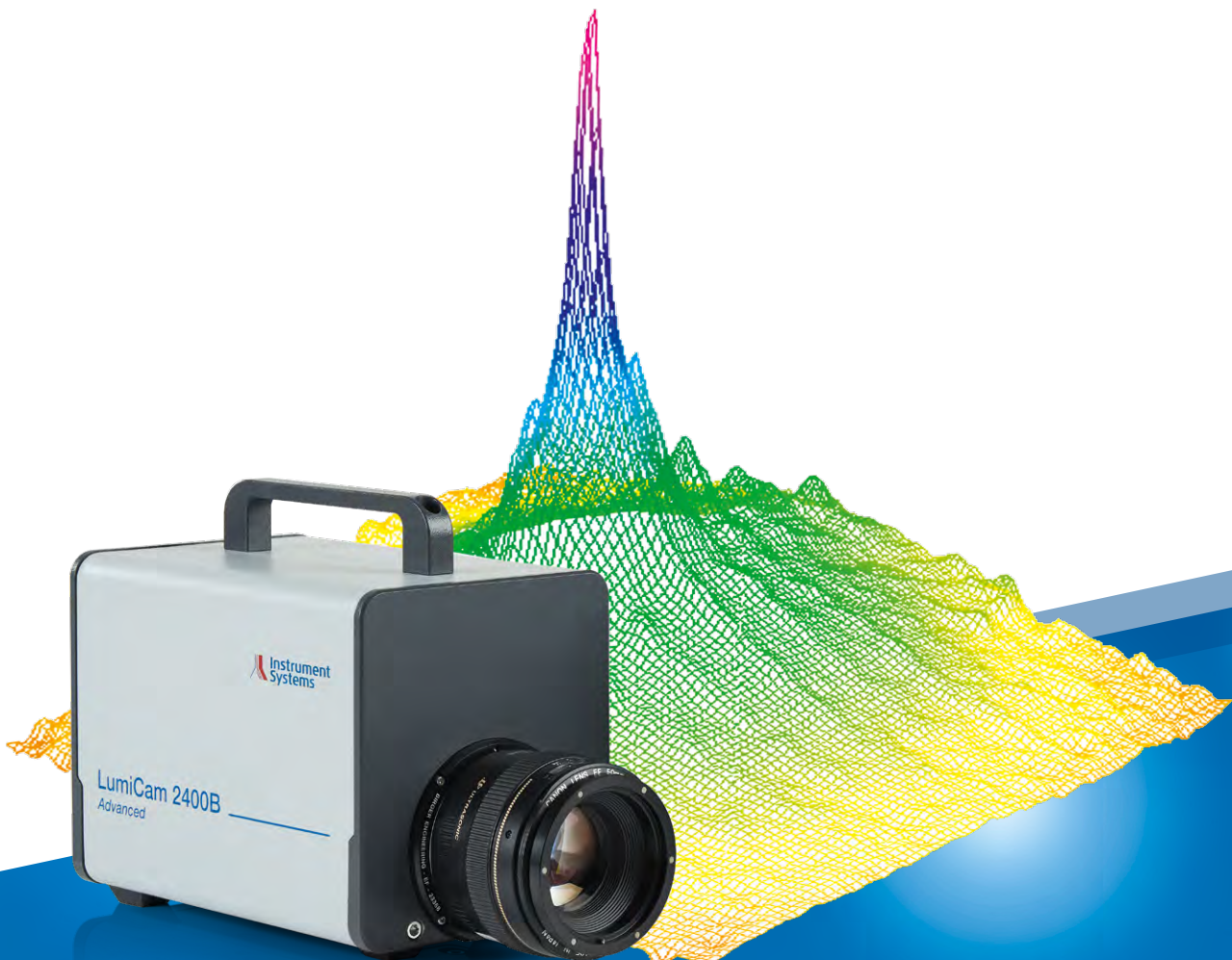
