LABORATORY PROFILE

2025 Edition

Optical & Thermal Testing Laboratory

OTM Solutions Pte Ltd

ilac-MRA

Accredited Laboratory
SAC - SINGLAS
LA-2016-0610-G

SINGAPORE GREEN BUILDING COUNCIL MEMBER

OTM

Choose OTM.

Work with the expert in

Optical & Thermal Measurement solutions.

Table of contents

Choose OTM. Work with the expert in Optical & Thermal Measurement solutions.

We focus on optical & thermal testing

OTM Solutions Pte Ltd was founded in 2013, with the vision of being Singapore's best optical & thermal testing laboratory.

We have dedicated personnel, equipment, quality system and expertise available to deliver accurate and reliable optical & thermal testing services to our customers.

2025 is the 12th year of our laboratory's operation. We look forward to working with you in 2025.

Key milestones

- 2013: Incorporated as OTM Solutions Pte Ltd
- 2014: Qualified for IGDB data submission
- 2016: Accredited by SAC-SINGLAS
- 2017: Joined as SGBC corporate member
- 2018: Qualified for CGDB data submission
- 2023: 10th anniversary

Choose OTM. Work with the expert in Optical & Thermal Measurement solutions.

We are competent in optical & thermal testing

SAC-SINGLAS accreditation according to ISO/IEC 17025
Accredited in 2016

SGBC lab partner for SGBP certification
Qualified in 2017

NFRC/LBNL IGDB submission
Qualified in 2014

AERC/LBNL CGDB submission
Qualified in 2018

SAC-SINGLAS accreditation: the Singapore Laboratory Accreditation Scheme (SINGLAS) managed by Singapore Accreditation Council (SAC).

SGBC lab partner: lab partner of Singapore Green Building Council (SGBC) for Singapore Green Building Product (SGBP) certification.

IGDB submission: submission of glass product optical data to the International Glazing Database (IGDB) managed by National Fenestration Rating Council (NFRC) and Lawrence Berkeley National Laboratory (LBNL).

CGDB submission: submission of window attachment product optical data to the Complex Glazing Database (CGDB) managed by Attachments Energy Rating Council (AERC) and LBNL.

Choose OTM. Work with the expert in Optical & Thermal Measurement solutions.

SAC-SINGLAS accredited

Internationally recognized

Material Solar Reflectance Index (SRI) Test Report

Report number: OTM2104001

Client:

Company name
Address line 1
Address line 2
Address line 3

Attention: Name

Laboratory:

Optical & Thermal Testing Laboratory
OTM Solutions Pte Ltd
21 Woodlands Close
#07-05 Primz Bizhub
Singapore 737854

Tel: (+65) 6908 0126
WhatsApp: (+65) 8838 1374
Email: info@otm.sg
Web: www.otm.sg

View laboratory profile

The Optical & Thermal Testing Laboratory of OTM Solutions Pte Ltd is accredited to ISO/IEC 17025 under the Singapore Accreditation Council - Singapore Laboratory Accreditation Scheme (SAC-SINGLAS, Certificate No: LA-2016-0610-G).

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council.

What is SAC-SINGLAS accreditation?

We always highlight that our lab is SAC-SINGLAS accredited. The rationale is explained here.

No laboratory license

Operating a lab, including a third-party lab, does not require a license in Singapore (and in most parts of the world).

Voluntary SAC-SINGLAS accreditation

The Singapore Laboratory Accreditation Scheme (SINGLAS) managed by Singapore Accreditation Council (SAC) is a voluntary lab accreditation scheme based on ISO/IEC 17025.

The accreditation criteria are comprehensive and cover all essential parts of lab operation.

SAC audits the lab every year, to ensure the compliance of the lab quality system to ISO/IEC 17025.

SAC accredited reports

An SAC-SINGLAS accredited lab is authorized to issue SAC accredited reports bearing the “ilac-MRA” and “SAC-SINGLAS” marks, for testing services conducted under the terms of accreditation.

SAC accredited reports are internationally recognized, thanks to the Mutual Recognition Arrangements (MRAs) signed by SAC.

Benefits of engaging an SAC-SINGLAS accredited lab

The annual audit by SAC verifies the maintenance and calibration of instruments, personnel qualifications, test result accuracy, and other critical aspects of laboratory operations .

A general lab customer usually does not have the knowledge and resources to thoroughly check a lab’s quality system. It is effortless and risk-free to select an SAC-SINGLAS accredited laboratory.

For decision-makers, e.g. governments or buyers, SAC accredited reports are more trustworthy.

Laboratory instruments

UV/VIS/NIR spectrophotometer

FTIR spectrometer

Emissometer

Heat flow meter

Hot wire thermal conductivity meter

Drying & heating chamber

Choose OTM. Work with the expert in Optical & Thermal Measurement solutions.

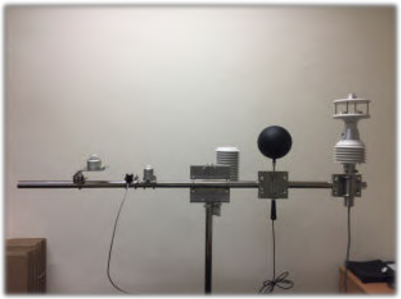
Handheld & on-site instruments

Portable spectrophotometers

Roller wave gauge

Standard colour tiles

Data loggers & sensors



Micro-climate station

Weather station

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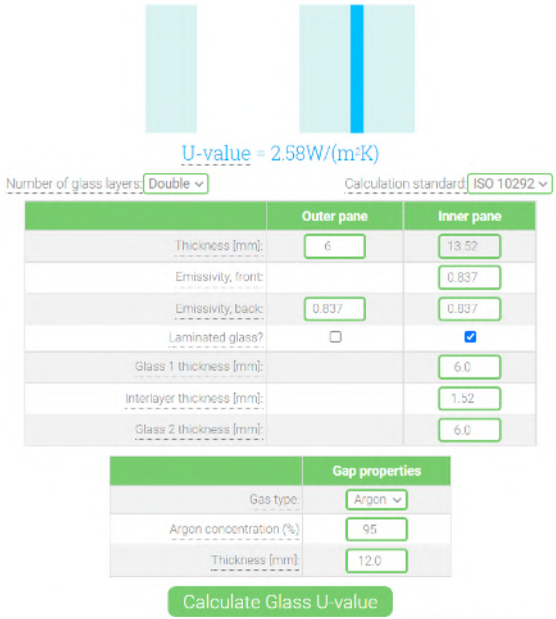
Online optical & thermal calculators

5 free and user-friendly online optical & thermal calculators were developed by us, for interested customers to perform their own calculations and explore various possibilities.

Online ETTV U-value calculator



Online glass U-value calculator

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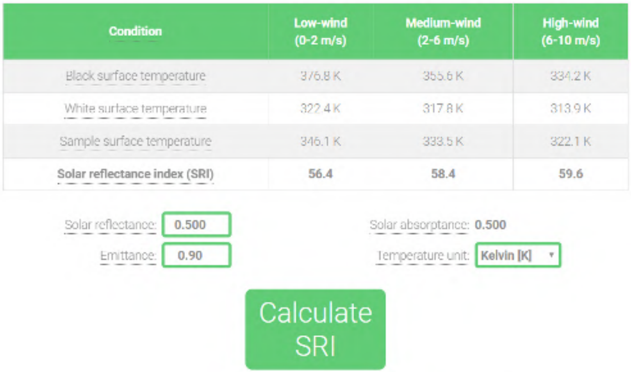
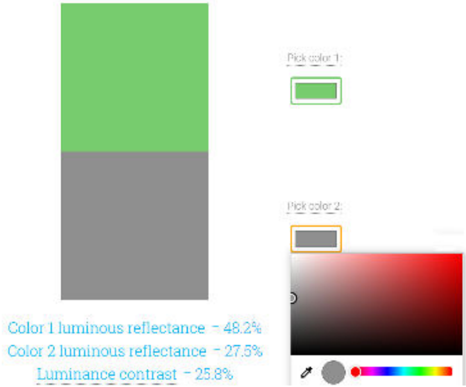
Online optical & thermal calculators

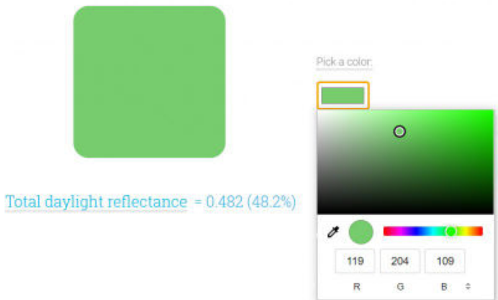


Condition	Low-wind (0-2 m/s)	Medium-wind (2-6 m/s)	High-wind (6-10 m/s)
Black surface temperature	376.8 K	355.6 K	334.2 K
White surface temperature	322.4 K	317.8 K	313.9 K
Sample surface temperature	346.1 K	333.5 K	322.1 K
Solar reflectance index (SRI)	**56.4**	**58.4**	**59.6**

Online solar reflectance index (SRI) calculator



Online luminance contrast calculator



Online total daylight reflectance calculator

Scan me

Try online calculators

Choose OTM. Work with the expert in Optical & Thermal Measurement solutions.

Focus on one thing.

Do it well.

Focus on optical & thermal testing.

Be Singapore's best

optical & thermal testing laboratory.

We compare our results with external labs regularly

Testing quality is paramount to both our customers and us. At OTM, we've implemented a robust laboratory quality system based on ISO/IEC 17025 and are improving it continually.

