Fabric Blackout Level Measurement

Leading window covering fabric suppliers strive to find the best products for its projects. Whether that means stronger, more durable, higher performing, or more stable fabrics, users want their products to perform as expected. Window shades are expected to control light and provide visual and thermal comfort for occupants. At one end of that spectrum are fabrics that significantly reduce light transmission. Common industry terms for these fabrics are dimout, room darkening, and blackout. All three terms refer to fabrics that are used for light elimination, but the use and definition of the terms may change depending on supplier. This paper will primarily use the term blackout and attempt to answer the question of what it means for a fabric to be blackout.

As improvements are made to these fabrics, the solar shading industry must match the advances in product technology with advances in evaluation. Some evaluation techniques have become so accepted into the textile industry that they are overlooked for change despite being outdated and inconsistent. Currently, fabric blackout measurement is not defined in the US and the techniques that exist do not meet the expectations of the end-user. Blackout fabrics are used in many applications from residential homes, to the hospitality sector, to office conference rooms. These fabrics are desirable in the solar shading industry for thermal and light control and privacy which is why it is so important that testing come up to speed with the market.

Design

Measurement of fabric blackout level requires the same level of care and attention used for all key performance values. It must be repeatable, operator-independent, quantifiable, and applicable. The test must be easily replicated by another facility and use defined variables. Incident light levels should parallel real-world sun exposure and metrics must be output in quantifiable terms that can be compared easily and used as quality control tolerances.

Measurement techniques should not be dependent on human vision, which introduces uncontrolled variability. For example, a dark-room inspection method relies on an operator's eyesight to be consistent and unbiased. However, the observations made by one person may be different for another.

Blackout fabrics are designed to eliminate light. A measurement of blackout must consider both the diffuse and direct components of light transmission. Additionally, the lux used to evaluate blackout needs to at least approximate real exposure. For most applications, the higher the lux of the incident sunlight, the more important the blackout rating becomes. If a design calls for a blackout fabric, the expectation is that the fabric and hardware block 100% of light, and blackout fabrics should be tested to meet that intent.

Intent

The façade of a building, and therefore a window and window shade, are exposed to different light levels, or lux, through the course of a day. Depending on the time of day, season, sun azimuth, and weather, the approximate lux can range from mild to intense. The table below provides some examples of possible sunlight levels:

Source Type/Description	Approximate Lux
Brightest possible atmospheric irradiation	120,000 – 130,000
Air Mass 1.5 global solar spectrum sunlight	109,870
Direct sunlight	32,000 – 100,000
Full daylight (no direct sun)	10,000 – 25,000
Some sunlight (dawn, dusk, overcast, etc.)	400 – 10,000

For window shading applications, the goal of a blackout fabric is to block sunlight that strikes the façade of a building. Test methods must accurately determine the fabric's effectiveness in the expected environment. Direct sunlight on a window shade should be tested to at an appropriate level with respect to true light intensities.

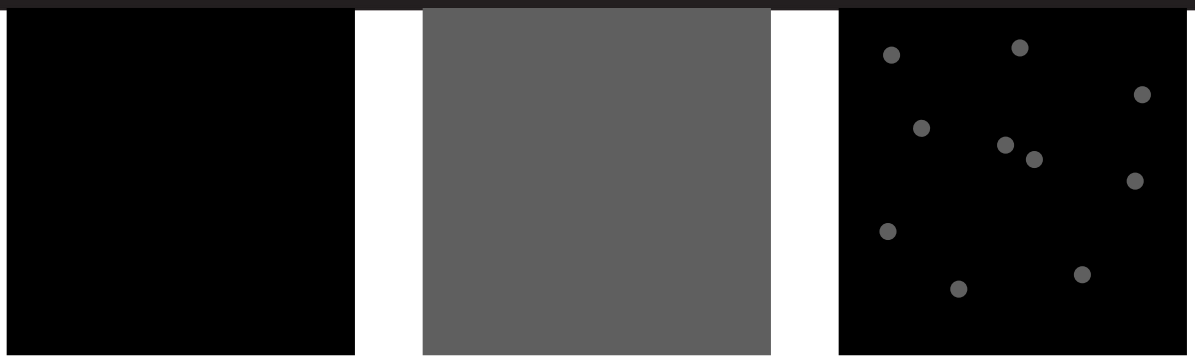
Methods

There are several methods of blackout evaluation that exist today, each with varying degrees of precision and correlation to the quality of a blackout fabric.