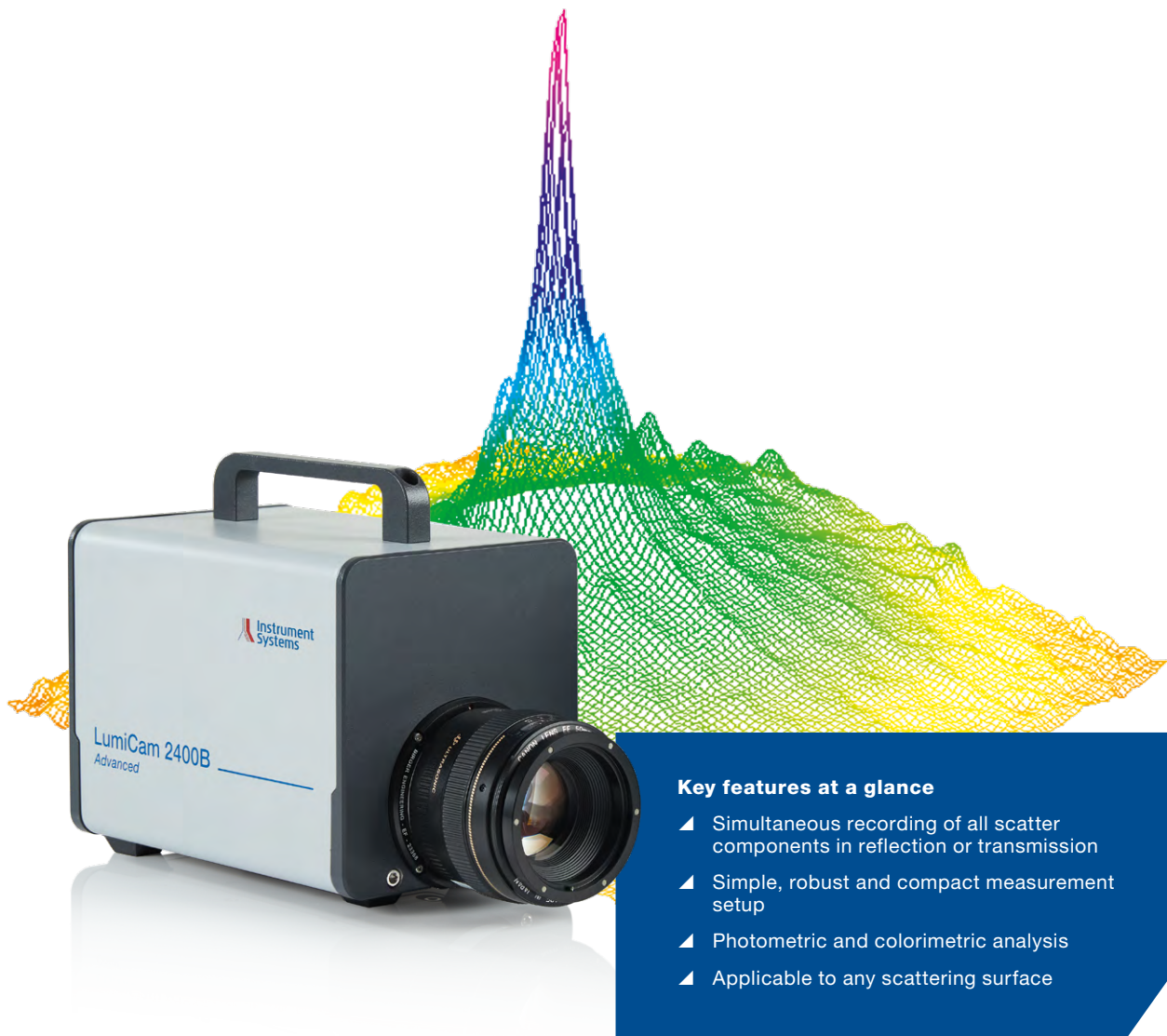