Quality control measures

At OTM, we adhere strictly to ISO/IEC 17025, with the following important practices:

- Impartiality in laboratory operations
- Regular instrument calibration & maintenance
- Detailed work instructions
- Competent personnel
- Traceable measurement results
- Minimized measurement uncertainties
- Regular performance verifications
- Regular quality assurance tests

Quality assurance tests

To ensure test result validity and reliability, the laboratory implements the following quality assurance measures:

- Daily instrument performance verification with retained samples
- Quarterly internal quality assurance tests with retained samples
- Participation in proficiency tests (PTs) or inter-laboratory comparisons (ILCs)

Listed below are the PTs & ILCs participated by the lab:

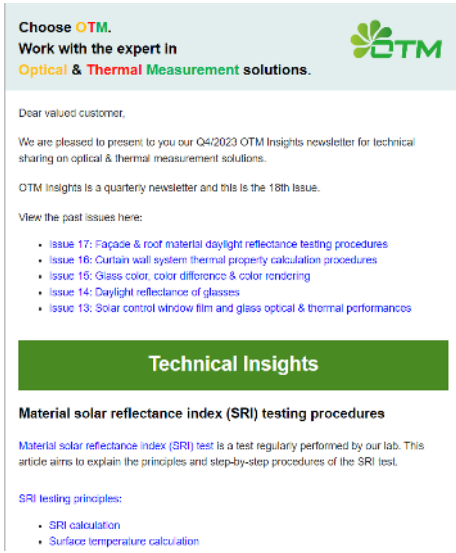
- 2014: ILC on glass testing, organized by LBNL
- 2015: ILC on glass testing, organized by LBNL
- 2017: ILC on complex glazing testing
- 2018: ILC on spectral reflectance testing
- 2019: PT on thermal conductivity testing
- 2020: ILC on glass testing, organized by LBNL
- 2021: PT on thermal conductivity testing
- 2023: ILC on thermal conductivity, emissivity and spectral reflectance testing

OTM Insights newsletter

We released 18 issues of OTM Insights newsletter quarterly between Q3/2019 and Q4/2023.

Listed below are the last 10 issues of OTM Insights newsletter:

- OTM Insights Issue 18 (Q4/2023): Material solar reflectance index (SRI) testing procedures
- OTM Insights Issue 17 (Q3/2023): Façade & roof material daylight reflectance testing procedures
- OTM Insights Issue 16 (Q2/2023): Curtain wall system thermal property calculation procedures
- OTM Insights Issue 15 (Q1/2023): Glass color, color difference & color rendering
- OTM Insights Issue 14 (Q2/2022): Daylight reflectance of glasses
- Issue 13 (Q3/2022): Solar control window film and glass optical & thermal performances
- Issue 12 (Q2/2022): Optical property testing for IGDB / CGDB submission
- Issue 11 (Q1/2022): Understanding OTM glass test report
- Issue 10 (Q4/2021): Gas fill and double glazing unit (DGU) thermal performance
- Issue 9 (Q3/2021): Low-e coating and glass optical & thermal performances



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Dear valued customer,

We are pleased to present to you our Q4/2023 OTM Insights newsletter for technical sharing on optical & thermal measurement solutions.

OTM Insights is a quarterly newsletter and this is the 18th issue.

View the past issues here:

- Issue 17: Façade & roof material daylight reflectance testing procedures
- Issue 16: Curtain wall system thermal property calculation procedures
- Issue 15: Glass color, color difference & color rendering
- Issue 14: Daylight reflectance of glasses
- Issue 13: Solar control window film and glass optical & thermal performances

Technical Insights

Material solar reflectance index (SRI) testing procedures

Material solar reflectance index (SRI) test is a test regularly performed by our lab. This article aims to explain the principles and step-by-step procedures of the SRI test.

SRI testing principles:

- SRI calculation
- Surface temperature calculation

OTM Insights newsletter issue 18

Choose OTM. Work with the expert in Optical & Thermal Measurement solutions.

OTM Blog

We update our OTM Blog regularly, with technical tips and service updates.

Listed below are selected bog posts added in 2023 & 2024:

- 01/04/2024: Can the testing fee be reduced by skipping some glass optical property results?
- 04/03/2024: Can glass optical & thermal property test be performed on shattered tempered glass pieces?
- 05/02/2024: Does rook wool thermal conductivity increase or decrease with density?
- 02/01/2024: Thermal conductivity of 90° rotated mineral wool material
- 04/12/2023: Can transparent plastic materials be tested as glazing materials?
- 20/11/2023: Diffuse daylight reflectance of glasses
- 16/10/2023: Glass substrate for window film optical & thermal property testing
- 02/10/2023: Substrate for paint/coating material SRI testing
- 04/09/2023: Glass U-value and glass tilt
- 17/07/2023: Aged solar reflectance index (SRI) testing
- 19/06/2023: What is emissivity?
- 05/06/2023: Solar heat gain (SHGC & SC) of opaque glasses
- 15/05/2023: Wavelength range in spectral transmittance measurement

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Visit OTM blog

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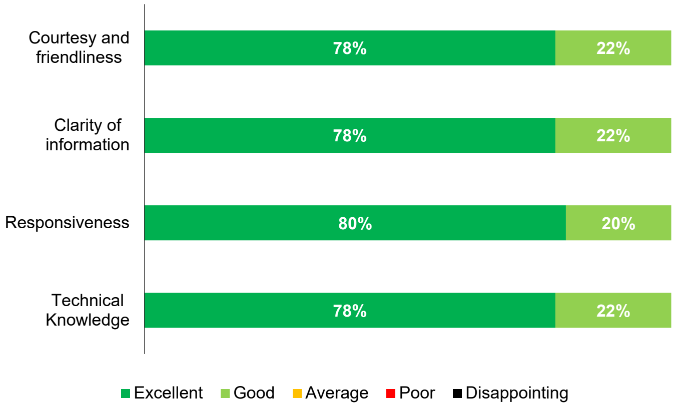
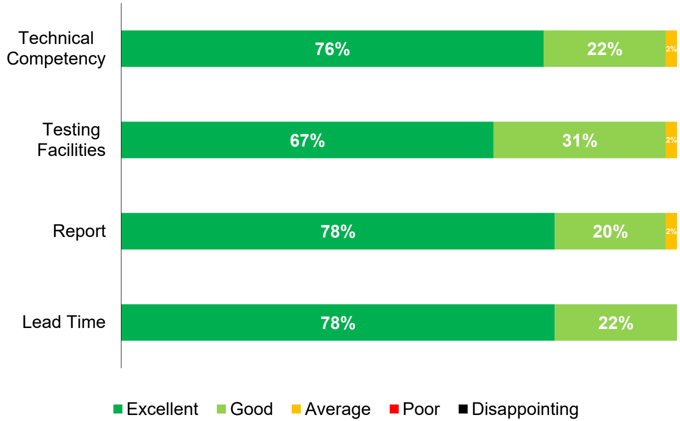
We do our best for high customer satisfaction

100% customers are satisfied with our customer services



Rating on customer services

Most customers are satisfied with our testing services (2% rated the first 3 items as average)



Rating on testing services

Source of data: customer satisfaction survey conducted in 2024. 55 customers participated the survey.

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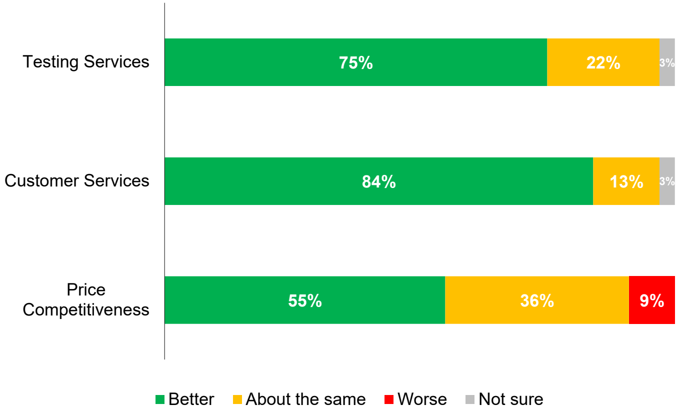
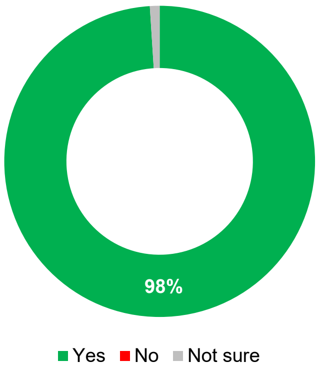
We do our best for high customer satisfaction

Most customers rated us better than or about the same as other labs.

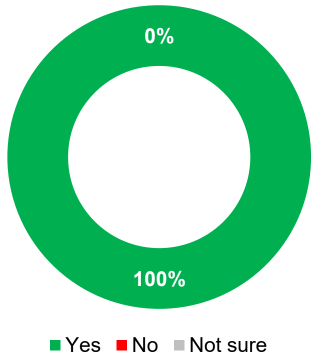


Comparison with other labs

98% customers are willing to work with OTM again, and 100% are willing to recommend OTM to others



Work with OTM again in the future



Recommend OTM to others

Further efforts on price competitiveness:

- Uniform pricing to all
- Automatic volume discounts
- Automatic loyalty discounts

Source of data: customer satisfaction survey conducted in 2024. 55 customers participated the survey.

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We serve regional & international customers

Our main customer base is the building and construction industry, from material manufacturers to construction companies. We welcome international customers. Our customers are from in total 35 countries, as of 2024.

A-G

- Argentina
- Australia
- Cambodia
- Canada
- China
- Costa Rica
- Egypt
- France
- Germany

H-N

- Hong Kong
- Hungary
- India
- Ireland
- Israel
- Japan
- Korea
- Malaysia
- Mauritius
- Netherland
- New Zealand

O-T

- Oman
- Philippines
- Qatar
- Saudi Arabia
- Singapore
- South Africa
- Sri Lanka
- Taiwan
- Tanzania
- Thailand
- Turkey

U-Z

- UAE
- UK
- USA
- Vietnam

We understand the physics in optical & thermal testing

Publications

Chen, F. and Wittkopf, S. K. (2012) Summer condition fenestration thermal transmittance measurement using calorimetric hot box. 53, Energy and Buildings.

Chen, F. and Wittkopf, S. K. (2012) Solar heat gain coefficient measurement with indoor calorimetric hot box and solar simulator. 53, Energy and Buildings.

Chen, F., Choo, T. S. and Ouyang, J. (2013) The effects of fenestration systems on occupant thermal and visual comfort in the tropics. SB13 Singapore Conference.

