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D&S Technical Note 11-1

SSR-ER Reflectance Measurements for Large Radius Cylindrical Surfaces

The model SSR-ER Solar Spectrum Reflectometer can be used to measure non-flat surfaces by creating a "secondary" reflectance standard matching the shape of the non-flat surface. This is accomplished by measuring a reflective film material as applied to a flat surface and recording the reflectance values obtained as a "programmable" standard. The same film material is applied to the non-flat surface geometry and this surface is used as a reflectance standard.

The technique depends on the angular distribution of reflection from the film being about the same as that from the samples to be measured. For example, if the samples to be measured are roofing tiles which are mostly diffuse, a white diffuse material such as white vinyl tape can be used for the "secondary" or working standard. Aluminum tape can be used for a surface that is mostly specular. As shown below, a simple measurement will indicate the likely magnitude of any error due to a difference in angular distribution of reflection.

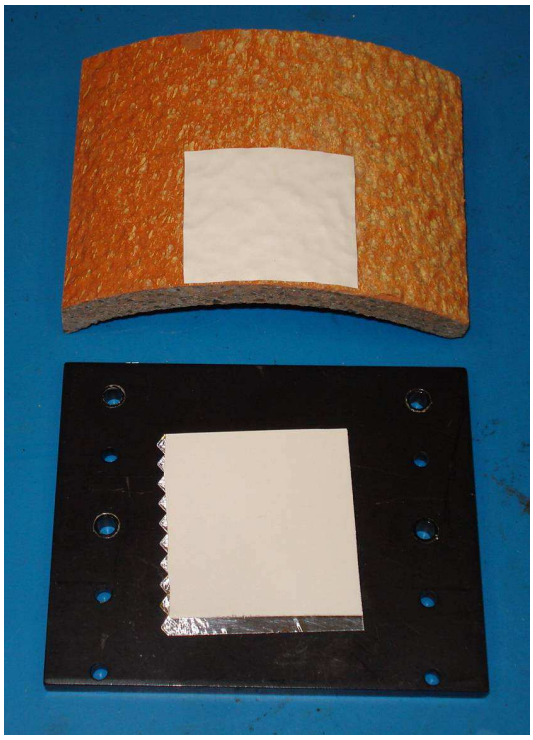
Adapter hardware can be made available for measuring non-flat surfaces with the SSR. An adapter allows the measurement port to be positioned repeatable with respect to the sample and the standard. However, for a cylindrical surface with a large enough diameter of curvature, the operator can manually position the measurement head with sufficient accuracy. Note that since the reflectance measurement is made at an incidence angle of 20 degrees, the azimuth angle (rotation angle in the plane of the sample surface) of the detector head must also be duplicated on the standard and the sample. Some experimentation suggests that a minimum sample diameter of 4 inches (102 mm) is manageable without an adapter. A hardware adapter is recommended for smaller diameters due to significant errors that can occur with misalignment of the measurement port.

A note of caution is necessary concerning the use of white reflective materials (vinyl tape, paper, paint etc.) for working standards as outlined below. The material used must be opaque and in typical thickness, most are not. If the material is not opaque the reflectance will have some dependence on the surface to which it is applied. For this reason the vinyl tape used in the example below is first applied to aluminum tape to ensure that the combination is opaque.

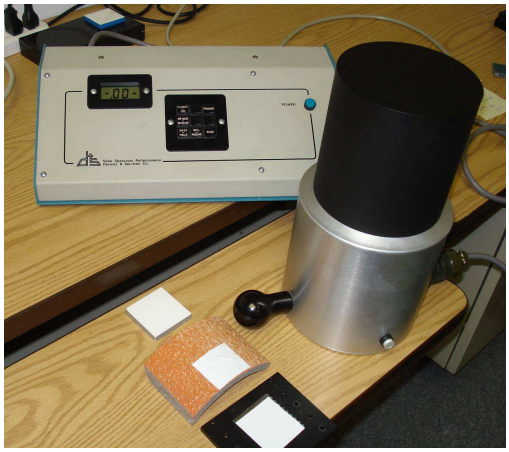
Also note that the reflectance measured with this technique is the surface reflectance of the material as if it were flat. It is not the reflectance of the curved surface in aggregate. For any non-flat geometry, the reflectance will be at least a little lower than the surface reflectance due to a portion of the reflected energy restriking the surface. D&S Technical Note 09-2 "A Proposed Correction to Reflectance Measurements of Profiled Surfaces" describes the calculation of the "aggregate" reflectance for a class of curved surfaces that are extruded shapes.

Step by Step Instructions

1. Set up, power up and allow the SSR to warm up for a few minutes. Apply about five inches of white vinyl tape to a similar length of aluminum tape. Apply pieces of the white vinyl/Al tape to a flat backing and to a spot on the cylindrical sample. Be sure that the piece applied to the sample extends well beyond the one inch port diameter size since a portion of the surface will not be in contact with the port.