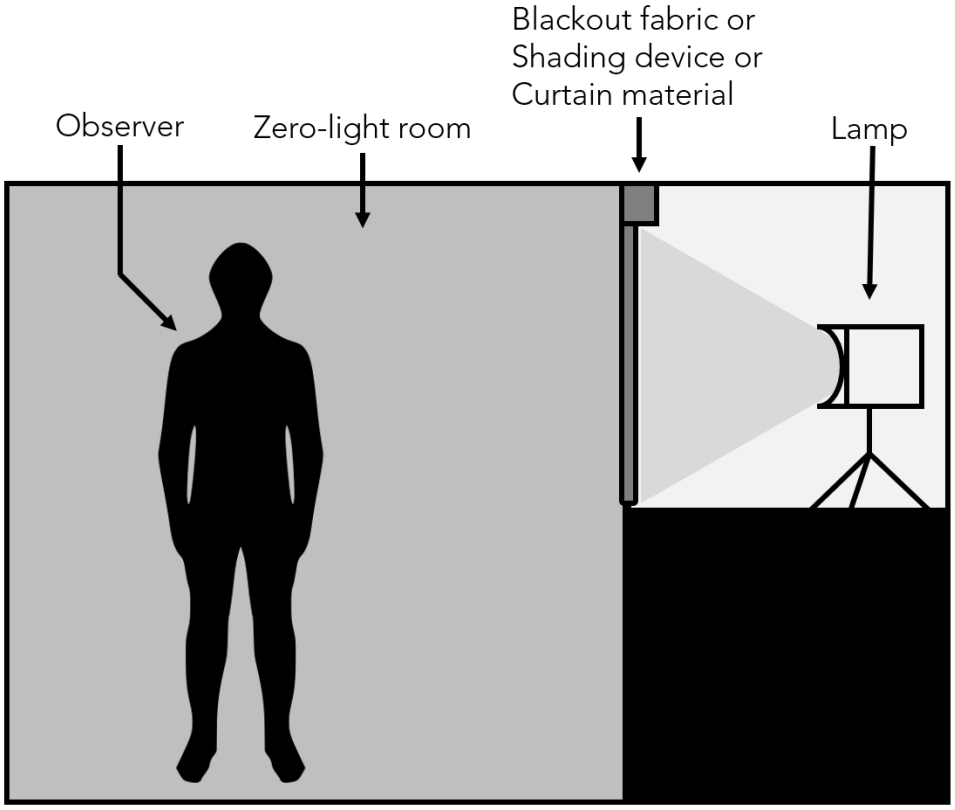
Dark Room Inspection Methods

In its simplest form, blackout can be evaluated by a dark room test. In this test, a room is sealed from any external light, and a light source is placed behind the fabric, or material being tested. An observer is placed in the room and allowed to let their eyes adjust to the darkness for 5-10 minutes. Once adjusted the light source is activated and the observer looks for any glow or pinholes in the fabric. Light passing through the fabric would indicate a poor or failing blackout. This test is reported as Pass or Fail.

> Pros: This test simulates the environment that the fabric would be used in.
>
> Cons: The test only provides Pass/Fail results, subjective observations, and does not provide quantitative means of measuring or comparing results.



100% Blackout | Some Glow | Pinholes/Starry Appearance



AS 2663.2: Textiles-Fabrics for window furnishings-Coated curtain fabrics

This Australian standard measures the opacity (blackout level) using a light meter to measure the Ev of light that passes through a fabric. “The percentage opacity of the fabric is calculated by measuring the amount of light being transmitted through an aperture in a box both before and while the aperture is covered by a specimen of fabric [1].”

Pros: The blackout is calculated using before and after measurements.

Cons: The incident light is not based on established environmental expectations. Ev is a measure of ideal camera settings, not a measure of lux.

EN 14501: Blinds and Shutters-Thermal and Visual Comfort-Performance Characteristics and Classification

The European standard for solar heat gain also includes a section for opacity control. "The performance of dim-out and blackout products is expressed by the level of illuminance under which no light is perceivable behind the [fabric] [2]." Classifications are provided for different incident lux levels. A 'Dim out' classification is given to a fabric if no light is perceived when tested under 1,000 Lux and a 'Black out' fabric classification is given if no light is perceived when tested under 100,000 Lux. This test utilizes a similar set-up to the dark room inspection method but specifies incident light levels and categories of fabric performance.

Pros: The method sets levels of performance and defined incident light levels.

Cons: The method uses the dark room inspection method, does not quantify performance, and provides no comparative power.

American Association of Textile Chemists and Colorists (AATCC)

The two test methods below are used to measure the light blocking properties of window covering textiles against light passing through them and being seen by a standard observer on the darkened side of the textile (typically a curtain or drape.) TM203 is the more recent test method from the AATCC.