Chen, F. (2013) Annual equivalent shading coefficient (AESC) index for thermal performance rating of fenestration in Singapore. SB13 Singapore Conference.

Presentations

Chen. F. (2012) SERIS' approach towards a standard calorimetric method for solar heat gain coefficient (SHGC) measurement. 2012 International Collaboration Seminar: Development of Evaluation Method for G-value, Korea.

Chen. F. (2012) SERIS' experience on calorimetric G-value measurement. The 2nd International Seminar Regarding G-value Measurement Method, China.

Chen, F. (2013) The ABCs of fenestration system U-value and G-value. Seminar on Energy Efficient Facades and Fenestrations in the Tropics, Singapore.

Chen, F. (2013) Fenestration: the New Focal Point of Tropical Green Building Innovations. SGBC and SIBL Joint Seminar: Holistic Approach to Sustainable Development, Singapore.

Chen, F. (2013) The ABCs of Facades in the Tropical Climate. 2nd Seminar on High Performance Façades in the Tropics, Singapore.

Chen, F. (2013) Fenestration System Thermal Performance Rating for Summer Condition. APEC Policy Workshop for Energy Efficient Envelopes, Thailand.

Chen, F. (2015) New Perspectives on Energy Efficient Fenestrations in Tropical Climate. Fenestration Days China, China.

Chen, F. (2017) Accurate Measurement of Transmittance and Reflectance for Engineering Applications. PerkinElmer INTour Seminar 2017, Singapore.

Your premium optical & thermal testing laboratory:

- Broadest scope
- Best accuracy
- Fastest delivery
- Friendliest price

Full services optical & thermal testing laboratory

Glass properties

IGDB / CGDB submission

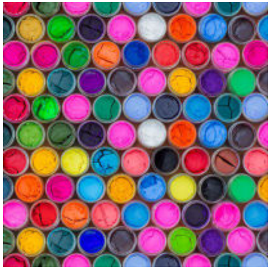
Frame U-value & SHGC

Solar reflectance index (SRI)

Daylight reflectance

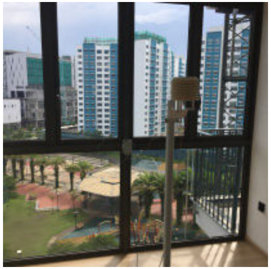
Thermal conductivity

Emissivity



Colour

Luminance contrast



On-site monitoring

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Laboratory test of glass optical & thermal properties

Test methods

There are 3 major glass test methods. It is important to select an appropriate test method for fair comparison:

- NFRC method: NFRC 100/200/300/301
- EN method: EN 410/673
- ISO method: ISO 9050/10292

We support all 3 methods, with the NFRC method as the default.

Sample types

All general glass types: laminated glass, glass with window film, insulating glazing unit and partially fritted glass.

Instruments

- PerkinElmer Lambda 950 spectrophotometer
- PerkinElmer Spectrum Two spectrometer

Standard result set

- Visible light transmittance
- Visible light reflectance (front & back)
- Solar energy transmittance
- Solar energy reflectance (front & back)
- Solar heat gain coefficient (SHGC)
- Shading coefficient
- U-value (winter & summer)

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More information at otm.sg

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Expert in glass optical & thermal property testing

Extended results

Upon a customer's request, we can report additional results preferred by the industry, particularly in the window film sector:

- UV transmittance & rejection
- Infrared transmittance & rejection
- Total solar energy rejection
- Light-to-solar gain (LSG) ratio
- Luminous efficacy
- Colour (transmitted & reflected)
- Colour rendering index (CRI)
- CIE damage factor
- Skin damage factor

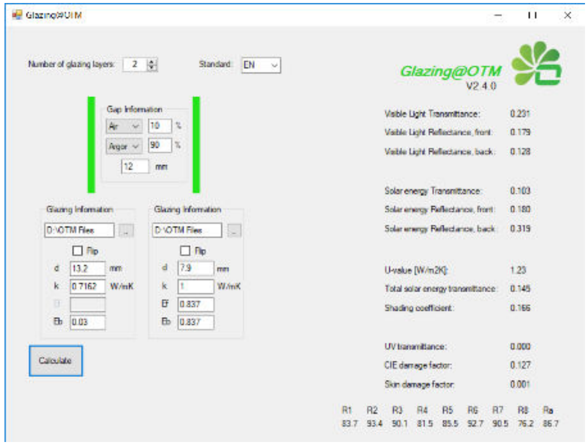
Advanced calculations

Upon a customer's request, we can perform the following advanced calculations:

- Extract low-e layer optical properties and construct new low-e glasses.
- Extract PVB/SGP interlayer optical properties and construct new glass laminates.
- Extract window film optical properties and attach it to a different glass.

Home-made calculation software

We develop our own glass calculation software from scratch to ensure the best capabilities and flexibility.



Glazing@OTM software

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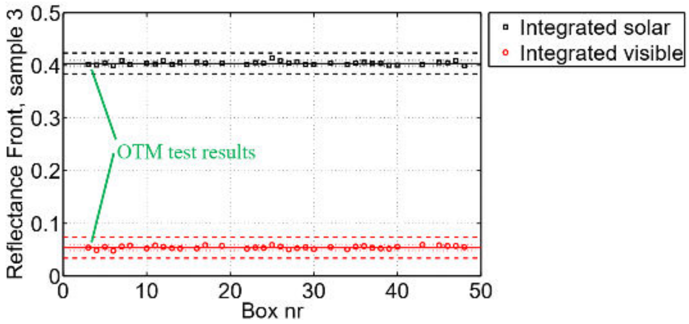
We are as accurate as world's best laboratories

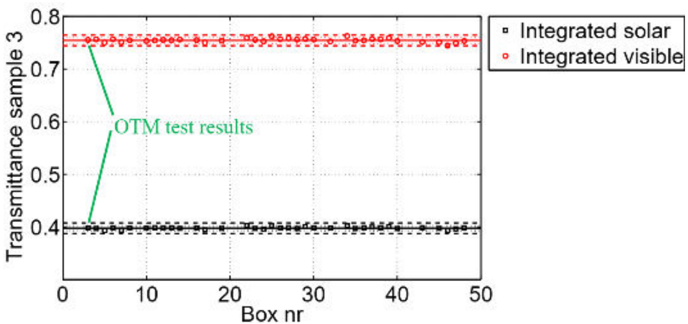
We participate in the inter-laboratory comparison (ILC) organized by the Lawrence Berkeley National Laboratory (LBNL) regularly.

Below are the result comparisons of the ILC conducted in 2015, where the results measured by OTM ranked among the most accurate of the 36 participating labs .

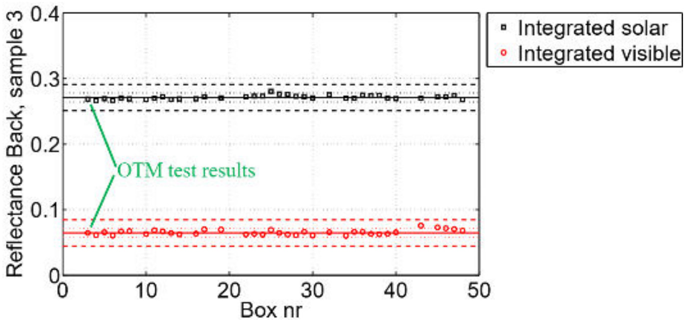
We also participated in the LBNL ILC in 2019, with excellent accuracy demonstrated.



Comparison of reflectance results (front side)



Comparison of transmittance results



Comparison of reflectance results (back side)

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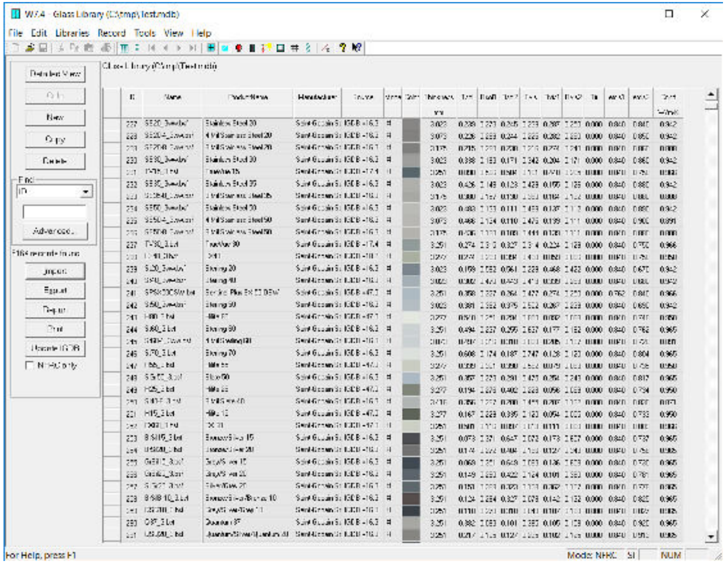
We are eligible for IGDB submission

OTM is qualified to submit data to the IGDB, the world's largest glass optical property database, managed by NFRC and LBNL.

If you are using the renowned LBNL WINDOW software, the optical data were probably tested by OTM.

Additionally, OTM is also qualified to submit data to the CGDB, managed by AERC and LBNL.



LBNL WINDOW software

IGDB: International Glazing Database
CGDB: Complex Glazing Database
NFRC: National Fenestration Rating Council
AERC: Attachments Energy Rating Council
LBNL: Lawrence Berkeley National Laboratory

Choose OTM. Work with the expert in Optical & Thermal Measurement solutions.

How are glass optical & thermal properties tested?

Curious about glass testing procedures? The key concepts are explained here.

No direct measurement

In contrast to the common assumptions, the U-value & SHGC of a glass are not directly measured by an instrument with controlled temperature difference and solar radiation.

Only spectral optical properties are physically tested

In the lab, we only test the spectral transmittance/ reflectance in the 300 nm – 2500 nm range (ultraviolet, visible light and near infrared) and the spectral reflectance in the 5 μm – 25 μm range (infrared).

