

Mini-Diff V2 3D (Hemispheric) Scatterometer BRDF/BTDF

For 3D Scattered Light Measurements

Introduction

Our Mini-Diff V2 Solution includes camera-based 3D hemispherical scattering measurement instruments used to characterize scattering surfaces. It provides Bidirectional Reflectance Distribution Function (BRDF) and Bidirectional Transmittance Distribution Function (BTDF) measurements, as well as Total Integrated Scattering (TIS) calculations for Red, Green, and Blue (RGB) colors and in the near-infrared wavelengths. Mini-Diff images hemispherical scattered intensity and delivers color data in reflection or transmission.

Mini-Diff V2 is a portable product that enables fast, accurate measurements of luminous energy distribution. This data can be used to characterize surfaces.

The incident light is provided by four collimated Light-Emitting Diodes (LEDs) set up at 0°, 20°, 40°, and 60° incident angles for reflective and transmissive measurements.

The results (relative scattered intensity and BRDF/BTDF) can be saved in text formats or can be exported to optical software format.

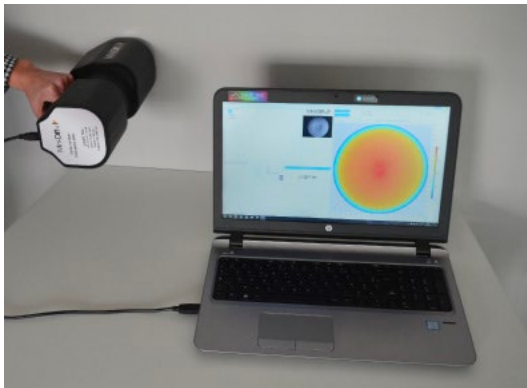


Figure 1. Mini-Diff V2

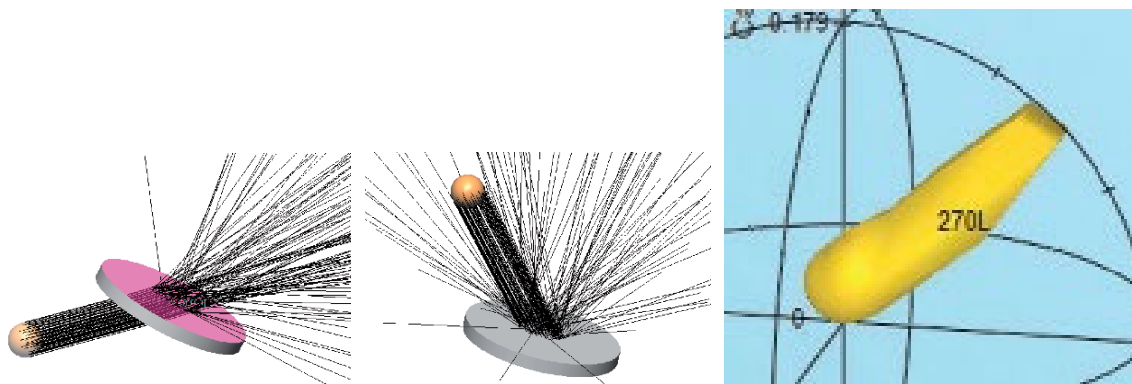


Figure 2. BSDF 3D scattering example



Figure 3. Mini-Diff V2



Figure 4. BRDF

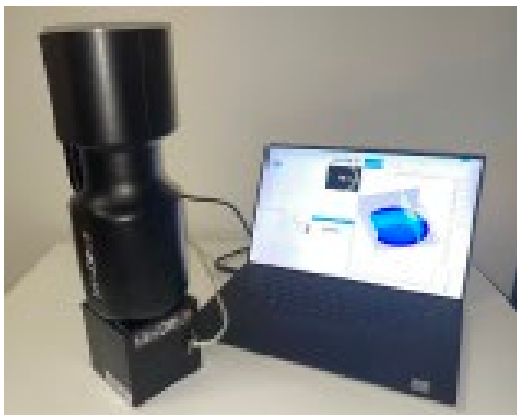


Figure 5. BTDF

Applications

- Reflector/diffuser material characterization for automotive design
- Photorealistic rendering: accurate measurement of diffusing behavior
- Cosmetics characteristics
- Roughness controls in production
- LCD backlighting: Brightness enhancement film (BEF), dual brightness enhancement film (DBEF) inspection, diffusing films
- Diffuser/display quality control
- Material characterization for many incident angles

Reflective Materials

Mini-Diff V2 instruments provide a quick measurement of the BRDF for several incident angles and three colors.

