Characterization of the Reflectivity of Various White Materials

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ABSTRACT

We present total reflectance measurements and Lambertian characterization of various materials that are commonly (and uncommonly) used as a screen for imaging system calibration (such as flat fielding). We measure the total reflectance of the samples over a broad wavelength range (250 nm < λ < 2500 nm) that is of interest to astronomical instruments in the ultraviolet, visible, and near-infrared regimes. A Helium-Neon laser was used to determine how closely the various materials' diffuse reflectance characteristics match that of a Lambertian surface.

Introduction

The material choice for a calibration screen can have a significant impact on the quality and ease with which calibration data is obtained. Desirable characteristics include reflectivity across a broad range of wavelengths, a high level of reflectivity to ensure the maximum amount of calibration light is reflected and a Lambertian reflectance profile. Table 1 lists a selection of screen candidates.

Code	Sample
WP01	Duraflect
WF01	Da-Lite Da-Mat
WF02	Da-Lite High Contrast Matte White
WF05-1	Stretchy Screens Fabric
WF05-2	Stretchy Screens Fabric + flat mylar
WF05-3	Stretchy Screens Fabric + textured mylar
WF06-1	Stretch Shapes White Trapeze Plus Fabric
WF06-2	Stretch Shapes White Trapeze Plus Fabric + flat mylar
WF06-3	Stretch Shapes White Trapeze Plus Fabric + textured mylar

Table 1. A selection of screen and screen+backing material combinations.

We used a Hitachi High-Tech U-4100 UV-Visible-NIR Spectrophotometer at the Texas A&M University Materials Characterization Facility (MCF) and obtained reflectance profiles for the samples. With this system we measured precise reflectance values at each wavelength (in 1 nm steps) for the wavelength range 250 nm < λ < 2500 nm.

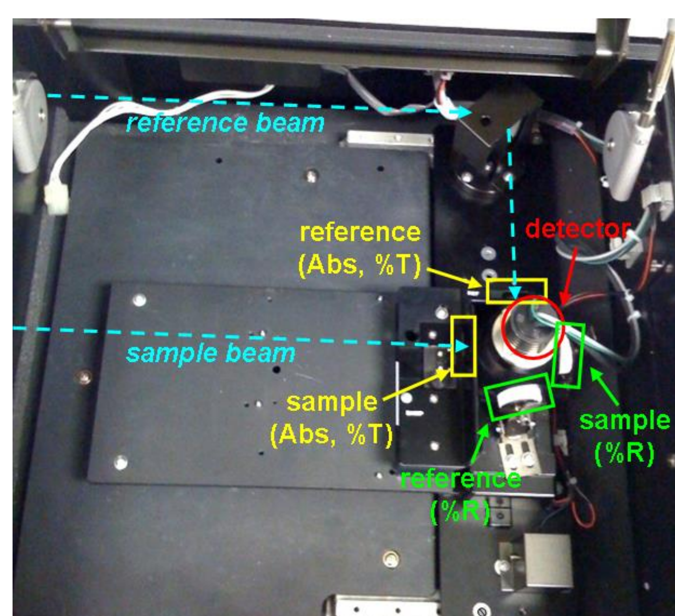


Figure 1. The reference and test sample are placed in the 6 o'clock and 3 o'clock positions of the integrating sphere, respectively. A baseline measurement at each wavelength of the reference BaSO4 wafers (~100% reflectance) in both the reference and sample slots of the dual beam spectrophotometer is obtained. We then measure a second reference sample having 5% reflectivity (Labsphere SRS-05), and measure the reflectivity of the test sample. A ratio of the reference sample to the values provided by the manufacturer is used to construct the absolute reflectivity of the test sample as a function of wavelength.