Broadband optical properties are calculated

Weighted averaging is performed, with the standard AM1.5 solar spectrum or the standard room temperature blackbody emission spectrum as the weights, to get the following broadband optical properties:

- Visible light transmittance/reflectance
- Solar energy transmittance/reflectance
- Emittance

Thermal properties are calculated

Using standard environmental conditions and mathematical models defined in the standards, the following thermal properties are calculated:

- U-value
- SHGC and shading coefficient

Detailed testing procedures

Step-by-step testing procedures for the following glass types are available on our website:

- Single glazing testing procedures
- Double glazing unit (DGU) testing procedures
- Partially fritted glazing testing procedures

What are U-value, SHGC and shading coefficient?

U-value, SHGC and shading coefficient are the 3 key thermal properties influencing building envelope energy efficiency. The basic concepts are explained here.

U-value

$$U\ [W/(m^2K)] = \frac{\text{Heat transmitted through a glass [W]}}{\text{Area } [m^2] \times \text{Temperature difference [K]}}$$

The U-value represents the insulation performance of a glass under an indoor/outdoor temperature difference. A smaller U-value indicates better thermal insulation.

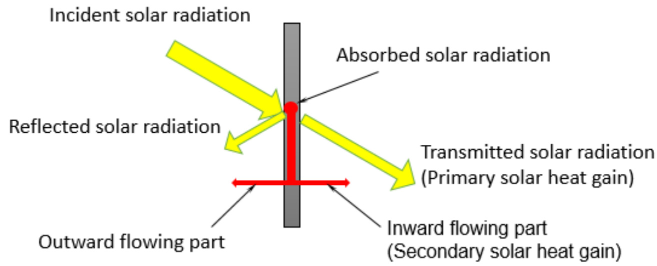
The U-value depends on environmental conditions, e.g. indoor/outdoor wind speed. Therefore, the summer condition and winter condition U-values are different.

Solar heat gain coefficient (SHGC)

$$\text{SHGC [-]} = \frac{\text{Solar heat transmitted through a glass [W]}}{\text{Solar heat incident on a glass [W]}}$$

The SHGC represents the solar heat gain performance of a glass. A smaller SHGC indicates better control of solar heat gain .

SHGC consists of two components, primary and secondary solar heat gains, as shown below.



Shading coefficient

$$\text{SC [-]} = \frac{\text{SHGC [-]}}{0.87}$$

The shading coefficient is equivalent to the SHGC in physical terms. It is calculated by dividing the SHGC by 0.87, which is the nominal SHGC of clear glass.

The differences between NFRC, EN & ISO methods

There are three widely adopted glass test methods:

- NFRC method: NFRC 100/200/300/301
- EN method: EN 410/673
- ISO method: ISO 9050/10292

The differences between them are explained below.

Measurement principles: same

The measurement principles in all 3 methods are the same. The same types of instruments are used.

Testing: NFRC method is more detailed

The NFRC method provides more detailed and specific testing requirements, while the EN/ISO methods are brief in comparison.

Test results obtained using the NFRC method can be directly applied to EN/ISO calculations, but not vice versa.

Calculation: different solvers & conditions

The differences in the calculation parts are substantial:

- Solver: the NFRC method uses a numerical solver, while the EN/ISO methods use an analytical solver.
- Environmental conditions: differences in solar spectrum, temperature, wind speed, etc..

Results: significant difference in SHGC

The visible light transmittance/reflectance results are the same across the 3 methods.

The winter condition U-value results are close, but the EN/ISO method does not provide a summer condition U-value.

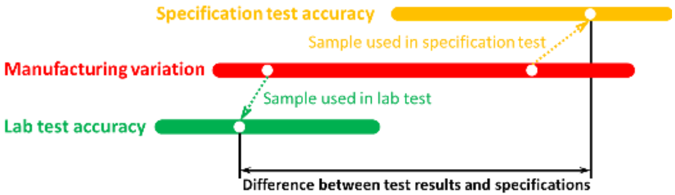
The SHGC results can differ significantly (e.g. >0.02), due to variations in environmental conditions.

Which method is recommended?

The choice depends on your project requirements. If no specific method is indicated, the NFRC method is recommended due to its detailed requirements and broad industry adoption.

Why are test results different from specifications?

It is impossible for our test results to be the same as the manufacturer's specifications. Some explanations are provided here.



It is normal and inevitable

As outlined above, there are 3 possible factors:

- Specification test uncertainty
- Production variation
- OTM test uncertainty

It is impossible to eliminate all uncertainties and variations, so some differences are inevitable.

Production variation

Different samples are used in the specification test and in OTM test.

These samples are not identical, especially if they were produced in different lots, years or plants.

Specification test uncertainty

The manufacturer's specifications are subject to uncertainty. It is also important to know the test methods used to obtain those specifications.

OTM test uncertainty

Our results are with certain uncertainty, as specified in the test report. We will be fully responsible to our result accuracy. If our results are inaccurate, we will re-test at no cost or refund the full price.

Project suggestions

- Understand your project requirements.
- Consult your glass supplier about typical production variation and specification accuracy.
- Check with OTM for measurement uncertainty

Factors affecting glass U-value

The glass U-value represents its insulation performance under an indoor/outdoor temperature difference. The following factors affect the glass U-value.

Glass surface emissivity

A low-emissivity (low-e) surface reduces radiative heat exchange with its surroundings, resulting in a lower U-value.

The nominal emissivity of an uncoated glass surface is 0.84, which leads to a higher U-value due to the high emissivity.

For single glazing glasses, hard low-e coating, which can withstand scratches and moisture, is used. It has a typical emissivity of 0.1 - 0.3, and significantly reduces the glass U-value.

Soft low-e coating with better performance is often used for double glazing units (DGUs), as the coating is encased in the DGU gas gap and protected. Its typical emissivity ranges 0.02 - 0.1, superior to hard low-e coatings.

DGU gas fill

DGU gas fill (gap size and gas type) affects the convective heat transfer rate in a DGU gas gap.

The gap size cannot be too small or too large. There is an optimal gap thickness, depending on the low-e coating and environmental conditions. In Singapore, a 12 mm thick air gap is most commonly used.

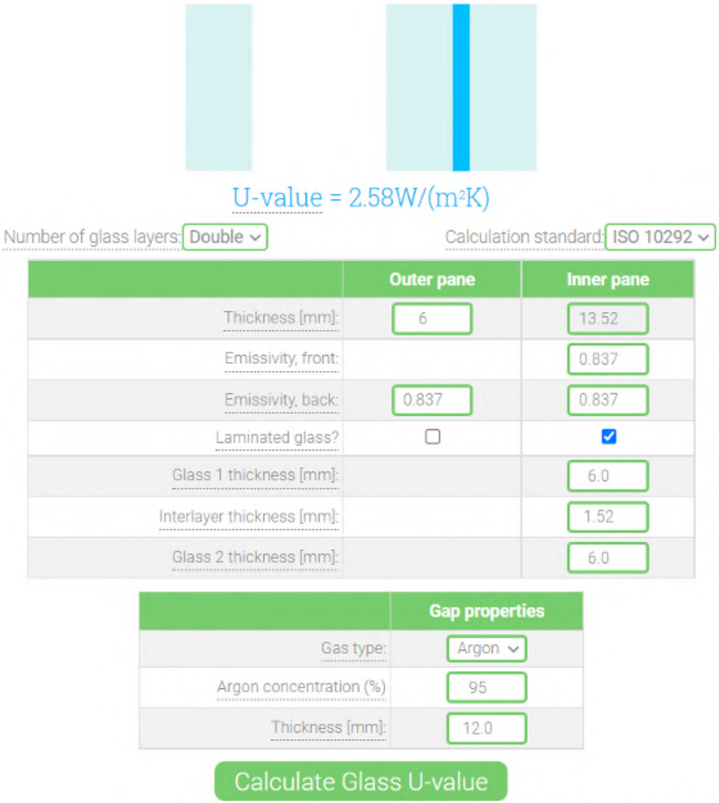
DGUs filled with argon gas have substantially lower U-values compared to those filled with air, due to the lower thermal conductivity and higher density of argon gas.

Glass thickness

Glass thickness affects the heat conduction rate. As glass is a good conductor of heat and glass thickness can only vary in a narrow range, increasing glass thickness has minimal impact on the U-value.

Because PVB interlayer is a poor conductor of heat, laminated glass tends to have a slightly lower U-value than monolithic glass.

Online glass U-value calculator



How to use this calculator?

- Select the number of glass layers
- Select the calculation method
- If applicable, toggle the laminated glass option
- Input the glass and interlayer thicknesses
- Enter the emissivity values
- If applicable, set the gas type and gap thicknesses

The glass U-value will be calculated and updated immediately whenever there are changes to the input .

Calculation principle

The calculator follows ISO 10292 or EN 673.

Try the calculator

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Laboratory testing for IGDB & CGDB submission

IGDB test methods

- NFRC 300
- NFRC 301

IGDB sample types

All sample types in the scope of IGDB submission, e.g. glasses or window films, excluding diffuse samples, e.g. fritted glasses.

Instruments for IGDB testing

- PerkinElmer Lambda 950 spectrophotometer
- PerkinElmer Spectrum Two spectrometer

Results for IGDB submission

- A text file in the IGDB data format

Refer to pages 20 - 29 for more information on our glass testing services.

CGDB test methods

- AERC 1.1

CGDB sample types

All samples types in the scope of CGDB submission, e.g. fabrics.

Instruments for CGDB testing

- PerkinElmer Lambda 950 spectrophotometer
- Devices and Services AE1 RD1 emissometer

Results for CGDB submission

- A homogeneity report
- A text file in the CGDB data format

For both IGDB and CGDB submissions, the customer is responsible for submitting the results. OTM will provide the necessary technical support to assist the customer throughout the process.

What are the procedures of CGDB submission testing?

If you are new to CGDB submissions, the testing procedures are outlined below.

Homogeneity test

The purpose of the homogeneity test is to evaluate the consistency of a product and identify a representative sample for further testing.

A total of 18 samples needs to be sampled from different lots and positions. The visible light transmittances or reflectances of the 18 samples is measured to assess the product's homogeneity.

Based on the homogeneity test results, a representative sample is selected for detailed optical property testing.

