APPLICATION NOTE

Materials Characterization

Material Characterization Analyzers for Building Glass Measurements

Introduction

Building or Architectural glass products control the amount of light and heat entering a building, offering safety and security, insulation against noise, providing privacy, comfort and decoration. Building glass products can play a vital role in improving energy efficiency and reducing CO_2 emissions in buildings which account for as much as 50 percent of the energy consumed in developed countries. Choosing the right materials used for buildings can significantly help improve energy efficiency and reduce costs.

Glass optical and thermal performances are evaluated based on a set of properties such as visible transmittance, visible reflectance, solar transmittance, solar reflectance, UV transmittance, U-value, shading coefficient (SC) and solar heat gain coefficient (SHGC).

Common Building Glass Norms Used Are:

- ISO 9050:2003
- JIS R 3106
- EN673
- Haze Standards
- EN 410
- NFRC Standards
- CIE

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Instrumentation for Building Glass Measurements

To measure these parameters a set of inputs from several instruments are required for their calculation. The important instruments are:

- UV/Vis/NIR Spectrometer with an integrating sphere for measurements of visible, solar spectral transmittance and reflectance at normal incidence.
- Fourier-Transform Infra-Red (FT-IR) spectrometer with accessory for measurement of emittance values. Accessories on both instruments can make measurements on large glass panes.
- Thermal conductivity is also required and can be measured by guarded hot plate or hot disc measuring principle.

PerkinElmer has the following methods on UVWinlab Software.

Calculations can be integrated into UVWinlab software methods to enable quick and easy measurement.

1. Measurement of Glass and Architectural Materials to EN410
2. ASTM G173 Total Solar Reflectance Method

PerkinElmer LAMBDA™ 1050+ UV/Vis/NIR Spectrometer

PerkinElmer Frontier Emissivity System

PerkinElmer Spectrum 3™ FT-IR

PerkinElmer Architectural Glass Module can perform many of these calculations without needing to export the data to a third party application.

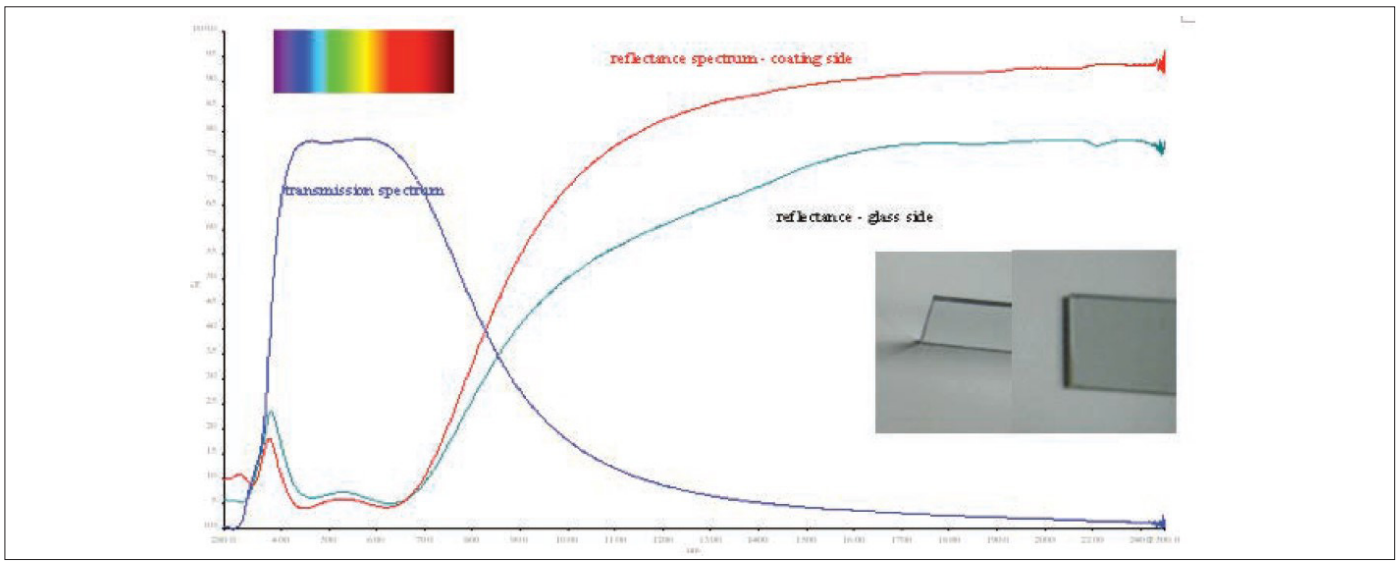


Figure 1. Spectra of low e-glass in transmission and reflectance of both glass and coating side.