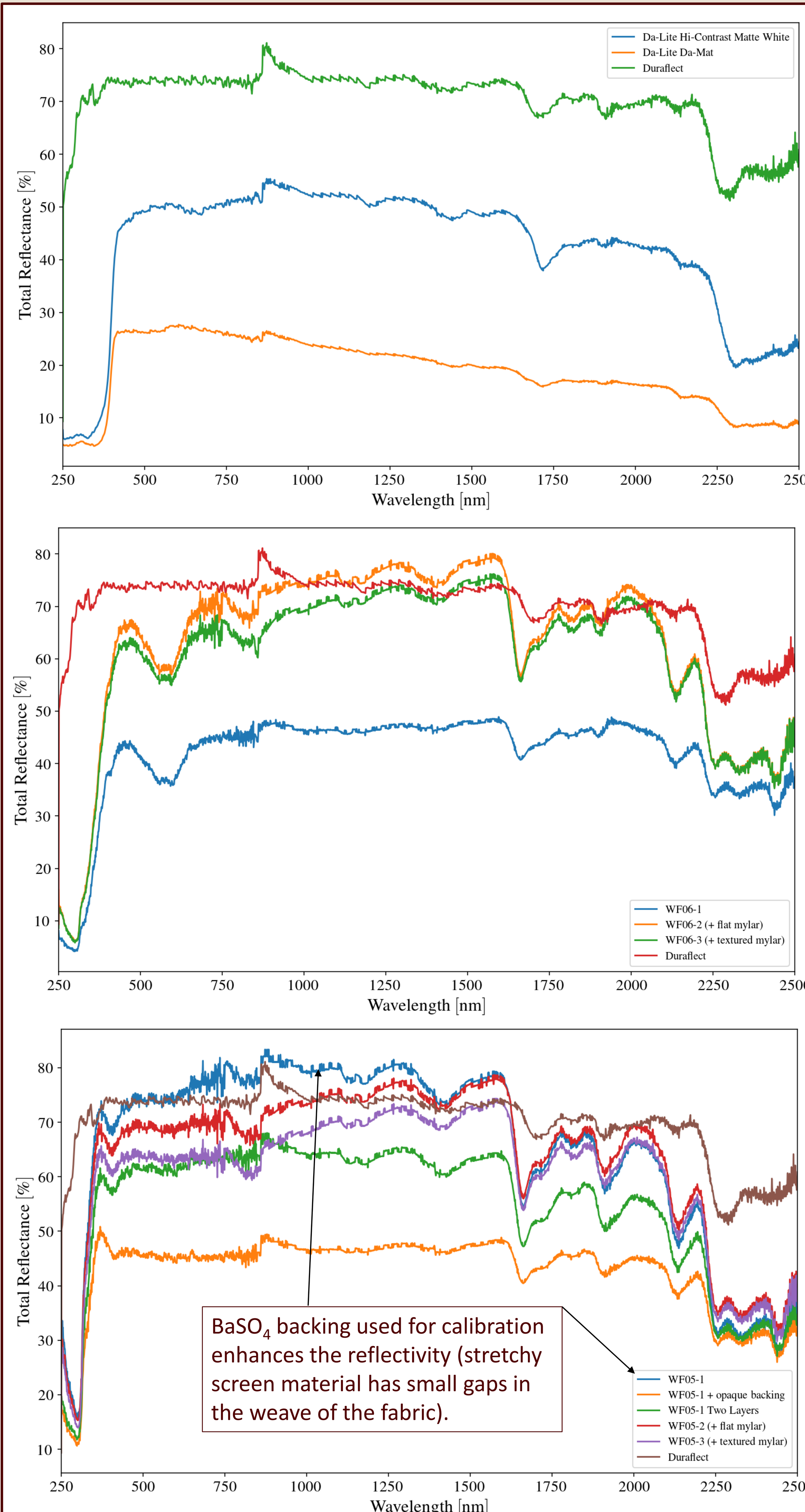