For product families with multiple variants, simplified procedures for the homogeneity test are available. Please visit our website for additional details.

Optical property test

In the optical property test, the following properties of the representative sample are measured:

- Direct-hemispherical and diffuse spectral transmittance in the 300 nm – 2500 nm range
- Direct-hemispherical and diffuse spectral reflectance in the 300 nm – 2500 nm range
- Thermal emissivity and infrared (IR) transmittance

Result compilation

Based on the test results, two result files are compiled:

- A homogeneity test report in MS Excel format
- A text file in CGDB data format containing the optical property test results

The two files should be submitted together by the customer.

Frame U-value & SHGC calculation service

Calculation methods

- NFRC 100/200
- NFRC Simulation Manual

Solar reflectance test method

- ASTM E903

Frame and fenestration types

- All general frame types: aluminium frame, aluminium frame with thermal break, and uPVC frame
- All general fenestration types: window and curtain wall system

Calculation software

- LBNL WINDOW/THERM

Solar reflectance test instrument

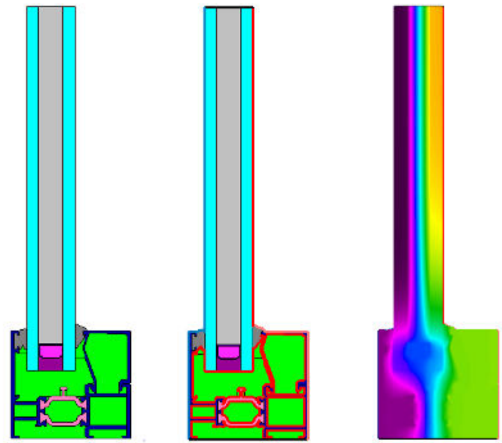
- PerkinElmer Lambda 950 spectrophotometer

Standard calculation result set

- Frame U-value and SHGC
- Edge-of-glazing U-value and SHGC
- Centre-of-glazing U-value and SHGC
- Fenestration system U-value and SHGC

Standard solar reflectance test results

- Solar reflectance and absorptance



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Why are frame U-value & SHGC important?

The industry is increasingly recognizing the significance of frame U-value and Solar Heat Gain Coefficient (SHGC) in tropical climates. Below is an overview of their importance in different conditions.

Frame U-value: critical in winter conditions

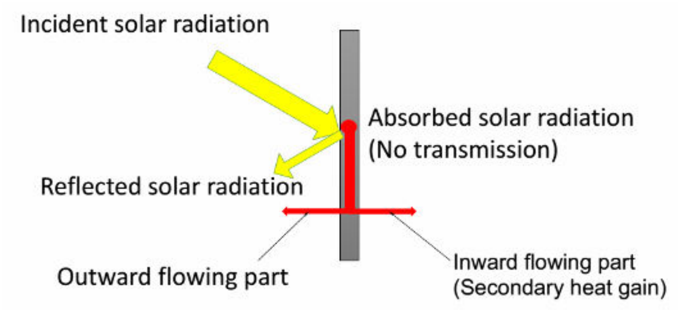
Due to the large indoor/outdoor temperature difference, the overall fenestration U-value plays a crucial role in thermal performance during winter.

As the U-value of frames, particularly aluminium frames, is typically greater than the U-value of low-e insulating glazing units, frame U-value is important in winter conditions.

Frame SHGC: critical in summer conditions

Due to the large solar heat gain, the overall fenestration SHGC is important in summer conditions.

The solar heat gain through a frame can be significant. Shown below is the heat transfer mechanism.



Frame U-value influences SHGC

The secondary heat gain through a frame depends on its solar absorptance and U-value.

Frames with lower solar absorptance and U-value result in a reduced SHGC.

Understanding these factors is crucial for reducing solar heat gain in buildings.

4 reasons to engage OTM for frame U-value & SHGC calculation

- We are a neutral and independent third-party lab
- We are technically competent
- We use the NFRC method consistently
- We offer a special bundle price when both frame and glass are evaluated by OTM

How are frame U-value and SHGC calculated?

Curious about the frame U-value and SHGC calculation procedures? The key concepts are explained below.

Physical property testing not required

The thermal conductivity and emissivity of common fenestration materials are available in a standard material database.

It is not required to test the materials, unless your material is not available in the database.

Optional solar reflectance testing

By default, the solar reflectance of all materials is set to 0.5 or 0.7. It is optional to test your material's solar reflectance for better accuracy.

Frame cross-section drawing required

Frame cross-section drawing in CAD format is needed. The bill of materials (BOM) of the fenestration is also required.

2D modelling in THERM

A 2D model is created using LBNL THERM software, with the standard environmental conditions applied. The frame and edge-of-glazing U-values and SHGCs are calculated.

Area-weighted averaging in WINDOW

In LBNL WINDOW software, the overall fenestration system U-value and SHGC are determined through area-weighted averaging of frame, edge-of-glazing, and centre-of-glazing U-values and SHGCs.

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Roof material solar reflectance index (SRI) test

Test methods

- ASTM E903
- ASTM C1371 (with TN 11-2)
- ASTM E1980

Sample types

All general materials with flat surface: roof materials, pavement materials and façade cladding materials.

Instruments

- PerkinElmer Lambda 950 spectrophotometer
- Devices and Services AE1 RD1 emissometer

Standard result set

- Solar reflectance & absorptance
- Thermal emittance
- SRI at 3 wind conditions

For non-roof materials, it is possible to test the solar reflectance only.

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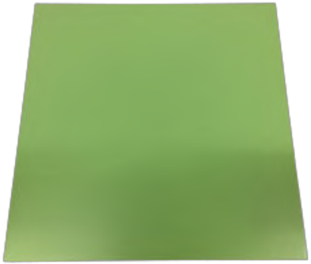
We are familiar with all sample types



PVDF coated metal plate

Waterproofing membrane

Concrete

Ceramic tile

Granite

Wood

Paint

Roof tile

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What is solar reflectance index (SRI)?

SRI is a key parameter in urban heat island (UHI) mitigation. Materials with higher SRI tend to have lower surface temperatures when exposed to solar radiation. Below are the key concepts.

Surface temperature under solar radiation

The surface temperature depends on both surface optical properties and environmental conditions.

Solar reflectance and thermal emittance are the two primary properties affecting surface temperature.

Under standard environmental conditions, surface temperatures for three wind speeds can be calculated.

Reference white and black surfaces

A surface with solar reflectance = 0.80 and emittance = 0.9 is defined as the reference white surface.

A surface with solar reflectance = 0.05 and emittance = 0.9 is defined as the reference black surface.

Solar reflectance index (SRI)

The surface temperatures of the reference white surface (T_{white}), of the reference black surface (T_{black}), and of a sample (T_{sample}) can be calculated. An SRI can then be calculated from the 3 temperature results.

$$SRI = \frac{T_{black} - T_{sample}}{T_{black} - T_{white}} \times 100$$

Since there are three standard wind speeds, there are three SRI values for each material.

It is possible for SRI values to be greater than 100 or negative.

For horizontal or low-sloped surfaces only

Strictly speaking, the concept of SRI is not applicable to façades, as the temperature calculation model is for horizontal and low-sloped surfaces only.

In LEED certification, only solar reflectance is required for non-roof areas.

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How is solar reflectance index (SRI) tested in the lab?

Curious about the SRI testing procedures? The important concepts are explained here.

SRI calculation

SRI is calculated based on solar reflectance and thermal emittance, following ASTM E1980.

These two properties are measured separately, using different instruments.

Thermal emittance measurement

Thermal emittance is directly measured with the instrument emissometer, following ASTM C1371.

Solar reflectance measurement

There are three acceptable solar reflectance measurement methods:

- ASTM E903
- ASTM C1549
- ASTM E1918

The 3 methods are equivalent essentially. The differences lie in the solar radiation source, detector and optical geometry.

ASTM E903 is the most accurate, as it uses a spectrophotometer.

At OTM, ASTM E903 is employed. The spectral reflectance of a sample in the solar spectrum range (300 nm – 2500 nm) is measured. Weighted averaging, with the standard AM1.5 spectrum as the weights, is performed to get the solar reflectance.

Initial and aged SRI

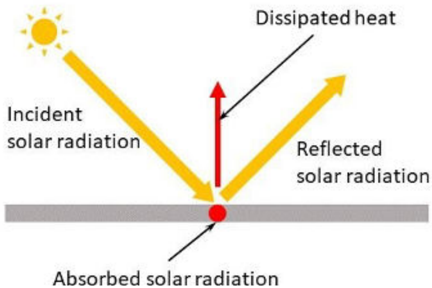
SRI decreases over time due to soiling and weathering The aged SRI is a more realistic representation than the initial SRI in the lifetime of a building.

At this moment, we can test the initial SRI only. If the aged SRI is needed, the aging process should be performed by the customer.

Factors affecting solar reflectance index (SRI)

Solar reflectance index (SRI) can be understood as a scaled surface temperature, with reference to the reference white and black surfaces. The factors affecting SRI are explained here.

Surface temperature under solar radiation



For a surface under solar radiation, its surface temperature is affected by two factors:

- Solar reflectance: the fraction of solar radiation reflected back for the surface.
- Thermal emittance: the fraction of absorbed solar radiation dissipated back as heat.

Solar reflectance & SRI

Materials with high solar reflectance are able to reflect more incident solar radiation back to the sky and absorb less.

As solar reflectance is correlated to colour, in general, the lighter the colour, the higher the SRI.

Additionally, materials with high reflection to near-infrared (NIR) radiation are with relatively higher solar reflectance too.

Thermal emittance & SRI

Materials with high thermal emittance can dissipate more absorbed solar radiation back to the environment.

However, most materials are with high thermal emittance, typically in the range of 0.8 - 0.95. There are not much room and technology available to increase the thermal emittance of a surface.

Online solar reflectance index (SRI) calculator

Condition	Low-wind (0-2 m/s)	Medium-wind (2-6 m/s)	High-wind (6-10 m/s)
Black surface temperature	376.8 K	355.6 K	334.2 K
White surface temperature	322.4 K	317.8 K	313.9 K
Sample surface temperature	346.1 K	333.5 K	322.1 K
Solar reflectance index (SRI)	**56.4**	**58.4**	**59.6**

Solar reflectance: **0.500** Solar absorptance: **0.500**

Emittance: **0.90** Temperature unit: **Kelvin [K]**

Calculate SRI

How to use?