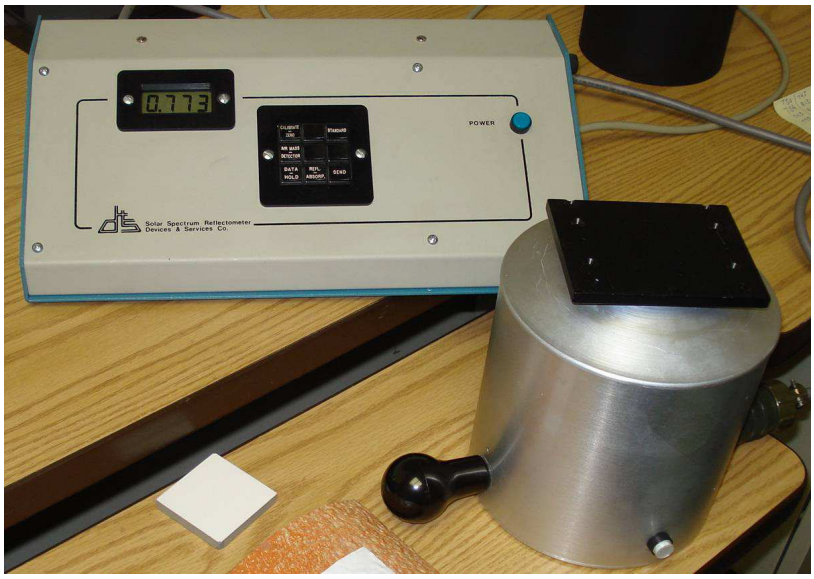


2. Zero the instrument with the blackbody cavity supplied by pressing the Calibrate/Zero key.

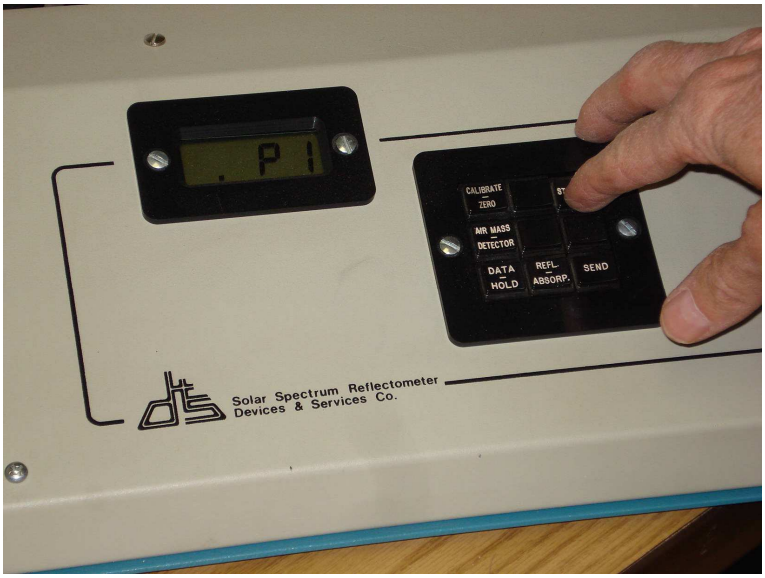


3. Calibrate with one of the tile reflectance standards supplied with the instrument. Note that the tile designation must match the currently active standard selection for the instrument. Press the Standard key momentarily to verify the active standard selection. Press the Calibrate/Zero key to initiate calibration.

4. Place the flat white tape sample on the measurement port and allow the instrument to sample the reflectance. NOTE that as with all measurements, to ensure that background lighting does not affect the reading; leave the sample on the port during an entire off/on cycle of the source lamp. With the white tape sample remaining on the port and a valid reflectance reading on the display, program the reflectance value into the SSR by pressing (and holding) the Standard and Calibrate/Zero keys simultaneously. When the two key combination is recognized the display will show "- P1" and then toggle through the five available programmable standards, P1 through P5. The reflectance values are programmed into the selected location upon releasing the two keys. Program standard P1 by releasing the keys immediately upon seeing the "- P1" display. The reflectance values for the white tape are now saved as standard P1.

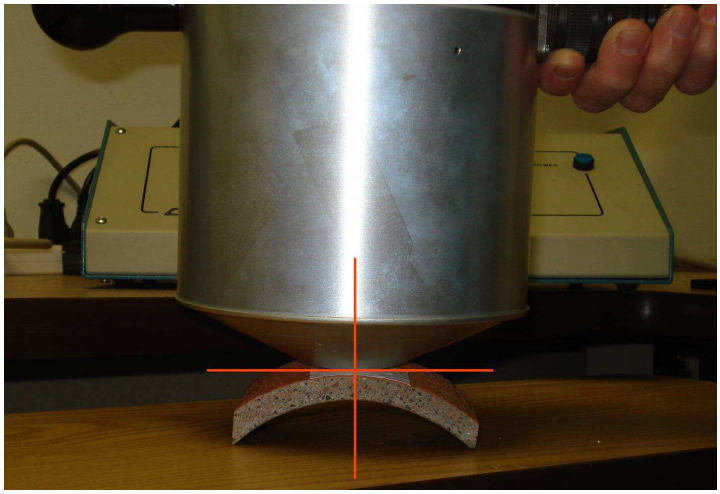


5. Now select P1 as the active reflectance standard by pressing and holding the Standard key. Release the key when P1 is displayed.



6. Position the measurement port on the white tape applied to the cylindrical surface as shown. The port should be square and centered on the surface. Using the signal cable or (optional) handle the instrument should be lined up approximately at a right angle to the axis of the cylindrical surface. Note the reflectance value as compared to the “flat” measurement. In this example, the measured flat reflectance of the white tape was 0.774 and measured on the curved

sample, 0.760. The difference of only 0.014 indicates that any error due to the sample curvature will be very small since it will be a fraction of the 0.014 difference.



7. With the measurement head and port still positioned on the white tape applied to the sample, press the Calibrate/Zero key to calibrate the instrument. Note that the reading will adjust to the value saved for the white tape as measured flat. The values are automatically scaled up to account for the incomplete illumination of the curved working standard. The instrument is now calibrated for the curved sample shape.

8. Move the measurement head to the sample surface to make a measurement. Maintain the same alignment of the head with the sample. The reflectance reading obtained is approximately the surface reflectance of the sample.