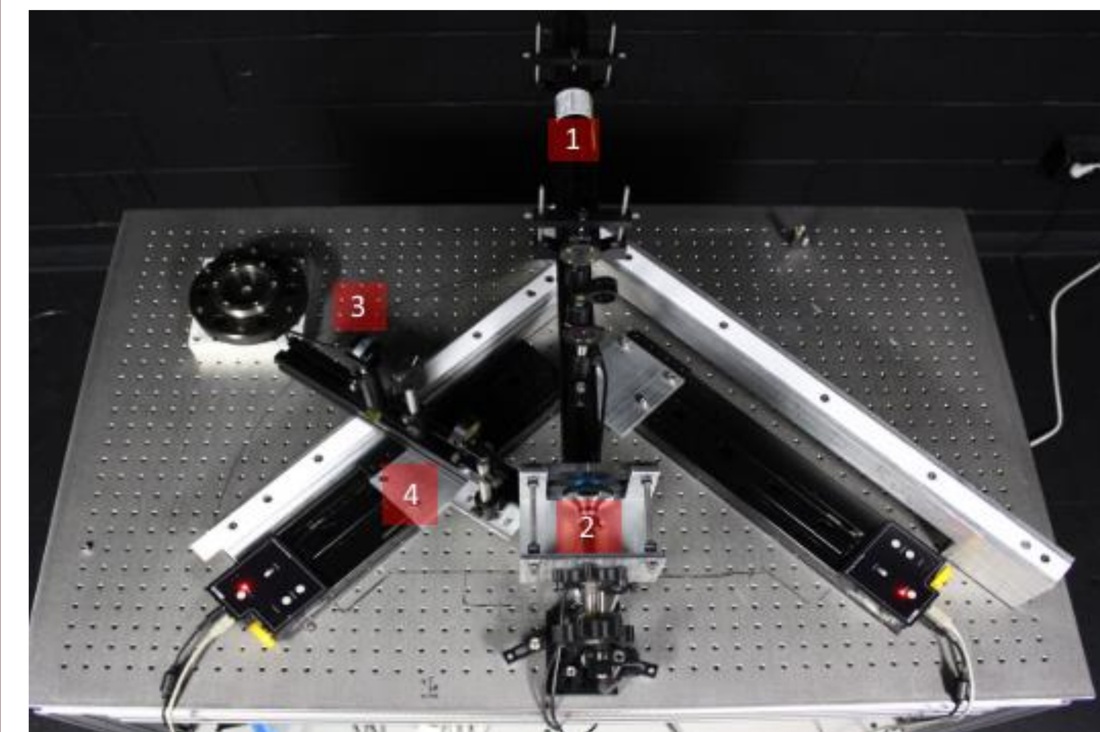