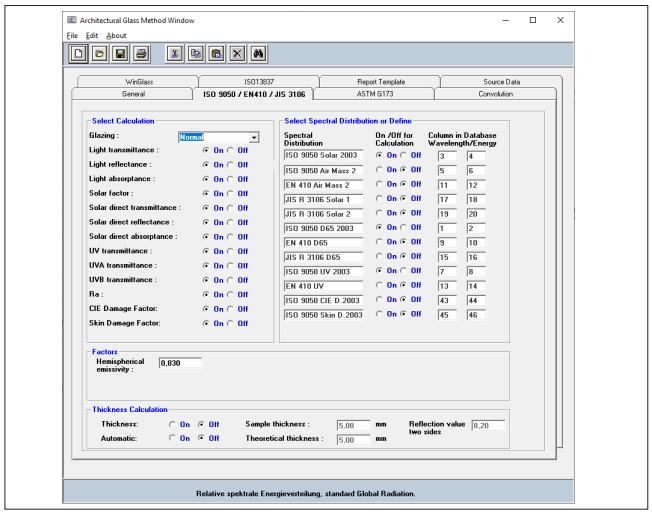


Figure 2. Architectural glass method window.

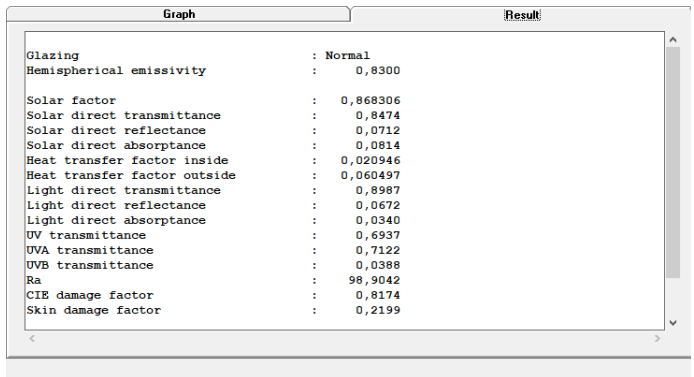


Figure 3. Results window for low e-glass calculations.

To obtain more parameters, popular software used in the glass industry is the LBNL Optics and Windows programs to analyze the glazing under selected environmental conditions. The analysis require UV spectral data, IR spectral data, thermal conductivity value and thickness of the samples collected and are combined together to perform these calculations. PerkinElmer Spectrum 10 software, used on the Spectrum 3 FT-IRs, can be loaded with Macros and together with a highly efficient input software template, convert the IR and UV/Vis/NIR data files together with addition of thermal conductivity and thickness values, allow the combined data to be input to perform calculations on these software. Highly efficient input of data translates into higher productivity.

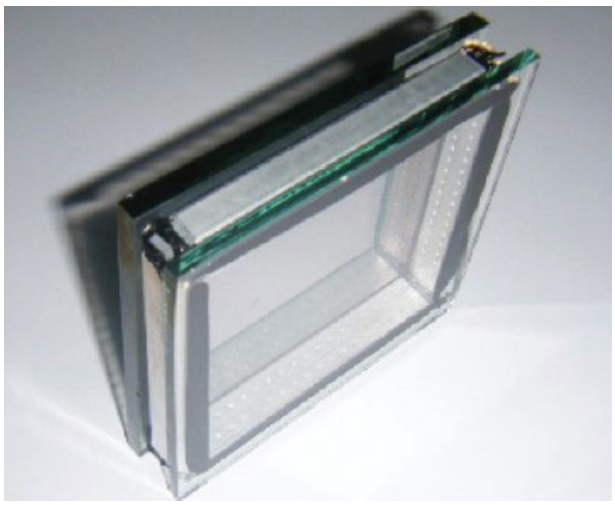
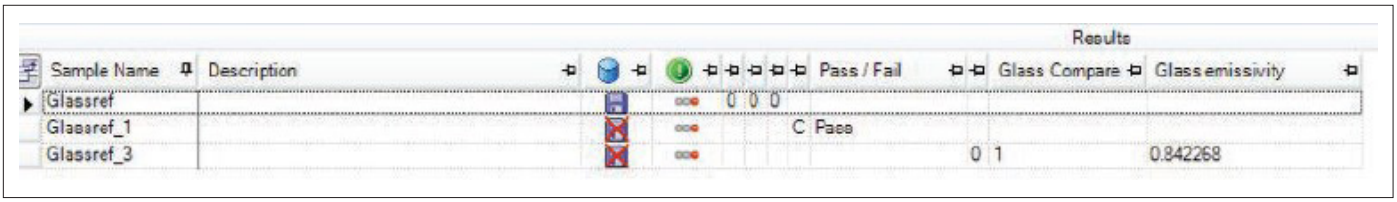


Figure 3. Picture of Double glazing insulating glass unit.