Input the solar reflectance and emittance values.

The surface temperatures and SRIs (at 3 wind speed conditions) are automatically displayed.

Calculation principle

The calculator follows ASTM E1980.

Try the calculator

Fulfil BCA daylight reflectance requirements with ease

Test methods for non-glass materials

- ASTM E903
- ASTM E971
- CIE 130

Test methods for glass materials

- ASTM E903
- NFRC 300

Sample types

All general façade and roof materials with flat surface: aluminium cladding, concrete, roof tile and glass.

Instrument

- PerkinElmer Lambda 950 spectrophotometer

Standard result set for non-glass materials

- Total daylight reflectance
- Diffuse daylight reflectance
- Specular daylight reflectance

Standard result set for glass materials

- Daylight reflectance

Glass materials are with specular reflection only. The concept of total/diffuse/specular reflection is not applicable to glasses.

Glasses with ceramic frit are considered non-glass materials.

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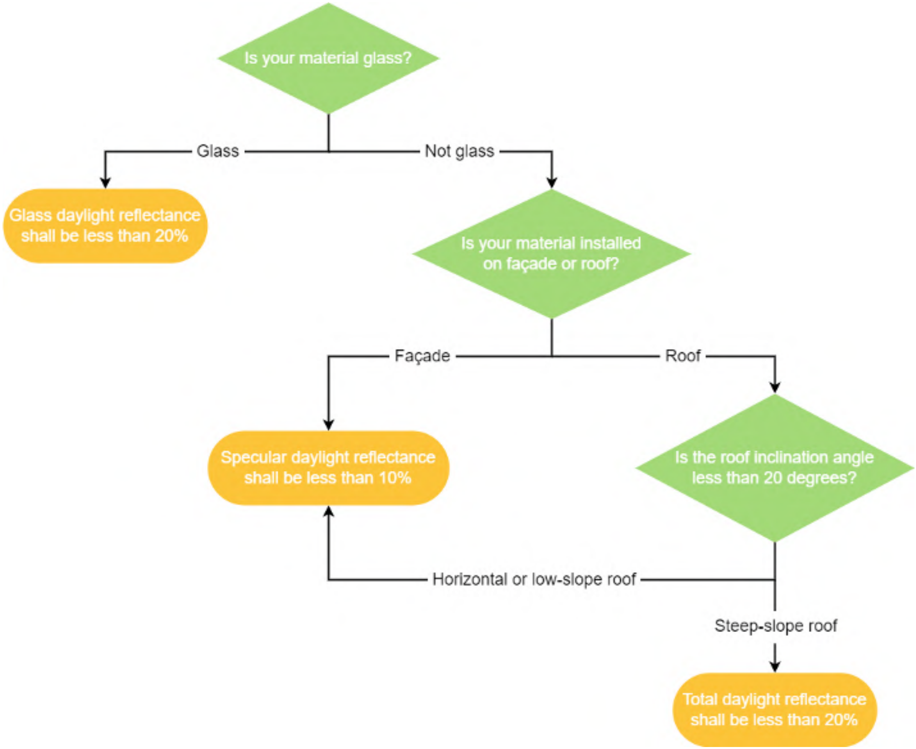
BCA daylight reflectance requirements

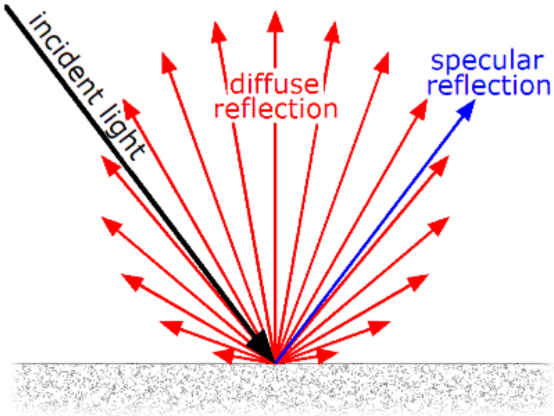
Use the flow chart below to check if your material can meet the BCA daylight reflectance requirements.



Is daylight reflectance correlated to colour & gloss?

Instruments for colour and gloss measurement are available in many companies. The relationship between daylight reflectance, colour and gloss is explained here.

What is daylight reflectance?



Daylight reflectance is the fraction of natural daylight reflected by a surface. It consists of:

- Specular daylight reflectance : the portion reflected in a mirror-like manner
- Diffuse daylight reflectance: the portion scattered in different directions
- Total daylight reflectance: the sum of specular and diffuse components

Daylight reflectance and colour

For colour measurement instruments with integrating spheres, the Y value in the Yxy colour space (with D65 illuminant, 10° observer) is close to the daylight reflectance results.

- The Y result in SCI (specular component included) mode is equivalent to the total daylight reflectance.
- The Y result in SCE (specular component excluded) mode is equivalent to the diffuse daylight reflectance.
- The difference between them is equivalent to the specular daylight reflectance.

Daylight reflectance and gloss

The gloss result is proportional to the specular daylight reflectance, but they are not equivalent.

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How is daylight reflectance tested in the lab?

Curious about the daylight reflectance testing procedures? The important concepts are explained here.

No simple handheld device

BCA requires the measurements to be performed according to the ASTM E903 method with 150 mm integrating sphere.

Most handheld devices cannot meet this requirement.

Instrument measured spectral reflectance

The instrument (UV/VIS/NIR spectrophotometer) measures the spectral reflectance in the visible light range (380 nm – 780 nm).

When the instrument is in the specular-component-included (SCI) mode, the total spectral reflectance is measured.

When the instrument is in the specular-component-excluded (SCE) mode, the diffuse spectral reflectance is measured.

The specular spectral reflectance is the difference between the above two.

Calculation of broadband results

The broadband results (total/diffuse/specular daylight reflectance) are calculated from the spectral results (total/diffuse/specular spectral reflectance), by weighted averaging, with the standard daylight spectrum and human vision sensitivity as the weights.

At OTM, a home-made software (DLR@OTM) is used for the calculations and it also generates test reports automatically.

How to meet BCA daylight reflectance requirements?

Some tips on meeting BCA daylight reflectance requirements are discussed here.

Less than 10% specular daylight reflectance

The less than 10% specular reflectance requirement is applicable to façades, horizontal and low-sloped roofs (less than 20 degrees of inclination).

Most materials can meet this requirement easily, with the following typical specular daylight reflectance:

- Rough surfaces (e.g. concrete and tile): close to 0% specular daylight reflectance
- Painted surfaces (e.g. PVDF coated aluminium plate): around 1 - 2%
- Glossy non-metal surfaces (e.g. polished granite): less than 5%
- Shiny metal surfaces (e.g. bare stainless steel): more than 10% possible

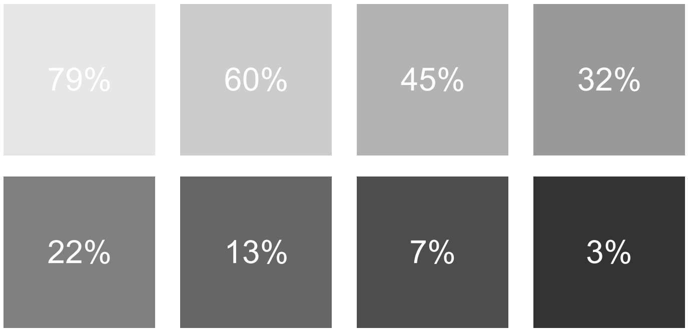
Due to the strong specular daylight reflection, shiny metal surfaces should be used with caution.

Less than 20% total daylight reflectance

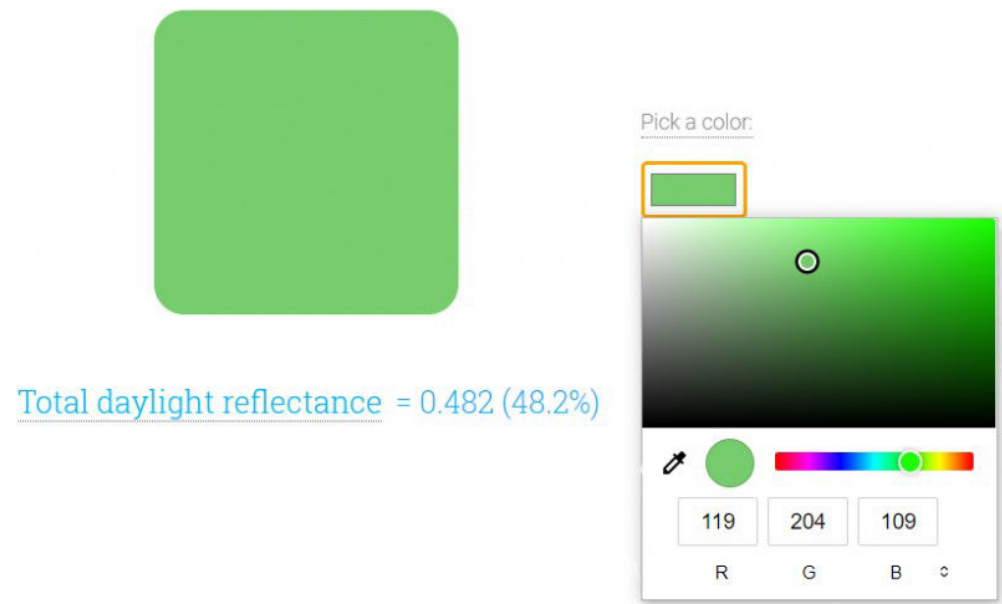
The less than 20% total daylight reflectance requirement is applicable to steep-sloped roofs only (more than 20 degrees of inclination).

The total daylight reflectance is correlated to surface colour. To lower the total daylight reflectance, dark colours shall be used. It is impossible to lower the total daylight reflectance without colour change.

