Instructions for participants in the 2011 LBNL inter-laboratory comparison part 2: *Measurement of optical properties of diffuse and light-redirecting materials*

Introduction

Laboratories that submit data to the International Glazings Database (IGDB) have to participate in an inter-laboratory comparison (ILC) every four years. This a procedure that allow both contributors and database maintainers to confirm that the measurement capabilities of the laboratories are of high quality. In 2011 a specular ILC was carried out and with that set of samples diffuse samples were also provided for.

The IGDB is limited to specular samples and Lawrence Berkeley National Laboratory (LBNL) is working on producing a database for non-specular samples called the Complex Glazing Database (CGDB). The five samples to be measured in this part of the ILC are all examples of what could go into the database.

Previous ILCs of light-scattering samples have indicated that the agreement is not as good as for specular sampels and one of the goals for this ILC is to quantify this variation.

These instructions contain some negative instructions, i.e. “do not do”, which was based on how the part one instructions were interpreted.

The box

Warning: Note that the glass edges might be sharp and cause cuts. Especially if any of your samples have broken. Take necessary precautions to avoid injury.

Each box is labeled on the outside with its number, e.g. Box 14. All reports will use this number as identifier rather than the individual laboratories.

The 2011 complex ILC consists of 5 samples:

6. Viracon V1086 simulated sandblasted on 6 mm Starphire
7. Viracon V175 white on 6 mm Starphire
8. Solutia diffuse interlayer on 3 mm Starphire
9. 3M light-redirecting applied film on 6 mm Starphire
10. PVC over PET shadescreen from Ferrari Textiles Corporation Soltis 93 - 3002 sand

Each sample have a sticker on the back side with the box number and sample number, e.g. 14-7 would be the identifier on the white fritted glass in box 14. The numbering of the samples start at 6 to avoid mixing them with the specular samples.

Cleaning the samples

The samples have been handled with care but that is no guarantee that the samples are clean. Use your standard cleaning procedure if you have one. Otherwise recommended practices to consider are soap and water or ethanol are typically good solvents. Using a soft cloth soaked with soap water could be used to mechanically remove dirt. Rinsing with preferably deionized water and drying with dry air or nitrogen are other good practices. Please describe your cleaning procedure in the comments section of your instrument description, see below.

Measurement instructions

UV/Vis/NIR

The UV/Vis/NIR range is defined as 300-2500 nm. The data interval must be equal to, or lower than the values specified in Table 1.

Range (nm)	Maximum interval (nm)
300-400	5
400-1000	10
1000-2500	50

Table 1: N.B. It is allowed to use a constant interval of 5 nm.

A different number of properties has to be measured depending on which sample is being studied, this is detailed in Table 2. The sample property is named using three letters:
Letter 1 can be R or T signifying reflectance or transmittance
Letter 2 can be T or D signifying total (direct-hemispherical) or diffuse only
Letter 3 can be F or B signifying front and back

The back of the sample is defined by the untreated glass side, i.e. for sample 6 and 7 the fritted surface is the front side, and for sample 9 the surface with the applied film is the front surface. Samples 8 and 10 are considered to have identical front and back properties. Table 2 also has 2 columns for IR measurements which are explained in the next section.

Sample#	λ	TTF	TDF	RTF	RDF	TTB	TDB	RTB	RDB	EF	TIR
6	x	x	x	x	x	x	x	x	x	x	
7	x	x	x	x	x	x	x	x	x	x	
8	x	x	x	x	x						
9	x	x		x		x		x		x	
10	x	x	x	x	x					x	x

Table 2: Properties to be measured and reported for each sample

Orientation of sample 9

Sample 9 is highly asymmetric and a normal integrating sphere will give different results depending on how you orient the sample. The incident light will be distributed unevenly in a plane.The film is marked in one corner to provide orientation information.

Without any direction the results will vary significantly, but it is not simple to know how to orient it to get the most accurate result. For this ILC we will try to orient it so that the direct interaction between the transmitted/reflected light and sphere features, i.e. ports and baffles, is minimal.