- After a two-step calibration (one step with a black standard to cancel the stray light and one step with a Lambertian standard to calibrate the response of the camera), it is possible to measure:
 - Reflectors
 - Paints
 - Diffusing material
 - Sockets
 - Optical mounts and more
- The measured relative scattered intensity can be saved in text files, slices files, mesh format, bidirectional scatter distribution function (BSDF) format, ABg (Harvey Shack), and Gaussian/Lambertian model.
- TIS measurements are estimated by the Mini-Diff V2 software. This feature allows you to compare samples directly with the efficiency of the diffusers.
- Mini-Diff V2 software also accounts for anisotropic material measurement and is capable of directly generating files for illumination design software.

Example: Reflector Alanod Miro5

Reflector material can have complex behavior depending on the incident plane. The Mini-Diff V2 allows users to capture scattering for angles of incidence, parallel and perpendicular to stripes (anisotropic material).

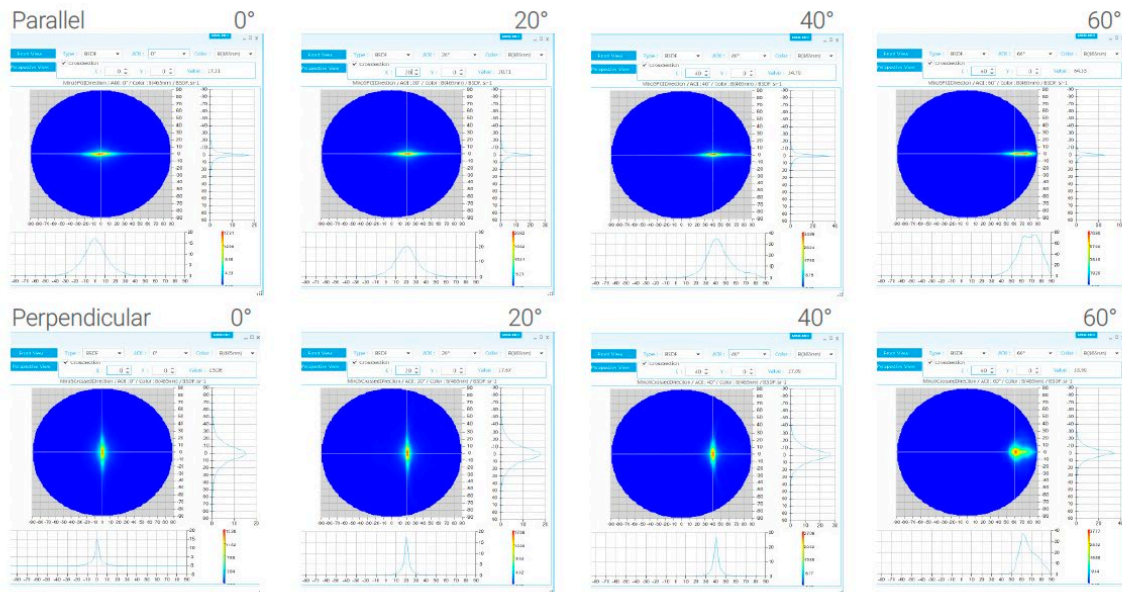


Figure 6. Reflector Alanod Miro5

Transmissive Materials

- Mini-Diff V2 allows a quick measurement of the BTDF for several incident angles.
- One external part “transmission module” can be supplied with the Mini-Diff V2 as an option and includes collimated LEDs on a large area (diam 10 mm) in order to be insensitive to the sample placement.
- After a one-step calibration using one Lambertian transmissive standard (supplied), it is possible to measure diffusing materials:
 - Opal glass
 - Diffusing plastics
 - Brightness Enhanced Film (BEF)
 - Beam shaper (diffractive optics)

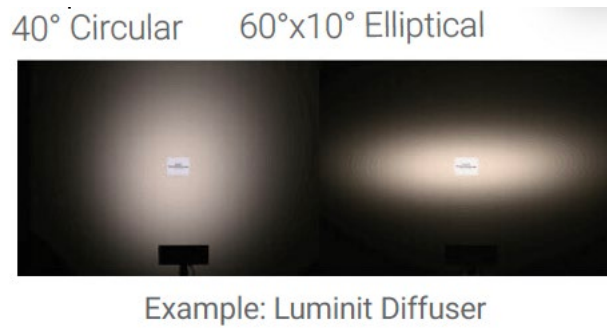


Figure 7. Luminit Diffuser

Reflective and Transmissive Materials

Mini-Diff V2 devices enable you to measure BRDF and BTDF on one diffuser (front and back side measurement) and can be used to build a ready-to-use BSDF file for illumination design software.