AATCC TM148: Light Blocking Effect of Textiles: Photodetector Method

TM148 measures transmitted light with a photometer and is designed so transmitted diffuse light is excluded from the measurement. Diffuse light is the portion of light that is redirected or scattered after passing through the fabric.

Cons: Diffuse light is excluded from the measurement. Glow is primarily a result of diffuse light.

AATCC TM203: Light Blocking Effect of Textiles: Spectrophotometric Method

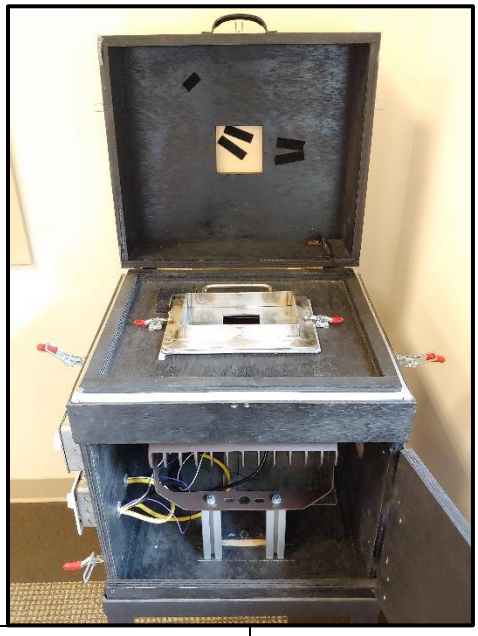
TM 203 uses a spectrophotometer to measure the transmittance of light through a fabric. An integrating sphere captures both the diffuse and direct transmitted light in the measurement. The tested area is restricted to the size of the spectrophotometer's aperture.

Cons: The test area is very small, and the light exposure duration is very short. Light blocking properties may not match the perception of a human eye that is adjusted to a dark environment.

ASTM

There is no ASTM method that directly measures blackout properties of fabrics. The closest method would be the light transmittance standard within in ASTM 903: Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrated Spheres. The tested area is restricted to the size of the spectrophotometer's aperture.

Solution



Based on the ideal design principles, Mermet developed a blackout level test method utilizing a light box, camera, and photo software to measure blackout/glow levels.

A sample of fabric, or other product, is positioned 5.5 inches in front of an LED light [3] and exposed to a controlled light level set to provide an incident 100,000 lx [4]. This lux level aligns Mermet with the benchmark set by the EN 14501 standard. An image is then taken using a Canon 40D camera. Images are taken with the following exposure settings:

Aperture	f/5.0
Shutter Speed	30 seconds
ISO Speed	100

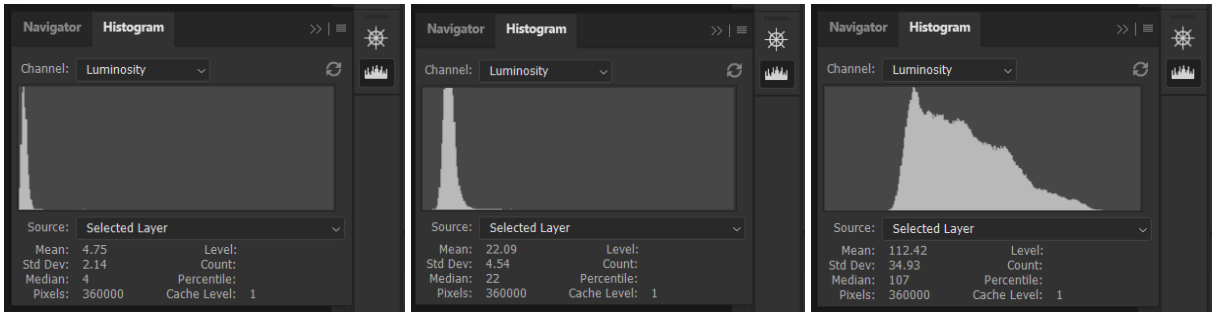
The camera settings were selected to capture all possible light that passes through the test specimen. The shutter speed of 30 indicates that the camera takes a picture across a full 30 second time period. These settings are equivalent to an Ev of -0.33.

The luminosity of the resulting image is evaluated using PhotoShop. Each pixel is measured at a value from 0 to 255 (0 being no light and 255 being total illumination) and then the result is averaged. The 0 to 255 scale is based on an 8-bit output for luminosity. The blackout is calculated using the following equation:

$$\textbf{Blackout (\%)} = \frac{\textbf{255 - Mean Luminosity}}{\textbf{255}}$$

A histogram shows how the pixels are distributed by graphing the number of pixels at each of the 255 brightness levels in an image. On this graph, pixels with the same brightness level are stacked in bars along a vertical axis. The higher the line is from this axis, the greater the number of pixels at that

brightness level. The further to the right the curve is, the higher the luminosity of the image. The example below shows these distributions and their respective blackout.