A total daylight reflectance calculator is available on our website. Shown below are the calculated total daylight reflectances of typical grey colours.



Online total daylight reflectance calculator



How to use?

Pick an colour with the colour picking tool.

The total daylight reflectance of the colour is automatically displayed.

Calculation principle

The calculator essentially calculate the luminance value (equivalent to the total daylight reflectance) of the screen displayed sRGB colour.

Try the calculator

Thermal conductivity of solid, powder, liquid & paste

Unlike other tests, there are different thermal conductivity test methods for different sample types.

For thick solid samples with two flat surfaces

- Test method: ASTM C518
  - Up to 2.5 W/(m·K)
  - Mean temperature: -15 °C to 65 °C
  - With external thermocouple kit for materials with large thermal conductivity
- Sample types: insulation materials, concrete panels, composite panels
- Instrument: Thermtest HFM100 heat flow meter

For homogeneous solid, powder, paste and liquid samples

- Test method: ASTM C1113, D5930 or D7896 with manufacturer's instructions
  - Up to 10 W/(m·K)
  - At room temperature only
- Sample types: general solid, powder, paste and liquid samples
- Instrument: Xiatech TC3000E hot wire thermal conductivity meter

Standard result set

- Thermal conductivity

Upon request, the results of thermal resistance and U-value can be calculated and included.

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Two instruments, more capabilities

Feature comparison

Instrument	Heat flow meter	Hot wire thermal conductivity meter
Method	ASTM C518	ASTM C1113, D5930 or D7896 with manufacturer’s instructions
Measurement principle	Steady state measurement ● Typical measurement time: 1 h ● Calibration required	Transient measurement ● Typical measurement time: 1 min ● Calibration not required
Sample type	Both homogeneous materials and layer-by-layer composite materials, solid only	Homogeneous materials only; solid powder, paste and liquid
Solid sample size	Typically: 300 mm x 300 mm, with maximum 100 mm thickness Both sides shall be flat and parallel.	For solid samples, typically 50 mm x 50 mm x 5 mm Two samples are needed, at least one side shall be flat.

Thermal conductivity, thermal resistance & U-value

They are different properties of material insulation performance. The differences are explained here.

Thermal conductivity

Thermal conductivity represents the ability of a material to conduct heat.

Its unit is W/(m·K) and it is independent of material thickness. Typically, thermal conductivity is used for homogeneous materials only.

Thermal resistance

Thermal resistance is a measure of a material's ability to resist heat flow. It is calculated from thickness and thermal conductivity. It is dependent on thickness and its unit is $(m^2K)/W$.

$$\text{Thermal resistance } [(m^2K)/W] = \frac{\text{Thickness [m]}}{\text{Thermal conductivity } [W/(m \cdot K)]}$$

For a typical wall system consisting of multiple wall layers, the total thermal resistance is simply the sum of the individual layers' thermal resistances.

Typically, thermal resistance is used for materials with known thickness or multi-layer systems.

U-value

$$U\ [W/(m^2K)] = \frac{1}{\text{Sum of thermal resistance of all solid \& air layers } [(m^2K)/W]}$$

U-value is the reciprocal of the sum of the thermal resistances of all solid and air layers in a wall or roof system. Its unit is $W/(m^2K)$. U-value is also known as thermal transmittance.

Typically, U-value is used for a complete wall or roof system. The U-value concept is not applicable when considering only a few layers of a wall or roof.

How is thermal conductivity tested in the laboratory?

Curious about the thermal conductivity testing procedures? The important concepts are explained here.

With heat flow meter

A steady state temperature difference is maintained across the two sides of a sample (e.g. 20°C). The heat flux through the sample is measured with heat flux transducers. The thermal conductivity is calculated from the heat flux, temperature difference and sample thickness.

As it is challenging to measure heat flux accurately, a comparison method is used. A reference material with known thermal conductivity is measured to get a correction factor. The correction factor is used to correct the sample measurement result.

Calibration is always required for the heat flow meter method.

With hot wire thermal conductivity meter

The hot wire probe is sandwiched between two pieces of solid samples and it is heated up by a short pulse of current. The heat from the hot wire is dissipated to the sample. The dissipation rate is correlated to the material thermal conductivity.

The temperature variation history is analysed to get the thermal conductivity.

For solid samples, it is important to maintain good thermal contact between the sample surfaces and the hot wire probe.

Calibration is not required for the hot wire method. The method is fast, as it is not required to attain a steady state.

Sample thickness in ASTM C518 testing

In thermal conductivity testing according to ASTM C518, a test sample is clamped between two plates and compressed.

Some customers are concerned if thermal conductivity results are affected by the compression.

3 thicknesses

Conceptually, there are 3 thicknesses of a sample:

- Uncompressed thickness: the thickness of a sample in the free state without compression;
- Installation thickness: the thickness of a sample in the intended installation.
- Testing thickness: the thickness of a sample during thermal conductivity testing.

Testing thickness & thermal conductivity

When a sample is compressed to a smaller thickness, its density increases and the increased density affects the thermal conductivity.

A sensitivity study was performed by OTM in 2020. In this study, when the sample was compressed by 10%, the result variation was less than 1.7%.

Thermal conductivity result is not sensitive to testing thickness variation. If the compression is small (e.g. less than 5%), the result variation is negligible for general engineering applications.

Testing thickness of soft samples

For soft samples, the customer should declare the installation thickness, if it is significantly different from the uncompressed thickness. Otherwise, the installation thickness is assumed the same as the uncompressed thickness.

In both scenarios, the sample is compressed slightly to the testing thickness (within 5% variation from the installation thickness) for good thermal contact.

Thermal resistance not reported

By default, the thermal resistance of a sample is not reported, as the instrument measured thermal resistance is smaller due to sample compression.

Online ETTV U-value calculator

Number of material layers: 4 Wall/Roof type: Vertical Wall

Material	Source	Name	Color	Thermal conductivity [W/(m·K)]	Thickness [mm]		Thermal resistance [(m^{2}K)/W]
1	Library	Metal: aluminium alloy		211	2	Edit	0.000
2	Library	Plaster: perlite		0.115	10	Edit	0.087
3	Library	Brick, dry (covered by plaster/tile)		0.807	80	Edit	0.099
4	Library	Concrete (2400 kg/m^3)		1.442	100	Edit	0.069
					Outside surface film resistance:		0.044
		Inside surface type: High emissivity			Inside surface film resistance:		0.120

R-value = 0.255 (m^{2}K)/W U-value = 2.38 W/(m^{2}K)

Calculate U-value

How to use?

- Select the number of layers
- Select the wall/roof type
- Set the properties of each layer
- Select the inside surface type

The wall/roof U-value is calculated and updated immediately when there are input changes.

Calculation principle

The calculator follows BCA Guidelines on Envelope Thermal Transfer Value for Buildings.

Try the calculator

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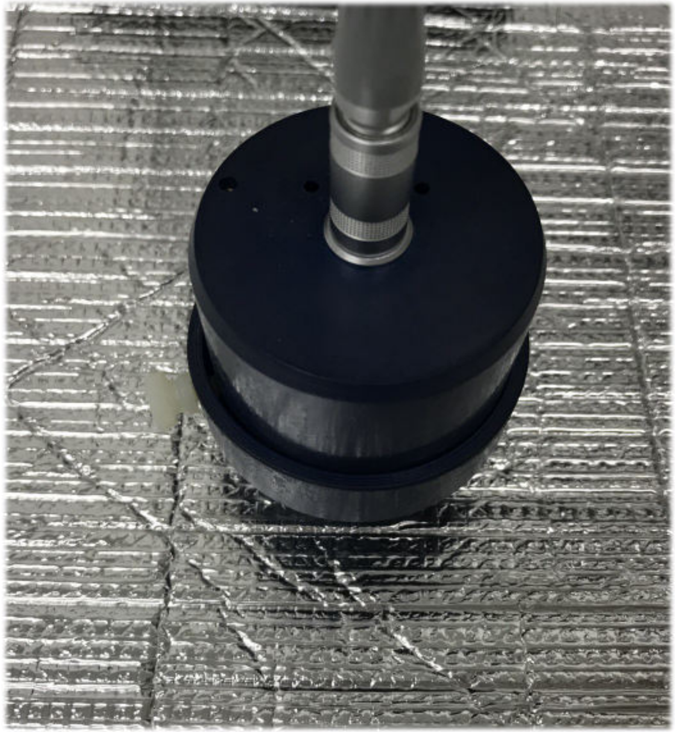
Material emittance / emissivity testing

The terms emittance and emissivity are often used interchangeably. Emittance is the standard term used in the standards.



Test method

- ASTM C1371 (with TN 11-2)

Sample types

All general materials with flat surface, excluding glasses.

For glass materials, the NFRC 301 method is recommended.

Instrument

- Devices and Services AE1 RD1 emissometer

Standard result set

- Emittance

Why is emittance important to insulation performance?

Emittance is an important property of material insulation performance. The basic concepts are explained here.

Three heat transfer modes

Heat is transferred through three modes: conduction, convection, and radiation.

To reduce conduction, materials with low thermal conductivity should be used.

To reduce convection, air cavities of appropriate thickness should be used.

To reduce radiation, materials with low emittance should be used.

Emittance is related to the radiative heat transfer.

Emittance & radiative heat transfer

All surfaces emit infrared radiation. They also reflect and absorb infrared radiation emitted by the surrounding surfaces. The emittance of a material determines how much infrared heat it emits, reflects and absorbs.

The emittance of most natural surfaces is around 0.9. For a surface with 0.9 of emittance, the infrared heat emitted by it is 90% of that by a perfect black body. It also absorbs 90% of incident infrared heat and only reflects 10% back.

For some low-emittance surfaces, the emittance is around 0.05. For a surface with 0.05 of emittance, the infrared heat emitted by it is only 5% of that by a perfect black body. It also only absorbs 5% of incident infrared heat and reflects 95% back.

Low-emittance surfaces effectively reduce radiative heat transfer and enhance insulation performance. They are typically applied on the indoor side topmost layer of a wall/roof or on the surface facing an air cavity to maximize their insulating effect.

