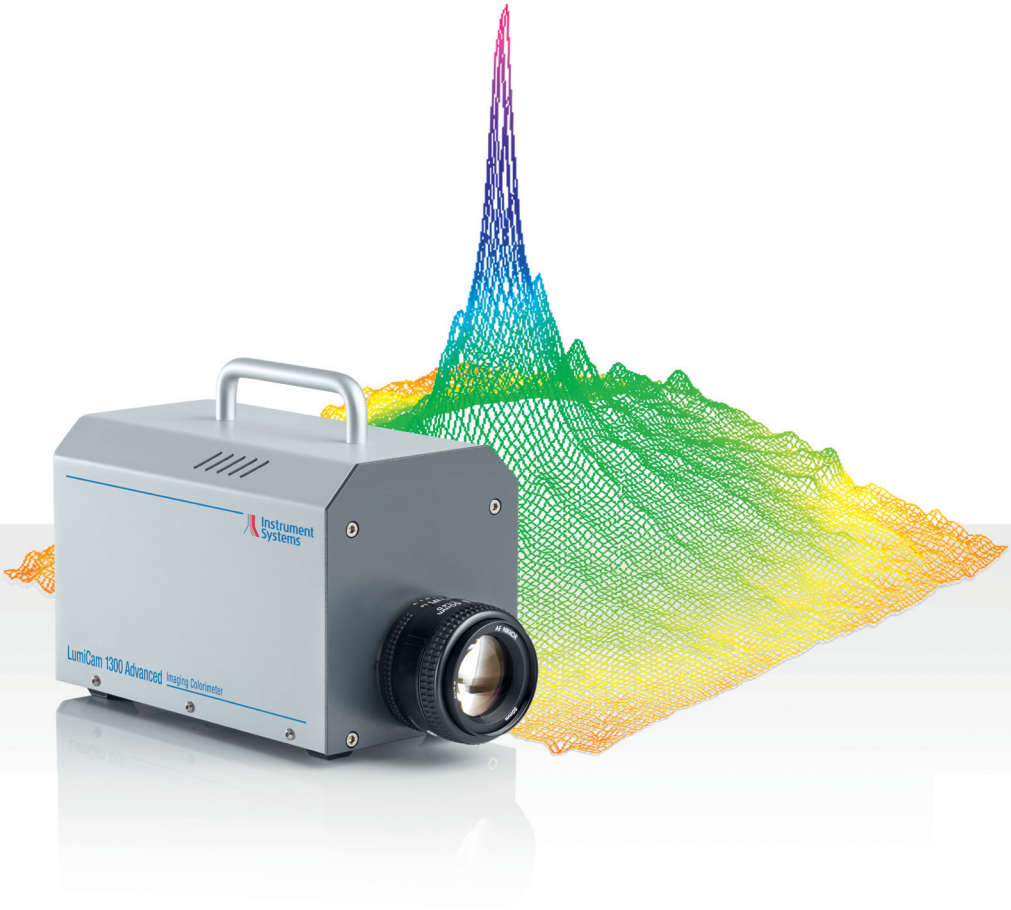
BSDF Analysis Kit

Fast, high-resolution analysis of scattered light with the LumiCam 1300 series

Product highlights

- Simultaneous recording of all scatter components in reflection or transmission mode
- Simple, robust and compact measurement setup
- Colorimetric analysis
- Applicable to any scattering surface
- 3D representation of the directional variations of scattered light



The bidirectional scattering distribution function (BSDF) provides a comprehensive characterization of the scattering properties of a sample. It allows identification and separation of specular and non-specular components and thus evaluation of appearance characteristics, e.g. haze or distinctness of image.

Instrument Systems offers a robust toolset for time-saving determination of the bidirectional scattering distribution function of planar samples with a compact measurement setup and without mechanical scanning. A software module calculates the directional distribution of light scattered from samples, e.g. display screens, from the two-dimensional point spread function (PSF). This simple approach can in many cases replace expensive and time-consuming mechanical scanning systems.

The BSDF Analysis Kit supports all models of the imaging measurement system LumiCam 1300.