98.13% 91.34% 55.91%

Interpretation

Creating science-based, measurable, and repeatable blackout level testing, based on real-world conditions, will only benefit the window covering industry as a whole. After putting many of the industry's most popular blackout fabrics through the new testing platform, we found the blackout levels were commonly below the 100% level, with many in the 80% - 90% range. Mermet's new testing platform seeks to reset consumer expectations to a. higher standard, and push manufacturers to produce higher quality fabrics. This shift will take time and involves multiple elements such as fabric engineering, processing, raw material selection, and cost.

Mermet specification sheets, for blackout products, provide the blackout level for every available color option. Please see the addendum for the full list of all Mermet blackout products and their measured blackout level.

Definitions

Below are terms relevant to the testing and evaluation of blackout level.

Blackout Level – The average percentage of light that is blocked by a fabric.

Glow – The average percentage of light that passes directly or diffusely through a fabric.

Glow (%)=100 - Blackout Level (%)

Blackout Fabric – A fabric that eliminates light transmission to 0%

Room Darkening – The property of a fabric or material to block most of light transmission.

Dim-Out Fabric – A fabric that significantly reduces light transmission but still allows some diffused light through.

Lumen (lm) – The units of measurement for luminous flux, the total quantity of visible light emitted by a source per unit of time. A measure of the total amount of visible light in some defined beam or angle or emitted from some source.

Lux (lx) – The SI unit of illuminance, measuring luminous flux per square meter, equal to one lumen per square meter. Lux is a measure of the intensity of total visible light perceived by the human eye.

Exposure Value (Ev) – Ev is a number used in photography to represent the combination of several camera settings that affect exposure. Ev is an estimation of how much light you need for a decent photo with these settings. For a given ISO speed and light meter calibration constant, there is a direct relationship between Ev and lux.

Photometer – An instrument for measuring the intensity of light. Light is converted into an electric current using a photoresistor, photodiode, or photomultiplier.

References

[1] AS 2663.2: Textiles-Fabrics for window furnishings-Coated curtain fabrics

[2] EN 14501: Blinds and Shutters-Thermal and Visual Comfort-Performance Characteristics and Classification

[3] Light source: Prolight 15,000 Lumen LED light (Model # 4110150) with adjustable brightness. This source can produce incident light from 19,000-150,000 lx.

[4] Lux Meter: Extech® Instruments LED Light Meter (Model LT45).

Addendum

Blackout Level of Mermet Fabrics

Date of Publication: June 1, 2024

Style	Color	Blackout*
Elba Twilight™	Quartz	98%
Elba Twilight™	Pumice	98%
Elba Twilight™	Limestone	99%
Elba Twilight™	Slate	99%
Elba Twilight™	Basalt	98%
Elba Twilight™	Obsidian	99%
Flocké®	Loutre	100%
Flocké®	Chartreux	100%
Flocké®	Mississippi	100%
Flocké®	Sahel	100%
Flocké®	Blanc	100%
Sofia Twilight™	Oat	98%
Sofia Twilight™	Barley	98%
Sofia Twilight™	Poppyseed	99%
Sofia Twilight™	Rye	100%
Sofia Twilight™	Buckwheat	99%
Sofia Twilight™	Pumpernickel	98%
Sparta Twilight™	Black/White	100%
Sparta Twilight™	Emery/White	100%
Sparta Twilight™	Pewter/White	100%
Sparta Twilight™	Gypsum/White	99%
Sparta Twilight™	Chalk/White	100%
Sparta Twilight™	White/White	89%
Sparta Twilight™	Emery/Emery	100%
Sparta Twilight™	Pewter/Pewter	100%

Sparta Twilight™	Black/Black	98%
Zora Twilight™	White/White	100%
Zora Twilight™	Chalk/White	100%
Zora Twilight™	Frost/White	100%
Zora Twilight™	Canvas/White	100%
Zora Twilight™	Linen/White	100%
Zora Twilight™	Khaki/White	100%
Zora Twilight™	Pewter/White	100%
Zora Twilight™	Graphite/White	100%
Zora Twilight™	Black/White	100%
Zora Twilight™	Pewter/Pewter	100%
Zora Twilight™	Graphite/Graphite	100%
Zora Twilight™	Black/Black	100%

*The above table represents nominal values for blackout level (%).