BSDF Analysis Kit

High-resolution BSDF-analysis with the LumiCam series



We bring quality to light.



Key features at a glance

- ▲ Simultaneous recording of all scatter components in reflection or transmission
- ▲ Simple, robust and compact measurement setup
- ▲ Photometric and colorimetric analysis
- ▲ Applicable to any scattering surface

01 \ \ BSRF analysis with the LumiCam imaging colorimeter

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

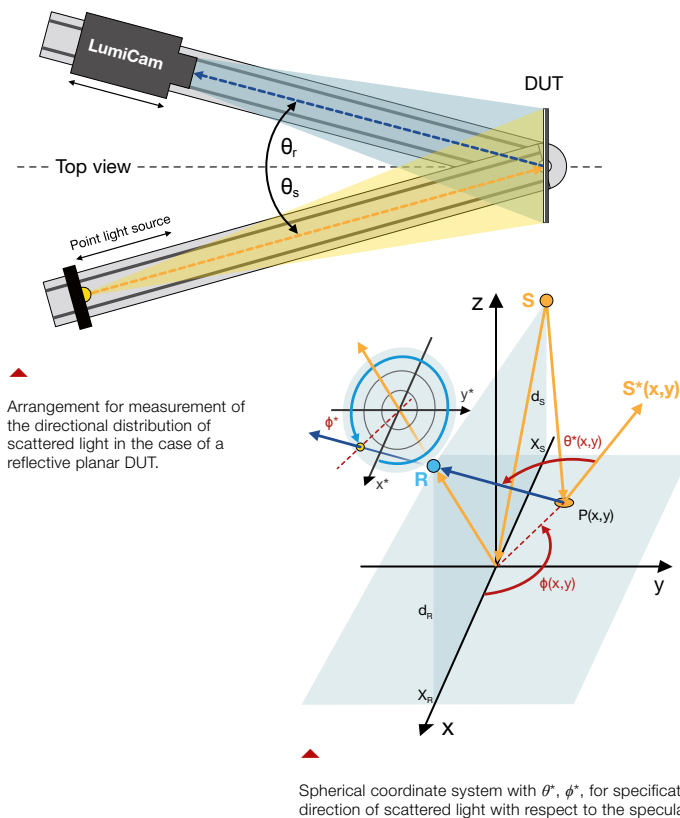
planar samples with a compact measurement setup without mechanical scanning. A software module calculates the directional distribution of light scattered from planar samples, e.g. display screens, from the two-dimensional point spread function (PSF), i.e. the lateral distribution of reflected luminance and chromaticity. This approach can in many cases replace expensive and time-consuming mechanical scanning systems.

Applications

The **BSDF analysis kit** 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 (anti-glare coatings, diffusers, windows) or reflection (coated paper, inkjet paper).

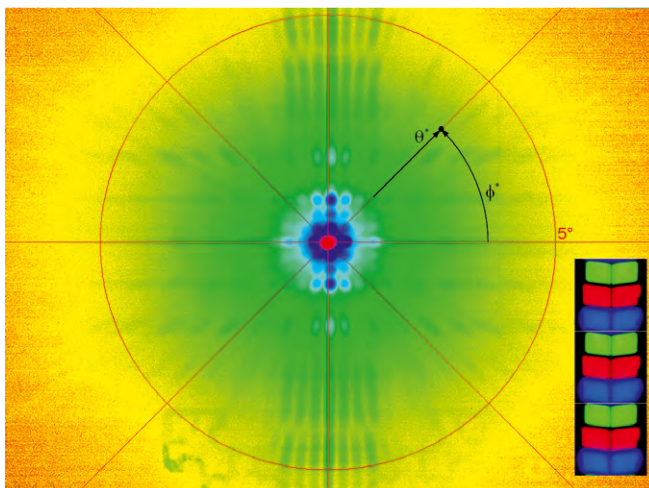
02 \\ Compact, easy-to-use setup for measurement of the directional distribution of scattered light



The compact BSDF setup comprises the required hardware components (optical bench with DUT fixture, point light-source with precision current source, diffuse and specular reflectance standard) and a software module. The LumiCam is arranged in the specular direction with respect to the point light-source within a plane perpendicular to the device under test (DUT).