Figure 2. Total reflectivity of the materials in Table 1.

Figure 3. MADLaSR[1], a variable angle power monitor, in Lambertian mode. The laser light source (1) is fixed perpendicular to the sample surface (2). The reflected power is measured by a photodiode (3) as the moveable arm (4) travels between 10° and 90°.



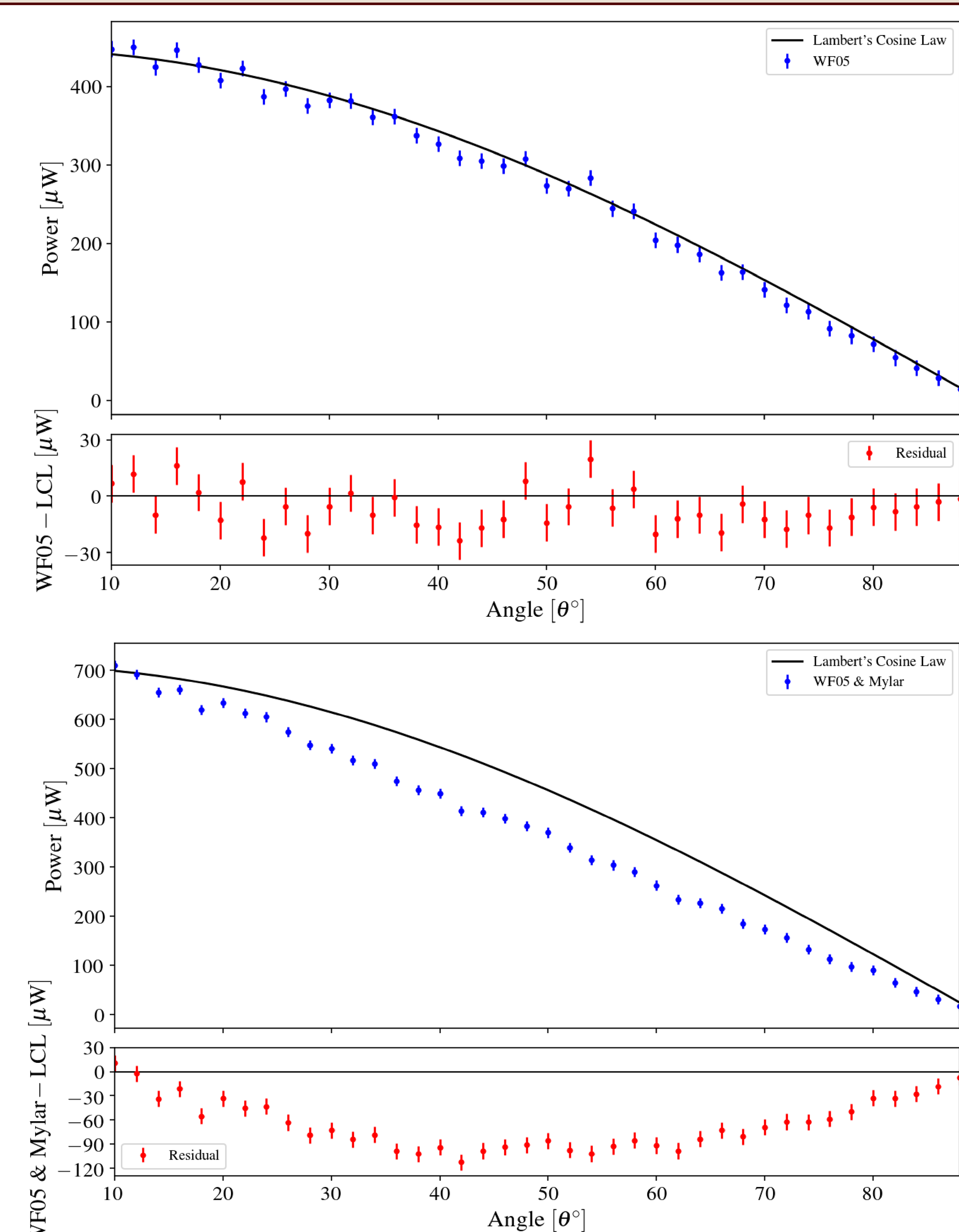


Figure 4. Measured power as a function of angle for a nylon-spandex screen material and the same material with a Mylar backing. The profile expected for an ideal Lambertian surface is shown as a solid line and the difference between them is plotted below. A clear deviation from a Lambertian surface is easily seen when the Mylar backing is added.

CONCLUSIONS

We have presented measurements of the amount of total reflectance as well as Lambertian characterization of various materials that have been or may be used as calibration or projection screens. The combination of these measurements provide a quantitative basis for selecting a screen material that will match the performance requirements of a particular experiment.

Complete information about all of the samples including reflectivity plots and text files of the calibrated data will be made available at **http://instrumentation.tamu.edu/reflectance.html**. We are in the process of updating the plots to be interactive, allowing a user to zoom in on a particular region of interest and then save it as an image as well as better features for comparing materials. The same page includes information on how to suggest or submit a sample for testing.

References

[1] Gardner, L. E., Prochaska, T., Schmidt, L. M., Marshall, J. L., Sauseda, M., Torregosa, M., and DePoy, D. L., "Madlasr: multi-angle detector of lambertian and specular reflectivity," Proc.SPIE 10706(168) (2018).

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