Laboratory or on-site colour difference testing

Test methods

There are numerous test methods for colour & colour difference testing. We can support many of them. Typically:

- ASTM E1331
- ASTM D2244

Sample types

All general materials; it is possible to measure samples in powder or granular form

Instruments

- PerkinElmer Lambda 950 spectrophotometer
- Konica Minolta CM-2500d spectrophotometer

Standard result set

Depending on the test methods used. Typically:

- Color in the CIELAB colour space
- Colour difference in the CIELAB colour space

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Can colour results be used for colour matching?

Although colours can be measured instrumentally, it is recommended to use physical colour standards for colour transfer. The reasons are explained below.

Absolute vs. relative colour measurement

The CIELAB colour space is the most commonly used system in the building and construction sector.

- Absolute Colour Measurement: the measured L*a*b* values represent the colour in an absolute sense, as they are not compared to any reference.
- Relative Colour Measurement: the ΔE*ab value represents the colour difference between a test sample and a reference colour.

Higher accuracy in relative colour measurement

When measuring colour differences (ΔE*ab), both the test and reference colours are measured using the same instrument. Since many uncertainty sources cancel out, the accuracy is very high (typically better than ±0.05).

Lower accuracy in absolute colour measurement

In absolute colour measurements (L*a*b* values), the test colour is not compared to a reference, meaning more uncertainty sources affect the measurement. As a result, the accuracy is lower (typically ±1.5).

Use physical colour standards for colour matching

When multiple instruments are involved in colour matching, it is best to use a physical colour standard to ensure consistency.

By conducting multiple relative colour measurements against the same physical standard, overall uncertainty is significantly reduced compared to using different instruments for independent absolute colour measurements.

Luminance contrast & luminous reflectance testing

Test methods

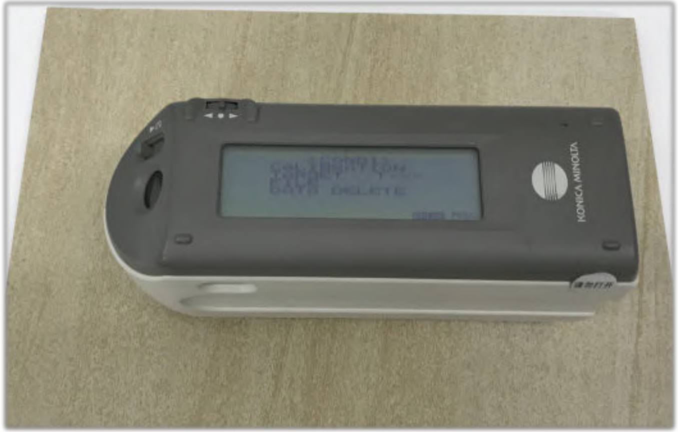
- AS 1428.1
- AS/NZS 1428.4.1

Sample types

- All general materials: flooring tiles, pavement materials, Tactile Ground Surface Indicators (TGSIs)
- Always two samples in a pair

Instruments

- Konica Minolta CM-2500d spectrophotometer



Standard result set

- Luminous reflectance
- Luminance contrast

Example applications

- To determine if there is sufficient luminance contrast between adjacent building elements for the safety of building users

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What are luminous reflectance & luminance contrast?

Sufficient luminance contrast is crucial in the selection of Tactile Ground Surface Indicators (TGSIs). Luminance contrast is determined by comparing the luminous reflectance of two surfaces.

The basic concepts of these properties are explained below.

Luminous reflectance

Luminous reflectance refers to a surface's ability to reflect visible light. It is also known as visible light reflectance or daylight reflectance.

- A perfect white surface has a luminous reflectance of 100 (100% reflectance).
- A perfect black surface has a luminous reflectance of 0 (0% reflectance).

Luminous reflectance can be measured by a portable or benchtop spectrophotometer.

Luminance contrast

Luminance contrast quantifies the difference in luminous reflectance between two surfaces.

It is calculated using the following equation:

$$\text{Luminance contrast} = \frac{125 \times (LR_1 - LR_2)}{LR_1 + LR_2 + 25}$$

where, LR_1 and LR_2 are the luminous reflectances of surface 1 and surface 2, respectively

Luminance contrast is a calculated quantity and it is always in terms of two surfaces in a pair.

Luminance contrast is different from colour contrast. Surface pairs with large colour contrast may still be with small luminance contrast.

How to prepare samples for luminance contrast test?

Luminance contrast is always in terms of two samples in a pair. The sample preparation methods of 3 typical scenarios are explained here.

Side-by-side flat surfaces

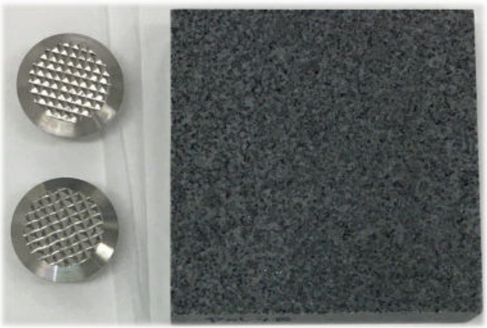
For this scenario, two flat-panel samples are submitted.

A flat surface with integrated TGSI studs

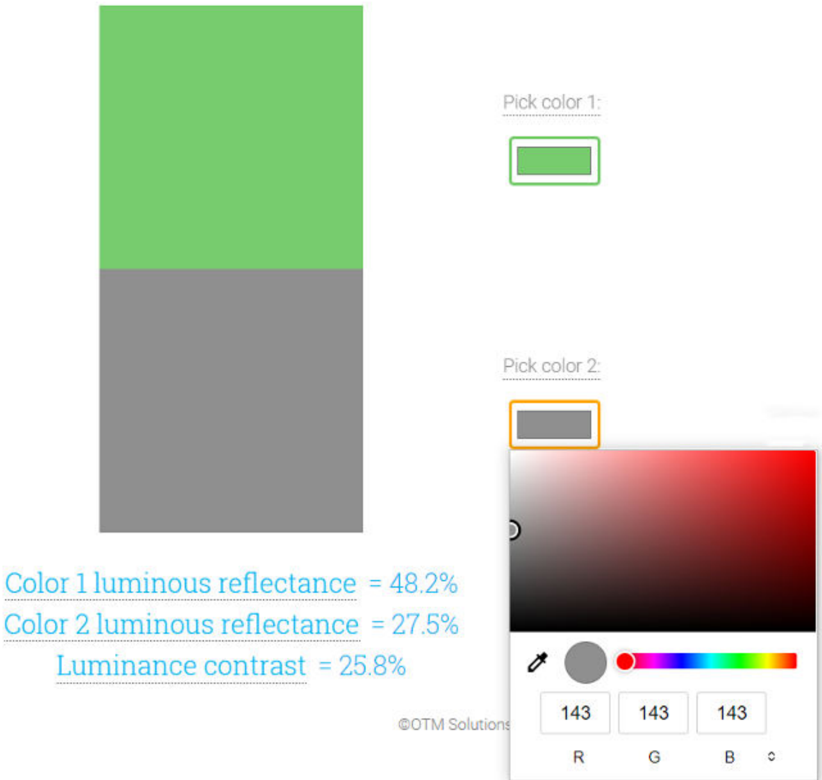
For this scenario, an integrated sample is submitted.

A flat surface with loose TGSI studs

For this scenario, a flat surface sample and a few TGSI studs are submitted separately.



Online luminance contrast calculator



How to use?

Pick two colours with the colour picking tools.

The luminous reflectances of the two colours and the luminance contrast between them are displayed.

Calculation principle

The calculator essentially calculate the luminance values (equivalent to the luminous reflectances) of the screen displayed sRGB colours.

Try the calculator

On-site testing & monitoring

Standard on-site testing methods

- Glass colour uniformity: ASTM C1376
- Glass roller wave: ASTM C1651
- Glass edge lift: EN 1863-1
- Wall U-value: ISO 9869 -1

Custom methods for on-site monitoring

For custom on-site monitoring, proposals will be prepared based on the project requirements. We can monitor the following for your decision making:

- Weather: wind speed/direction, solar irradiance, air temperature/humidity
- Façade performance: surface temperature, heat flux, transmitted solar irradiance & visible light
- Thermal comfort: indoor air speed, temperature & humidity, globe temperature

Instruments

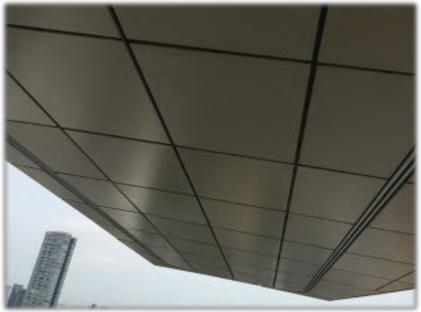
We have a wide collection of instruments for on-site testing & monitoring. New instruments can be added when there are special needs.

Reference projects

A number of on-site testing & monitoring projects have been performed by us:

- Glass colour uniformity measurements
- Façade cladding colour matching
- Thermochromic glass performance monitoring in 4 HDB flats
- Low-e glass performance comparison in 4 EC flats
- Thermal micro-climate monitoring in 5 sites of a commercial building
- Frame thermal performance monitoring at the BCA Skylab
- Frame thermal performance monitoring at a new commercial building

Reference projects



Cladding colour uniformity

Glass colour uniformity

Monitoring at BCA Skylab

Thermochromic glass monitoring

Low-e glass comparison

Micro-climate monitoring

Choose OTM. Work with the expert in Optical & Thermal Measurement solutions.

On-site glass performance monitoring system

An on-site glass optical & thermal performance monitoring system was customized by OTM.

Outdoor measurement system

On the outdoor side, the following quantities were measured:

- Incident daylight illuminance [lux]
- Incident solar irradiance [W/m^2]
- Air temperature [°C]

Indoor measurement system

On the indoor side, the following quantities were measured:

- Transmitted daylight illuminance [lux]
- Transmitted solar irradiance [W/m^2]
- Air temperature and glass surface temperature [°C]

Wireless data logging system

The data logging system is wireless and battery powered. Hole drilling and AC power supply are not required.

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