted aluminum samples: the total solar reflectance (TSR) and solar reflectance index (SRI). The standards followed are:

- E903-20: Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
- E1980-11r19: Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces

Experimental

The Cary 5000 UV-Vis spectrophotometer with the External DRA-2500 attachment (Figure 1) was used to measure the UV-Vis spectrum of four painted aluminum coupons following the standard methods described in ASTM E903-20 and E1980-11r19. The Agilent Cary 5000 and 7000 UV-Vis spectrophotometers are high-precision instruments that provide excellent photometric performance in the required solar wavelength range. Plus, they are easily combined with the External DRA-2500 to allow for both diffuse and specular reflectance and transmittance measurements of a wide variety of sample types.

The integrating sphere of the External DRA-2500 permits simultaneous measurement of reflectance and transmittance, which is required to fulfill the requirements of both TSR and SRI standards.



Figure 1. Agilent Cary 5000 UV-Vis spectrophotometer with External DRA-2500.

Results and discussion

The calculations required to determine the TSR and SRI of the sample are provided by the ASTM methods E903-20 and E189-11r19. The Cary WinUV software, version 6.6, features the ability to perform both calculations within the software (Figure 2) and generate a single report (Figure 3) containing all the relevant information required for the standards. To perform the calculations within Cary WinUV software, the thermal emissivity of the material (calculated following the ASTM standard C1371-15r22) was entered as part of the sample name.

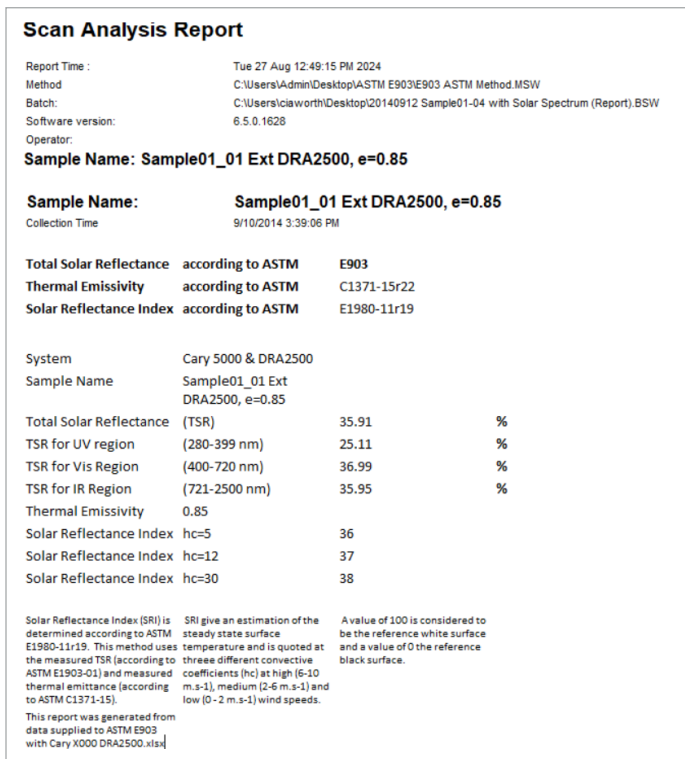


Figure 2. Scan analysis of painted aluminum coupon sample using ASTM method E903-96 and E1980-11r19 methods.

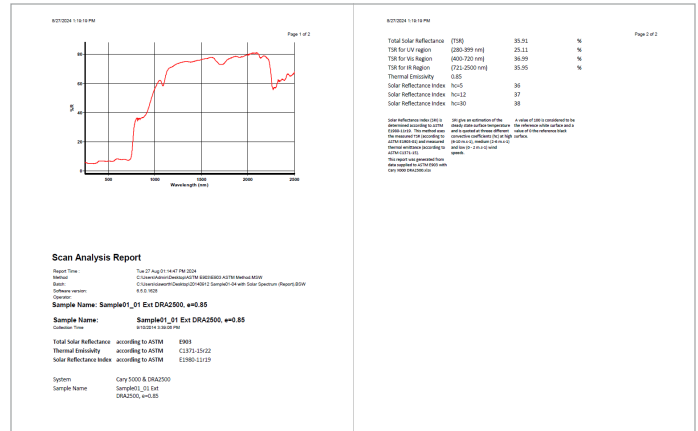


Figure 3. Report of painted aluminum coupon analysis according to ASTM standards E903-20 and E1980-11r19.

Conclusion

An Agilent Cary 5000 UV-Vis spectrophotometer with an Agilent External DRA-2500 was used to calculate the TSR and SRI values of four painted aluminum samples according to the ASTM standards E903-20 and E1980-11r19. The optical properties of the samples were calculated and reported within the Agilent Cary WinUV software as part of a turnkey solution for high-throughput research and development of building materials.

References

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