Instrument Systems
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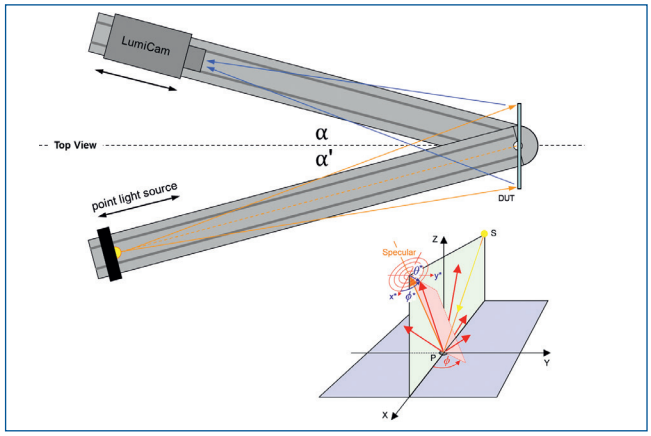
Compact setup – cost-saving method

The compact BSDF setup comprises hardware components (point light-source with precision current source, diffuse reflectance standard and specular reflectance standard) and a software module. The LumiCam and point light source are symmetrically (α= α') arranged within a plane perpendicular to the device under test (DUT).

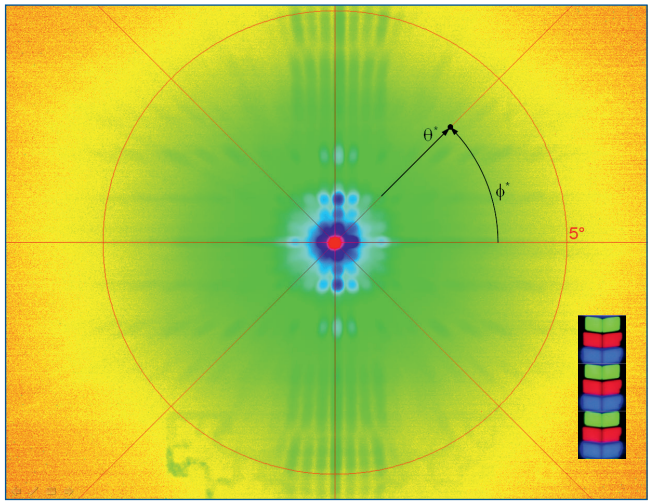


Arrangement for reflection measurement of the PSF as a basis for evaluation of the BSDF of a planar sample and definition of the used coordinate system.

Using the LumiCam 1300 Mono/Color/Advanced, the lateral distribution of luminance or tristimulus values scattered from the DUT is recorded. From this, the directional scattering distribution function (BSDF) can be calculated via the software module.
The distance of source and LumiCam 1300 to the sample determines the angular range and resolution.

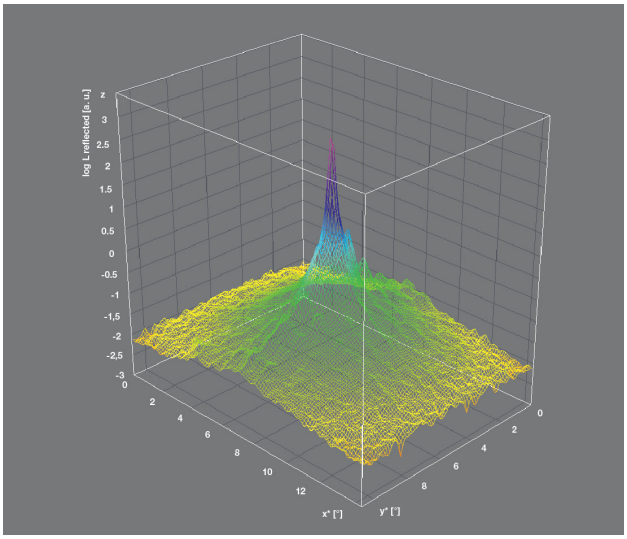
Easy evaluation and intuitive graphical representation

Transformation of the point spread-function (luminance/ chromaticity image) by the software module yields the BSDF in a polar plot representation, with each location corresponding to a direction of light propagation.