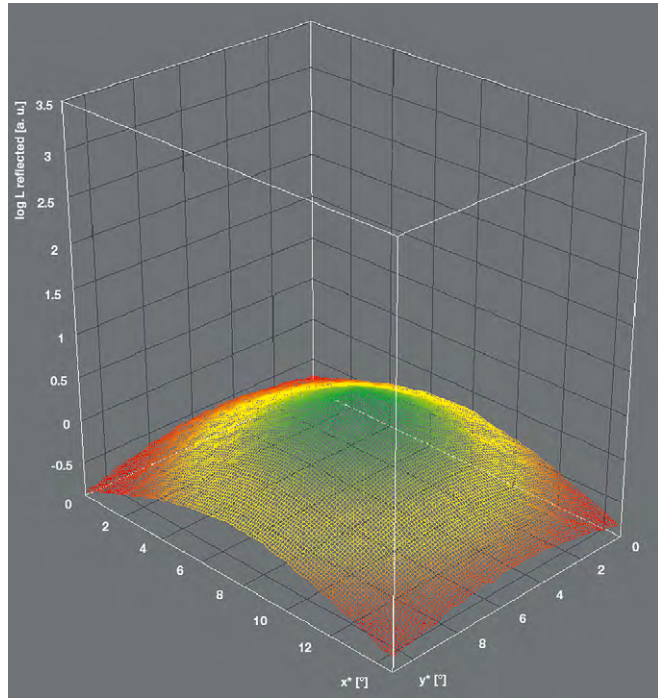
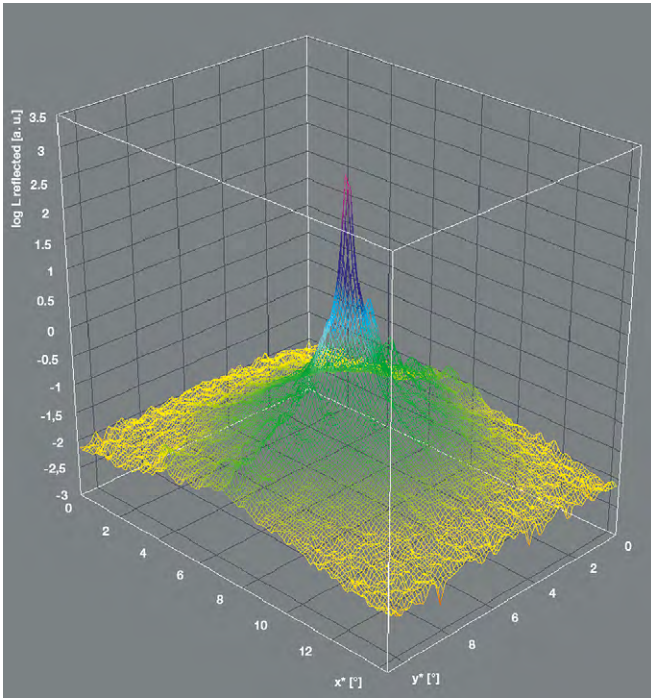
The LumiCam records the lateral distribution of tristimulus values (X,Y,Z; Y only in case of the LumiCam Mono variant) scattered from the DUT. From this lateral distribution, the directional scattering distribution (BSDF) in the vicinity of the specular direction is calculated via the software module. The distance of source and LumiCam to the sample determine the angular range and the resolution of the measurement.

03 \\ Evaluation and graphical representation of the results



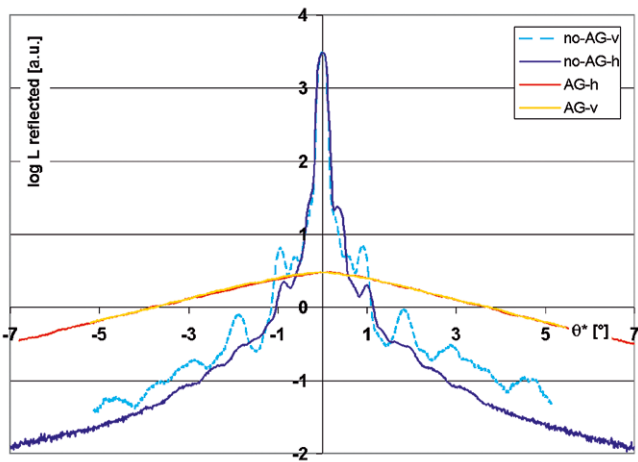
Transformation of the point spread-function (i.e. lateral distribution of luminance and chromaticity) by the software module yields the BSDF as shown here in a polar plot representation. Each location in this polar coordinate system corresponds to a direction of light propagation. The center represents the specular direction to which the difference angle θ^* is related.

▲ Pseudo-color representation of the BSDF of an LCD screen as a function of the spherical angles θ^* and ϕ^* . The diffraction caused by the pixel matrix of the display is more pronounced in the vertical direction due to the subpixel arrangement of the DUT as shown in the inset.



3D representation of the directional distribution of light scattered from an LCD-touch-screen combination without anti-glare treatment (log. luminance vs. θ^*). The specular reflection peak is dominant, diffraction caused by the pixel matrix is visible while scattering is hardly noticeable.

3D representation of the directional distribution of light scattered from a desktop computer monitor with LCD-screen with pronounced scattering caused by the anti-glare polarizer applied for control of reflection of ambient light-sources (log. luminance vs. θ^*).



Intensity of light (logarithm of relative luminance) scattered in the horizontal and vertical direction as a function of the angle of inclination, θ^* , corresponding to the 3D representations of the two LCD screens shown above.

The BSDF analysis software calculates the directional distribution of scattered light from the X, Y, Z data transferred from the LumiCam. The results are presented as follows:

- ▲ luminance vs. direction of light propagation in a polar coordinate system,
- ▲ luminance vs. angle of inclination, θ^* , for one azimuth angle, ϕ^* (profile),
- ▲ chromaticities (x, y or u',v') vs. angle of inclination, θ^* , for one azimuth angle, ϕ^* , in the corresponding chromaticity chart (CIE 1931 or 1976) in reference to the chromaticity of the light-source.