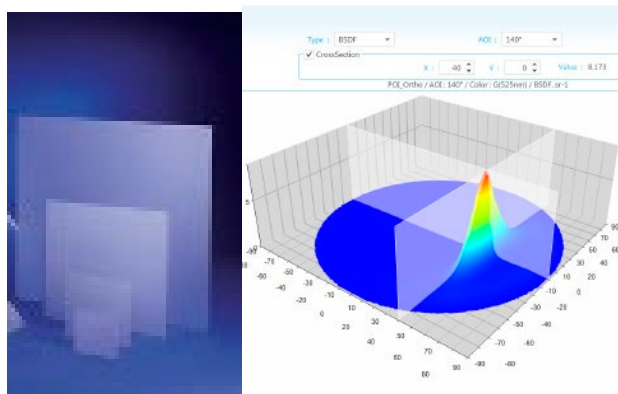


Figure 8. Reflective and transmissive materials

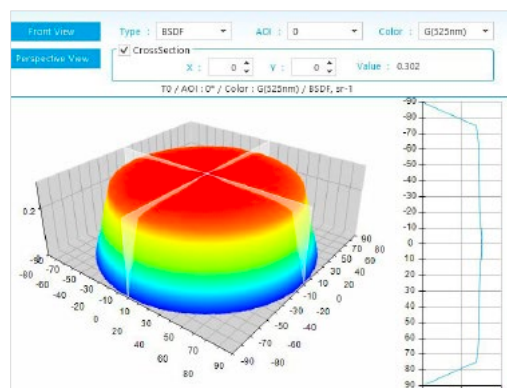


Figure 9. Example of measurement with one Spectralon sample (Lambertian standard)

Color Measurements

Mini-Diff V2 have RGB light sources used for BRDF and BTDF and allow BSDF measurement for each color. It can give a global color estimation in CIE $L^*a^*b^*$ space using the TIS estimation. You can look at the RGB 3D BSDF from the Mini-Diff software.

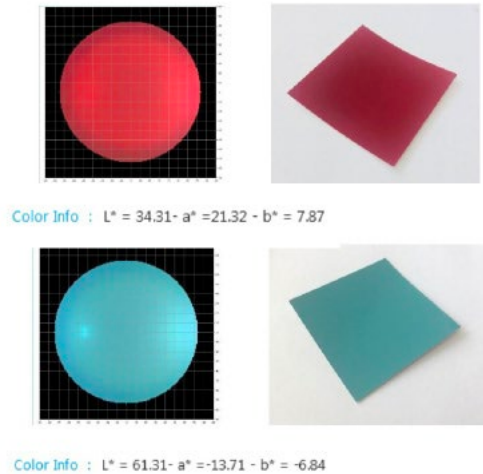


Figure 10. RGB 3D BSDF from the Mini-Diff software

Calibration and Accuracy

Mini-Diff V2 includes three standard calibration samples: black, reflective Lambertian, and transmissive Lambertian.

Technical Specifications

Instrument	Mini-Diff V2 RGB	Mini-Diff V2 IR 850nm	Mini-Diff V2 IR 940nm
Sources	- Red: 630nm [b.A=25nm] - Green: 525nm [t.A=35nm] - Blue: 465nm [b.A=25nm]	850nm [t.A=40nm]	940nm [t.A=30nm]
Camera	640*480 pixels	640*480 pixels	640*480 pixels
Angle of incidence for reflection and transmission	4 incident angles: 0°; 20°; 40°; 60°	4 incident angles: 0°; 20°; 40°; 60°	4 incident angles: 0°; 20°; 40°; 60°
Spot size on the sample surface/measured area	1 mm diameter	1 mm diameter	1 mm diameter
Field of view	+/-75° (150° total)	+/-75° (150° total)	+/-75° (150° total)
Calibration: (for 1 AOI)			
Reflection	20 seconds	20 seconds	20 seconds
Transmission	10 seconds	10 seconds	10 seconds
Measurement: (for 1 AOI)			
Reflection	10 seconds	10 seconds	10 seconds
Transmission	10 seconds	10 seconds	10 seconds
Results: Dynamic range Angular resolution Accuracy repeatability Stability	105 1° <5% <2% 30 minutes	104 1° <5% <2% 30 minutes	104 1° <5% <2% 30 minutes
Data exchange	- Text file (ASTM format) - BSDF format (imported in commercial software) - Fit to Gaussian/Lambertian format - Slice files (IES type) - Mesh file - Fit to ABg Export to format: LightTools, TracePro, OptiWorks, Relux and more		

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