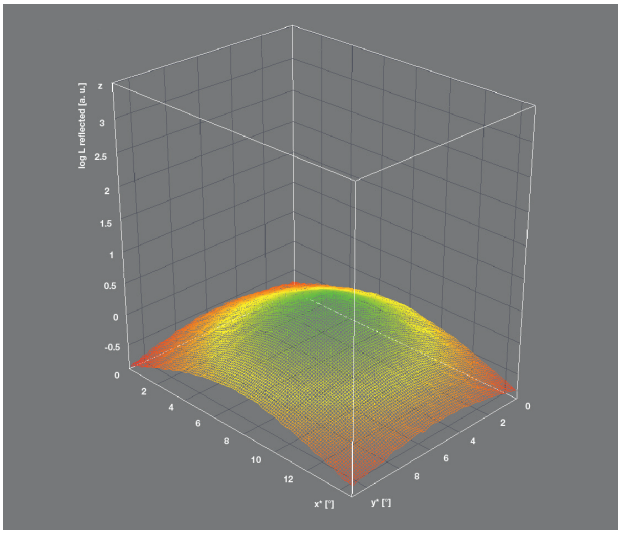


2D false color representation of the BSDF of an LCD screen as a function of the spherical angles Φ* and θ*. The scatter caused by the pixel matrix is more pronounced in the vertical direction due to the subpixel arrangement of the DUT shown in the inset.

The center of the polar coordinate system represents the specular direction to which the difference angle θ* is related.



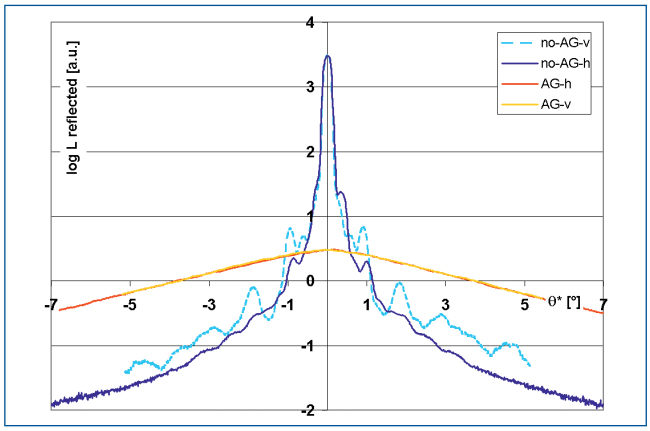
Tablet computer LCD-screen without AG-layer



Desktop LCD-monitor with AG-polarizer

3D surface plots of the BSDF of two LCD screens with different anti-glare (AG) coatings. They show the reflectance characteristics of the LCD touch screen combination of a tablet computer without anti-glare coating (scattering due to the pixel structure: matrix scatter) and the BSDF of a desktop computer monitor for office work with pronounced scattering due to the AG-polarizer.

The BSDF as a function of the spherical angles θ* and Φ* can also be represented as a 3D surface plot. This is an intuitive way of visualizing the scatter properties of DUTs. For example, the different reflection characteristics of different LCD screens can be captured at a glance. Moreover, profiles can be generated from the BSDF image for the azimuth angles of interest and the profile data can be exported for further analysis and graphical representation as shown below.



Vertical and horizontal profile of the reflection characteristics of the tablet computer LCD-screen without AG-layer (no-AG-v, no-AG-h) and the desktop LCD-monitor with AG-polarizer (AG-v, AG-h) shown on page 2.

Various applications

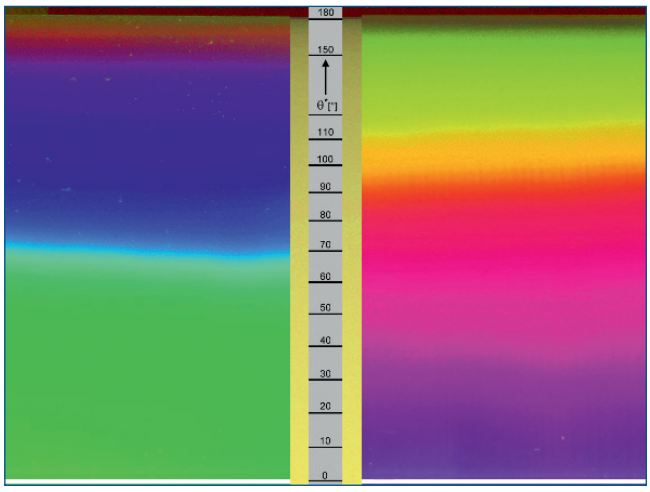
This BSDF measurement setup enables characterization of a wide range of light scattering materials:

- Electronic displays and their components (anti-glare layers, touch panels, diffusers, etc.)
- Paintwork (automotive, graphics)
- Arbitrary scattering surfaces and films in transmission (AG coatings, diffusers, windows) or reflection (coated paper, inkjet paper).