This result data may be stored to file or transferred to other software (e.g. spreadsheet) for further evaluation or graphical representation, e.g. 3D plots as shown above.

04 \\ The basis: LumiCam 2400B series

The LumiCam series of imaging colorimeters is optimized for photometric and colorimetric accuracy. It provides the solid basis for BSDF evaluation by measurement of the lateral distribution of the tristimulus values of scattered light within just a few seconds. LumiCam colorimeters are available with two sensor resolutions up to five megapixels and with optional neutral density filters for expansion of the measurement range toward high intensities.

LumiCam models are available in three different variants: Mono, Color and Advanced. The LumiCam Advanced is provided with 6 color filters instead of 4 for improved accuracy when measuring narrow emission spectra (e.g. LEDs). The B variants of the LumiCam series feature motorized lenses (adjustable focus and aperture) with focal lengths ranging from 24 mm to 100 mm for increased ease of operation.

The LumiCam series is proven in measurement systems in research, development and quality assurance. Typical applications include measurements of lateral uniformity of luminance and chromaticity applied to displays and automotive control elements, electronic display screens and public information displays and advertising screens.



▲ Latest generation of LumiCam series with 5 MP CMOS sensor and motorized lenses: LumiCam 2400B.

04 \\ Technical specifications

LumiCam 2400B	20 mm lens	28 mm lens	50 mm	100 mm lens
Focal length	20 mm	28 mm	50 mm	100 mm
Minimum focusing distance (DUT to lens)	17 cm	19 cm	44 cm	18 cm
Minimum measurement distance (DUT to housing)	25 cm	25 cm	50 cm	30 cm
Image size at min. measurement distance (h x v)	78 mm x 65 mm	61 mm x 51 mm	71 mm x 59 mm	12 mm x 10 mm
Pixel size at min. measurement distance	32 μm x 32 μm	25 μm x 25 μm	29 μm x 29 μm	5 μm x 5 μm
Image size at 1 m distance (h x v)	387 mm x 323 mm	281 mm x 234 mm	152 mm x 127 mm	73 mm x 61 mm
Pixel size at 1 m distance	160 μm x 160 μm	116 μm x 116 μm	63 μm x 63 μm	30 μm x 30 μm

05 \ Ordering 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-110	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)
LC-BSDF-115	DUT holder for the BSDF setup in reflective configuration, ideal for displays. (height: 70-265 mm; width: up to 260 mm (centered); thickness: ideal up to 14 mm)
LumiCam 2400B variant	
LC2400B-100	LumiCam 2400B Mono Imaging photometer with 2430 x 2030 pixels, without PC, without software
LC2400B-110	LumiCam 2400B Mono Imaging photometer with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>German</i> configuration
LC2400B-120	LumiCam 2400B Mono Imaging photometer with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>English</i> configuration
LC2400B-200	LumiCam 2400B Color Imaging photometer and colorimeter with 2430 x 2030 pixels, without PC, without software
LC2400B-210	LumiCam 2400B Color Imaging photometer and colorimeter with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>German</i> configuration
LC2400B-220	LumiCam 2400B Color Imaging photometer and colorimeter with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>English</i> configuration
LC2400B-300	LumiCam 2400B Advanced Imaging photometer and colorimeter with 2430 x 2030 pixels, without PC, without software
LC2400B-310	LumiCam 2400B Advanced Imaging photometer and colorimeter with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>German</i> configuration
LC2400B-320	LumiCam 2400B Advanced Imaging photometer and colorimeter with 2430 x 2030 pixels, with desktop PC and LumiCam software, <i>English</i> configuration
Objective lenses and accessories	
LC-323	24 mm lens for LumiCam 2400B, article includes firmly mounted adapter ring for OD filter
LC-324	50 mm lens for LumiCam 2400B, article includes firmly mounted adapter ring for OD filter
LC-326	100 mm lens for LumiCam 2400B, article includes firmly mounted adapter ring for OD filter
LC-372	OD 2 filter for LumiCam 2400B
LC-374	OD 4 filter for LumiCam 2400B
DTS400	Manual XYZ positioning system
Others	
LC-BSDF-100	BSDF analysis kit for LumiCam 2400B for the measurement of the „bidirectional reflectance/transmittance distribution function“
LC-BSDF-110	Optical bench for transmissive or reflective measurements with the BSDF analysis kit for the LumiCam 2400B
LC-BSDF-115	DUT holder for the BSDF setup in reflective configuration



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