Double-glazing are double glass window panes separated by a air or other gas filled space to reduce heat transfer across a part of the building envelope. The optical calculation of a double pane can be performed easily on the PerkinElmer Architectural Glass Module. LBNL Windows can provide U-value and SHGC thermal properties values.

Figure 4. Picture of a construction site where the Spectrum 3 can be used to determine the correct side of single coated glass to be installed.

A double glazing unit will show a substantial lowering of the U-value and to a smaller extent the SHGC value. Double glazing unit is especially effective to reduce heat transfer and helps to keep heating or cooling bills of the building low. Coated glass is sometimes installed with the wrong side in buildings as it is difficult for inexperienced workmen to accurately determine the coated side just by looking at it. The Spectrum 3 FT-IR with accessory for emissivity measurements from PerkinElmer can be used to determine the emissivity of the sides of the coated glass to be installed or even on installed glass in buildings. Innovative technology (OpticsGuard™) empowers the usage in a non-environmentally controlled location without the worry of humidity damaging the instrument. Measured glass can be any size and at any spot as long as it can be reached with the accessory. The measurement is fast with a Macro to calculate the emissivity value quickly and in the field it allows speedy decisions to be made. The FT-IR can be reconfigured with other accessories such as ATR to examine polymers, paints etc. with a wide selection of libraries to identify materials.



		Results			
Sample Name	Description	Pass / Fail	Glass Compare	Glass emissivity	
Glassref		0 0 0			
Glassref_1		C Pass			
Glassref_3			0 1	0.842268	

Figure 5. Emissivity calculation from Macro.

Upward Looking 270 mm Integrating Sphere Accessory

The use of light-diffusing samples such as patterned cover glasses used in solar cells and textured/coated glasses used in buildings and greenhouses is increasing. The ability to accurately measure the transmission and reflection properties of these materials is a key requirement in the development and manufacture of high efficiency solar cells and light-diffusing glazing.

Integrating spheres are widely used for the reflectance and transmittance of light-diffusing samples However, the UL270 enables light-diffusing materials to be measured more reliably and accurately than ever before.

UL270 Accessory

The UL270 is an upward-looking 270 mm dual-compartment integrating sphere accessory for the PerkinElmer high-performance LAMBDA 1050+ UV/Vis/NIR spectrophotometers (Figure 6).

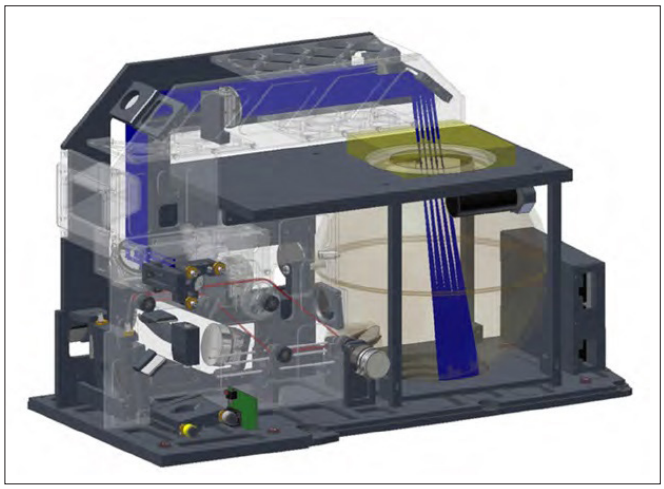


Figure 6. UL270 integrating sphere accessory in the LAMBDA 1050+ Spectrophotometer.

The Specifications of UL270

- Utilize photomultiplier in the UVVis and InGaAs detectors to cover 250 - 2500 nm range
- Port sizes of 100 mm and 50 mm
- Measures T and R from the same spot
- Ideal for sheet glass applications
- 8° incidence angle (both T and R)
- Solution for patterned/ frosted glass as used in solar applications
- Baffles to prevent detector from seeing transmission and reflection ports
- Measurement of samples up to 450 mm x 250 mm x 50 mm using standard cover (larger samples are possible using customised light shielding)
- Accuracy less than 0.2%T and 0.5%R for a specular sample

When a diffuse sample is illuminated by the beam of the spectrometer, the transmitted light exits the sample over an area much larger than the beam diameter due to internal scattering. With the standard port sizes of ca. 20 mm, much of the transmitted radiation falls outside the port area and is lost. So for accurate transmittance measurements, a sphere with a transmission port as large as 100 mm is required to capture all the transmitted light. The UL270 enables light-diffusing materials to be measured more reliably and accurately than ever before.