Coming soon – cylindrical geometry

With a cylindrical geometry (linear white light source plus cylindrical samples, e.g. interference films wrapped around a cylinder), a wider range of angles can be covered. In the example below, θ* covers the range from 0° to 180°.

A typical application of this measurement setup is an investigation of the change of color and visual appearance of effect pigments and coatings with respect to viewing direction.



Colorimetric analysis of polymeric interference films derived with cylindrical geometry setup. The colors indicate the changing appearance of the films with respect to viewing direction.

The LumiCam 1300 family

LumiCam 1300 imaging measurement system is the basis for fast BSDF evaluation. It captures the lateral distribution of scattered luminance or color coordinates within seconds. Instrument Systems offers the LumiCam 1300 in three different versions.

- **LumiCam 1300 Mono**
  Compact luminance camera for reliable and precise measurements
- **LumiCam 1300 Color**
  Version with additional color filters for luminance and color measurements
- **LumiCam 1300 Advanced**
  Advanced camera concept for maximum accuracy in luminance and color measurements.

The LumiCam 1300 is a proven measurement system in the areas of research, development and quality assurance, as well as production. In addition to determining the BSDF, it is ideal for a multitude of different applications for the measurement of luminance and color distribution of display and control elements in vehicles, homogeneity analysis of flat screens or electronic information signs, homogeneity analysis of lamps and luminaires used in general lighting or capturing luminous intensity distribution curves for small lamps and luminaires.

Interchangeable objective lenses with adjustable focus and aperture offer solutions for accommodating a wide range of distance, resolution and image field size. Objective lenses with focal lengths ranging from 14 mm to 100 mm are supplied for all three models. The measuring range of luminance can be expanded using appropriate density filters.

Technical Specifications for Lenses

Specification	28 mm lens	50 mm lens	100 mm lens
Focal length	28 mm	50 mm	100 mm
Min. focusing distance (DUT to lens)	180 mm	370 mm	110 mm
Min. measurement distance (DUT to housing)	250 mm	500 mm	300 mm
Object width	64 mm	77 mm	14 mm
θ* h (max.)	20°	12°	7°
Object height	48 mm	57 mm	10 mm
θ* v (max.)	15°	9°	5°
Image size at min. measurement distance (h x v)	64 mm x 48 mm	77 mm x 57 mm	14 mm x 10 mm
Pixel size at min. measurement distance	47 µm x 47 µm	56 µm x 56 µm	10 µm x 10 µm
Image size at 1 m distance (h x v)	300 mm x 220 mm	160 mm x 120 mm	80 mm x 60 mm
Pixel size at 1 m distance	217 µm x 217 µm	119 µm x 119 µm	58 µm x 58 µm

[1] Ranges of θ* (horizontal, vertical) covered with different objective lenses of the LumiCam 1300
[2] All data are typical values

Order information

Order number	Description
BSDF Analysis Kit	
LC-BSDF-100	BSDF measurement set including analysis software (WibuKey), point light source and Arroyo power supply
LC-BSDF-120	Optical bench (max. working distance 550 mm), fixtures for LumiCam 1300, light source and DUT plate suitable for reflection measurements of displays up to 535 x 300 mm (h x v)
LumiCam model	
LC1300-102	LumiCam 1300 Mono Imaging photometer with 1370 x 1020 pixels; incl. Gigabit Ethernet interface, software and control computer
LC1300-202	LumiCam 1300 Color Imaging photometer and colorimeter with 1370 x 1020 pixels; incl. Gigabit Ethernet interface, software and control computer
LC1300-302	LumiCam 1300 Advanced Imaging photometer and colorimeter with 1370 x 1020 pixels; incl. Gigabit Ethernet interface, software and control computer
Objective	
LC-312	28 mm objective lens
LC-314	50 mm objective lens
LC-316-1	100 mm objective lens
LC-362	Neutral density filter, optical density 2 (for LC-312, LC-314, LC-316-1)
LC-364	Neutral density filter, optical density 4 (for LC-312, LC-314, LC-316-1)

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