Depending on the design of the sphere used this will vary, by illuminating the sample with white light and looking into the sphere it is possible to see where light is being initially distributed in the sphere.

For the 150 mm Labsphere sphere that is commonly used with Perkin-Elmer instruments one reasonable way to position the sample was with the marked corner up.

If your sphere is of a different design you are recommended to adapt and position the sample so that similar conditions are met (minimize interaction with sphere features). Feel free to discuss this matter with me.

N.B. there is no guarantee that this method is the most accurate, but it is an attempt to make measurements as comparable as possible.

Emittance

Important: In phase one several participants only provided emissivity values rather than measured spectral IR reflectance values. That was incorrect, please provide measured data.

The emittance of clear glass was studied in detail in phase 1 so we are only looking at other surfaces for this ILC. The IR range is defined as 5-25 μm with a data interval of at least 1 μm, data at longer wavelengths is appreciated. Samples 6-9 are opaque in this region and only front reflectance is to be measured. Sample 10 is not opaque in IR so IR transmittance should be measured as well as front reflectance.

If you have access to an emissometer we are interested in results using such instruments as well. Use of emissometer is not yet an accepted procedure for IGDB submission, but we want to collect data to compare results from such instruments with FTIR and dispersive

instruments.

Measurement corrections

Measurement of light scattering samples using an integrating sphere is not an absolute method and the reflectance of your reference is significant as well as your sphere geometry in combination with the scattering distribution of the sample.

Please do not manipulate data before submitting. If your instrument does any manipulation of the measured data with respect to sample diffuseness, reference reflectance, or something else, please provide documentation describing what it does.

Also please provide documentation if your instrument requires specific corrections that are not described by general integrating sphere theory.

Reporting instructions

Instrument information

There is no need to update this if you have not changed any of your instruments or settings. An example text file box0info.txt will be provided, please fill that out with your information to the best of your capabilities. This is also where you would describe your cleaning procedure. When saving the file you are supposed to replace the 0 with the box number you have received.

Sample data

For this ILC there will be a different format that is simpler than the IGDB format.
As in part one all data should be saved as text files.
Each sample should be stored in its own file, e.g. **`box14_7.txt`**
All results will have the nine columns corresponding to:

λ, TTF, TDF, RTF, RDF, TTB, TDB, RTB, RDB

Please do not include text headers or any other information not asked for, only nine columns of numbers separated by space(s), tab(s), and/or comma(s). There is no need to round the answer to reduce the number of significant digits provided from your instrument.
For properties not measured you have to fill the matrix with zeros.
The full wavelength range from 300 nm to 25000 nm should be stored in the same file.
IR reflectance data should be recorded in the **RTF** column and the IR transmittance of sample 10 should be recorded in the **TTF** column.

Reference data

If you have calibration data for the diffuse reference you use it should be provided as a text file with one column for wavelength and one for reflectance. The please name this file **`box#_reference.txt`**.

Submission checklist

1. Five text files, one for each sample, containing 9 columns of data measured with properties in order: **λ, TTF, TDF, RTF, RDF, TTB, TDB, RTB, RDB,** properties not measured in accordance with Table 2 should be reported with zeros.Your submission should contain 5 text files. If you have, e.g., box nr 5 you shall submit box5_6.txt, box5_7.txt,..., box5_10.txt (N.B. there are no blank spaces or dashes in these filenames).
2. Optical properties of reference sample used, if available. If not available and you are using a Spectralon sample please estimate the age of that sample. The file name of this data should be box#_reference.txt.
3. If changed since part one, and updated box#info.txt file. If you used a specular reference for part you will have to update it to mark what kind of diffuse reference you are using.
4. Documentation of any corrections performed by yourself or the instrument, i.e. multiplication with diffuse reference reflectance.
5. If you use multiple instruments to characterize the same box, add 100 to your box number for the second instrument, 200 for the third etc.

The files should be emailed to jcjonsson@lbl.gov.

Goal

The goal of the ILC is to quantify the variation of measurements of diffuse and light redirecting products using the same equipment that is used for measuring specular glazings.

Questions

For any questions please contact jcjonsson@lbl.gov or igdb@lbl.gov.

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