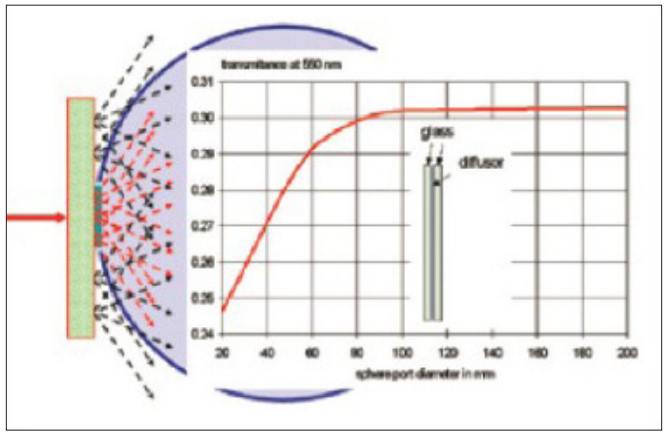


Figure 7. Schematic showing why there is a need for large port diameter when measuring light-diffusing materials.

Representative Sampling

Many light-diffusing glasses have a large pattern and consequently demand a large beam size to ensure representative sampling of the glass. Figure 8 below shows a picture of a small ceramic frit and a textured glass that can be analyzed. The UL270 uses a 20 mm circular beam diameter unlike smaller spheres that typically use a 8 x 3 mm rectangular beam. The 20 mm beam diameter provides ca. 10 times the surface area ensuring a more representative sampling of the glass pattern.

Ceramic Frit Glass | Textured Glazing

Figure 8. Small ceramic frit and a textured glass can be analyzed by UL270.

Measurement Flexibility

The UL270 can switch from transmittance mode to measure the diffuse reflectance without moving the sample. This permits unattended data collection of both modes of measurement, significantly improving productivity and sample throughput.

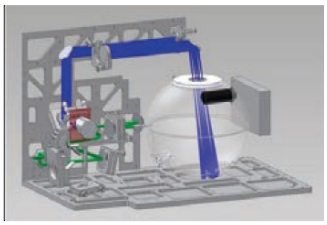


Figure 9. Transmittance mode.

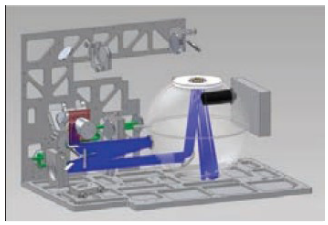


Figure 10. Reflectance mode.

The ability to measure both %T and %R on the same sample allows calculation of glass properties such the absorption loss (%A = 100 - %R - %T). Reflection measurements also allow the optical characterization of coatings, for example anti-reflection coatings, on the glass such as film thickness as well as properties of individual layers in multi-layer coatings. The large horizontal sample area permits the analysis of samples as large as 400 mm x 250 mm x 50 mm using the standard covers, and larger samples with customized covers.

Conclusion

PerkinElmer offers a suite of instruments with accessories and software specially tailored for building glass analysis. The UV/Vis/NIR Spectrometer, Fourier-Transform Infra-Red (FT-IR) and Thermal Conductivity instruments are required for measurement of optical solar and thermal properties of glass. Emittance measurements on both Spectrum 3 and LAMBDA 1050+ instruments can make measurements on large glass panes without the need for cutting into small pieces. Calculations can be performed on integrated methods using PerkinElmer UVWinlab software, PerkinElmer Architectural Glass Module and several other third party applications software. Spectrum 10 FT-IR software with loaded Macros and a highly efficient input software template combines IR, UV/Vis/NIR, thermal conductivity and thickness values together for input into LBNL Optics and Windows programs to perform calculations on optical, solar, thermal and color properties. LBNL Windows can provide U-value and SHGC thermal properties values. Data input is highly efficient translating into higher productivity. PerkinElmer offers the Upward Looking 270 mm Integrating Sphere Accessory to accurately measure the transmission and reflection properties of light-diffusing samples such as patterned cover glasses used in solar cells and textured, fritted and coated glasses used in buildings and greenhouses.

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